STRATIGRAPHY OF LOWER MISSISSIPPIAN ROCKS IN SOUTHWESTERN MISSOURI

by

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STRATIGRAPHY OF LOWER MISSISSIPPIAN
ROCKS IN SOUTHWESTERN MISSOURI

By Charles Philip Kaiser

INTRODUCTION
Scope of Study

General confusion, based largely on lack of specific detailed information, has existed for some time with regard to Mississippian stratigraphy in southwestern Missouri. Such reference as has been made to the geology of Mississippian rocks in this portion of Missouri of recent years has been largely of limited scope and with reference to small areas. Accordingly it seemed logical to attempt a comprehensive examination of the entire area. Particularly it seemed desirable since Mississippian rocks dip westward off the Ozark flanks under the oil producing areas of the Mid-Continent area. It was hoped that detailed knowledge of the Mississippian rocks in the area of outcrop would help much in solving the complex problems involving these rocks in the subsurface to the west and southwest.

Considerable lack of agreement with regard to the inter-relationships of Kinderhook formations in southwestern Missouri has been much in evidence in publications in recent years. The major point at which opinion seemed to diverge was over the relationships of the Chouteau-Sedalia sequence in the north to the Compton-Northview sequence in the south. Opinion differed also as to the relative age of the Sedalia formation and even to the question as to whether the Sedalia should be
recognized as a valid formation. In view of this apparent lack of agreement, detailed studies of the Kinderhook sections appeared desirable.

The Osagian series was named for exposures along Osage River in west-central Missouri. A detailed study of the Osagian rocks in the type area seemed desirable, especially since disagreement exists among various writers as to what formations of the Osagian series are represented at the type section.

The Osagian rocks exposed along the west flank of the Ozark dome consist predominantly of a thick series of cherty crinoidal limestones interbedded with soft crinoidal marls. The normal stratigraphic sequence is sometimes complicated by bioherm structures. The general lithology is very similar throughout, although several unconformities exist within the series. Because of the consistent lithology of the Osagian series, it is difficult to separate one formation from another on the surface without the use of paleontology. Hence the problem of separation of units in the subsurface becomes unusually difficult. It seemed probable that a study of the lithology, stratigraphy, and faunas of a part of the outcrop area might aid in solving some of the problems encountered in the subsurface Mississippian rocks in the Mid-Continent area where Osagian rocks produce oil.

The Burlington limestone in southwestern Missouri has long been known to contain abundant, well preserved faunas, especially camerate crinoids. Many of these fossils have a limited vertical range. An attempt was made in this study to establish definite life zones in the Burlington limestone of southwestern Missouri, and to correlate them with those that Rowley (1908) and Laudon (1937) proposed in northeastern Missouri and Iowa. It was also a purpose of this study to determine
whether the Burlington limestone pinch-out between Springfield, Greene County and the Tri-State mining district is due to transgressive overlap or to post-Burlington pre-Keokuk erosion.

Lastly, this is part of an overall plan begun by L. R. Laudon some 15 years ago to study the Mississippian rocks throughout North America. This study connects directly with work previously completed by Cline (1934) on the Osagian formations of the southern Ozark region, and Laudon (1939) on the Osagian rocks of northeastern Oklahoma.

Location of the Area

The district studied includes the outcrop area of Mississippian rocks in southwestern Missouri (see plate 2). Most of the field work was done in a triangular area from Warsaw, Benton County, on the north to Springfield, Greene County, and Joplin, Jasper County, on the south.

Since lower Mississippian rocks are soft and occur between hard calcareous rocks, the later Mississippian rocks outcrop as an escarpment facing inwards toward the Ozark dome. Hence the most complete sections are exposed along the eastern outcrop edge of the Mississippian band of outcrop. The youngest Mississippian rocks are normally exposed only far down the dip slope to the west and consequently are normally limited to partial sections.

Due to the fact that the dip is less steep in the Springfield Plateau area to the south the band of outcrop is much wider in this area.

Procedure

The field work on this problem was begun in the summer of 1942, when more than a month was spent in the area. The work in the field was carried on intermittently from 1942 through the spring of 1946.
PLATE I. Map showing location of stratigraphic sections studied for this report. See stratigraphic sections at the end of report for detailed location of above localities.
PLATE 2. Map showing distribution of Pennsylvanian, Mississippian, and Ordovician rocks in southwestern Missouri (Taken essentially from the Geological Map of Missouri).
During this time at least five 2 to 3 week periods were devoted to field work, and a large number of 3 or 4 day week-end field trips were conducted in the area in accompaniment with students from the Department of Geology at the University of Kansas. In addition to field work in the area included in this report, separate trips were taken to north-central Iowa, north-central Missouri in Cooper, Howard and Saline counties, northwestern Arkansas and northeastern Oklahoma. A total of more than 5 months field work was carried out in connection with this thesis problem.

An attempt was made to examine as many outcrops of Mississippian rocks as possible in southwestern Missouri, and 64 localities were chosen for detailed study (see plate 1). A discussion of these 64 stratigraphic sections is given at the end of this report. The procedure at each of these sections was as follows: a graphic section was plotted showing character of the outcropping beds; fossils were collected from all fossiliferous zones; and hand samples were taken from each different lithologic unit. Insoluble residues to aid in lithologic determinations were made in the laboratory from 176 of the lithologic hand samples, most of which were from Kinderhookian rocks. In addition to studying surface exposures, most of the cores from core holes drilled by the U. S. Army Engineers for the proposed dam near Osceola, St. Clair County, were examined; and samples from the Waking et al No. 1 H. Doubler well in sec. 30, T. 29 N., R. 22 W., Greene County and drillers' logs from several wells in western St. Clair County and eastern Vernon County were studied.

Previous Work

Mississippian rocks in southwestern Missouri were first identified by Swallow in 1855. He recognized the following divisions in the area:
Vermicular sandstone and shale, Chouteau limestone, Encrinital limestone, and Archimedes limestone. The first two he assigned to the Chemung group of the Devonian system, and the last two to the Carboniferous system.

He thought that the Vermicular sandstone (Northview of this report) occurred below the Chouteau limestone because he correlated it with the Hannibal formation of northeastern Missouri. He named the Chouteau limestone for exposures at Chouteau Springs, Cooper County, Missouri, and divided it into Lower Chouteau and Upper Chouteau. He divided the Encrinital limestone (Burlington of this report) into eight divisions.

Swallow referred all the rocks between the St. Louis and Encrinital limestones to the Archimedes limestone. He believed that all the rocks in the area around Grand Falls, Newton County, Missouri, belonged to this formation. He presented a stratigraphic section of the rocks along Osage River two miles above Warsaw, Benton County, Missouri.

Broadhead (1874) described the geology of Barton, Cedar, Jasper, and Vernon counties, Missouri. He proposed that the Lithographic limestone, Vermicular sandstone and shale, and Chouteau limestone be included in the Chouteau group.

Williams (1891) proposed that the Mississippian series be divided into the Chouteau group, Osage group, and Genevieve group. He followed Broadhead in the usage of the Chouteau group, but Williams definitely assigned it to the Mississippian.

Simonds (1891) and Penrose (1891) simultaneously used the term Boone in print for the first time. The Boone formation was named from exposures in Boone County, Arkansas.

Hopkins (1893) named the St. Joe limestone from exposures near St. Joe, Searcy County, Arkansas.

In 1895 Weller divided the rocks lying above the Chouteau limestone
near Springfield, Greene County, Missouri, into twelve faunal zones, mainly using brachiopods: zones I to V were included in the Burlington limestone and zones VI to XII in the Keokuk limestone. He assigned the Burlington and Keokuk limestones to the Osage group.

Shepard (1898) described the geology of Greene County, and adjacent counties, Missouri, in considerable detail. He named the King limestone, Sac limestone, and Phelps sandstone and referred them to the Hamilton group of the Devonian system. He divided the Kinderhook into the Louisiana limestone, Hannibal shale, and Chouteau limestone; and the Augusta group (Osagean) into the Lower and Upper Burlington limestone. Shepard pointed out that there are no beds of Keokuk age in the Springfield area.

Weller (1899) described a fauna from the Vermicular sandstone near Northview, Webster County, Missouri, and assigned it to the Kinderhook group.

Williams (1900) published a list of fossils from the St. Joe marble, Carrollton limestone, and Boone chert. He said that the St. Joe marble contains a typical Kinderhook fauna.

In 1901 Weller named the Northview formation from exposures near Northview, Webster County, Missouri, to include the beds which had previously been known as the Vermicular sandstone and shale, and he said that this formation represented a facies change of the Chouteau limestone of central Missouri. He did not agree with Shepard's correlation of these beds with the Hannibal shale. Weller named the Pierson limestone from exposures along Pierson Creek, Greene County, Missouri, and correlated it with the upper Chouteau limestone of central Missouri. Shepard had referred these beds to the Chouteau
limestone. He correlated the Sac and King limestones of Shepard with the lower Chouteau limestone of central Missouri, and the Phelps sandstone of Shepard with the Sylamore sandstone. Weller did not find beds of Louisiana age in Greene County, Missouri.

Buckley and Buehler (1904) and Buehler (1907) discussed the stratigraphy of many of the limestone quarries in southwestern Missouri.

In 1904 Ulrich used Osage and Boone as synonymous group terms. He assigned the St. Joe limestone to the lower part of the Osage, or Boone. He correlated the St. Joe limestone with the lower Burlington limestone at Burlington, Iowa, and he thought that all the rest of the cherty Boone limestone was of Keokuk age.


Smith and Siebenthal (1907) said that the Grand Falls chert and the Short Creek oolite horizons divide the Boone formation into three limestone-chert terranes. They named the Short Creek oolite from exposures along Short Creek in the southeast part of Cherokee County, Kansas. They thought that the Burlington-Keokuk contact was probably at the base of the Grand Falls chert. All of the Boone formation above the base of the Grand Falls chert was thought by them to be of Keokuk age.

In 1908 Rowley separated the Burlington limestone of Pike County, Missouri, into upper and lower Burlington. He established the following divisions of the lower Burlington: Batocrinus calvini horizon, Uperocrinus longirostris horizon, Cactocrinus expansus horizon, and Coral horizon.

Weller (1910) correlated the Fern Glen formation of eastern Missouri
with the St. Joe marble of Arkansas, the New Providence shale of Indiana and Kentucky, and part of the Lake Valley beds of New Mexico; and he thought that they all were of late Kinderhook age. He said that the Chouteau limestone represented the entire Kinderhook interval in central Missouri, and is probably contemporaneous in part with the Louisiana limestone of northeastern Missouri. He believed that the Chouteau limestone was older than the Fern Glen formation. He also thought that the Pierson limestone in Greene County, Missouri, represented the upper part of the Chouteau, and thus, was older than Fern Glen age.

In the geological introduction to his Monograph on Mississippian Brachiopoda, Weller (1914) gives a general account of the Mississippian stratigraphy of Illinois, Iowa, and Missouri. His views regarding correlation had changed practically none since 1910.

Snider (1914) reported that the Boone formation ranges in age from Kinderhook to Keokuk. He thought that the Kinderhook was represented by shale and limestone of Fern Glen age, and that most of the Boone is of Burlington-Keokuk age. In 1915 he thought that the St. Joe limestone of northeastern Oklahoma contained a Burlington fauna.

Girty (1915-a) came to the conclusion that the upper part of the Boone that contains the Productus magnus fauna in the Joplin area, Jasper County, Missouri, was of Keokuk age, and not of Warsaw age. Later in the same year, Girty (1915-b) reversed his decision concerning this, and agreed with Weller that the Productus magnus fauna was Warsaw in age. Girty (1915-b) was the first to question the Kinderhook age of the Fern Glen and St. Joe limestones. He did this in a roundabout way. He correlated the Fern Glen and St. Joe limestones with the Chouteau limestone, but he thought that the Chouteau limestone should be correlated with the lower Burlington limestone. In this same paper Girty lists
a collection of fossils from within 10 feet above the top of the St. Joe limestone near St. Joe, Searcy County, Arkansas, which he thought to be of Burlington age.

Purdue and Miser (1916) were the first to study the type area of the Boone formation in considerable detail. They said that the Boone formation comprises strata of Kinderhook, Osage, and Warsaw ages. They correlated a stratum of oolite with the Short Creek oolite of the Joplin District. They recognized the St. Joe limestone as a member at the base of the Boone, but did not commit themselves as to whether it was Osage or Kinderhook in age.

Wilson (1922) gave a log of a deep well drilled in the Springfield, Greene County, Missouri area.

Weller (1926) divided the Mississippian rocks into faunal zones. Some of these are as follows: Leptaena analoga zone (represents all of the Kinderhook), Spirifer grimesi-logani zone (Burlington and lower Keokuk), Productus crawfordsvillensis (upper Keokuk), Productus magnus (lower Warsaw), Brachythyris subcardiiformis (upper Warsaw and Spergen or Salem), and Lithostrotion canadensis (St. Louis).

Greene and Pond (1926) described 35 feet of limestone at the Belvoir quarry, in the SE¼ sec. 26, T. 38 N., R. 30 W., Vernon County, Missouri, which they correlated with the upper Burlington limestone of the Joplin area.

In 1927 Buchanan said that the St. Joe limestone contains an early Burlington fauna, that the lower part of the Boone formation contains a late Burlington fauna, and that the more fossiliferous upper portions of the Boone formation contain a Keokuk and early Warsaw fauna.

Hoffman (1927) studied the Chouteau (including Sedalia dolomite)
limestone in Benton, Henry, Hickory, Pettis, and St. Clair counties, Missouri. She recognized that the Chouteau limestone thinned to the south, and that there was a gradual increase in shale content from north to south.

Moore (1928) presented a discussion of the early Mississippian formations in all of Missouri. He restricted the Chouteau limestone to include only the "Lower Chouteau" of Swallow. He proposed the name Sedalia limestone to replace Swallow's "Upper Chouteau", and designated the Sweeney quarry, in sec. 4, T. 46 N., R. 19 W., Cooper County, Missouri, as the type section. The Chouteau limestone was assigned to the Kinderhook group and the Sedalia limestone to the Osage group. In this report Moore named the Reeds Spring limestone for exposures near Reeds Spring, Stone County, Missouri. He believed this limestone to be younger than Fern Glen age, and in part, or even entirely, slightly older than rocks of Burlington age. However, in a footnote in this paper, Moore noted that in the type area of the Fern Glen he found a dense cherty limestone overlying the reddish shale which he correlated with the Reeds Spring limestone of southwestern Missouri. He found that the only deposit of Burlington age in the Joplin area was the Reeds Spring limestone. Moore believed that the Northview formation occurred below the Chouteau limestone, and accordingly, he proposed the name Compton for the limestone that he found under the Northview formation in the vicinity of Compton, Webster County, Missouri. However, he said that the Compton limestone contains a fauna typically representative of the Chouteau. Moore presented many stratigraphic sections in southwestern Missouri.

Girty (1928) came to the conclusion that the Boone chert near Batesville, Arkansas, consists of beds of St. Joe, Burlington, Keokuk.
In 1930 Croneis said that the Boone formation contains beds of Kinderhook, Burlington, Keokuk, and Warsaw ages. He questioned the use of the term Boone in the "formation" sense. He was the first to point out that there were beds younger than the St. Joe member that also are of Fern Glen age.

Fowler and Lyden (1932) recognized several lithologic divisions of the Boone formation, to which they assigned letters of the alphabet. Later, Fowler and others (1934) grouped these divisions or beds into formations as follows: Bed R consists of the Reeds Spring and Fern Glen formations, Beds K, L, M, N, O, P, and Q are considered as divisions of the Keokuk limestone, Beds B, C, D, E, F, G, H, and J were assigned to the Warsaw limestone.

Weidman (1932) applied the term Green limestone for a medium to fine grained, grayish to brownish crystalline limestone containing a small and variable amount of greensand or glauconite. According to him, this limestone ranges from 5 to 25 feet in thickness, and occurs usually 25 to 30 feet above the Short Creek oolite.

Moore (1933) published an abstract in which he said that the Grand Falls chert of the Joplin district appears to be of Reeds Spring instead of Keokuk age. He found stratigraphic units in the type Fern Glen section near St. Louis that correspond to the Sedalia and Reeds Spring limestones. He correlated the St. Joe limestone with the lower non-cherty portion of the Fern Glen. Moore said that the Reeds Spring limestone was separated from the Burlington limestone by a disconformity and a marked difference in faunal characters.

In 1936 Moore introduced the term Valmeyer series to include the Osage and Meramec groups.
Cline (1934) presented evidence that the "Boone formation" should be suppressed as a synonym of the Osagian series. He described the Osage formations (St. Joe, Reeds Spring, Burlington, Keokuk, and Warsaw) of southwestern Missouri, northwestern Arkansas, and northeastern Oklahoma. He pointed out that typically there is a gradual gradation from the St. Joe limestone into the Reeds Spring limestone, but he found an unconformity between them at two localities. He believed that the Grand Falls chert is only a local variant of the upper Reeds Spring limestone. He came to the conclusion that the Reeds Spring is pre-Burlington in age. Cline placed the Warsaw limestone in the Osage series, and he considered the Short Creek oolite as its basal member.

Giles (1935) reviewed the Boone problem in general. He said that the Short Creek oolite is a fairly persistent member that occurs from 100 to 125 feet below the top of the Boone. He recognized it in Benton, Boone, and Washington counties, Arkansas. He was unable to recognize the Grand Falls chert in Oklahoma and Arkansas. According to him the upper Burlington is apparently not represented in the Boone limestone of Oklahoma and Arkansas.

In 1937 Laudon presented evidence against combining the Osage and Meramec rocks into the Valmeyer series. He divided the Burlington limestone of Missouri and Iowa into the following seven faunal zones: Batocrinus calvini zone, Uperocrinus longirostris zone, Cryptoblastus melo zone, Cactocrinus proboscidiatus zone, Phystocrinus ventricosus zone, Dizygocrinus rotundus zone, and Pemtremites elongatus zone. He showed that the Burlington limestone transgressively overlaps against the underlying Kinderhookian surface north and west from Hannibal, Missouri.

Clark (1937) found rocks of St. Louis age in western Dade County, Missouri, along Horse Creek and Sons Creek. According to him this forma-
tion has been preserved on the downthrown side of the Chesapeake fault.

Branson (1938 and 1944) refused to accept the term Kinderhookian, and used Lower Mississippian to replace it. He assigned the Compton, Northview, Pierson, Fern Glen, and Reeds Spring members to the Chouteau formation. The lower Sedalia was correlated with the upper Chouteau and the upper Sedalia with the Lower Burlington. He correlated the Bushberg sandstone with the Sylamore sandstone. He thought that the Northview member was a facies change of the upper Chouteau (Sedalia of Moore) in central Missouri. In 1944 he placed the Burlington, Keokuk, and Warsaw formations in the Middle Mississippian, not recognizing the term Osagian. He listed Sylamore, Phelps, St. Joe, Sedalia, Boone, Kinderhook, and Osage as obsolete names.

Moore and others (1939) gave a summary of Mississippian stratigraphy in the Tri-State mining district. They correlated the Pierson limestone of the Springfield, Missouri area with the St. Joe limestone to the south, and the Sedalia limestone to the north. The Grand Falls chert was considered as a comparatively widespread but discontinuous member of the Keokuk limestone. They believed that the Reeds Spring limestone probably rests unconformably on the St. Joe limestone. They pointed out that the Burlington limestone pinches out somewhere between Mt. Vernon, Lawrence County, and Joplin, Jasper County, Missouri. They placed the Warsaw limestone of the Tri-State district in the Meramec series.

In 1939 Laudon discussed the Osagian rocks in northeastern Oklahoma, which, for the most part, supported evidence presented by Oline (1934). He presented twelve stratigraphic sections from the outcrop area of the Osagian rocks. He stated that in northeastern Oklahoma the Burlington limestone is not present, and that no rocks in the area
correlate with the Warsaw limestone as exposed in the upper Mississippi Valley.

Lee (1939) correlated the Northview and Compton formations with the Chouteau limestone. In 1940 he described the transition of Northview to Chouteau from south to north in the subsurface of Kansas. In northern Kansas he found the Sedalia limestone overlain by the Gilmore City limestone. This suggested to him that the Sedalia is more closely allied to the Chouteau than to the overlying rocks of Osage age. In 1943 Lee recognized three subdivisions of the Chouteau in the subsurface of northeastern Kansas. The lowest he correlated with the Compton limestone, the middle with the Northview shale, and the upper he said occupies the same stratigraphic position as the Sedalia limestone of the outcrops in Pettis County, Missouri.

Clark (1941-a) reported the following Mississippian formations to be present at the Mary Arnold mines, SE\(\frac{1}{4}\) sec. 7, T. 26 N., R. 20 W., Christian County, Missouri: Burlington limestone, Grand Falls chert and limestone, Pierson limestone, Northview shale, Compton limestone, and Sylamore sandstone. In the same year (1941-b) Clark described the geology of the Cassville quadrangle, Barry County, Missouri. He placed the Sylamore and Noel formations in the Devonian system. He did not recognize Kinderhookian and Osagian as valid terms. The St. Joe and Reeds Spring limestones were classed as Lower Mississippian, and the Keokuk as Middle Mississippian. The St. Joe limestone was divided into the following members: a basal green shale, the Compton limestone, the Northview calcareous shales, the Pierson limestone, and an upper unnamed limestone. Clark said that farther to the north and east the Compton, Northview, and the Pierson are designated as members of the Chouteau formation. He designated the Grand Falls chert
as the upper beds of the Reeds Spring limestone. According to him the Burlington limestone is absent in the Cassville quadrangle.

Kaiser (1945) recognized the following 4 faunal zones in the Burlington limestone in western Missouri along Osage River: Batocrinus calvini–Uperocrinus longirostris zone, Cryptoblastus mele zone, Cactocrinus proboscidialis zone, and Physetocrinus ventricosus zone. He presented evidence in favor of placing the Sedalia dolomite in the Kinderhookian series instead of Osagian series. The Sedalia dolomite was divided by him into lower, middle, and upper members on the basis of chert content.

Lee et al (1946) prepared maps and cross-sections showing Mississippian rocks in the Forest City basin of Missouri, Kansas, Iowa, and Nebraska.

Acknowledgments

Thanks are expressed to all the residents of the area who assisted in the collection of field data. M. C. Hunt and Harold Bullard of Osceola, H. L. Morris of Eldorado Springs, Paul Sunderland and John Perryman of Springfield, and Harold Mammen of Lockwood aided materially in this investigation. I express particular appreciation to L. R. Laudon, who suggested the study, spent much time with me in the field, and critically read the manuscript. Special assistance in preparation of the manuscript and field aid was given by R. C. Moore. Help was received from John C. Frye, M. L. Thompson, J. M. Jewett, W. H. Schoewe, Edith Lewis, Betty Hagerman, and Doris Leonard of the State Geological Survey of Kansas; Wallace Lee and Vinton Fishel of the Federal Geological Survey. Thanks are also due to many students in the Department of Geology at the University of Kansas, especially A. L. Bowsher, B. J. Chronic, J. R. Leonard, R. M. Jeffords, R. J. Knox,
and O. S. Fent, for help in all phases of this project.

Valuable base maps of the area were obtained from Edward L. Clark and the later H. A. Bushler of the Missouri Geological Survey. Frank C. Greene, also of the Missouri Geological Survey, furnished data concerning dry holes drilled in western St. Clair County and eastern Vernon County. Stafford Happ of the U. S. Army Engineers made it possible for me to spend one week with him in the Osceola, St. Clair County area.
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*Fig. 1.*—Formations exposed in thesis area.
STRATIGRAPHY
KINDERHOOKIAN SERIES

Rocks of Kinderhookian age present in the area encompassed by this report include the Sylamore, Chattanooga, Chouteau, Sedalia, and Northview formations. Many geologists prefer to place the Sylamore and Chattanooga formations in the Devonian system. The Sylamore formation is thin and discontinuous, but is commonly present in southwestern Missouri. The Chattanooga shale is present only in the extreme southwestern corner of Missouri. The Chouteau limestone as restricted by Moore (1928, p. 78) is present throughout all except the extreme southern part of the area studied for this report. It maintains a fairly constant thickness, but is locally absent. Evidence is presented in this report to show that the Compton limestone of Moore is synonymous with the Chouteau limestone, and that the term Compton should be dropped from geological literature. The Sedalia dolomite, as defined by Moore (1928, p. 78), is a valid formation, but it is Kinderhookian in age instead of Osagian. It contains a typical Kinderhookian fauna very close to the Chouteau fauna. The Sedalia is well developed in the northern part of the area studied. The lower and middle portions of the Sedalia are demonstrated to be a facies equivalent of the Northview formation. The upper non-cherty zone of the Sedalia dolomite is much more widespread than the underlying zones, and the former overlies the Northview formation in much of the central part of southwestern Missouri. The Chouteau, Northview, and Sedalia formations thin southward from Springfield, Greene County, until in the vicinity of Galena and Reeds Spring, Stone County, the St. Joe limestone rests on the Sylamore sandstone. At places where the Sylamore is missing, the St. Joe rests on Ordovician rocks.
In the area studied for this report the total thickness of the Kinderhookian rocks ranges from a featheredge in the southern part to at least 79 feet along U. S. highway 66 in the SE$_3$ sec. 22 and the SW$_4$ sec. 23, T. 30 N., R. 19 W., Webster County (locality 15, plate 1). Kinderhookian rocks are locally absent in Stone County in the vicinity of Galena and Reeds Spring.

Branson (1938 and 1942) has been almost alone among geologists and geological surveys, except perhaps for Ulrich (1911), in not accepting Kinderhookian, Osagian, Meramecian, and Chesterian as series divisions of the Mississippian. Branson uses lower, middle, and upper to replace them. His lower Mississippian is the same as what is generally accepted as the Kinderhookian series. He includes strata lying above the Bushberg formation and below the Burlington limestone in his Chouteau formation. He divides the Chouteau formation of southwestern Missouri into the Compton, Northview, Pierson, and Reeds Spring members, and states that St. Joe and Sedalia are obsolete names. I do not agree with any part of Branson's classification. However, Branson did make a valuable contribution in that he was one of the first to realize that the Northview formation is a shale facies of the same age as the Sedalia dolomite.

Sylamore Sandstone

The Sylamore sandstone was named by Penrose (1891, pp. 113, 114) for exposures on Sylamore Creek, Stone County, Arkansas. This formation represents the first rock deposited after an erosional interval of long time duration. In places it seems to represent only a thin re-worked zone. It rests on Ordovician rocks throughout the area studied. Ulrich (1911, p. 455) said that the Sylamore sandstone (of Arkansas) represents a sandy beach deposit.
Location of Measured Sections

1. Composite section from area 1 to 2 miles SE of Reeds Spring, Stone County.
4. Composite section of several outcrops in vicinity of Springfield, Greene County. Thicknesses are corrected to looking NE at No. 11 Doubler well in sec. 30, T. 29N., R. 22W.
6. Road cut, NE cor. sec. 21, and NW cor. sec. 22, T. 31N., R. 23W., Greene County.
7. Bluff at Burns, NE ¼ sec. 11, T. 33N., R. 22W., Polk County.
8. Road cut, SW ¼ sec. 27, T. 35N., R. 23W., Polk County.
11. Road cut, cen. NW cor. sec. 27, T. 39N., R. 22W., Benton County.

Generalized south-north cross-section showing stratigraphic relationships of Kinderhookian rocks of the beginning of Osagean time.

Reeds Spring, Springfield, Sedalia dol., Northview fm., Chouteau Is.
Reeds Spring, Springfield, Sedalia dol., Northview fm., Chouteau Is.
Reeds Spring, Springfield, Sedalia dol., Northview fm., Chouteau Is.
Reeds Spring, Springfield, Sedalia dol., Northview fm., Chouteau Is.
Reeds Spring, Springfield, Sedalia dol., Northview fm., Chouteau Is.
PLATE 4—A. West-east diagrammatic cross-section through a part of Kansas, the Tri-State mining district, Mt. Vernon, Springfield, and Northview, Missouri, showing the thickening of the Northview formation near Northview; the Burlington limestone pinch-out between Mt. Vernon and Joplin; and the extremely thin pre-Reeds Spring Mississippian section in the Joplin area. The Chattanooga shale appears in the western part of Cherokee County, Kansas.

PLATE 4—B. South-North diagrammatic cross-section from Noel to Nevada, Missouri, through the Tri-State mining district showing the thin pre-Reeds Spring Mississippian section in the Joplin area.
The Sylamore formation is not shown on plate 3 because it is too thin to show on such a small scale. There are not many localities in southwestern Missouri where the Ordovician-Mississippian contact is well exposed; thus, the Sylamore sandstone was observed at only a few localities.

General character.--The Sylamore sandstone is composed of medium to coarse grains of translucent to transparent, well-rounded, frosted quartz. It is generally highly argillaceous, and is conglomeratic at some localities. The color ranges from white to brown, and is commonly green. Phosphatic nodules, which according to Moore (1928, p. 81) vary in size from 1/8 to 1 inch or more in diameter, are especially characteristic of the formation. The fauna is composed essentially of fish remains, conodonts, and coprolites. At localities where the Sylamore sandstone is thin, generally less than 6 inches, it has the appearance of a reworked zone, and contains as much shale as sandstone, if not more. At a road cut and quarry along U. S. highway 54 in the NE³ sec. 21, T. 37 N., R. 22 W., Hickory County (locality 10-a, plate 1), the Sylamore was noted to contain numerous small crystals of gypsum and some glauconite.

In one of the core holes drilled by the U. S. Army Engineers at the proposed site of the Osceola Dam about 2 miles southwest of Osceola, St. Clair County, 3 inches of green Sylamore sandstone is present on top of the Jefferson City dolomite of Ordovician age. The sandstone serves as a crack filler to a depth of 2 inches in the top of the dolomite, and it contains numerous fragments of angular chert, the largest being one-half inch across at the largest dimension.

Distribution and thickness.--The Sylamore is a thin, discontinuous, but persistent formation that occurs at the base of the Kinderhookian
series throughout most of Missouri, Kansas, Arkansas, Oklahoma, and other nearby states. It is not present everywhere in southwestern Missouri, but where present it ranges in thickness from a featheredge to 4 feet. Generally it is less than 12 inches thick. The Sylamore sandstone is considerably thicker in northern Arkansas and eastern Oklahoma than it is in southwestern Missouri.

The Sylamore sandstone was encountered in nearly all the core holes drilled by the U. S. Army Engineers in the vicinity of the proposed site of the Osceola Dam along Osage River about 2 miles southwest of Osceola, St. Clair County. It ranges in thickness from 3 to 12 inches. Branson (1938, p. 154) reports that the Bushberg sandstone (Sylamore of this report) ranges up to 20 feet in thickness in the vicinity of Warsaw, Benton County. Mehl (Branson, 1938, p. 155) measured 41 feet of Bushberg below the Chouteau limestone at an outcrop 1$\frac{1}{2}$ miles west of Fairfield, Benton County. I have not seen the Sylamore sandstone this thick in Benton or surrounding counties, and I believe that Branson and Mehl may have become confused with a shale or siltstone facies of the Sedalia or Chouteau formations. The Sylamore sandstone was observed to be 4 inches thick in a road out and quarry in the NE$\frac{1}{4}$ sec. 21, T. 37 N., R. 22 W., Hickory County (locality 10-a, plate 1). Two inches of sandy shale occurs between the Chouteau formation and Ordovician rocks in Laird Bluff near the center of sec. 31, T. 40 N., R. 22 W., Benton County.

Moore found 2 to 5 inches of Sylamore sandstone below the Chouteau limestone in the Sweeney quarry, sec. 4, T. 46 N., R. 19 W., Cooper County, Missouri. Shepard (1898, p. 79) said that 2 feet of Phelps (Sylamore of this report) sandstone is present in shafts of the Phelps mines in the NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 1, T. 28 N., R. 21 W., Greene County, and (Shepard, 1898, pp. 80, 81) recorded several localities where the Phelps
sandstone is 4 feet thick. In the same report, Shepard (p. 80) reports 4 to 6 inches of Phelps sandstone present in the shafts of the Delaware Mining Company in the SE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 29, T. 27 N., R. 22 W., Christian County. Clark (1941b, p. 84) and Grobshkopf et al. (1943, p. 8) report that the Sylamore sandstone, where present, in the Cassville quadrangle, Barry County, ranges in thickness from a feathered edge to 3 feet, but is characteristically less than 12 inches thick. Laudon (1939, p. 336, fig. 11) shows 10 feet of Sylamore sandstone between the Sallisaw sandstone, Devonian system, and the Chattanooga shale at a section 2 miles north of Marble City, in the NW$\frac{1}{4}$ sec. 15, T. 13 N., R. 23 E., Sequoyah County, Oklahoma. Taff (1905, p. 3) reports a maximum thickness of 30 feet for the Sylamore sandstone in the Tahlequah quadrangle of Oklahoma and Arkansas. McKnight (1935, p. 67) said that the Sylamore in the Yellville quadrangle of Marion County, Arkansas, ranges in thickness from a knife-edge to 18 feet, but is generally between 2 inches and 5 feet in thickness. Penrose (1891, p. 114) reports that the Sylamore sandstone reaches a maximum thickness of 40 feet in Stone County, Arkansas. Adams and Ulrich (1905, p. 3) measured 75 feet of sandstone in the Fayetteville quadrangle of Arkansas and Missouri, which they referred to the Sylamore sandstone.

Stratigraphic relations.—The Sylamore sandstone, where present, rests unconformably on rocks of Ordovician age and unconformably beneath the Chouteau limestone throughout most of southwestern Missouri. Locally, where the Chouteau limestone is absent, the Sylamore may lie unconformably below the Sedalia or Northview formations. In the southern part of southwestern Missouri, where all other Kinderhookian formations are absent, the Sylamore lies unconformably beneath the St. Joe limestone. The Sylamore sandstone occurs stratigraphically below the Chattanooga shale.
in the extreme southwestern corner of Missouri. In central Missouri, Moore (1928, p. 85) reports 2 to 5 inches of Sylamore sandstone separating the Cooper limestone of Devonian age from the overlying Chouteau limestone. Clark (1941b, p. 87) and Grohskopf et al. (1943, pp. 7, 8) report that in Barry County, Missouri, the Sylamore may rest on the Fortune formation of Devonian age.

**Faunal character.**--Fish teeth and bone, conodonts, and coprolites comprise the greater part of the fauna of the Sylamore formation. Teeth of Ptychodus calceolus seem to be fairly common. Numerous bone fragments of a larger fish, probably Dinichthys, have been found in this formation. Branson and Mehl (1933) and Branson (1938, pt. 2, pp. 128-148) have described numerous species of conodonts from the Bushberg sandstone (in part Sylamore of this report), but they have been so confused as to the true relationships of the Bushberg, Sylamore, Phelps, Hannibal, and sometimes Northview formations that for the most part the geologic ranges of the species they have listed have little meaning. Branson (1938, pt. 1, pp. 159-181) listed a large invertebrate fauna from the Bushberg sandstone at a locality 7 miles west of Montgomery City, Missouri, but it does not seem probable to me that these fossils came from the same stratigraphic horizon as the Sylamore sandstone of southwestern Missouri.

**Age and correlation.**--The Sylamore sandstone is considered as the basal formation of the Kinderhookian series, Mississippian system, in this report. It is possible that it ranges in age from pre-Chattanooga to pre-St. Joe. Weller (1901, p. 140) correctly pointed out that the Phelps sandstone of Shepard (1898, pp. 77-81) was synonymous with the Sylamore sandstone, and the term Phelps has since been abandoned. The Sylamore sandstone is correlated with the Misener sand of the subsurface of Oklahoma and Kansas.
Branson (1938 and 1944) found that stratigraphic horizons represented by the Bushberg and Sylamore sandstones in central Missouri converge southward toward the area concerned in this dissertation. He has proceeded on the assumption that any sandstone present at the base of the Chouteau limestone is correlative to the Bushberg. Consequently, he has not recognized the Sylamore sandstone in southwestern Missouri, but has considered the sandstone which lies beneath the Chouteau limestone and on the Ordovician rocks as the Bushberg. My work has demonstrated that in the southern part of southwestern Missouri the Sylamore sandstone may be present between Chouteau and Ordovician rocks. I have not attempted to determine the extent and relationships of Bushberg versus Sylamore sandstones in southwestern Missouri. It seems most probable to me that the nonfossiliferous sandstone present at the base of the Mississippian rocks in southwestern Missouri is the Sylamore sandstone. This is not to be construed as calling the Sylamore as correlative to the Bushberg.

Chattanooga Shale

The Chattanooga shale was named by Hayes (1891, p. 143) for exposures at Chattanooga, Tennessee. It is a formation of widespread distribution, occurring in Tennessee, Kentucky, northwestern Georgia, northern Alabama, northeastern Mississippi, Illinois, Missouri, Arkansas, Oklahoma, Kansas, Iowa, and Nebraska. Simonds (1891, pp. xiii, 26, 27) applied the name "Eureka" to a black shale exposed near Eureka Springs, Carroll County, Arkansas, that occurs below the St. Joe limestone and above rocks of Ordovician age. In 1904 Adams et al. (pp. 24, 25) pointed out that the term "Eureka" was preoccupied and they proposed the term Noel for a black shale which they correlated with the "Eureka"
shale of the Eureka Springs, Arkansas, area. The type locality of the Noel shale is near Noel, McDonald County, Missouri. The following year Adams and Ulrich (1905, p. 3) apparently abandoned the term Noel in favor of Chattanooga in the Fayetteville quadrangle of Arkansas and Missouri, because they thought that the black shale at Noel was Devonian in age while the black shale at Eureka Springs was Mississippian in age.

General character.--Clark (1941b, p. 91) describes the Chattanooga shale (same as his Noel formation) of the Cassville quadrangle, Barry County, Missouri, as follows:

The Noel formation is composed of black carbonaceous shale which on exposure becomes fissile and breaks into thin sheets and plates. The color lightens with weathering to shades of green and brown. The carbonaceous content is sufficiently high that it will burn in a stove, but it leaves a large amount of ash and fuses to the bowl. The shale is strongly jointed with the joints sharply defined and inclined to the bedding in such a manner as to break into prismatic blocks. In some areas the joints are curved and discoid blocks result. Where massive, the uniformity of the material results in the shale possessing a conchoïdal fracture. Freshly broken fragments may possess a bituminous odor and in McDonald county, Missouri, and northwestern Arkansas pockets of natural gas have been found in this shale.

Distribution and thickness.--The Chattanooga shale occurs only in the southwestern corner of the area studied, chiefly in McDonald, Newton, and Barry counties, Missouri. Isolated patches of this formation undoubtedly occur north and east of these counties. The Chattanooga shale in these counties ranges in thickness from a knife-edge to at least 59 feet. Marbut (Winslow, 1894, p. 386) seemingly was the first to recognize this formation in southwestern Missouri. He reported it 50 feet thick on Sugar creek in the extreme southeastern corner of McDonald County, and 30 feet thick on Mill creek in sec. 30, T. 21 N., R. 32 W., McDonald County. He said that 20 feet of this black shale is exposed about half a mile below Noel inlets of Elk River, and 12 feet is exposed at a spring along Roaring River in sec. 34, T. 22 N.,
R. 27 W., Barry County. He also stated that this black shale is absent east of Barry County. Wilson (1922, p. 106) reported that 59 feet of Chattanooga shale was encountered in a deep well drilled at Noel, McDonald County. Shepard (1898, pp. 67-70) referred 4 feet of shale that crops out along James River in the SE\(\frac{1}{4}\) sec. 29, T. 27 N., R. 22 W., Christian County, to the Eureka shale (Chattanooga shale of this report). I have visited this locality and I believe that this 4 feet of shale should be assigned to the Northview formation. Clark (1941b, p. 90) reports that the Noel shale (Chattanooga shale of this report) in the Cassville quadrangle ranges in thickness from a featheredge to 20.5 feet. The maximum thickness was measured by him in Dry Hollow in the SE\(\frac{1}{4}\), NW\(\frac{1}{4}\), SE\(\frac{1}{4}\), sec. 30, T. 22 N., R. 27 W. Smith and Siebenthal (1907, p. 2) reported that the Chattanooga shale was not found by them in the Joplin district. Weidman (1932, pp. 10, 11) apparently referred all the shale between the base of the Reeds Spring limestone and the top of the Ordovician system in the Tri-State district to the Chattanooga shale. This is not correct, because this interval includes the Northview formation. I believe that the 35 feet of shale reported by Smith and Siebenthal (1907, p. 2) below the Reeds Spring limestone in the Mystic shaft in the bottom of Gordon Hollow is Northview in age rather than Chattanooga as reported by Weidman (1932, pp. 10, 11).

Adams et al. (1905, p. 3) said that in the Fayetteville quadrangle of Arkansas and Missouri the Chattanooga shale ranges in thickness from 30 to 70 feet and averages about 50 feet. Purdue and Miser (1916, p. 9) report that the Chattanooga shale is apparently absent east of the central part of the Harrison quadrangle of Arkansas and Missouri, and that it reaches a maximum thickness of 50 feet along Bar Eagle Creek in the western part of the Eureka Springs quadrangle of Arkansas and Missouri.
Croneis (1930, p. 41) reported that the Chattanooga shale, which is relatively widespread in northwestern Arkansas, ranges in thickness from a few inches to nearly 85 feet, with an average thickness of about 30 feet. He further states that it thickens toward the west, and is thicker in northeastern Oklahoma than in Arkansas.

Laudon (1939) gives the following thicknesses for the Chattanooga shale in northeastern Oklahoma: 61 feet in the SE ¼ sec. 31, T. 26 N., R. 24 E., Ottawa County (fig. 2); 67 feet just downstream from Spavinaw dam, near Spavinaw, Mayes County (fig. 5); 37 feet in the SE ¼ sec. 25, T. 16 N., R. 22 E., Cherokee County (fig. 10); and 60 feet in the NW ¼ sec. 15, T. 13 N., R. 23 E., Sequoyah County (fig. 11).

McQueen and Greene (1938, p. 34) report that 120 feet of Chattanooga shale was encountered in a core hole drilled in sec. 4, T. 59 N., R. 38 W., Holt County, Missouri. The Chattanooga shale in northwestern Missouri ranges from a featheredge to 120 feet.

Leatherock and Bass (1936, pp. 91, 94) showed that a large area in Osage and Kay counties, Oklahoma, and Cowley and Chautauqua counties, Kansas, contains no Chattanooga shale, and that in a 15 to 20 mile belt surrounding the shaleless area, the Chattanooga shale ranges in thickness from a knife edge to 80 feet.

Lee (1940, p. 22) gives the following account of the Chattanooga shale in Kansas:

The Chattanooga shale was deposited widely in Kansas east of the central Kansas uplift, but it was subsequently removed by erosion in certain areas along the Nemaha ridge, in Cowley and Chautauqua counties east of the ridge, and in places on the flank of the central Kansas uplift. The shale is generally black in southeastern Kansas where it is in most areas less than 50 feet thick. Toward the north it thickens to more than 250 feet and becomes for the most part gray-green and in places includes some dolomitic and ooliticaceous shale.
Plate 3 of this same report shows the Chattanooga shale absent in most of Cherokee and Crawford counties, Kansas.

Stratigraphic relations.--The Chattanooga shale where present in the area in southwestern Missouri conformably overlies the Sylamore sandstone, or, where the Sylamore is absent, it lies unconformably on rocks of Ordovician age. The Chattanooga shale unconformably underlies the St. Joe limestone in southwestern Missouri.

Age and correlation.--The Chattanooga shale is here assigned to the lower part of the Kinderhookian series, Mississippian system. According to some geologists, the lower part of the Chattanooga is Devonian and the upper part is Mississippian. I believe that the Chattanooga shale of southwestern Missouri, northwestern Arkansas, and northeastern Oklahoma is, at least in part, of the same age as the Chattanooga shale east of the Ozark uplift. I further believe that the black shale which occurs at this stratigraphic horizon throughout the area of its distribution should all be referred to the Chattanooga shale regardless of whether or not it is Devonian at one place and Mississippian at another, because it is a mappable rock unit and an excellent subsurface marker throughout much of the mid-continent region. I recommend that the term Noel not be used for this formation in southwestern Missouri.

The Chattanooga shale is correlated with the Ohio shale of Ohio and north-central Kentucky (Wilmarth, 1938, pp. 405, 1534) and the Saver-ton and Grassy Creek shales of western Illinois and northeastern Missouri (Moore, 1928, fig. 2).

Chouteau Limestone

The Chouteau limestone was named by Swallow (1855, pp. 101-103) for exposures at Chouteau Springs, in sec. 16, T. 48 N., R. 18 W., Cooper
County, Missouri. Swallow divided this formation into the following two quite distinct divisions:

1st. At the top, immediately under the Enocrinital Limestone, we find some forty or fifty feet of brownish gray, earthy, silico-magnesian limestone in thick beds, which contain disseminated masses of white or limpid calcareous spar. This rock is very uniform in character, and contains but few fossils. Reticulated corals, and Fucoidal markings like the Cauda-galli, are most abundant. . . .

2d. The upper division passes down into a fine compact blue, or drab thin-bedded limestone, whose strata are quite irregular and broken. Its fracture is conchoidal, and its structure, somewhat concretionary.

Swallow (1855, p. 195) indicates a thickness of 30 feet for the upper Chouteau, and a thickness of 20 feet for the lower Chouteau at Chouteau Springs.

Hoffman (1927) wrote a thesis describing the Chouteau limestone in central Missouri. She used Chouteau to include the same beds as originally defined by Swallow.

Moore (1928, p. 78) restricted the Chouteau limestone to include only the "lower Chouteau" of Swallow. Moore said:

Since the "Upper Chouteau" is different in lithologic character, areal distribution, fauna and stratigraphic relations, it has appeared desirable to distinguish it as a separate formation that is here classed as a basal portion of the Osage group. From exposures in the vicinity of Sedalia, Pettis county, the name Sedalia limestone is proposed. The Chouteau limestone is here restricted to include only the lower divisions of compact, drab, fossiliferous limestone.

The Chouteau limestone as redefined by Moore is recognized in this report as valid, and the Chouteau limestone of southwestern Missouri is correlated directly with the Chouteau of the type section.

Moore proposed the name Compton (see stratigraphic relations) for the limestone that occurs below the Northview formation in Webster and Greene counties, Missouri. He pointed out that the Compton limestone contains a fauna typically representative of the Chouteau, but he thought that the Northview formation occurred below the Chouteau limestone,
that, therefore, the Compton limestone could not be correlated with the Chouteau limestone. Evidence is presented in this report to show that the Northview formation is a siltstone and shale facies deposited at the same time as the Sedalia dolomite; thus the Northview formation occurs stratigraphically above the Chouteau limestone. Therefore the Chouteau and Compton formations occupy the same stratigraphic position and are one and the same formation. As Chouteau has priority over Compton, I recommend that the term Compton be dropped from geological literature as a synonym of Chouteau limestone. Branson came to this same conclusion in 1938 (part 1, p. 10) when he said:

The lower Chouteau [Chouteau of Moore and this report] has been traced from outcrop to outcrop from central Missouri to Greene County and there can be no doubt that the Compton represents the lower part and should not be considered as a separate formation.

Shepard (1898, pp. 74-77) gave the name Sac to a hard, bluish-gray, compact limestone having a maximum thickness of 18 feet that outcrops at various points along Sac River and its branches. He reported that this limestone occurs just below the Phelps sandstone. Weller visited some of Shepard's localities and was able to obtain a collection of fossils from the Sac limestone. In a paper on the Kinderhookian formations of Missouri, Weller (1901, p. 138) said:

From the list of fossils just given it will be seen that the fauna of the Sac limestone corresponds closely with that of the typical Chouteau limestone of central Missouri, and more especially with the lower division of the Chouteau limestone as described by Swallow.

The Phelps sandstone that Shepard reported overlying the Sac is a silty phase of the lower part of the Northview shale. Weller (1901, pp. 138, 159) also pointed out that Shepard's Louisiana limestone of Greene County is a lithologic variation of the Sac limestone.

From the above it seems that Shepard's Sac limestone is the same as, and should have priority over, Moore's Compton limestone. Moore did not
use the term Sao for the beds which he referred to the Compton, because he (1928, pp. 113, 114) thought that Shepard's Sao limestone was either Devonian or Ordovician in age.

Weller (1901, p. 135) also said that the manner of occurrence of Shepard's (1898, pp. 71-74) King limestone seems to indicate that it is but a facies of the Sao limestone. In this report I consider the terms Sao, King, and Compton as synonyms of the Chouteau limestone.

General character.—Moore (1928, p. 85) gives the following description for the Chouteau limestone at the quarry at Sweeney, in sec. 4, T. 46 N., R. 19 W., Cooper County, Missouri:

<table>
<thead>
<tr>
<th>Limestone Description</th>
<th>Thickness Feet</th>
<th>Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limestone, bluish drab, slightly mottled, compact, with sharply conchoidal fracture. Beds thin, nodular, separated by wavy shale partings</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Limestone, drab, fine granular, fracture subconchoidal, beds rather massive. Slightly magnesian</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Limestone, bluish gray, compact, with sharply conchoidal fracture and thin nodular beds. Chert in discontinuous bands. Persistent shale seam 3 ft. 9 in. from base</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Limestone, light grayish brown, fine granular, mottled with small elongate patches of dark bluish gray, probably organic in origin. Chert seam at top</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Limestone, brownish drab, darker than above, dense, compact, with sharply conchoidal fracture. Thin uneven layers with wavy shale partings. Occasional calcite veins and fillings</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Limestone, brownish gray, fine-grained, dense, rather massively bedded. Persistent chert band at top</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Limestone, light buff gray, fine-grained, characterized by rather uniform, even beds, 2 to 6 inches in thickness, which are separated by thin shale partings. Persistent prominent shale bands at top and bottom</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

Total                                           25             8

The Chouteau limestone, where typically developed in southwestern Missouri, consists of gray to tan silty limestone. The amount of silt ranges
from 1 to 15 percent. The texture is generally finely crystalline, but at some places there are dense beds. Probably the most characteristic feature of the Chouteau limestone is its thin irregular almost nodular bedding, with the individual beds generally ranging in thickness from 2 to 6 inches. The Chouteau limestone is usually highly fossiliferous, and crinoid fragments far outrank all other forms in number. The crinoid stem fragments are relatively small in size. In this respect the Chouteau limestone is much more finely crinoidal than the Burlington limestone, but it is very similar to the Sedalia dolomite. Chert is very scarce in the Chouteau limestone. It occurs in relatively small irregular nodules usually not more than 4 inches across in the longest dimension. The Chouteau is light to dark gray in color, opaque, and fossiliferous. At a road out in the NE$_{2}$ sec. 21, T. 37 N., R. 22 W., Hickory County (locality 10-a, plate 1), the Chouteau limestone contains very little true chert, but the middle part contains abundant light-gray siliceous nodules. The Chouteau chert is very similar to the Sedalia chert, and not at all like any chert in the Osagian series.

Lee (1940, p. 29) gives the following description of the subsurface character of the Chouteau limestone:

The limestone from well cuttings in Kansas that is correlated with the Compton [Chouteau of this report] is typically a fine-textured, slightly greenish-gray limestone with a waxy luster. It varies in character and in some places is semi-granular and crinoidal and gray or pale buff gray. The cuttings ordinarily contain no chert.

The insoluble residues are very small and show only small amounts of white, shapeless, fragile, and spongy siliceous aggregates.

**Distribution and thickness.**—The Chouteau limestone in southwestern Missouri ranges in thickness from a featheredge to a maximum of 18 feet. It is present throughout most of the area studied, except the extreme southern part. Two feet of typical Chouteau limestone crops out along
Fig. 2.—Sylamore and Chouteau formations in road cut along U.S. 54 in NE 1/4 sec. 21, T. 37 N., R. 22 W., Hickory County, Missouri (locality 10-a, plate 1).

Fig. 3.—Chouteau limestone on Laird Bluff, center sec. 31, T. 40 N., R. 22 W., Benton County, Missouri (locality 13, plate 1).
The Ordovician is not exposed at this locality; therefore, the complete thickness of the Chouteau could not be determined from the study of surface exposures. This is the southernmost outcrop at which the Chouteau limestone is exposed at the surface. The Chouteau is not present at an outcrop along James River in the SE\textsubscript{\frac{1}{4}} sec. 29, T. 27 N., R. 22 W., Christian County, and it is missing at all outcrops in the vicinity of Galena and Reeds Spring, Stone County. It is also seemingly absent in northwestern Arkansas and northeastern Oklahoma.

The Chouteau limestone is locally absent in the northern part of the area studied for this report. This is probably due to topographic highs on the Ordovician rocks. The lower Northview shale member rests on Ordovician rocks in a road cut along Greene County highway BB just east of Asher Creek in the NE corner sec. 21, and the NW corner sec. 22, T. 31 N., R. 23 W. Kaiser (1945, p. 11) found that the Chouteau limestone was absent near Pape in a road cut near the center sec. 18, T. 37 N., R. 27 W. (locality 54, plate 1), and in a bluff along Clear Creek in the NW corner SE\textsubscript{\frac{1}{4}} sec. 20, T. 37 N., R. 28 W., St. Clair County.

In the area studied for this report the maximum thickness of 18.5 feet for the Chouteau limestone was found in core hole No. 1, site No. 1 of the U. S. Army Engineers in the SW\textsubscript{\frac{1}{4}} SE\textsubscript{\frac{1}{2}} NW\textsubscript{\frac{1}{4}} sec. 19, T. 38 N., R. 25 W., St. Clair County. The Chouteau limestone is 18 feet thick on Laird Bluff along Osage River near the center sec. 31, T. 40 N., R. 22 W. (locality 13, plate 1); 16 feet thick on Jackman Bluff in sec. 1, T. 39 N., R. 23 W., Benton County (locality 12, plate 1); and 16 feet thick on a bluff along the west side of James River in the SE\textsubscript{\frac{1}{4}} sec. 21, T. 29 N., R. 20 W., Greene County (locality 17, plate 1). Nine feet of Chouteau limestone was measured along a road cut and river bank in the center NW\textsubscript{\frac{1}{4}}.
8 feet of it was found in a road cut in the NE\textsuperscript{2} sec. 21, T. 37 N., R. 22 W., Hickory County (locality 10a, plate 1). Eight feet of the Chouteau limestone is exposed at the junction of James River and Turnbo Creek in sec. 3, T. 29 N., R. 19 W., Webster County (locality 16, plate 1).

In discussing the Chouteau limestone along Osage River in western Missouri Kaiser (1945, p. 11) said that between Warsaw and Osceola it ranges in thickness from 13 to 18.5 feet, but from Osceola west it thins rapidly.

According to Moore et al. (1939, p. 5):

Outcrops on Grand River, 14 miles southeast of Miami, Oklahoma, show the presence of about 5 feet of Compton [Chouteau of this report] limestone resting on Chattanooga shale. It is probable that this limestone extends northwesterly beneath a part, or perhaps all, of the Tri-State mining area but it is undoubtedly thin and it lies considerably below the chief zones of mineralization.

Laudon (1938) did not find any rocks of Chouteau age at any of the sections studied by him in northeastern Oklahoma. I believe that the Chouteau limestone is absent in most of the Tri-State mining district.

The Chouteau limestone is widespread in distribution in eastern Kansas, northern Missouri, southeastern Nebraska, southern Iowa, and western Illinois. Abernathy (1943, p. 89) reported 5 feet of Compton (Chouteau of this report) present in the well of the Jayhawk Ordnance Works in the NW corner SE\textsuperscript{4} NE\textsuperscript{4} sec. 4, T. 34 S., R. 25 E., Cherokee County, Kansas.

Lee in 1940 (plate 7) did not find any Chouteau in the St. Louis Sm. and Ref. Co. No. 1 Ballard well in sec. 10, T. 35 S., R. 24 E., Cherokee County, Kansas. He (1940, pp. 30, 31) reports the following thicknesses of the Compton (Chouteau of this report) in wells in eastern Kansas: 29 feet in the Hogueland well in sec. 3, T. 24 S., R. 15 E., Woodson County; 28 feet in the Dahl well in sec. 25, T. 26 S., R. 20 E.,
Allen County; and 10 feet in the Marhenke well in sec. 34, T. 25 S., R. 11 E., Greenwood County.

In 1943 Lee (p. 87) said the following concerning the Chouteau limestone:

The Compton [Chouteau of this report] is 25 to 40 feet thick in most wells in northeastern Kansas but locally, as in part of Franklin county, it is less than 10 feet thick and it wedges out near the Oklahoma border.

Moore (1928, p. 61) gives the following account of the Chouteau limestone in northeastern Missouri:

In southern Pike county and in Lincoln county there is a limestone beneath the Sedalia which is apparently referable to the Chouteau. On Mississippi river this limestone has an exposed thickness of about 20 feet but along Cuivre river east of Troy, it is more than 50 feet thick. The same limestone is observed east of Mississippi river in Calhoun and Jersey counties, Illinois, with unmistakable lithologic and faunal characters of the Chouteau. Its maximum observed thickness in this region is about 55 feet.

Moore (1928, p. 85) measured 25 feet 8 inches of Chouteau limestone at Sweeney, in sec. 4, T. 46 N., R. 19 W., Cooper County, Missouri. He (pp. 87-92) reported the following thicknesses of the Chouteau at other localities in central Missouri: 55 feet on the Sanford Tippett farm, in sec. 12, T. 50 N., R. 18 W., Howard County; 42 feet 9 inches at Providence, Boone County; 40 feet 11 inches at Easley, Boone County; and 10 feet on Little Charette Creek, 1 1/2 miles southeast of Truesdale, Warren County.

Stratigraphic relations.—The Chouteau limestone in the area studied rests unconformably on the Sylamore sandstone, and, where the Sylamore is absent, the Chouteau lies unconformably on rocks of Ordovician age. In northeastern Missouri the Chouteau rests unconformably on the Hannibal formation. In the area studied for this report the Chouteau conformably underlies the Sedalia dolomite in the northern part and the Northview formation in the central part. The Chouteau pinches out in the southern part of the area between Springfield, Greene County, and the
SE$_2^1$ sec. 29, T. 27 N., R. 22 W., Christian County; it apparently dis-
appears southward before the Northview formation pinches out, so that at
no place does the Chouteau limestone underlie rocks younger than Sedalia-
Northview age.

Swallow was considerably confused as to the true stratigraphic re-
lations of the Chouteau limestone. He correctly believed that the Chou-
teau limestone was overlain by the "Enocrinital" limestone (Burlington).
However, he thought that the Chouteau limestone was underlain by the Ver-
micular sandstone and shales (Hannibal) which in turn was underlain by
the Lithographic limestone (Louisiana). We now know that the Hannibal
and Louisiana formations are not present in Cooper County or anywhere
else in southwestern Missouri. Moore (1928, p. 78) recognized this con-
fusion when he said:

Swallow has reported the presence of the "Vermicular sandstone
and shale" in considerable thickness in Cooper County. Examination
by the writer of localities mentioned by Swallow and of descrip-
tions of the lithologic character of the supposed "Vermicular" make
it clear that portions of the "Upper Chouteau" or Sedalia limestone
were mistaken for the northeast Missouri formation. The "Litho-
graphic" (Louisiana) limestone which is also described by Swallow
in Cooper county, on La Mine river, is certainly the Chouteau.

Thus, it is very probable that Swallow (1855) included some of the lower
Burlington beds at some localities in Cooper County in the Chouteau
limestone. This is especially true (as section 17, opposite p. 103)
where he describes the sequence as consisting of Lithographic limestone,
Vermicular sandstone and shale, Chouteau limestone, and Enocrinital lime-
stone.

Broadhead (1874, pp. 65-68) made a similar mistake when he reported
the sequence in Cedar County, Missouri, as follows: Lithographic lime-
stone, Vermicular sandstone and shales, Chouteau limestone, Enocrinital
limestone, and Keokuk group. In this case the Lithographic limestone is
the same as the Chouteau limestone of Moore, the Vermicular sandstone and
shales is the same as the Northview formation, and the Chouteau limestone is probably the upper part of the Sedalia dolomite and the lower part of the Burlington limestone.

Many early geologists made the mistake of correlating the Vermiculur sandstone and shale (Northview) of southwestern Missouri with the Vermiculur sandstone and shale (Hannibal) of northeastern Missouri. This early miscorrelation seemingly influenced Moore (1928, p. 108) to believe that the Northview formation occurred below the Chouteau limestone; therefore when he found a limestone below the Northview formation in Webster and Greene counties, Missouri, he named it the Compton limestone (Moore, 1928, pp. 108, 109, 118-122). Moore was, in a way, aware of discrepancies in his correlations when he (p. 121) said:

A faunal study of the Compton limestone indicates close relationship with the Chouteau of central Missouri. However, its stratigraphic position beneath the Northview sandstone and shale indicates either that the characteristic elements of the Chouteau fauna appeared earlier in the southwest Missouri region than in central Missouri, or that the Northview is relatively younger than has been supposed.

and (p. 122):

It seems best to regard the Compton limestone as a thin extension of a part of the Chouteau limestone of central Missouri. The character of its fauna suggests a position higher in the Kinderhook than would be supposed from its stratigraphic position beneath the Northview formation. It is almost certainly as young as the typical Chouteau limestone, and is not at all equivalent to the Louisiana limestone.

In 1939 (p. 5) Moore said:

The Compton limestone consists of light-blue to bluish-gray fine-grained dense somewhat nodular limestone which is mostly non-ocherty and carries a Kinderhook fauna that corresponds closely to that of the Chouteau limestone of central Missouri.

I have earlier in this discussion pointed out that the Chouteau and Compton limestones are synonymous.
Faunal character.--The Chouteau limestone is generally rather abundantly fossiliferous. The fauna is distinctive of the Chouteau, and it is very closely related to the fauna of the Sedalia and Northview formations. The Chouteau limestone is characterized by the following species: Cleistopora typa (Winchell), Vesiculophyllum sedaliense (White), Hapsiphyllum calaculus (White and Whitfield), Actinocephalus arrosum (S. A. Miller), A. boonensis Peck and Keyte, A. trujugis (S. A. Miller), Cryptoblastus roemer (Shumard), Brachythyrus chouteauensis (Weller), Chonetes gelenparkensis Weller, Leptaena analoga (Phillips), Paraphorhynchus elongatus Weller, Reticularia cooperensis (Swallow), Shumardella obsolens (Hall), Spirifer latior Swallow, S. louisianensis Rowley, and S. platorynotus Weller.

The fauna of the Chouteau limestone of central Missouri is, for all practical purposes, identical with that of the Compton limestone as defined by Moore in 1928 (pp. 118-122). Moore has been aware of this similarity for some time (1928, pp. 121, 122, and 1939, p. 5). Since the Compton and Chouteau formations occupy the same stratigraphic position and have the same fauna and lithology, I recommend that the term Compton be dropped as a synonym of Chouteau.

I obtained collections of fossils from the Chouteau limestone at the following three localities: a quarry in the NE 1/4 sec. 19, T. 40 N., R. 22 W., Benton County (locality 62, plate 1); a quarry and road cut along U. S. highway 54 in the NE 1/4 sec. 21, T. 37 N., R. 22 W., Hickory County (locality 10-a, plate 1); and on the bluff along the west side of James River in the SE 1/4 sec. 21, T. 29 N., R. 20 W., Greene County (locality 17, plate 1).

Age and correlation.--The Chouteau limestone is assigned to the Kinderhookian series, Mississippian system, and lies stratigraphically
between the Hannibal formation below and the Northview and Sedalia formations above.

When Swallow (1855, pp. 101-103) first described the Chouteau limestone, he referred it to the Chemung group of the Devonian system. Broadhead (1874, p. 28) questioned the assumption that Chouteau limestone of southwestern Missouri was of the same age as the Chemung group of New York, but Williams (1896, p. 285) was the first to conclusively prove that the fauna of the Chouteau is Carboniferous and not Devonian.

Clark (1941b, pp. 101-104) described a Compton member of the St. Joe formation in the Cassville quadrangle, Barry County, Missouri, but this is not to be correlated with the Compton limestone as defined by Moore in Webster County, Missouri. Instead, it represents only the lower part of the St. Joe limestone. I do not believe that the Chouteau limestone is present in Barry County.

The Chouteau limestone of southwestern Missouri is correlated with the Chouteau limestone of central and northeastern Missouri. It is the same formation as that which occurs in eastern Kansas and has been called Compton in various publications of the State Geological Survey of Kansas.

**Sedalia Dolomite**

Moore (1928, p. 149) named the Sedalia dolomite for the gray to light-buff "silico-magnesian" limestone which Swallow (1855, pp. 101-103) called Upper Chouteau, and he assigned it to the Osagian series. He regarded the quarry at Sweaney, in sec. 4, T. 46 N., R. 19 W., Cooper County, Missouri, as the type locality for the formation.

The Sedalia dolomite is relatively widespread in distribution. It occurs in Missouri, eastern Kansas, southeastern Nebraska, southern Iowa, and western Illinois. It has a very characteristic and distinctive lithology, and is a good mappable unit which can be traced laterally over
a large area, both on the surface and in the subsurface. The Sedalia dolomite is accepted as a valid formation in this report; it is used to include the same beds that Moore originally assigned to it, but is referred to the Kinderhookian series instead of the Osagian series. The lower non-cherty zone and the cherty zone of the Sedalia dolomite grade laterally southward into the Northview formation.

The Missouri and Kansas Geological Surveys and Branson have all consistently misused the term Sedalia. McQueen and Greene (1938, pp. 32, 33) used the Sedalia dolomite in the subsurface of northwestern Missouri to include only the beds above the cherty zone, and they placed the cherty zone and underlying non-cherty dolomite in the Chouteau formation. They assigned the Sedalia dolomite to the Osagian series. Lee (1940, pp. 37-40) used the Sedalia dolomite in the same sense as McQueen and Greene, but he found the Gilmore City limestone overlying the Sedalia dolomite in the subsurface of Kansas. He said that if the Gilmore City is of Kinderhookian age, as reported by Laudon (1933), then the Sedalia must also be of Kinderhookian age. In this report, Lee (pp. 35, 36) classed the Sedalia and Gilmore City formations as rocks of Kinderhookian or Osagian age. Lee in 1943 (pp. 66-68) assigned all beds between the Chattanooga shale and the Gilmore City limestone in the Forest City basin in Kansas to the Chouteau limestone of the Kinderhookian series. This interval includes the Chouteau and Sedalia formations of this report. However, Lee (p. 67) recognized essentially the same lithologic units that are present in the outcrop area, as shown by the following:

Three members of the Chouteau are recognized in the subsurface of northeastern Kansas: a relatively pure semigranular limestone at the base that corresponds to the Compton limestone [Chouteau of this report] of southeastern Kansas, an impure very cherty sucrose gray dolomite in the middle that corresponds to the Northview shale [Lower and Middle Sedalia of this report], and a brown to buff sucrose dolomite containing only small amounts of chert at the top [Upper Sedalia of this report].
Greene in 1945 lumped all beds in northwestern Missouri between the Chattanooga shale and the Burlington limestone (Chouteau, Sedalia, and Gilmore City formations) into the Chouteau limestone of the Kinderhookian series. Thus, he is using Chouteau almost as synonymous with Kinderhookian. Lee in 1946 (sheet 5) accepted the Sedalia dolomite as valid and placed it in the Kinderhookian series, but he still used it only for the beds above the cherty zone.

Branson (1938 and 1944) has never understood the Sedalia dolomite, even at the type locality. He (1944, p. 199) said:

Moore (1928) united the upper part of the Chouteau and the lower part of the Burlington into a member which he called the Sedalia formation.

and (p. 202):

In the writer's opinion the Sedalia in the western part of the region of outcrop represents upper Chouteau and the eastern part lower Burlington.

General character.—Moore (1928, pp. 151, 152) gives the following description of the Sedalia dolomite from the type locality at Sweeney, in sec. 4, T. 46 N., R. 19 W., Cooper County, Missouri:

<table>
<thead>
<tr>
<th>Sedalia limestone</th>
<th>Thickness</th>
<th>Feet</th>
<th>Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>18. Limestone, light bluish to bluish gray, fine-grained, uniform, lower part thin-bedded, upper part massive, upper surface very even. Contains fossils</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>17. Shale, light bluish to yellowish, calcareous, sandy, especially toward bottom</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Limestone, light blue, lighter and more greenish than beds below, arenaceous. Appears to rest with slight disconformity upon the eroded surface of the subjacent limestone. Greatest thickness</td>
<td>1</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>15. Limestone, light blue, weathering to brown, dolomitic and siliceous, very massive, uniform texture, fracture subconchoidal. Marked by fine stylolites at intervals. The upper surface</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
apparently eroded and markedly uneven to the extent of 9 inches

14. Shale parting, dark bluish

13. Limestone, like 15 with large chert bluish-black flinty nodules with thin white rims, larger in size in the lower part of the bed

12. Shale, calcareous, a prominent parting on weathered surfaces

11. Limestone and chert like 13. The chert occurs in nodules and irregular, discontinuous bands throughout the zone. It is very fossiliferous, especially in the upper part, being crowded with the remains of bryozoans and other fossils

10. Shale parting

9. Limestone like 15

8. Chert, white, in thin, continuous band. The chert resembles a very siliceous limestone rather than the dark flint, and contains many poorly preserved bryozoans and other fossils

7. Limestone, like 15. Very massively bedded. Marked by innumerable fine, horizontal lines which on weathering stand out in relief because of greater resistance to erosion

6. Chert, dark bluish, flinty, in thin persistent band

5. Limestone, like 15

4. Shale parting

3. Limestone like 15

Total

In this report beds 3-7 of above are assigned to the lower non-cherty zone, beds 8-13 to the cherty zone, and beds 14-18 to the upper non-cherty zone.

The Sedalia dolomite of central and southwestern Missouri, where typically developed, is divisible into three easily recognizable lithologic zones. The middle zone is highly cherty, and the lower and upper zones contain little, if any, chert. These three zones are present at the type
locality of the formation. The Sedalia consists essentially of dolomite which is very similar in appearance in all three zones. There are no stratigraphic breaks between the zones. Siltstone beds may occur locally at any horizon in the Sedalia dolomite. Many beds in the Sedalia are highly crinoidal, consisting mostly of stem fragments. Most of these fragments are relatively small in size, thus giving the rock an appearance which I call finely crinoidal. The crinoid fragments are about the same size as those that occur in the Chouteau limestone. On weathering, the crinoid fragments sometimes leach out; this gives the dolomite a porous appearance, but the interstices are not connected. This type of porosity occurs in all three zones of the Sedalia dolomite.

The lower and upper zones may be extremely massively bedded, individual layers being in many places 10 feet or more in thickness. Moore (1928, pl 149) says that these massive beds weather in rather smooth, characteristicly rounded surfaces unlike either the Chouteau or the Burlington.

Dolomite of the lower two-thirds of the Sedalia grades laterally southward into siltstone and shale of the Northview formation in southern Hickory County and northern Cedar and Polk counties. In this transition area it is very difficult to divide the Sedalia dolomite into zones.

Lower non-cherty zone.--This zone consists of gray to tan mottled, silty, calcareous, dense, massive, fossiliferous dolomite which contains very little chert. The silt content ranges from 1 to 50 percent. Some beds are finely crinoidal and at some localities these crinoidal beds are porous. In core hole No. 1, site No. 1, of the U. S. Army Engineers, in the SW¼ SE¼ NW¼ sec. 19, T. 38 N., R. 25 W., St. Clair County, the middle 7 feet of this lower non-cherty zone was found to be highly calcareous, and geologists of the U. S. Army Engineers logged this zone as
Fig. 4.—Chouteau and Sedalia formations in road cut along U.S. 54 in NE¼ sec. 21, T. 37 N., R. 22 W., Hickory County, Missouri (locality 10-a, plate 1). Dolomite in lower part of the Sedalia formation at right-hand side of picture grades laterally into shale.

Fig. 5.—Same road cut as fig. 4.
Fig. 6.—Cherty zone of Sedalia dolomite on Jackman Bluff in sec. 1, T. 39 N., R. 23 W., Benton County, Missouri (locality 12, plate 1).

Fig. 7.—Cherty zone of Sedalia dolomite on Laird Bluff in center sec. 31, T. 40 N., R. 22 W., Benton County, Missouri (locality 13, plate 1).
limestone. The dolomite in the lower part of the Sedalia dolomite grades laterally into a tan dolomitic shale in a road cut along U. S. highway 54 in the NE\(^2\) sec. 21, T. 37 N., R. 22 W., Hickory County (see figs. 4, 5), and a large amount of siltstone occurs in the lower non-cherty zone in a road cut in the NE\(^2\) sec. 8, T. 38 N., R. 24 W., St. Clair County (locality 57, plate 1).

Cherty zone.—This zone is characterized by abundant lens-like chert nodules, siliceous nodules, quartz geodes, and vein fillings and globs of white calcite (see figs. 6, 7). The above forms occur in dolomite that has the same lithologic characteristics as the dolomite in the lower non-cherty zone. The dolomite occurs in thin irregular beds which are usually separated by irregular lens-like chert nodules. The middle 9 feet of this zone in core hole No. 1, site No. 1, of the U. S. Army Engineers, in the SE\(^2\) SW\(^1\) NE\(^2\) sec. 19, T. 38 N., R. 25 W., St. Clair County, was logged as limestone by geologists of the U. S. Army Engineers. The upper part of this cherty zone contains 3\(\frac{1}{2}\) feet of tan, silty, dolomitic, finely crystalline, medium to thin-bedded, crinoidal limestone on Kisinger Bluff along Osage River near the NW corner NE\(^2\) sec. 7, T. 40 N., R. 22 W., Benton County (locality 14, plate 1). The chert is light to dark gray in color, opaque, and fossiliferous. It is almost identical with the chert that occurs in the Chouteau limestone. It occurs in very irregular lens-like nodules usually not more than 6 inches thick and up to 20 feet or more wide. Numerous light-gray rounded siliceous nodules, usually 1 to 2 inches in diameter, were found in dark-gray dolomite at about the horizon of the cherty zone at a road cut and quarry along U. S. highway 54 in the NE\(^2\) sec. 21, T. 37 N., R. 22 W., Hickory County (locality 10-\(a\), plate 1), and in core hole No. 1, site No. 1, of the U. S. Army Engineers.
The quartz geodes that occur in the cherty zone are rounded and range from less than 1 inch to 6 inches in diameter. Most of them are almost solid quartz and have only a small, if any, cavity in the center; however, some of them have large cavities lined with well formed quartz crystals. Quartz geodes are most abundant in the western part of St. Clair County and the northwestern part of Cedar County, especially in the vicinities of Taberville and Eldorado Springs. Literally truck loads of them are weathered out and lying in a road ditch and small stream near the center of sec. 11, T. 36 N., R. 28 W., St. Clair County. A great number of these quartz geodes were used in constructing the spring house in Eldorado Springs.

Quartz geodes were found in road cuts along Missouri highway 83 in the center NE 2 sec. 2 and the SW 2 sec. 27, T. 35 N., R. 23 W., Polk County (localities 8, 9, plate 1). These outcrops are in the transition zone between the Sedalia dolomite phase and the Northview siltstone and shale phase. The geodes are most abundant just at the top of a Sedalia-like dolomite bed, but at the road cut in the SW 2 sec. 27 they seem also to be coming from the Northview shale phase. None of these geodes were found in Benton and Hickory counties.

Vein fillings and globs of white calcite are a distinctive feature of this member throughout most of the outcrop area. The globs are irregular in shape and range up to 6 inches or more in width in the longest dimension.

Upper non-cherty zone.—This member typically consists of gray to tan mottled, silty, calcareous, dense to finely crystalline, thin-bedded to massive, fossiliferous (generally finely crinoidal) dolomite similar in appearance to the dolomite in the lower zones, which is distinguished from the underlying cherty zone by the absence of chert (see fig. 8).
The silt content of the dolomite ranges from 1 to 50 percent. The dolomite of this zone is porous at many places due to the leaching out of relatively small crinoid fragments. Relatively pure limestone beds occur at some localities. Two and one-half feet of gray, dolomitic, silty, dense, medium-bedded limestone occurs in the lower part of this zone in the quarry along U. S. highway 54 in the NE\textsuperscript{4} sec. 21, T. 37 N., R. 22 W., Hickory County (locality 10-a, plate 1). The upper 2 feet of this zone is limestone at Kissing Bluff along Osage River near the NW corner NE\textsuperscript{1} sec. 7, T. 40 N., R. 22 W., Benton County (locality 14, plate 1).

Sedalia-Northview transition.—The lower non-cherty and cherty zones of the Sedalia dolomite grade southward into shale and siltstone of the Northview formation. Hoffman (1927) was the first to suggest this when she said (p. 37):

There is a gradual increase in shale content in the limestone [Sedalia of this report]. The muddy appearance of some of the beds increases southward and more beds take on this aspect. At Gerster and Weableau the entire formation is shaly.

Moore in 1928 did not recognize this transition; in fact, he thought that the Northview formation was stratigraphically lower than the Chouteau limestone. Hoffman's thesis was completed before Moore's paper was published, but most of the field work for Moore's paper was done before 1916. Moore's paper was probably in press by the time Hoffman had completed her study.

Branson (1938, pt. 2, p. 3) was aware of the Sedalia-Northview transition as shown by the following:

The Northview is classed by the writer as a phase of the Chouteau. A thin siltstone which appears in the middle of the Chouteau limestone in the western part of the central area of Missouri (Cooper County) thickens southward.

Branson was using Chouteau in this report in a very broad sense.
Fig. 8.—Contact between Sedalia and Burlington formations on Jackman Bluff, Sec. 1, T. 39 N., R. 23 W., Benton County, Missouri (locality 12, plate 1).
Lee (1940, pp. 31, 32) described the Sedalia-Northview transition in eastern Kansas from a study of well cuttings. In his report, Lee said that the transition was from Northview to Chouteau, but he included in the Chouteau limestone the beds which I refer to the lower non-cherty and the cherty zones of the Sedalia dolomite.

I have found the following evidence in favor of the Sedalia-Northview transition. (1) Both formations rest conformably on the Chouteau limestone; thus they occupy the same stratigraphic position. (2) The Sedalia and Northview formations contain closely related Kinderhookian faunas. The Northview facies contains more molluscan elements than the Sedalia facies. (3) The Sedalia dolomite contains siltstone and shale beds which are similar in appearance to the siltstone and shale of the Northview formation, and dolomite beds occur in the Northview which are lithologically identical with the dolomite of the Sedalia. A Sedalia-like dolomite bed 3 feet thick grades into Northview-like shale within 10 feet in a road cut along U. S. highway 54 in the NE_4 sec. 21, T. 37 N., R. 22 W., Hickory County (locality 10-a, plate 1). Insoluble residues of both formations are alike. (4) Quartz geodes were found in the Northview shale at a road cut along Missouri highway 83 in the SW_4 sec. 27, T. 35 N., R. 23 W., Polk County (locality 9, plate 1). These geodes are identical with those found in the Sedalia dolomite in the Eldorado Springs-Taberville area.

Distribution and thickness.—The Sedalia dolomite occurs in all except the southern part of the area studied for this report. Outcrops are numerous, especially on the bluffs along the major streams. In this area the Sedalia dolomite ranges in thickness from a featheredge to 70 feet, and, in general, there is a gradual thickening from east to west. The maximum thickness was observed on a bluff on the south side of Osage
River near the center of sec. 5, T. 37 N., R. 28 W., St. Clair County (locality 53, plate 1). In the transition zone from Sedalia to Northview, the overall thickness of both formations ranges from 40 to 60 feet.

**Lower non-cherty zone.**—The thickness of this zone ranges from a knife edge to 19 feet. The maximum thickness occurs on the bluff on the south side of Osage River near the center of sec. 5, T. 37 N., R. 28 W., St. Clair County (locality 53, plate 1). This zone is 15.5 feet thick on Jackman Bluff along the north side of Pomme de Terre River in sec. 1, T. 39 N., R. 23 W., Benton County (locality 12, plate 1); 14.7 feet thick in core hole No. 1, site No. 1, of the U. S. Army Engineers in the SE\textsuperscript{1} \text{SE}\textsuperscript{1} NW\textsuperscript{1} sec. 19, T. 38 N., R. 25 W., St. Clair County; and 10 feet thick in a road cut in the NE\textsuperscript{1} sec. 8, T. 38 N., R. 24 W., St. Clair County (locality 57, plate 1). It was found to be only 4 feet thick on Laird Bluff along Osage River near the center of sec. 31, T. 40 N., R. 22 W., Benton County (locality 13, plate 1). The Chouteau limestone at this outcrop is exceptionally thick. The lower non-cherty zone is not all exposed on Kisinger Bluff along Osage River near the NW corner SE\textsuperscript{1} \text{SE}\textsuperscript{1} NW\textsuperscript{1} sec. 7, T. 40 N., R. 22 W., Benton County (locality 14, plate 1).

**Cherty zone.**—This zone ranges in thickness from a featheredge to 26 feet. The minimum and maximum thicknesses occur at the same localities as the minimum and maximum thicknesses of the lower non-cherty zone. The cherty zone has a thickness of 22 feet in a road cut in the NE\textsuperscript{1} sec. 8, T. 38 N., R. 24 W., St. Clair County (locality 57, plate 1); 17 feet in core hole No. 1, site No. 1, of the U. S. Army Engineers in the SW\textsuperscript{1} SE\textsuperscript{1} NW\textsuperscript{1} sec. 19, T. 38 N., R. 25 W., St. Clair County; 11.5 feet on Kisinger Bluff along Osage River near the NW corner NE\textsuperscript{1} sec. 7,
T. 40 N., R. 22 W., Benton County (locality 14, plate 1); and 9.5 feet on Jackman Bluff along the north side of Pomme de Terre River in sec. 1, T. 39 N., R. 23 W., Benton County (locality 12, plate 1).

Upper non-cherty zone.—This zone has a much wider distribution than either of the underlying zones. It ranges in thickness from a feather-edge to 25 feet. The maximum thickness occurs on the bluff on the south side of Osage River near the center of sec. 5, T. 37 N., R. 28 W., St. Clair County. This zone is 17 feet thick in a road cut in the NE\(^2\)/\(_4\) sec. 8, T. 38 N., R. 24 W., St. Clair County (locality 57, plate 1); 16.5 feet thick on a bluff in the SE\(^1\)/\(_2\) NE\(^1\)/\(_2\) sec. 11, T. 33 N., R. 22 W., Polk County (locality 7, plate 1); 15 feet thick in core hole No. 1, site No. 1, of the U. S. Army Engineers in the SW\(^1\)/\(_2\) SE\(^1\)/\(_2\) NW\(^1\)/\(_2\) sec. 19, T. 38 N., R. 25 W., St. Clair County; 12 feet thick on the bluff along Finley River at Lindenlure, Christian County (locality 3, plate 1); 9 feet thick in a road cut along Missouri highway 64 in the center W\(^1\)/\(_2\) W\(^1\)/\(_2\) sec. 11, T. 34 N., R. 26 W., Cedar County (locality 48, plate 1); 8.5 feet thick on Kisinger Bluff along Osage River near the NW corner NE\(_3\)/\(_4\) sec. 7, T. 40 N., R. 22 W., Benton County (locality 14, plate 1); 7.5 feet thick on Laird Bluff along Osage River near the center of sec. 31, T. 40 N., R. 22 W., Benton County (locality 13, plate 1); 7 feet thick in a road cut along Greene County highway BB in the NE corner sec. 21 and the NW corner sec. 22, T. 31 N., R. 23 W. (locality 6, plate 1); and 5 feet thick on Jackman Bluff along the north side of Pomme de Terre River in sec. 1, T. 39 N., R. 23 W., Benton County (locality 12, plate 1). Fourteen and one-half feet of this zone is exposed on Ball Hill in sec. 3, T. 29 N., R. 19 W., Webster County (locality 16, plate 1).

Moore (1928, pp. 149, 150) gives the following account of the Sedalia dolomites:
The Sedalia limestone is most typically developed in the central Missouri region in Pettis, Cooper, Howard and Boone counties, where exposures in quarries and the bluffs of various streams are numerous. Eastward toward Mississippi river exposures are not so abundant but the formation is fairly continuous into Lincoln and St. Louis counties. On the east side of Mississippi river in Jersey, Calhoun and Pike counties, Illinois, it is well developed and may be observed with all characteristic features in the bluffs of Mississippi river as far north as Kinderhook. The magnesian layer (Bed 7) of the Mississippian section at Burlington, is regarded as the equivalent of the Sedalia limestone although it differs somewhat in lithologic character.

In thickness the Sedalia ranges from a minimum of practically nothing to a maximum of about 40 feet in the central portion of the state. In the northeastern part of Missouri the thickness of the formation is nearly constant averaging about 10 to 15 feet. The magnesian limestone (Bed 7) at Burlington, Iowa, is about 3 to 5 feet.

The Sedalia dolomite occurs in the subsurface of northwestern Missouri, northeastern Kansas, southwestern Iowa, and southeastern Nebraska. Geologists who have studied the Sedalia dolomite in this region have not used it to include the same beds that Moore originally assigned to it. Therefore, the thicknesses that have been published for the Sedalia in this area are not in most cases reliable.

Stratigraphic relations.—In much of the area studied for this report the Sedalia dolomite lies conformably on the Chouteau limestone. I found no evidence of a stratigraphic break between the two formations. The Chouteau limestone is absent locally, and at these places the Sedalia dolomite rests either on the Sylamore sandstone, if present, or on rocks of Ordovician age. The lower non-cherty and cherty zones of the Sedalia dolomite occupy the same stratigraphic position as the Northview formation to the south of it. In this southern area, the upper non-cherty zone of the Sedalia dolomite conformably overlaps the Northview formation.

The Sedalia dolomite is unconformably overlain by Osagian rocks ranging in age from St. Joe to Burlington.

All of the above forms also occur in the Chouteau limestone. I believe that the Chouteau and Sedalia formations represent a period of continuous deposition.

The fauna of the Sedalia dolomite is not at all like the fauna of the Fern Glen formation. Although many of the Sedalia species range up into the lower Osagian rocks, the Sedalia is characterized by the absence of the large robust brachiopods such as *Athyris lammellosa* (L'Eveille), *Cliothyridina obmaxima* (Mc Chesney), *Dictyclostus fernglenensis* Weller, and *Spirifer rowleyi* Weller. The camerate crinoids represented in the Sedalia dolomite are characterized by a relative few primitive species of *Actinocrinites*, *Platycrinites* and possibly *Agaricocrinites*. The large array of species belonging to *Cactocrinus*, *Uperocrinus*, *Dorycrinus*, *Batocrinus*, *Macrocrinus* and other genera do not appear until Osagian time. Representatives of these last named genera do not occur in the Sedalia dolomite.

The best faunal collecting in the Sedalia dolomite is from the chert in the cherty zone; however, I did obtain fossils from dolomite.
beds at a few places. On Kisinger Bluff in the NW corner NE^2 sec. 7, T. 40 N., R. 22 W., Benton County (locality 14, plate 1), fossils were collected from the limestone beds at the top of the Sedalia dolomite.

Age and correlation.—I believe that the Sedalia dolomite is Kinderhookian in age rather than Osagian. My reasons for this belief follow. (1) All the species that occur in the Sedalia dolomite are Kinderhookian forms very closely related to species found in the Chouteau limestone. The fauna of the Sedalia dolomite is not closely related to the fauna of the Fern Glen formation as suggested by Moore (1928, p. 150). (2) The lower non-cherty and the cherty zones of the Sedalia dolomite grade laterally southward into the Northview formation, and the Northview formation is accepted as being Kinderhookian in age by practically all geologists. (3) I saw no evidence of a stratigraphic break between the Chouteau and Sedalia formations, and I believe that they represent a period of continuous deposition. (4) The chert in the cherty zone is, for all practical purposes, identical to the chert of the Chouteau limestone. (5) The insoluble residue of the Sedalia dolomite is very similar to that of the Chouteau limestone. (6) Lee (1940) identified rocks of Gilmore City age overlying rocks of Sedalia age in the subsurface of Kansas. Laudon (1933) described a Kinderhookian fauna from the Gilmore City formation. (7) The Sedalia-Northview sea occupied approximately the same basin as the Chouteau sea.

The Sedalia dolomite does not correlate with the Fern Glen formation, as suggested by Moore (1928, p. 150, 151, and 1933). It now seems probable that the Sedalia dolomite is stratigraphically lower than the Hampton rocks of Iowa, which underlie the Gilmore City formation.
Northview Formation

The Northview formation was named by Weller (1901, pp. 140-144) for exposures near Northview, Webster County, where he found the formation most fossiliferous. Weller (p. 140) pointed out that these beds had previously been called the Vermicular sandstone and shale and correlated with the Hannibal shales of northeastern Missouri. This was done by Swallow (1855, pp. 103, 104), Broadhead (1874, pp. 66, 67), and Shepard (1898, pp. 86-92). At the time Weller defined the Northview formation, he said that it certainly was not the equivalent of the typical Hannibal shales.

The Northview formation grades northward into dolomite of the Sedalia dolomite. This transition is discussed under the Sedalia dolomite.

General character.—Weller (1901, p. 140) described the Northview formation as follows:

It is typically made up of two members, a lower bluish shale and an upper fine-grained yellowish sandstone. The two members of the formation grade from one into the other with no sharp line of separation, and one member is frequently thickened at the expense of the other, the lower shale member being the most persistent.

These two members are well developed throughout the outcrop area.

Lower member.—This member is composed of gray to tan silty shale that, i.e., somewhat calcareous or dolomitic. The shale of this member is soft and weathers rapidly from beneath the overlying siltstone. At a few localities the lowest 1 to 2 feet is more silty than the rest of the member. Quartz geodes, similar in appearance to those found in the cherty zone of the Sedalia
dolomite, apparently occur in this lower member of the Northview in a road cut along Missouri highway 83 in the SW 1/4 sec. 27, T. 35 N., R. 23 W., Polk County. This outcrop is in the transition zone from Northview to Sedalia. The lower member of the Northview formation is sparsely fossiliferous.

Upper member.—This member consists of alternating beds of siltstone and shale (see fig. 9). The shale of this member is lithologically identical with the shale of the lower member. The siltstone consists of well-rounded frosted quartz grains that are generally well cemented together with either calcite or dolomite. These last two minerals make up 10 to 25 percent of the siltstone. The siltstone is tan in color, and it is usually massive. At many localities it contains numerous hollow tubes which originally were believed to represent worm borings, thus the term vermicular. It is now generally accepted that these tubes were formed by roots of plants.

Weller (1899, pp. 9-52, and 1901, pp. 140-144) found this member abundantly fossiliferous near Northview, Webster County.

Distribution and thickness.—The Northview formation ranges in thickness from a featheredge to at least 77 feet, which was observed in the vicinity of Northview, Webster County. It is present throughout the central part of the area studied for this report. Numerous outcrops of the Northview formation occur along the major streams in Webster, Greene, northern Christian, Polk, Cedar, southern Hickory, western Wright, and northwestern Douglas counties, and the formation is present in the subsurface of Dade, Lawrence, northern Newton, Jasper, Barton, and southern Vernon counties. The Northview formation does not seem to be present in any of the counties along the southern border of southwestern Missouri. It is not present in the
Fig. 9.—Upper Northview formation in road cut in SE corner NE 1/4 sec. 16, T. 30 N., R. 21 W., Greene County, Missouri (near locality 5-B, plate 1).
Cassville quadrangle of Barry County as reported by Clark (Branson, 1944, pp. 206, 207).

Lower member.—The maximum thickness of this member, 50 feet, was observed in a road cut along U. S. highway 66 in the SW½ sec. 22 and the SW½ sec. 23, T. 30 N., R. 19 W., Webster County, 1 mile north of Northview (locality 15, plate 1). Four feet of shale, which I refer to this member, is exposed along James River in the SW½ SE¼ sec. 29, T. 27 N., R. 22 W., Christian County (locality 2, plate 1). Shepard (1898, p. 67) referred the shale at this outcrop to the Eureka shale (Chattanooga of this report). The 4 feet of shale mentioned above is the only part of the Northview formation present at this locality.

This member is 43.5 feet thick in a road cut along Greene County highway BB in the NE corner sec. 21 and the NW corner sec. 22, T. 31 N., R. 23 W. (locality 6, plate 1); 43 feet thick in a road cut along Missouri highway 64 in the center W½ W⅓ sec. 11, T. 34 N., R. 26 W., Cedar County (locality 48, plate 1); 36 feet thick near the center of the north line sec. 23, T. 30 N., R. 21 W., Greene County (locality 5-a, plate 1); and 25 feet thick on the bluff along Finley River at Lindenlure, Christian County (locality 3, plate 1).

Upper member.—This member was found to be thickest at a road cut along U. S. highway 66 in the SW¼ sec. 22 and the SW¼ sec. 23, T. 30 N., R. 19 W., Webster County (locality 15, plate 1) where it is 27 feet thick. This member is 20.5 feet thick in a road cut along Greene County highway BB in the NE corner sec. 21 and the NW corner sec. 22, T. 31 N., R. 23 W. (locality 6, plate 1); 15.5 feet thick in a road cut along Missouri highway 64 in the center W½ W⅓ sec. 11, T. 34 N., R. 26 W., Cedar County (locality 48, plate 1); and 14 feet thick in a bluff in the SW corner SW¼ sec. 16, T. 30 N., R. 21 W.,
Greene County (locality 5-b, plate 1).

It is absent in the SW\(\frac{1}{4}\) SE\(\frac{3}{4}\) sec. 29, T. 27 N., R. 22 W., (locality 2, plate 1) and at Lindenlure, Christian County (locality 3, plate 1). In the southern area, the upper member apparently was removed by pre-Osagian erosion.

Moore, Fowler, and Lyden (1939, p. 6) said that the Northview formation underlies at least a part of the Tri-State mining district, but, if so, it is undoubtedly thin and discontinuous. They reported 2 feet of Northview exposed on Grand River, southeast of Miami, Oklahoma. Laudon (1939) did not find beds of Northview age at outcrops studied by him in northeastern Oklahoma.

The Northview formation is widespread in the subsurface of southeastern Kansas and the northern part of northeastern Oklahoma. Lee (1940, pp. 30, 31) reports that the Northview formation in southeastern Kansas is thin near the Oklahoma border, but it thickens gradually toward the north. He found a maximum thickness of 61 feet in the Dahl well in sec. 25, T. 26 S., R. 20 E., Allen County. The Northview is only 5 feet thick in the Marhenke well in sec. 34, T. 25 S., R. 11 E., Greenwood County. Lee (1940, pl. 7) did not find beds of Northview age in the St. Louis Sm. & Ref. Co. No. 1 Ballard well in sec. 10, T. 35 S., R. 24 E., Cherokee County.

Abernathy (1943, p. 89) reported 5 feet of Northview shale in the Jayhawk Ordnance Works well in the NW corner SW\(\frac{1}{4}\) NE\(\frac{1}{4}\) sec. 4, T. 34 S., R. 25 E., Cherokee County, Kansas.

Stratigraphic relations.--The Northview formation in most of the area of its occurrence conformably overlies the Chouteau limestone. The Chouteau limestone apparently pinches out southward before the
Northview formation. Thus in the southern part of the area of its occurrence, the Northview formation unconformably overlies the Sylamore sandstone, or, where the Sylamore is absent, the Northview lies on rocks of Ordovician age. I found no outcrops where the Northview forma-
tion and the Chattanooga shale were both present. I believe that the Northview formation pinches out southward before the Chattanooga shale makes its appearance.

The Northview formation is conformably overlain by the upper non-cherty zone of the Sedalia dolomite over a large area. At a few localities, where the Sedalia is missing, rocks of Osagian age rest unconformably on the Northview formation. The Northview formation occupies the same stratigraphic position as the lower two-thirds of the Sedalia dolomite.

**Faunal character.**—The fauna of the Northview formation was first described by Weller in 1899. He found the formation fossiliferous in the neighborhood of Northview, Webster County, and most of his fossils came from that locality. Weller relisted this fauna in 1901 (pp. 140-144). Moore (1923, pp. 125, 126) reported a fauna from the lower shale member from a locality east of Cedar Gap, Wright County. Branson (1938, pt. 2, pp. 3-46) recorded a fauna that he collected from the Northview formation at King Butte in sec. 27, T. 31 N., R. 22 W., Greens County. Fossils are rare in the Northview formation at most localities.

**Typical representative fossils of the Northview formation are**

- *Chonotes glenparkensis* Weller
- *Dielasma chouteanensis* Weller
- *Reticularia cooperensis* (Swallow)
- *Spirifer louisianensis* Rowley
- *Elymella missouriensis* Miller and Gurley
- *Pernopsecten cooperensis* (Shumard)
- *Bellerophon blairi* Miller and Gurley
- *Loxonema temulineatum*
(Shumard), and *Straparollus missouriensis* Miller and Gurley. All of these species are also characteristic of the Chouteau limestone.

**Age and Correlation.**—The Northview formation was assigned to the Kinderhookian series by Weller in 1899, and this has been accepted by most geologists. The fauna of the Northview formation is closely related to the fauna of the Chouteau limestone.

The Northview formation is correlated with the lower and middle zones of the Sedalia dolomite. It does not correlate with the Hannibal formation as suggested by Moore (1928, p. 127), Branson (1938, pt. 2, p. 4), and many earlier geologists; and it is not a member of the St. Joe limestone as suggested by Clark (Branson, 1944, pp. 206, 207).

**OSAGIAN SERIES**

Wachsmuth and Springer (1878, pp. 228, 229) were the first to point out the advisability of considering the Burlington and Keokuk limestones as a stratigraphic unit. They wrote:

> Our late investigations confirm the opinion, long held by us, that the Keokuk limestone and the Upper and Lower Burlington beds are only subdivisions of one geological formation, which might appropriately be called the "crinoidal limestone".

The term Osage group was introduced by Williams (1891, p. 169) to include the Burlington and Keokuk limestones. In 1892, Keyes accepted as valid the Osage limestone to include the Burlington limestone, Keokuk limestone, and Warsaw beds. Later, in 1893 (p. 60), he refused to accept the term Osage because:

> At Osceola [St. Clair county, Missouri], where the most typical section of the "Osage" is exposed, the rocks
appear to be as typical Burlington as at the city of Burlington itself. Recent visits have disclosed no Keokuk whatever at the place in question. One of the chief reasons for proposing Osage was that the beds of southwestern Missouri were thought to contain a mingling of faunas of both Burlington and Keokuk beds. In so far as personal observation goes, the Kinderhook, Burlington, and Keokuk beds are as sharply contrasted lithologically, faunally, and stratigraphically as in southeastern Iowa. From the foregoing it would seem that the "Osage" formation at its typical locality is practically coextensive, and therefore synonymous, with the Burlington limestone.

In the same paper (p. 59) Keyes proposed the term Augusta limestone to include—

those rocks exposed in the Mississippi valley which have heretofore been called the Burlington and Keokuk limestones.

In 1895 Weller pointed out (p. 198) that—

The Osage Group is the earliest name suggested for this series of strata.

Later (1898), he presented additional evidence which favored the acceptance of Osage rather than Augusta. The term Osage, or more recently Osagian, has gained almost universal acceptance. Chamberlin and Salisbury (1906, pp. 501, 502) were the first to regard the Mississippian as a system. At the same time they assigned series rank, for the first time, to the Osagian rocks.

At the time Williams introduced the term Osage Group, he did not give the geographic location from which the name was derived. Thus, no type locality or type area was designated. Keyes (1893, pp. 59, 60) says that Williams suggested—

the title "Osage" from the name of the chief river of southwestern Missouri which cuts through some of the Lower Carboniferous series in Saint Clair county,
and Keyes further stated that the most typical section of Osagian rocks is exposed at Osceola in St. Clair County, Missouri. He also pointed out that there are no rocks of Keokuk age in the Osceola area.

Osceola is in the deepest part of an east-west structural basin, and therefore as much Osagian is present here as any place along Osage River. The Burlington limestone is the only formation of Osagian age represented in the Osceola area, and only about the lower two-thirds of it is present. The most complete section is at the Hunt-Bullard quarry about 1 mile west of town in the NE 1/4 NW 1/4 SE 1/4 sec. 18, T. 36 N., R. 25 W. (locality 56, plate 1). The lowest beds are best exposed in a railroad cut in the town of Osceola 2 blocks east of the dam across Osage River. I am in agreement with Keyes that there are no rocks of Keokuk age in the Osceola area. Thus, it does seem that, as Keyes (1893, p. 60) pointed out, at the most typical section the term Osagian is synonymous with the Burlington limestone. Nevertheless, the term Osagian has gained wide acceptance and should continue to be used.

The area south of Osage River in southwestern Missouri, northwestern Arkansas, and northeastern Oklahoma contains a nearly complete sequence of Osagian rocks. The St. Joe and Reeds Spring limestones occur below the Burlington limestone, and are now referred to the Osagian series, and the Keokuk limestone above the Burlington limestone was originally placed in the Osagian series. I do not know of any one locality in this area where a complete sequence of all four formations is represented. The St. Joe limestone attains a maximum thickness of about 100 feet near Willcockson, Arkansas (Croneis, 1930, p. 46).
and Laudon (1939, fig. 8) reported it to be 103 feet thick on the
west bluff of Illinois River in the center NW\frac{1}{4} sec. 24, T. 18 N.,
R. 22 E., Cherokee County, Oklahoma. The St. Joe is widespread in
distribution in the southern part of southwestern Missouri, north-
western Arkansas, northeastern Oklahoma, and southeastern Kansas.
The Reeds Spring limestone occurs in approximately the same area,
but it seems to extend somewhat farther in all directions than the
St. Joe limestone. The maximum thickness of the Reeds Spring was
reported by Moore (1928, p. 170) to be 225 feet near Wentworth,
Newton County, Missouri. The Reeds Spring limestone is more than
100 feet thick throughout a wide area in this four-state district.
The Burlington limestone is widespread in southwestern Missouri, but
it is only locally represented in northwestern Arkansas, northeastern
Oklahoma, and southeastern Kansas. It attains a maximum thickness of
145 feet in the Springfield, Greene County, area, and has an average
thickness of near 70 feet in much of southwestern Missouri. The Keokuk
limestone occurs only in the southwestern part of southwestern Missouri,
but it is widespread in northwestern Arkansas, northeastern Oklahoma,
and southeastern Kansas. It is best developed in the Tri-State mining
district, where it may reach a thickness of 200 feet or more. In this
study, the Warsaw limestone of many geological reports of this area is
considered as the upper part of the Keokuk limestone. I do not believe
that the Warsaw limestone is represented in southwestern Missouri,
northwestern Arkansas, and northeastern Oklahoma.

St. Joe Limestone

The St. Joe limestone was named by Hopkins (1898, pp. 150, 253)
for the red-colored limestone at the base of the Boone chert which is
entirely free from chert. Cline (1934, p. 1137) said:

Although a type section was not designated [by Hopkins], Girty (1915b, p. 25) has made it clear that the type section is at St. Joe, Arkansas, and is probably in a railroad cut on Mill Creek 1.5 miles north of the railroad station.

The St. Joe limestone is the basal formation of the Osagian series. It is a prominent formation which is widespread in the southern part of southwestern Missouri, southeastern Kansas, northwestern Arkansas, and northeastern Oklahoma. The St. Joe has received attention in most of the many geological reports published about this large area. Moore (1928), Cline (1934), and Laudon (1939) have discussed it at length. Weller (1901, pp. 144-147) named the "Pierson" limestone from exposures along Pierson Creek east of Springfield, Greene County, near the zinc mines. Moore, Fowler, and Lyden (1939, p. 7) stated that the "Pierson" limestone is equivalent in age to the St. Joe limestone. I agree with this correlation, and I recommend that the term "Pierson" be dropped as a synonym of St. Joe. My reasons for this follow. (1) The St. Joe and "Pierson" formations occupy the same stratigraphic position. Both occur at the base of the Osagian series below the Reeds Spring limestone. (2) The fauna of both formations is, for all practical purposes, identical. (3) The lithology of the St. Joe and "Pierson" formations is very similar. The chief difference is that the "Pierson" limestone at the type locality along Pierson Creek east of Springfield, Greene County, is all tan in color, and it does not contain red and green beds which are characteristic of the St. Joe limestone farther south. It seems probable that the "Pierson" limestone in the Springfield area contains a large amount of reworked mud and silt from the Northview formation. Also the "Pierson"
limestone contains considerably more chert than the St. Joe limestone (see figs. 11, 12, 17). I believe that the "Pierson" limestone of the Springfield area was deposited in a somewhat isolated bay or arm of the St. Joe sea. Evidence for this is shown in the outcrop along Finley River at Lindenlure, Christian County (locality 3, plate 1), where the St. Joe limestone is only 5 feet thick; whereas the "Pierson" limestone at the type locality is at least 38 feet thick and at Reeds Spring, Stone County, the St. Joe limestone is 46 feet thick. Thus, the St. Joe limestone is very thin between typical "Pierson" and typical St. Joe. This would account for the slight variation in lithology.

General character.—The St. Joe limestone typically consists of light-grey crinoidal limestone with a red to green silty and shaly zone near the middle. It is generally finely crystalline, and occurs in thin to medium beds. It contains very little chert. In the Springfield, Greene County, area the St. Joe (Pierson of Weller, 1901) is all tan in color, and it contains numerous small chert nodules throughout the entire section.

In northeastern Oklahoma and northwestern Arkansas, the St. Joe limestone is characterized by massive crinoidal bioherms. Landon and Bowsher (1941) described a large number of these bioherms in the Alamogordo member of the Lake Valley formation in New Mexico. The Alamogordo member is correlated with the St. Joe limestone. I did not find these crinoidal bioherms present in southwestern Missouri.

Distribution and thickness.—The St. Joe limestone occurs only in the southern part of the area studied for this report. There are numerous outcrops in McDonald, Barry, Stone, Christian, Greene, and
Webster counties, and a few scattered exposures in adjacent counties. It ranges in thickness from a featheredge to 75 feet, and the average in the southern tier of counties is about 40 feet. The St. Joe limestone is 46 feet thick at Reeds Spring, Stone County, (locality 1, plate 1), and 39 feet thick in sec. 29, T. 27 N., R. 22 W., Christian County (locality 2, plate 1). It is only 5 feet thick at Lindenlure, Christian County (locality 3, plate 1). The St. Joe is 38 feet thick at Turner, Greene County, and 10.5 feet thick on Ball Hill in sec. 3, T. 29 N., R. 19 W., Webster County (locality 16, plate 1). It pinches out a short distance north of Springfield.

Clark (1941b, pp. 96, 97) said that the St. Joe limestone in the Cassville quadrangle, Barry County, ranges in thickness from 26 to 75 feet, with an average thickness of 40 feet. Moore (1928, pp. 162, 163) reported 42.5 feet of St. Joe at the Truitt quarry, south of Elk Springs, and 34 feet 2 inches of St. Joe 1 mile north of Noel, McDonald County.

According to stratigraphic sections given by Laudon (1939), the St. Joe limestone in northeastern Oklahoma ranges in thickness from a featheredge to 103 feet. It is absent along Illinois River in the SE^2 sec. 25, T. 16 N., R. 22 E., Cherokee County, and in the SW^2 sec. 14, T. 13 N., R. 23 E., Sequoyah County.

Cronin (1930, pp. 45, 46) said the following about the St. Joe formation in northwestern Arkansas:

The St. Joe ranges in thickness from a feather edge to about 100 feet and is exposed in practically continuous outcrop, of dendritic pattern, from near Mountain View in Stone County to the Arkansas-Missouri boundary near Seligman, Missouri.

and:
the St. Joe becomes thinner toward the east and the southwest and is thickest in the central and northwestern parts of its area of exposure.

Lee (1940, pp. 48-51) reports that the St. Joe limestone was deposited in southern Kansas along the Oklahoma border as far west as Clark County, and on the Missouri border it has not been identified north of Cherokee County. The St. Joe ranges in thickness from a featheredge to 120 feet in this area.

Abernathy (1943, p. 89) gives a thickness of 22 feet for the St. Joe limestone in the well at the Jayhawk Ordnance Works, in the NW corner SE<sub>1/4</sub> NE<sub>1/4</sub> sec. 4, T. 34 S., R. 25 E., Cherokee County, Kansas.

Stratigraphic relations.—The St. Joe limestone rests unconformably on the Sedalia, Northview, Sylamore, and Chattanooga formations from north to south, and at places it lies on Ordovician rocks. The St. Joe rests on the Sedalia in most of Greene, Christian, and Webster counties, and on Ordovician rocks at outcrops near Galena and Reeds Spring, northern Stone County. The Chattanooga shale underlies the St. Joe limestone in much of Barry, McDonald, and Newton counties. The St. Joe limestone is conformably overlain by the Reeds Spring limestone and at all outcrops studied by me it grades insensibly upward into the Reeds Spring limestone (see fig. 10). Cline (1934, p. 1141) reported an unconformity between the St. Joe and Reeds Spring formations at two localities near Bunch, Oklahoma.

Faunal character.—The following species are common in the St. Joe limestone: Cyathaxonia arcuata Weller, Schizoblastus moorei Cline, Actinocrinites rubra (Weller), Agaricocrinites praecursor Rowley, Phystococrinus smalleyi (Weller), Platycrinites springeri (Weller), Trophocrinus corpulentus Peck, Athyris lamellosa (L'Eveille),
Fig. 10.—Contact between St. Joe and Reeds Spring formations in railroad cut \( \frac{1}{4} \) mile south-east of tunnel, or about 2 miles southeast of Reeds Spring, Stone County, Missouri (locality 1, plate 1).
Brachythryis suborbicularis (Hall), Cliothyridina incrassata (Hall), Cliothyridina obmaxima (McChesney), Dictyoclostus fernglenensis (Weller), Dielasma fernglenense Weller, Pseudosyrinx missouriensis Weller, Rhipidomella oweni Hall and Clarke, Schuchertella fernglenensis (Weller), Spirifer rowleyi Weller, and Spirifer vernonensis Swallow.

Many new species are represented in the St. Joe for the first time. A large part of them were clearly derived from late Kinderhookian forms. The St. Joe limestone contains numerous undescribed species, especially of camerate crinoids.

Age and correlation.—The St. Joe limestone represents the oldest rocks of Osagian age. It is correlated with at least the lower part of the Fern Glen formation of southeastern Missouri. The Alamogordo member of the Lake Valley formation and the St. Joe limestone are approximately the same age.

Reeds Spring Limestone

Moore (1928, pp. 189-192) assigned the name Reeds Spring to the widespread highly cherty limestone that occurs between the St. Joe and Burlington formations. He selected the railroad cuts just southeast of the town of Reeds Spring, Stone County (locality 1, plate 1), as the type locality for the formation. The type locality is well chosen, because this is one of the few places where the Reeds Spring limestone is abundantly fossiliferous.

The Reeds Spring limestone lies conformably on the St. Joe limestone, and is usually very difficult to pick the contact between the two. It is generally placed at the horizon where the limestone becomes cherty (see figs. 10, 17). There is a marked unconformity between the Reeds Spring and Burlington limestones, and all of the Reeds Spring
Fig. 11.—Middle part of St. Joe (Pierson) limestone in road cut at Turner, Greene County, Missouri (locality 18, plate 1).

Fig. 12.—Lower part of St. Joe (Pierson) limestone in road cut at Turner, Greene County, Missouri (locality 18, plate 1).
limestone is stratigraphically older than the Burlington limestone.

In geological reports previous to Moore's paper (1926) the Reeds Spring limestone is usually included in the Boone chert, and in these reports it is difficult to distinguish the Reeds Spring from the overlying limestones. In addition to Moore, Cline (1934) and Laudon (1939) have described the Reeds Spring limestone of the outcrop area in much detail.

General character.—The Reeds Spring limestone consists of about equal parts of limestone and chert (see figs. 13-16, 18). Typically, the limestone is dark gray in color and has a dense lithographic texture, but at some places, as the type locality, it is gray to tan in color and has a finely crystalline fossiliferous texture. The Reeds Spring is somewhat silty at the type locality. The limestone occurs in beds usually not more than 6 or 8 inches thick, which are separated by nearly as much chert. The chert is dark gray to blue in color and occurs in layers of irregularly rounded nodules generally not more than 3 or 4 inches across. It also occurs in massive layers which may reach a thickness of 8 inches, or even more. At most places the Reeds Spring limestone has the same lithologic characters from bottom to top.

Grand Falls chert member.—Smith and Siebenthal defined the Grand Falls chert from the exposure at Grand Falls, Newton County. They referred it to the lowermost Keokuk in the area. Moore (1933, pp. 203, 204) and Cline (1934, p. 1142) thought that the Grand Falls chert should be referred to the uppermost Reeds Spring limestone. I am in agreement with this. It seems to me that the Grand Falls chert at the type locality represents a highly mineralized zone of the upper Reeds Spring limestone formed during mineralization of the
Fig. 13.—Upper part of Reeds Spring limestone in quarry south of railroad about 1 mile southeast of Reeds Spring, Stone County, Missouri (locality 1, plate 1).

Fig. 14.—Lower part of Reeds Spring limestone along railroad about 1/8 mile southeast of tunnel, or about 2 miles southeast of Reeds Spring, Stone County, Missouri (locality 1, plate 1).
Fig. 15.—Lower part of Reeds Spring limestone in railroad cut at west end of tunnel about 1 mile southeast of Reeds Spring, Stone County, Missouri (locality 1, plate 1).

Fig. 16.—Same railroad cut as fig. 15.
Tri-State mining district, and that it is not a widespread stratigraphic marker. As evidence of this, the Grand Falls chert is not present in the stratigraphic section one-fourth to one-half mile downstream from its type locality. Landon (1939) did not find the Grand Falls chert in northeastern Oklahoma. Clark employed the term Grand Falls for the upper highly cherty beds in the Reeds Spring limestone in the Cassville quadrangle, Barry County, but I doubt that these beds correlate with the Grand Falls chert at the type locality.

**Distribution and thickness.**—The Reeds Spring and St. Joe limestones have approximately the same distribution in the area studied for this report. Outcrops of the Reeds Spring occur in McDonald, Newton, Jasper, Barry, Stone, Christian, Greene, Webster, and Lawrence counties. In this area it ranges in thickness from a featheredge to 225 feet. The Reeds Spring limestone thins to the north and completely pinches out in the area immediately north of Springfield, Greene County. It is 120 feet thick at Reeds Spring, Stone County (locality 1, plate 1), 92 feet thick at Lindenlure, Christian County (locality 3, plate 1), 75 feet thick in the Waking et al. No. 1 H. Doubler well in sec. 30, T. 29 N., R. 22 W., Greene County (locality 4, plate 1), and 54.5 feet thick on Ball Hill in sec. 3, T. 29 N., R. 19 W., Webster County.

Clark (1941b, pp. 117, 118) reports that in the Cassville quadrangle, Barry County:

> The thickness of the Reeds Spring formation varies from 110 feet to 175 feet, with an average thickness of 120 feet.

\[(1941\text{b}, p. 117)\]

Moore said:

> In southwestern Missouri the Reeds Spring limestone ranges in thickness from about 130 feet east of Oronogo
and near Porto Rico to 225 feet near Wentworth. The average of some scores of records in the Joplin district is around 150 feet.

There are numerous outcrops of Reeds Spring limestone in northwestern Arkansas and northeastern Oklahoma. Laudon (1939, p. 328) said that in northeastern Oklahoma the thickness ranges from 186 feet along Grand River southwest of Grove to as little as 21 feet in the sections north of Marble City.

Lee (1940, pp. 53-57) wrote that the Reeds Spring limestone is present in the subsurface of southern Kansas, and that it extends westward beyond the area of the St. Joe and overlaps upon the Kinderhookian surface. In this area it ranges in thickness from a feather-edge to 142 feet.

Abernathy (1943, p. 89) gives a thickness of 125 feet for the Reeds Spring limestone in the Jayhawk Ordnance Works well in the NW corner SE 1/4 NE 1/4 sec. 4, T. 31 S., R. 25 E., Cherokee County, Kansas.

**Stratigraphic relations.**—The Reeds Spring limestone lies conformably on the St. Joe limestone throughout most of the area of its occurrence. However, the Reeds Spring limestone extends somewhat beyond the area of the St. Joe limestone, and in this peripheral area it overlaps on to various Kinderhookian rocks. The Reeds Spring limestone is unconformably overlain by the Burlington limestone in Stone, Christian, Greene, Lawrence, and Webster counties. West of this area, the Burlington limestone pinches out, and the Keokuk limestone rests unconformably on the Reeds Spring limestone in the extreme southwestern part of Missouri, northwestern Arkansas, northeastern Oklahoma, and southeastern Kansas.

**Faunal character.**—The Reeds Spring limestone is non-fossiliferous
Fig. 17.--Contact between St. Joe (Pierson) and Reeds Spring formations in road cut at Turner, Greene County, Missouri (locality 18, plate 1).

Fig. 18.--Reeds Spring limestone in road cut at Turner, Greene County, Missouri (locality 18, plate 1).
at most localities. There are a few places, however, where it is abundantly fossiliferous; one of these is at the type locality. Moore (1928, pp. 190-193) obtained fossils from the Reeds Spring 1 mile west of Grand Falls in the SE\textsuperscript{3} SE\textsuperscript{3} sec. 29, T. 37 N., R. 33 W., Newton County, and 1-1/4 miles east of Crane, Stone County. In addition to the above three localities, Cline (1934, pp. 1144, 1145) collected from the Reeds Spring limestone at Noel, Missouri, at the dam at Spavinaw, Oklahoma, and south of the bridge over Spring Creek, 5.5 miles south of Locust Grove, Oklahoma. Cline prepared a faunal list of all known species from the Reeds Spring limestone.

The Reeds Spring limestone is characterized by Cyathaxonia arcuata Weller, Schizoblastus sayi Shumard, Actinocrinites rubra (Weller). Agaricocrinites praecursor Rowley, Physocorynus amalayi (Weller), Platycrinus springeri (Weller), Trophocrinus corpulentus Peck, Evactinopora sexradiata Meek and Worthen, Athyris lamellosa (L'Eveille), Ciithyridina obmaxima (McChesney), Dictyoclostus burlingtonensis (Hall), D. fernglenensis (Weller), Dipleasma fernglenense Weller, Pseudosyrinx missouriensis Weller, Ehipidomella oweni Hall and Clarke, Schuchertella fernglenensis (Weller), and Spirifer rowleyi Weller. As a whole, the fauna of the Reeds Spring limestone is very similar to the fauna of the St. Joe limestone. Some of the Reeds Spring species clearly indicate advanced stages of evolution over the St. Joe forms, however, these differences have not yet been recorded in the literature. The Reeds Spring limestone contains a wealth of undescribed species.

Age and correlation.—The Reeds Spring limestone is assigned to the lower part of the Osagian series, just above the St. Joe limestone. The Reeds Spring limestone contains essentially a late
Fern Glen fauna, and Moore (1933, pp. 203, 204) recognized beds of Reeds Spring age in the type Fern Glen section near St. Louis, Missouri. Thus the Reeds Spring is correlated with the upper cherty part of the Fern Glen.

Moore in 1928 (p. 191) believed that the Reeds Spring limestone is the time equivalent of at least a part of the lower division of the Burlington. However, in 1933 (pp. 203, 204) he said:

A disconformity above the Reeds Spring limestone and a marked difference in faunal characters serve to separate beds of Fern Glen age from the succeeding Burlington limestone.

Cline (1934, p. 1146) reported that the Reeds Spring limestone seems to be pre-Burlington in age. Evidence presented in this report indicates that there is a marked unconformity between Reeds Spring and Burlington time, which bears out Moore's 1933 conclusion.

Burlington Limestone

The Burlington limestone was named by James Hall in 1857 to include the beds which had previously been called the "Encrinital limestone". Faunal zones in the Burlington formation were first defined satisfactorily by Rowley in 1908, who recognized the following horizons in the lower part in Pike County, Missouri: Batocrinus calvini horizon, Uperocrinus longirostris horizon, and Cactocrinus expansus horizon. In the same area, Laudon (1937) used the zones defined by Rowley, but he preferred to call Rowley's Cactocrinus expansus horizon the Cactocrinus proboscidialis zone. He recognized a unit between the Uperocrinus longirostris and Cactocrinus proboscidialis zones which he called the Cryptoblastus melo zone. Laudon divided
the Burlington limestone above the *Cactocrinus proboscidialis* zone into the *Physetocrinus ventricosus* zone, *Dizygocrinus rotundus* zone, and *Pentremites elongatus* zone. The faunal zones as defined by Laudon are recognizable in southwestern Missouri. The *Batocrinus calvini* and *Uperocrinus longirostris* zones are much thinner in southwestern Missouri than in Pike County, and I was not able to distinguish between the two. They are treated as one zone in this report. Also the *Dizygocrinus rotundus* and *Pentremites elongatus* zones of Laudon are considered as one stratigraphic unit in southwestern Missouri.

In addition, a persistent zone, generally 1 to 2 feet thick, occurs below the *Batocrinus calvini* zone in the area studied for this report. It is composed of very thin irregularly bedded limestone which contains an abundant *Spirifer* fauna. Accordingly, this unit is called the *Spirifer* zone.

**General character.**—The Burlington limestone is divisible into two relatively distinct lithologic units. The lowest of these consists of about the lower one-third of the formation and includes the *Spirifer*, *Batocrinus calvini*, *Uperocrinus longirostris* and *Cryptoblastus mele* faunal zones. This lower part of the Burlington limestone is composed of alternate beds of brown and gray, fine to coarse-grained, crinoidal limestone with numerous brown dolomite beds. The limestone is somewhat silty, and locally siltstone beds occur at the base of the formation. The upper part of the *Cryptoblastus mele* zone is marked over a wide area along Osage River by a distinctively nodular dark-blue algae-like limestone bed. Chert is relatively scarce in this part of the Burlington limestone.

At several localities in St. Clair and Vernon counties the lower part of the Burlington limestone is not typically developed.
Fig. 19.—Lower part of Burlington limestone on bluff along Little Sac River near SW corner SE$_2$ sec. 16, T. 30 N., R. 21 W., Greene County, Missouri (locality 5-b, plate 1).

Fig. 20.—Lower part of Burlington limestone on Jackman Bluff in sec. 1, T. 39 N., R. 23 W., Benton County, Missouri (locality 12, plate 1).
In the NE\textsuperscript{\%} sec. 16, T. 37 N., R. 25 W., St. Clair County (locality 58, plate 1), the Burlington is represented by massive, tan, porous dolomite. The dolomite matrix contains numerous small fragments of crinoid remains. Some of the dolomite beds are conglomeratic and contain angular fragments of limestone, chert, and tan mud globs. Interbedded in the dolomite is one bed of deep-blue, finely crystalline limestone about 2 feet thick. The Burlington limestone has approximately these same characteristics in the W 1/2 sec. 27, T. 37 N., R. 25 W. (locality 59, plate 1), in the W 1/2 NE\textsuperscript{\%} sec. 31, T. 37 N., R. 28 W., St. Clair County (locality 51, plate 1), and in the Belvoir quarry, in the SE\textsuperscript{\%} sec. 26, T. 38 N., R. 30 W., Vernon County (locality 52, plate 1).

The upper two-thirds of the Burlington limestone, including the 

\textit{Physetocrinus ventricosus}, and \textit{Pentremites elongatus-Dizygoocrinus rotundus} faunal zones, is composed of almost pure gray to white, coarsely crystalline, highly crinoidal, medium to very thick-bedded limestone. Stylolites are abundant, and this part of the Burlington limestone contains a large amount of chert at many localities. The chert occurs in elliptical white nodules, usually not more than 6 or 8 inches in thickness, which are arranged in noncontinuous layers. These cherty layers cannot be traced from one locality to another. The chert content increases from north to south. The Burlington limestone contains very little chert in Benton County. It contains a considerable amount of chert at Osceola, St. Clair County, and is highly cherty in Greene County. However, the chert is not distributed equally in the Burlington limestone from one place to another, and very little chert can be found at some localities in the southern part of the area. The 28 feet of Burlington limestone exposed in a quarry in the NE corner SE\textsuperscript{\%} SE\textsuperscript{\%} sec.
Distribution and thickness.—The Burlington limestone is widely distributed in southwestern Missouri. It forms the crest of most of the bluffs along the major streams throughout the area. It has been removed by erosion from much of the eastern part of the area studied for this report. It seemingly was never deposited in the Tri-State mining district.

The Burlington limestone ranges in thickness from a featheredge to 145 feet. It is thickest in the Springfield area, Greene County. The average thickness over a large part of the area is probably near 70 feet. I do not know of any single locality where a complete section of the Burlington limestone is exposed.

This formation thins by transgressive overlap against the underlying Reeds Spring limestone south and west from Springfield. At Lindenlure in Christian County (locality 3, plate 1) and Reeds Spring in Stone County (locality 1, plate 1) the Physaeocrinus ventricosus zone rests unconformably on the Reeds Spring limestone. The Pentremites elongatus-Dizygoecrinus rotundus zone is present at Mt. Vernon, Lawrence County, but the Burlington limestone pinches out between this locality and the Tri-State mining district. From the above, it seems that in southwestern Missouri the Burlington limestone was deposited in a gradually expanding sea. Accordingly, the Pentremites elongatus-Dizygoecrinus rotundus zone was deposited over a larger area than any of the underlying zones. Apparently the sea continued to expand into Keokuk time, and the Keokuk limestone was deposited over a larger area than the Burlington limestone.

The Burlington limestone is exposed over a large area in northeastern, central, and southwestern Missouri; southeastern Iowa; western
Illinois; western Kentucky; and northern Arkansas. It is present in the subsurface of much of Kansas, western Oklahoma, southern Nebraska, southwestern Iowa, and northwestern Missouri.

Stratigraphie relations.--The Burlington limestone occurs stratigraphically between the Reeds Spring and Keokuk formations. There is a marked unconformity between the Reeds Spring and Burlington formations. The Reeds Spring and St. Joe formations pinch out northward a short distance north of Springfield, Greene County, and in the area north of this the Burlington limestone rests unconformably on the Northview or Sedalia formations.

The Keokuk limestone rests conformably on the Burlington limestone in the southwestern part of the area studied for this report. Throughout the remainder of the area the Burlington limestone is either the surface formation or is covered by a thin veneer of Pennsylvanian sediments. However, the Keokuk limestone was seemingly deposited over the whole area. Keokuk chert was found loose on the surface at most localities studied. The Keokuk limestone and the upper part of the Burlington limestone was removed from much of the area by pre-Pennsylvanian erosion. In the area just east of the Eldorado Springs fault (Kaiser, 1945, pp. 30-32) the Sedalia dolomite is overlain by Pennsylvanian sediments, and in the eastern part of the area studied Pennsylvanian deposits overlie rocks ranging in age from Burlington to Ordovician. Thus the Burlington limestone was completely eroded from some of the area before Pennsylvanian time. Channel sandstones of Pennsylvanian age are entrenched deeply into Mississippian rocks at many places in the western part of the area.

Faunal character.--The following life zones are recognizable in
the Burlington limestone of southwestern Missouri:

- **Pentremites elongatus-Dizygoocrinus rotundus zone**
- **Physetocrinus ventricosus zone**
- **Cactocrinus proboscidialis zone**
- **Cryptoblastus melo zone**
- **Batoocrinus calvini-Uperoocrinus longirostris zone**
- **Spirifer zone**

These life zones are defined by faunal assemblages, not by the geological range of any single species. An index fossil of one zone may occur in either underlying or overlying zones, but is always most abundant in the zone it helps to define. The boundary between zones is gradational and does not necessarily occur at a lithologic break, but lithologic breaks were used wherever possible. At many localities where identifiable fossils in the Burlington limestone are scarce, it is almost impossible to tell what zone is represented.

**Spirifer zone.**—This is the most diagnostic zone in the Burlington limestone of southwestern Missouri, and represents the oldest known deposits of Burlington age. It seemingly was deposited only in relatively low topographic places on the underlying surface. The Spirifer zone consists of gray, coarsely crystalline, very thin irregularly bedded, highly fossiliferous limestone. It is not more than 2 feet thick at most localities.

The Spirifer zone is characterized by abundant fragmental remains of Spirifer valves. Most of the specimens belong to one species which seems to be most closely related to Spirifer centronatus Winchell, although it occurs stratigraphically higher than S. centronatus Winchell has been reported. In some respects the species seems to be intermediate
between *S. centronatus* Winchell and *S. shepardi* Weller. A few individuals are questionably referred to *S. shepardi* Weller. All individuals are widest along the hinge line, which ranges up to 36 mm. The length of the shell ranges from 20 to 25 mm., and the convexity of the adult valves is generally 6 to 8 mm. The mesial sulcus on the pedicle valve is very shallow, and contains three to six plications. The lateral slopes are marked by 15 to 18 plications. The mesial fold on the brachial valve is depressed, and is marked most commonly by four plications. The lateral slopes are marked by 15 to 18 plications.

Other forms common in the *Spirifer* zone are *Brachythysis suborbicularis* (Hall), *Rhynochopora persinuata* (Winchell), *Spirifer mundulus* Rowley, *S. rowleyi* Weller, and *S. vernonensis* Swallow.

The *Spirifer* zone is most typically developed at Sac-Osage Heights on the south bluff of Osage River in the N 1/2 SE₁₄ sec. 8, T. 37 N., R. 26 W., St. Clair County (locality 55, plate 1). It also outcrops at the following localities: Jackman Bluff, sec. 1, T. 39 N., R. 23 W., Benton County (locality 12, plate 1); east side of Sac River in the SE₁₄ sec. 10, T. 33 N., R. 26 W., Cedar County; east bluff of Pomme de Terre River in the SE₁₄ NW₁₄ NE₁₄ sec. 11, T. 33 N., R. 22 W., Polk County (locality 7, plate 1); and south bluff of Little Sac River in the SW corner SE₁₄ sec. 16, T. 30 N., R. 21 W., Greene County (locality 5-b, plate 1).

*Batoocrinus calvini-Upcrocrinus longirostris* zone—Gray to brown, silty, finely crystalline, medium-bedded, slightly crinoidal limestone composes this zone. At some places thin beds of brown silty dolomite are interbedded with the limestone. At Osceola, St. Clair County, this zone is cross-bedded and contains some chert. This zone ranges in thickness from a featheredge to 18 feet.
The species which occur commonly in this zone are Triplophyllites cliffordanus (Milne-Edwards and Haime), Agaricocorinites pyramidatus (Hall), Batoorinus aequalis (Hall), B. subaequalis (MoChesney), Caecocrinus extensus Wachsmuth and Springer, C. multibrachiatus (Hall), Coelocrinus ventricosus (Hall), Dorycrinus unicornis (Owen and Shumard), and Uperocrinus longirostris (Hall). Batoorinus calvini is rare in southwestern Missouri.

Rowley (1908, pp. 36, 37) defined the Batoorinus calvini horizon and the Uperocrinus longirostris horizon from exposures of the Burlington formation in Pike County, Missouri, and Laudon (1937, pp. 1162, 1163) retained these terms in the same area. These two zones are thinner in the area included in this report than in Pike County, and outcrops where a large number of fossils can be collected are scarce in southwestern Missouri. Accordingly, the Batoorinus calvini zone and the Uperocrinus longirostris zones are not separated in this report.

The Batoorinus calvini-Uperocrinus longirostris zone is most typically developed in the Osceola, St. Clair County, area. The best places to study it are in a railroad cut 2 blocks east of the dam in Osceola and in a road cut on the west side of Osage River in the SW¼ sec. 9, T. 38 N., R. 25 W. Representative fossils of the zone were collected from the following localities: road cut at the center of the north line sec. 27, T. 39 N., R. 23 W., Benton County; road cut along highway Mo. 64 just east of Sac River in the center 1/2 W 1/2 sec. 11, T. 34 N., R. 26 W., Cedar County; road cut along highway BB in the NE corner sec. 21 and the NW corner sec. 22, T. 31 N., R. 23 W., Greene County; exposure in road ditch on the south side of U. S. 54 at the east edge of Collins, St. Clair County; and road cut along U. S. 54 in the NW¼ sec. 7, T. 36 N., R. 23 W., Hickory County.
Cryptoblastus melo zone—This zone is made up of gray to brown, medium crystalline, medium-bedded, crinoidal limestone, containing thin interbedded layers of brown silty dolomite. A dark-blue, nodular, algal-like limestone bed, 1 to 2 feet thick, defines the top of this zone over most of the area. The Cryptoblastus melo zone ranges in thickness from a knife edge to 13 feet. The zone is characterized by numerous specimens of Cryptoblastus melo var. melo Cline. Most of the species that are found in the Batoocrinus calvini-Uperocrinus longirostris zone are also present in this zone. No specimens of Orophocrinus stelliformis Shumard, which Howley and Laudon listed from this zone in Pike County, Missouri, have been found to my knowledge in southwestern Missouri.

The Cryptoblastus melo zone is generally well exposed at the same places as the Batoocrinus calvini-Uperocrinus longirostris zone.

Cactocrinus proboscidialis zone—This zone is composed of gray to tan, coarsely crystalline, massive, crinoidal limestone. Numerous fossiliferous chert nodules are present in the vicinity of Osceola, St. Clair County, but throughout the rest of the area this zone is surprisingly free from chert. The thickness of the zone ranges from a feather-edge to 26 feet. This is the zone often referred to as the "white ledge" by quarry men.

Moore (1926, pp. 186, 187) listed an extensive fauna from the chert nodules that are found in this zone at the Hunt-Bullard quarry near Osceola (locality 56, plate 1). It is difficult to obtain identifiable fossils from this zone, as it usually occurs in steep cliffs along the outcrop. Laudon (1937, p. 1162) lists Cactocrinus proboscidialis (Hall), C. multibrachiatuus (Hall), C. claris (Hall), C. reticulatus (Hall), Decadoocrinus rudis (Miller and Gurley), D. perplexus (Mack and
Worthen), Cyathoorinuss fragilis Miller and Gurley as common species in
this zone in Pike County, Missouri. The maximum development of
Cactoorinus was in this zone.

It is difficult to define the upper boundary of the Cactoorinus
proboscidialis zone because fossils are scarce and no lithologic break
is present except in the vicinity of Osceola, where a local unconformity
forms the boundary between the Cactoorinus proboscidialis and Physe-
etoorinus ventricosus zones.

Physetoorinus ventricosus zone—Gray, coarsely crystalline, massive,
crinoidal limestone composes this zone. It ranges in thickness from a
featheredge to 51 feet. The following fossils characterize this zone:
Actinoorinutes scitulus Meek and Worthen, Agaricoorinutes planoconvexus
(Hall), Cactoorinus caelatus (Hall), Eutroehoorinuates christyi (Shumard),
Macroorinus konincki (Shumard), Perieochoorinus whitei (Hall), Physeto-
orinus ventricosus (Hall), Platyorinus excavatus Hall, P. nodostriatus
Wachsmuth and Springer, Rhodoorinus barrisi Hall, and Uperoorinus
pyriformis (Shumard).

An unconformity of local extent is present at the base of the
Physetoorinus ventricosus zone in the vicinity of Osceola, St. Clair
County (see figs. 21, 22). Evidence for the unconformity is found at
the Hunt-Bullard quarry (locality 56, plate 1) as pointed out by Moore
(1928, pp. 185, 186), who wrote:

At Osceola, in St. Clair County, crinoidal limestone of
typical Burlington aspect is observed. Above the beds men-
tioned an erosional break is indicated by the somewhat uneven
upper surface of the limestone and the occurrence of a chert
conglomerate at the base of the succeeding limestone. The
pebbles in the conglomerate include several kinds of chert,
many of the fragments being angular and showing on one side
a somewhat porous, chalky weathering or a rim like that seen
in some of the subjacent Mississippian rocks. Burlington,
Kinderhook, and possibly older cherts may be recognized, but
lithologic character and fossils show that most of the chert
Fig. 21.—Disconformity in Burlington limestone at the Hunt-Bullard Quarry, NE3/4 NW3/4 SW1/4 sec. 18, T. 38 N., R. 25 W., St. Clair County, Missouri (locality 56, plate 1). Contact between Cactocrinus and Physetocrinus zones is placed at the base of this disconformity.

Fig. 22.—Closer view of fig. 21.
Fig. 23.—Physetocrinus zone of Burlington limestone on Kisinger Bluff in NW corner NE\(\frac{1}{4}\) sec. 7, T. 40 N., R. 22 W., Benton County, Missouri (locality 14, plate 1).
Fig. 24.—*Physococrimus* zone of Burlington limestone along road cut in NE¼ sec. 27, T. 29 N., R. 21 W., Greene County, Missouri (locality 19, plate 1).

Fig. 25.—*Physococrimus* zone in Burlington limestone at south end of quarry south of railroad about 1 mile southeast of Reeds Spring, Stone County, Missouri (locality 1, plate 1).
was derived from the Lower Burlington. Fossils partly weathered from the chert before redeposition project into the limestone matrix. The shapes, kinds and arrangement of the chert fragments show that this is a true conglomerate, and it indicates a hiatus at this horizon.

Moore tentatively identified the beds above the break as Keokuk. I collected Agaricocrinites planoconvexus (Hall), Aorocrinus parvus (Shumard), Cactocrinus glans (Hall), Eutrochoocrinus christyi (Shumard), Macrocrinus koninoki (Shumard), Physetocrinus ventricosus (Hall), Uperocrinus pyriformis (Shumard), and Rhipidomella burlingtonensis (Hall) from the recently weathered surfaces of these beds. Accordingly, these beds are assigned to the Physetocrinus ventricosus zone. The erosional break described above is present in a quarry in the SW 1/4 sec. 5, T. 38 N., R. 25 W., St. Clair County.

The Physetocrinus ventricosus zone is exposed over a larger area in southwestern Missouri than any other zone in the Burlington limestone. It forms the crest of most of the high bluffs from the northern part of the area to the southern part (see fig. 23). Typical zone fossils can be obtained from it at many localities.

Pentremites elongatus-Dizygoocrinus rotundus zone—This zone consists of gray to white, coarsely crystalline, very thick-bedded, highly crinoidal limestone. The thickness of this zone ranges from a feather-edge to 60 feet. A large number of elliptical chert nodules are present in layers in the limestone. The following species are typical of this zone: Metablastus lineatus (Shumard), Orbitremites norwoodi (Owen and Shumard), Pentremites elongatus (Shumard), Schizoblastus sayi var. sayi Cline, Actinocrinites multiradiatus (Shumard), A. verrucosus Hall, Agaricocrinites bellatrena (Hall), A. inflatus (Hall), Dichocrinus striatus (Owen and Shumard), Dizygoocrinus rotundus (Yandell and Shumard), Macrocrinus varneuilianus (Shumard), Physetocrinus ornatus
Fig. 26.—Pentamites—Dicyocelis zone of Burlington limestone at quarry of Garrett Construction Co. in north part of Springfield, Greene County, Missouri (locality 22, plate 1).

Fig. 27.—Same quarry as fig. 26.
Fig. 28.—*Pentremaites-Dizygoocrinus* zone of Burlington limestone in quarry of Ash Grove Lime and Cement Co., Springfield, Greene County, Missouri (locality 23, plate 1).
Fig. 29.—Pentremites-Dipygocrimus zone in Burlington limestone in quarry of Ash Grove Lime and Cement Co. at Galloway, Greene County, Missouri (locality 20, plate 1).

Fig. 30.—Same quarry as fig. 29.
(Hall), Strotoocrinus regalis (Hall), and Teleiocrinus umbrosus (Hall).

Laudon (1937, pp. 1162, 1163) differentiated between the Pentremites elongatus and Dizygoocrinus rotundus zones in Iowa on the basis of lithology. There is no lithologic break between these two zones in southwestern Missouri, and I do not have complete enough faunal collections to distinguish between them. Accordingly I have considered them as one unit in this study.

In southwestern Missouri the Pentremites elongatus-Dizygoocrinus rotundus zone is present only in Greene and Lawrence Counties, and a few outliers are probably present in surrounding counties. The best collecting from this zone is from the upper weathered parts in quarries at Springfield, Galloway, Ash Grove, Phenix, Greene County, and Mt. Vernon, Lawrence County (see figs. 26-30).

Age and correlation--The Burlington limestone is about middle Osagian in age. Species contained in the Burlington limestone are, for the most part, intermediate in development between similar forms in the early Osage St. Joe-Reeds Spring limestone, and the late Osage Keokuk limestone. Among the productive brachiopods a distinct trend in evolution can be followed from Dictyoclostus arcuatus (Hall) of the Kinderhookian through D. ferglenensis (Weller) of the St. Joe-Reeds Spring to D. burlingtonensis (Hall) of the Burlington limestone. In the spiriferoid brachiopods a similar trend can be followed from Spirifer graceri Weller of the Kinderhookian through S. rowleyi Weller of the St. Joe-Reeds Spring to S. grimesi Hall of the Burlington, and finally to S. logani Hall of the Keokuk.

The Actinoocrinitidae, Batoocrinidae, and Desmidoerinidae of the camerate crinoids took part in a remarkable development during Burlington time, which culminated in a wholesale extinction at the end of
Burlington time. The actinocrinitidae are represented in the St. Joe-Reeds Spring sequence by a relatively few, small, simple forms of *Actinocrinites* and *Physetocrinus*. *Cactocrinus* appeared suddenly in the lower Burlington and almost immediately developed into a large number of species. They are abundant in the *Batocrinus calvini-* *Uperocrinus longirostris* and *Cryptoblastus melo* zones; and they reached their maximum development in the *Cactocrinus proboscidialis* zone. Relatively few species of *Cactocrinus* are present in the *Physetocrinus ventricosus* zone, and *Cactocrinus glans* is the only species present in the *Pentremites elongatus*-Dizygoorinus rotundus* zone. *Actinocrinites*, *Physetocrinus*, *Strotoocrinus*, and *Steganocrinus* reached a maximum number of large, bizarre species in the *Pentremites elongatus*-Dizygoorinus rotundus* zone, and culminated in the huge actinocrinids of the Keokuk.

The batoocrinids of the lower Burlington expanded gradually and reached a culmination in the *Pentremites elongatus*-Dizygoorinus rotundus* zone where they are represented by a large variety of species of *Batocrinus*, *Macroocrinus*, *Dizygoocrinus*, *Eutrochoocrinus*, *Eretmocrinus*, and *Uperocrinus*. Many batoocrinids became extinct at the end of Burlington time.

The Desmidoocrinidae are represented in the St. Joe-Reeds Spring and lower Burlington beds by a few small species. By the close of Burlington time there was a large number of highly ornamented, bizarre species of *Agaricoocrinites* and *Dorycrinus*. A few of these persisted until Keokuk time, but most of them died at the end of Burlington time.

Stoyanow (1936, p. 507) correlated the upper part of the Escabrosa limestone of Arizona with the Burlington limestone. Laudon and Bowsher (1941, p. 2138) correlated the Dona Ana member of the Lake Valley...
formation with the Physetocrinus ventricosus zone of the Burlington limestone of the Mississippi Valley region. The upper part of the New Providence formation of Indiana and Kentucky has been correlated with the Burlington limestone (Stockdale, 1939, plate 6).

Keokuk Limestone

No attempt was made in this investigation to study the Keokuk limestone in detail. It was necessary, however, to become acquainted with the lithology and fauna of the Keokuk limestone in order to separate it from the underlying Burlington limestone. I believe that the Keokuk limestone does not have nearly as wide a distribution in southwestern Missouri as has been previously reported. I have collected upper Burlington fossils at numerous localities from limestone that has been referred to the Keokuk. Evidence is presented in this report which seems to indicate that the beds in the Tri-State mining district which have been called Warsaw should instead be referred to the Keokuk limestone. The Grand Falls chert is placed at the top of the Reeds Spring limestone, not in the base of the Keokuk limestone as was done originally by Smith and Siebenthal (1907).

General character.--The Keokuk limestone consists of light-gray to bluish-gray, generally finely crystalline, crinoidal, cherty limestone. The chert occurs in flat elliptical masses and more or less continuous beds usually 6 to 9 inches thick. The limestone beds in the lower part of the formation range in thickness from 2 to 8 feet and are generally separated by cherty zones; the upper part of the formation becomes very thin-bedded and is somewhat shaly. A 4 to 6 foot oolitic bed known as the Short Creek oolite occurs in the Keokuk limestone approximately 65 feet above the base. A thin glauconitic and phosphatic
bed (J bed of Fowler and Lyden, see Moore, Fowler, and Lyden, 1939, p. 9) is present about 40 feet above the Short Creek oolite. Fowler and Lyden consider this glauconitic zone as the contact between the Keokuk and Warsaw limestones. In 1928, Moore placed the Keokuk-Warsaw contact at the base of the Short Creek oolite.

**Distribution and thickness.**—The Keokuk limestone outcrops in the western part of the area studied for this report in southwestern St. Clair, eastern Vernon, western Cedar, southeastern Barton, Dade, northwestern Greene, Lawrence, Jasper, Newton, McDonald and Barry Counties. The maximum thickness is present in the Tri-State district where the Keokuk is locally more than 200 feet thick. It is generally less than 50 feet thick throughout most of the rest of the area. One seldom finds more than 70 feet of Keokuk exposed at one locality, and for this reason it is difficult to get an over-all picture from the study of outcrops.

Kaiser (1945, p. 30) found that the Keokuk limestone is not present along Osage River east of the Eldorado Springs fault. There are no beds of Keokuk age in the Springfield area, Greene County, as reported by Weller (1895) and Moore (1928, pp. 225-227). I have collected typical index fossils of the Pentremites elongatus-Dizygoorinus rotundus zone of the Burlington limestone from the youngest beds exposed at all the localities where Weller reported the Keokuk present. In addition I searched the area 2 to 3 miles west of Springfield and the Pentremites elongatus-Dizygoorinus rotundus zone is the youngest rock exposed.

Laudon (1939) found the Keokuk limestone present at most localities he studied in northeastern Oklahoma. The maximum exposed thickness in northeastern Oklahoma is approximately 80 feet.

**Stratigraphic relations.**—The Keokuk limestone was deposited conformably on the Burlington limestone in most of southwestern Missouri.
but it has been eroded off all but a small part of the area. Residual Keokuk chert was found at most localities studied for this report. In the Tri-State mining district, where the Burlington limestone was never deposited, the Keokuk limestone rests unconformably on the Reeds Spring limestone.

The Keokuk limestone is overlain by the St. Louis limestone, Meramecian series, in a small area in western Dade County; and the Cartersville formation, Chester series, in the Tri-State mining district. "Mayes" rocks rest on the Keokuk limestone over a large area in northwestern Arkansas and northeastern Oklahoma. Cherokee sandstone and shale, Pennsylvanian system, overlaps the Keokuk limestone over a wide area in southwestern Missouri, southeastern Kansas, and north-eastern Oklahoma.

Faunal character.—The Keokuk limestone is characterized by the following brachiopods: *Dictyoclostus setigerus* (Hall), *Delthyris similis* (Weller), *Orthotetes keokuk* (Hall), *Reticularia pseudolineata* (Hall), *Spirifer keokuk* Hall, *S. logani* Hall, and *Tetracamera subtrigona* (Meek and Wortenh). The genus *Actinocrinites* is represented by several huge, bizarre, highly specialized forms such as *Actinocrinites lowei* (Hall), *A. magnificus* (Wachsmuth and Springer), *A. multiramosus* (Wachsmuth and Springer), and *A. pernodosus* (Hall). Other common camerate crinoids in the Keokuk limestone include *Agaricocrinites wortheni* (Hall), *Doryocrinus mississippiensis* Roemer, and *Macrorinus jucundus* (Miller and Gurley). *Archimedes* and a large variety of fenestellid bryozoans are extremely abundant in the Keokuk limestone at many localities. Residual Keokuk chert occurs over much of the eastern part of the area studied for this report. Much of this chert contains an abundant bryozoan fauna. Relatively few of the large array
of camerate crinoids present in the upper Burlington limestone are present in the Keokuk limestone.

Although the Keokuk limestone is highly crinoidal, there are not many places in southwestern Missouri where one can collect identifiable fossils from it. *Spirifer keokuk* (Hall), was found to be extremely abundant in a zone about 2 feet thick at the following two localities: in a quarry 300 yards south and east of Pump Spur on the St. Louis-San Francisco Railroad in the NE\(\frac{1}{4}\) SW\(\frac{1}{4}\) sec. 32, T. 31 N., R. 27 W., Dade County (locality 44, plate 1), and in a quarry along the east side of Cedar County highway A just south of Horse Creek in the SW\(\frac{1}{4}\) sec. 17, T. 34 N., R. 28 W. (locality 47, plate 1).

A preliminary study seemed to indicate that the fauna of the so-called Warsaw beds of the Tri-State mining district is much more closely related to the fauna of the Keokuk limestone than has heretofore been supposed. Several specimens of *Astinocrinites lowei* (Hall), *A. cf. pernodosus* (Hall), and *A. cf. magnificus* (Wachsmuth and Springer) have been collected from the quarries near Carthage, Jasper County (locality 36, plate 1), by L. R. Laudon, A. L. Bowsher, and me, which are almost identical with the same species that occur in the type area of the Keokuk in the Upper Mississippi Valley. Many of the brachiopods that occur in the Carthage quarries, such as *Echinoconchus alternatus* (Norwood and Pratten), *Marginirugus magnus* (Meek and Worthen), *Orthotetes keokuk* (Hall), and *Spirifer keokuk* Hall, are typical Keokuk species.

**Age and correlation.**—The Keokuk limestone occurs in the upper part of the Osagian series stratigraphically above the Burlington limestone. At the present time many geologists place the Warsaw limestone in the Meramecian series; the Keokuk limestone then becomes the uppermost formation in the Osagian series. Although there is no stratigraphic
break between the Burlington and Keokuk limestones, the fauna of the Keokuk is quite distinctive from that of the Burlington. Many of the index fossils of the Keokuk obviously came from Burlington stock.

*Spirifer grimesi* Hall gave rise to *S. Logani* Hall; *Actinocrinites lowei* (Hall), *A. magnificus* (Wachsmuth and Springer), *A. multiramosus* (Wachsmuth and Springer), and *A. pernodosus* (Hall) of the Keokuk came from *Actinocrinites multiradiatus* (Shumard) or *A. lobatus* (Hall) of the Burlington. Many of the highly specialized species of the Keokuk became extinct at the end of Keokuk time.

The Keokuk limestone of southwestern Missouri, northwestern Arkansas, and northeastern Oklahoma is continuous with the Keokuk limestone of the Upper Mississippi Valley. Strata of Keokuk age occurs in the subsurface of a large part of the Mid-Continent area. The Fort Payne chart of Tennessee and Alabama (Moore, 1928, p. 223) and the Kenwood sandstone, Rosewood shale, Holtsclaw sandstone, Carwood formation, Locust Point formation, Brodhead formation, and Logan formation (Moore, 1928, p. 223, and Stockdale, 1939, plate 6) of the east-central interior have all been correlated with the Keokuk limestone.

**MERAMECIAN SERIES:**

The St. Louis limestone is the only Meramecian formation represented in the area studied for this report. It is only present locally in the western part of Dade County.

**St. Louis Limestone**

The St. Louis limestone was first recognized and described in southwestern Missouri by Clark in 1937. He reported it from six localities in western Dade County. I made only a preliminary study of the
district, and I am in agreement with Clark that the St. Louis limestone is represented. However, I believe that the fossil that Clark identified as *Spirifer pellaensis* Weller, is really *Spirifer keokuk* (Hall), and that the lower part of Clark's St. Louis sections should be referred to the Keokuk limestone. The lithology of these lower beds is much more like the Keokuk than the St. Louis. Clark (pp. 8, 9) gave a measured section at McCubbin Bridge across Horse Creek in the NW$^1_2$ NE$^1_4$ sec. 6, T. 31 N., R. 28 W., Dade County (locality 45, plate 1). The lower 7 feet 9 inches of this section is Keokuk in age rather than St. Louis. The 25 feet of rock exposed in Harold Mammen's quarry approximately 50 yards west of McCubbin Bridge is all Keokuk limestone. It seemed to me that the St. Louis limestone is not much more than 30 feet thick at the McCubbin Bridge locality, whereas Clark reported it to be more than 50 feet thick.

Clark (1937, pp. 9, 10) also presented a measured section at a quarry 300 yards south and east of Pump Spur on the St. Louis-San Francisco Railroad in the NE$^1_4$ SW$^1_4$ sec. 32, T. 31 N., R. 27 W., Dade County (locality 44, plate 1). I believe that the rock exposed at this quarry should be referred to the Keokuk limestone, not St. Louis as reported by Clark. In this quarry there is a very fossiliferous zone 12 to 15 inches thick approximately 10 feet from the top. *Spirifer keokuk* (Hall) is by far the most abundant species. I correlate this zone with a similar *Spirifer keokuk* (Hall) zone exposed in the upper part of a quarry along the east side of Cedar County highway A just south of Horse Creek in the SW$^3_4$ sec. 17, T. 34 N., R. 28 W. (locality 47, plate 1).
Some of the more important points concerning the stratigraphy of the Mississippian rocks exposed in southwestern Missouri are summarized below.

1. The Sylamore sandstone, which occurs stratigraphically at the base of the Chattanooga shale, is thin and poorly exposed. It occurs locally throughout the entire area.

2. The Chattanooga shale occurs only in the extreme southern part of southwestern Missouri.

3. There are no post-Chattanooga pre-Chouteau Mississippian rocks in southwestern Missouri.

4. The Chouteau, Northview, and Sedalia formations are present in the northern part of southwestern Missouri. These strata disappear southward and are not present along the southern border of the state.

5. It is recommended in this report that the term Compton be dropped, because it occupies the same stratigraphic position, has similar lithologic characters, and contains the same fauna as the Chouteau limestone.

6. The Sedalia dolomite, as defined by Moore, is considered as a valid formation, but it is Kinderhookian rather than Osagian in age. The middle part of the Sedalia dolomite is very cherty, and commonly contains quartz geodes.

7. The lower non-cherty and the cherty zones of the Sedalia dolomite grade laterally southward into the Northview formation. The upper non-cherty zone is much more extensive than the underlying zones of the Sedalia, and it overlaps the Northview formation over a wide area.

8. The Northview formation is divisible into a lower shale member and an upper siltstone member.
9. The lower and medial portions of the Burlington limestone are the only rocks of Osagian age present in the type area of the Osagian series in the Osceola area, St. Clair County.

10. The St. Joe and Reeds Spring limestones are present only in the southern part of southwestern Missouri.

11. The St. Joe limestone is not typically developed in the Springfield area, and here it has been called the Pierson limestone. It is recommended in this paper that the term Pierson be dropped as a synonym of St. Joe.

12. The Burlington limestone is divided into 6 faunal zones. The Burlington limestone thins southward and westward from Springfield by transgressive overlap against the underlying Reeds Spring limestone, and the entire formation disappears between Mt. Vernon, Lawrence County, and the Tri-State mining district.

13. A prominent unconformity exists between the Reeds Spring and Burlington limestones.

14. The Keokuk limestone is present only in the western part of the area. It does not have as wide a distribution as many geologists have thought. It is not present in the Springfield area, and it does not occur along Osage River east of the Eldorado Springs fault.

15. All the beds in the Tri-State mining district that have previously been referred to the Warsaw limestone are placed in the Keokuk limestone in this study.

16. Evidence is presented to show that beds which have previously been referred to the lower part of the St. Louis limestone in western Dade County, instead should be referred to the Keokuk limestone.
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STRATIGRAPHIC SECTIONS 1-64

The number of each stratigraphic section corresponds to a locality number shown on plate 1. Chert is shown in black on all the plotted sections.

Twenty-two of the stratigraphic sections are graphically shown.
Stratigraphic Section No. 1

Composite section of exposures 1 to 2 miles east of Reeds Spring, Stone County, Missouri, along railroad cuts, both east and west of tunnel, and in chert quarry 1/2 mile south of the west end of the railroad tunnel.

Osagian Series

<table>
<thead>
<tr>
<th>Stratigraphic Unit</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burlington limestone</td>
<td></td>
</tr>
<tr>
<td>Physetocrinus zone</td>
<td></td>
</tr>
<tr>
<td>Bed 6. Limestone, gray, coarsely crystalline, medium to thick-bedded, fossiliferous; contains much white chert nodules.</td>
<td>15.0</td>
</tr>
<tr>
<td>Unconformity</td>
<td></td>
</tr>
<tr>
<td>Reeds Spring limestone</td>
<td></td>
</tr>
<tr>
<td>5. Limestone, gray to tan, silty, finely crystalline, thin-bedded, fossiliferous; contains nearly as much blue to gray chert as limestone in alternating beds. The chert occurs in layers of relatively small nodules.</td>
<td>119.5</td>
</tr>
<tr>
<td>4. Shale, green, highly calcareous.</td>
<td>0.5</td>
</tr>
<tr>
<td>St. Joe limestone</td>
<td></td>
</tr>
<tr>
<td>3. Limestone, gray, finely crystalline, medium to thin-bedded, crinoidal.</td>
<td>16.5</td>
</tr>
<tr>
<td>2. Limestone, red to greenish-gray mottled, silty, medium to thin-bedded, crinoidal.</td>
<td>6.5</td>
</tr>
<tr>
<td>1. Limestone, light gray, finely crystalline, thin-bedded, crinoidal.</td>
<td>23.0</td>
</tr>
<tr>
<td>Unconformity</td>
<td></td>
</tr>
<tr>
<td>Ordovician rocks are exposed.</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>181.0</td>
</tr>
</tbody>
</table>

The St. Joe limestone is typically developed at this locality. It is fossiliferous, but identifiable forms are scarce. The St. Joe and underlying Ordovician rocks are exposed in railroad cuts one-eighth to one-half mile southeast of the tunnel.

The type section of the Reeds Spring limestone is at this locality. This is one of the few places where the Reeds Spring limestone is fossiliferous. Cline (1934, pp. 1144, 1145) prepared a faunal list of fossils from this locality.

The Burlington limestone is exposed in the extreme southern end of the large chert quarry to the south of the west end of the railroad tunnel. The lower part of the Burlington is missing, and the Physetocrinus zone lies unconformably on the Reeds Spring limestone. It is highly cherty
The following fossils were collected from the *Physetocrinus* zone at this locality:

- *Orbitremites norwoodi* (Owen and Shumard)
- *Aotinoorini multiradiatus* (Shumard)
- *Aoroorinus parvus* (Shumard)
- *Dichocrinus striatus* (Owen and Shumard)
- *Eutrohocrinus christyi* (Shumard)
- *Physetocrinus ventricosus* (Hall)
- *Steganoorinus sculptus* (Hall)
- *Strotocrinus glyptus* (Hall)
- *Uperocrinus pyriformis* (Shumard)

These forms show close affinities with the species of the *Pentremites* *elongatus*-Dizygoocrinus* rotundus* zone, but are not so far advanced in the stage of evolution. No specimens of *Pentremites elongatus* (Shumard) or *Dizygoocrinus rotundus* (Yandell and Shumard) were found.

Figures 10, 13-16, and 25 were taken at this locality.
Stratigraphic Section No. 2

East bluff along James River near Fraser's old mines in the SW^{1/4} SE^{3/4} sec. 29, T. 27 N., R. 22 W., Christian County, Missouri.

Osagian Series

Reeds Spring limestone

Bed 5. Limestone, gray, dense, very thin-bedded; contains as much chert as limestone. 60.0

St. Joe limestone

4. Siltstone, tan, calcareous, massive, crinoidal, soft. 1.5

3. Limestone, gray to tan, silty, finely crystalline, thin blocky beds; contains numerous thin shale partings and a large amount of chert. 16.0

2. Limestone, gray to tan, silty, finely crystalline, finely crinoidal; contains no chert. 20.0

Unconformity

Northview formation

Lower member

1. Shale, tan to gray, silty. 4.0

ORDOVICIAN rocks are exposed.

Total 101.5

Shepard (1898, p. 69) referred the 4 feet of Northview shale to the Eureka shale and said that this is the best location at which to study it. On the basis of Shepard's work, Moore (1928, p. 113) assigned the rocks at this locality as follows: 4 feet of Chattanooga shale, 20 feet of Compton limestone, and 10 feet of Pierson limestone.

This is the southernmost exposure of the Northview formation found by me. The upper siltstone member of the Northview is absent.
Stratigraphic Section No. 3

Bluff along the north bank of Finley River at Lindenlure, Christian County, Missouri.

Osagian Series

Burlington limestone

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bed 8.</td>
<td>Limestone, gray, coarsely crystalline, medium to thick-bedded, crinoidal.</td>
</tr>
</tbody>
</table>

Unconformity

Reeds Spring limestone

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.</td>
<td>Limestone, gray, dense, thin-bedded; contains almost as much chert as limestone.</td>
</tr>
<tr>
<td>6.</td>
<td>Limestone, very soft, prominent break.</td>
</tr>
<tr>
<td>5.</td>
<td>Limestone, gray, dense, medium to thick-bedded. The lower 6.5 feet contains very little chert.</td>
</tr>
</tbody>
</table>

St. Joe limestone

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>Limestone, tan, finely crystalline, medium to thin-bedded, crinoidal.</td>
</tr>
</tbody>
</table>

Unconformity

Kinderhookian Series

Sedalia dolomite

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td>Dolomite, tan, silty, slightly porous, finely crystalline, thick-bedded.</td>
</tr>
</tbody>
</table>

Northview formation

Lower member

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td>Shale, dark gray to tan, silty, blocky, thin-bedded, soft; slightly dolomitic in lower part.</td>
</tr>
</tbody>
</table>

Chouteau limestone

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Limestone, light gray, finely crystalline, thin irregularly bedded, crinoidal. Only the upper 2 feet is exposed.</td>
</tr>
</tbody>
</table>

Total 153.0

The upper siltstone member of the Northview formation is absent.

The St. Joe limestone is unusually thin. The Reeds Spring limestone is typically developed and forms the massive part of the bluff. The Physetoorinus ventricosus zone of the Burlington limestone rests unconformably on the Reeds Spring limestone. The lower zones of the Burlington limestone pinch out in the area between this locality and Springfield, Greene County. Specimens of Agaricocrinites planoconvexus (Hall) and Eutrochoocrinus christyi (Shumard) were collected from the Physetoorinus ventricosus zone of the Burlington limestone.
Stratigraphic Section No. 4

Waking et al. No. 1 H. Doubler well, in sec. 30, T. 29 N., R. 22 W., Greene County, Missouri.

Osagian Series
- Burlington limestone
- Unconformity
- Reeds Spring limestone
- St. Joe (Pierson) limestone
- Unconformity

Kinderhookian Series
- Sedalia dolomite
- Northview formation
- Chouteau limestone
- Unconformity

ORDOVICIAN rocks

The above well was drilled to a depth of 1,152 feet. I studied only the part down to the top of the Ordovician. The intervals given above were used to tie together all odd outcrops in the Springfield area into one continuous composite section. There is no one locality in the Springfield area where all the Mississippian formations are exposed in one continuous section.
Stratigraphic Section No. 5-a

Quarry and road cut near the center north line sec. 23, T. 30 N., R. 21 W., Greene County, Missouri.

Eight feet of typical Chouteau limestone is exposed in the creek and an old quarry just east of the road on the north side of the creek. There is an interval of 36 feet from the top of the Chouteau to the base of the first siltstone in the Northview formation. This lower shale member is very poorly exposed along the road.

Stratigraphic Section No. 5-b

Bluff on the south side of Little Sac River in the SW corner SE^_1, road cut near the center south line SE^_2, and road cut in the SE corner NE^_1 of sec. 16, T. 30 N., R. 21 W., Greene County, Missouri.

The lower shale member of the Northview is exposed in the road cut near the center of the south line of the SE^_1 of sec. 16. The upper siltstone member is well exposed in the road cut in the SE corner NE^_1 of sec. 16 (see fig. 9). The rest of the rocks outcrop on the bluff. The Spirifer zone contains the characteristic fossils at this locality. The Caecocrinus proboscidialis zone is unusually cherty.

Figures 9 and 19 were taken at this locality.

Stratigraphic Section No. 6

Road cut along Greene County highway BB just east of Asher Creek in the NE corner sec. 21 and the NW corner sec. 22, T. 31 N., R. 23 W., Missouri, about 3.5 miles east of Walnut Grove.

See accompanying plotted section.
Stratigraphic Section No.5-b

SEDALIA

Upper

Dolomite, tan to brown, slightly silty, finely crystalline to dense, thick-bedded.

Shale, tan, silty.

Siltstone, tan, dolomite.

Shale, tan, silty.

Siltstone, tan, dolomitic, massive.

Shale, tan, silty.

Siltstone, tan, dolomitic, massive.

Shale, tan, silty.

Siltstone, tan, slightly dolomitic.

Lower

Shale, tan, silty.

BURLINGTON

Upper

Limestone, dark gray, dense, medium-bedded; contains some chert nodules.

Limestone, light gray, finely crystalline, medium-bedded; contains numerous chert nodules.

Limestone, gray, finely crystalline, thick-bedded.

Limestone, gray to tan, finely crystalline to dense, thin-bedded.

Limestone, tan to gray, medium crystalline, thin-bedded, fossiliferous.

Lower

Dolomite, tan to brown, slightly silty, finely crystalline to dense, thick-bedded.
Siltstone, brown, argillaceous, massive, vermiculic; with intervening soft, silty shale.

Shale, light tan to brown, silty, thin-bedded.

Limestone, gray, finely crystalline, crinoidal; contains lots of chert. Not well exposed.

Limestone, tan to brown, silty, crinoidal in streaks; contains lots of calcite globs, many of which are calcified concretionary crinoids.

Limestone, brown, silty, finely crystalline, single bed.

Dolomite, brown, silty, medium-bedded, soft.

Dolomite, brown, silty, massive; contains calcareous vein fillings.

Siltstone, brown, argillaceous, massive, vermiculic; with intervening soft, silty shale.
Stratigraphic Section No. 7

Bluff along east side of Pomme de Terre River in SE¼ NW¼ NE¼ sec. 11, T. 33 N., R. 22 W., Polk County, Missouri, about ½ mile north of Burns.

Osagian Series

<table>
<thead>
<tr>
<th>Stratigraphic Unit</th>
<th>Thickness</th>
<th>Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burlington limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physetocrinus zone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bed 10. Limestone, gray, coarsely crystalline, very massive, crinoidal; contains no chert.</td>
<td></td>
<td>36.5</td>
</tr>
<tr>
<td>Caecocrinus zone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Limestone, gray, coarsely crystalline, very massive, crinoidal; contains no chert.</td>
<td></td>
<td>26.0</td>
</tr>
<tr>
<td>Cryptoblastus zone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Limestone, gray to tan, coarsely crystalline, medium-bedded, crinoidal; contains no chert.</td>
<td></td>
<td>6.0</td>
</tr>
<tr>
<td>Batocrinus-Uperocrinus zone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Limestone, gray, medium crystalline, medium to thick-bedded, crinoidal; contains no chert.</td>
<td></td>
<td>6.0</td>
</tr>
<tr>
<td>6. Limestone, tan to gray, medium crystalline, thin to medium-bedded, crinoidal; contains no chert.</td>
<td></td>
<td>2.5</td>
</tr>
<tr>
<td>Spirifer zone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Limestone, gray, medium to coarsely crystalline, thin-bedded, fossiliferous; contains no chert.</td>
<td></td>
<td>3.0</td>
</tr>
</tbody>
</table>

Unconformity

Kinderhookian Series

<table>
<thead>
<tr>
<th>Stratigraphic Unit</th>
<th>Thickness</th>
<th>Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedalia dolomite</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Dolomite, brown, sugary, medium-bedded.</td>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td>3. Dolomite, brown, silty, porous, finely crystalline, massive.</td>
<td></td>
<td>15.0</td>
</tr>
</tbody>
</table>

Northview formation

Upper member

<table>
<thead>
<tr>
<th>Stratigraphic Unit</th>
<th>Thickness</th>
<th>Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Siltstone, light tan, slightly dolomitie, soft.</td>
<td></td>
<td>2.5</td>
</tr>
<tr>
<td>1. Siltstone, light tan, hard.</td>
<td></td>
<td>0.5</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>99.5</td>
</tr>
</tbody>
</table>

The Spirifer zone is typically developed here; it is abundantly fossiliferous. The overlying Burlington zones are exposed in a massive bluff.

Stratigraphic Section No. 8

Road cut along Missouri highway 83 in the SW¼ sec. 27, T. 35 N., R. 23 W., Polk County.

This exposure is in the transition zone from Northview to Sedalia.
Stratigraphic Section No. 8

Siltstone, tan, slightly dolomitic massive.

Shale, tan, silty; apparently contains lots of quartz geodes.

Dolomite, tan, highly, silty, finely crystalline, medium to thin-bedded.
Stratigraphic Section No. 9

Road cut along Missouri highway 83 near the center E 1/2 sec. 2, T. 35 N., R. 23 W., Hickory County.

This exposure is in the transition zone from Northview to Sedalia.

Stratigraphic Section No. 10-a

Road cut and quarry along U. S. highway 54 in the NE 1/4 sec. 21, T. 37 N., R. 22 W., Hickory County, Missouri.

The 4 inches of sandy shale that occurs between Ordovician rocks and the Chouteau limestone is referred to the Sylamore sandstone. The Chouteau limestone is typically developed; it is highly fossiliferous. The lower part of the Sedalia dolomite is somewhat cross-beded, and dolomite grades laterally to shale in a very short distance. Fifteen feet of typical Northview shale occurs above the Sedalia dolomite. The lower beds of the Burlington limestone are poorly exposed in the slope just above the north side of the quarry.

Figures 2, 4, and 5 were taken at this locality.

Stratigraphic Section No. 10-b

Road cut along U. S. highway 54 in the center W 1/2 NW 1/4 sec. 20, T. 37 N., R. 22 W., Hickory County, Missouri, about 1.2 miles east of Wheatland.

The upper part of the Northview formation and the lower part of the Burlington limestone are poorly exposed. The upper part of the Physetocrinus ventricosus zone consists of a very peculiar marly, nodular limestone.
Stratigraphic Section No. 9

Dolomite, tan, silty, somewhat porous, finely crystalline, medium-bedded.

Shale, tan, slightly dolomitic, silty.

Siltstone, tan, slightly dolomitic.

Shale, tan, silty.

Dolomite, tan, silty.

Shale, tan, silty.

Numerous typical Sedalia quartz geodes are loose on top of this bed.

Dolomite, tan, silty, finely crystalline, medium-bedded.
Stratigraphic Section No.10-a

**Ordovician Rocks**

- **Chouteau**
  - Shale, tan, dolomitic
- **Sylamore**
  - Limestone, tan to gray, coarsely crystalline to dense, medium-bedded
  - Dolomite, tan, highly silty, finely crystalline to dense, medium-bedded

**Sedalia**

- **Limestone, gray, highly dolomitic, silty, dense, medium-bedded.**
- **Dolomite, dark gray, silty, dense, medium-bedded.**
- **Dolomite, gray to tan, calcareous, silty, finely crystalline, medium-bedded, crinoidal; contains numerous rather small gray siliceous nodules.**
- **Dolomite, gray to tan, mottled, dense, thin irregularly bedded; contains lots of irregular lens-like blocky chert nodules.**
- **Limestone, gray, silty, finely crystalline, medium to thin-bedded, fossiliferous; contains very little true chert, but the middle part contains abundant siliceous nodules.**

**Burlington**

- Shale, tan, slightly dolomitic, silty. Mostly covered.

**Northview**

- Dolomite, tan to gray, coarsely crystalline, medium-bedded, crinoidal.
**Stratigraphic Section No. 10-b**

- **SEDALIA**
  - Dolomite, tan, silty, finely crystalline, medium-bedded.
  - Shale, tan, dolomitic, silty.
  - Siltstone, tan, dolomitic.
  - Shale, tan, slightly dolomitic, silty.
  - Shale, tan, slightly dolomitic, massive.

- **BURLINGTON**
  - Siltstone, tan, slightly dolomitic, silty.
  - Shale, tan, slightly dolomitic.
  - Limestone, tan to gray, coarsely crystalline, medium-bedded, crinoidal.

- **BISTRACINUS Zone**
  - Limestone, tan to gray, coarsely crystalline, medium to thick-bedded, highly crinoidal; contains some chert in lower part.

- **CRYPTOPHACINUS Zone**
  - Limestone, tan to gray, marly, nodular, highly crinoidal.

- **NOO VIEW**
  - Upper Shale, tan, slightly dolomitic, silty.

Limestone, tan to gray, coarsely crystalline, medium to thick-bedded, highly crinoidal.
Stratigraphic Section No. 11

Road out at junction of side road and highway Mo. 83 near the center of the north line of sec. 27, T. 39 N., R. 23 W., Benton County, Missouri, about 1 mile north of Bentonville.

All rocks exposed at this locality are typically developed. The Cactocorinus proboscidialis zone contains 2 beds of nodular algal-like limestone very similar to the uppermost bed of the Cryptoblastus melo zone. The Spirifer zone is absent.

Stratigraphic Section No. 12

Jackman Bluff along the north side of Pomme de Terre River in sec. 1, T. 39 N., R. 23 W., Benton County, Missouri.

Figures 6, 8, and 20 were taken at this locality.

Stratigraphic Section No. 13

Laird Bluff along Osage River near the center sec. 31, T. 40 N., R. 22 W., Benton County, Missouri.

The Ordovician-Chouteau contact is very well exposed. The Chouteau limestone is typically developed. The Sedalia dolomite is relatively thin. A fossiliferous dolomite bed 2 feet thick occurs approximately 6 feet below the top of the Sedalia, in which Shumardella obsolens (Hall) is abundant. The Spirifer zone of the Burlington limestone is not present here.

Figures 3 and 7 were taken at this locality.
Stratigraphic Section No. II

Burlington

Bolomorphous Limerococmen Zone

Dolomite, brown, dense, weather to hackly surface. Limestone, gray, crinoidal.

Dolomite, brown, dense, weather to hackly surface.

Dolomite, brown, dense, weather to hackly surface. Agaricocrinus pyroideus Limestone, reddish brown, silty, finely crystalline, crinoidal.

Shale, yellow, silty, soft. Limestone, light buff to reddish brown, silty, finely crystalline, crinoidal.

Shale, yellow, silty. Northview facies. Limestone, gray to light buff, coarsely crystalline, crinoidal.

Abundant calcite fillings. Dolomite, gray to buff mottled, silty, thin irregularly bedded, contains very little chert.

Dolomite, gray to buff mottled, silty, thin irregularly bedded, contains abundant chert nodules. Brachythyrus chouteouensis, Chonetes gelnortkensis, Lepidella analoga.

Cochlcrinus Zone

Limestone, light buff, silty, crinoidal.

OSAGIAN-KINDERHOOKIAN CONTACT

Shale, yellow, silty. Northview facies.

Limestone, light buff, silty, crinoidal.

Limestone, gray to light buff, nodular, algal-like.

Limestone, gray to light buff, nodular, algal-like.

Limestone, gray to light buff, coarsely crystalline, crinoidal.

Limestone, gray to light buff, coarsely crystalline, crinoidal.

Limestone, gray to light buff, coarsely crystalline, crinoidal.

Limestone, brown, dense.

Limestone, brown, finely crystalline, crinoidal.

Limestone, brown, nodular, algal-like. Cryptoblastus melo, Cocclidcrinus multi-branchatus.

Limestone, gray, coarsely crystalline, crinoidal.

Cryptoblastus melo, Cocclidcrinus multi-branchatus.

Limestone, gray, coarsely crystalline, crinoidal.

Phyllactinocrinus Zone

Limestone, gray, coarsely crystalline, medium-bedded, crinoidal.
Stratigraphic Section No. 12

**ORDOVICIAN Rocks**

- **SEDALIA**
  - 85: Limestone, gray, coarsely crystalline, medium to thick-bedded, coarsely crinoidal.
  - 80: Limestone, gray, finely crystalline to dense, medium-bedded, crinoidal.
  - 75: Limestone, gray, finely crystalline to dense, medium-bedded, crinoidal.
  - 70: Limestone, gray, coarsely crystalline, thin irregularly bedded, coarsely crinoidal.
  - 65: Limestone, gray, coarse to tan, medium crystalline, medium to thin-bedded, crinoidal.
  - 60: Limestone, gray to tan, medium crystalline, medium to thin-bedded, crinoidal.
  - 55: Limestone, gray, finely crystalline to dense, very thin irregularly bedded, finely crinoidal.
  - 50: Limestone, gray, coarse to tan, finely crystalline to dense, medium-bedded, crinoidal.
  - 45: Dolomite, tan, silty, dense, massive.
  - 40: Dolomite, gray to tan, silty, dense, medium irregularly bedded; contains numerous lens-like nodules of chert.
  - 35: Dolomite, tan to gray, silty, dense, massive; beds weather to rounded surface.
  - 30: Dolomite, tan, silty, dense, massive.
  - 25: Dolomite, gray to tan, silty, dense, medium irreguilarly bedded; contains numerous lens-like nodules of chert.
  - 20: Dolomite, tan to gray, silty, dense, massive; beds weather to rounded surface.
  - 15: Limestone, gray, coarsely crystalline, thin irregularly bedded, coarsely crinoidal.
  - 10: Limestone, gray, silty, finely crystalline to dense, very thin irregularly bedded, finely crinoidal.
  - 5: Limestone, gray to tan, medium crystalline, medium to thin-bedded, crinoidal.
  - 0: Limestone, gray, silty, finely crystalline to dense, medium to thin-bedded, crinoidal.
Dolomite, gray, highly calcareous, silty, finely crystalline, thin-bedded, highly fossiliferous.

Dolomite, gray, silty, dense, medium to thin-bedded, contains numerous chert nodules.

Dolomite, gray, silty, dense, thin-bedded.

Dolomite, tan, silty, dense, massive, soft.

Limestone, light gray, silty, finely crystalline, very thin irregularly bedded, crinoidal; contains some chert nodules.

Limestone, gray, coarsely crystalline, medium to thick-bedded, crinoidal.

Limestone, gray, medium crystalline, medium-bedded, crinoidal.

Limestone, tan, finely crystalline, thin to medium-bedded, crinoidal.

Dolomite, gray, silty, dense, medium-bedded.

Limestone, light gray, silty, finely crystalline, medium-bedded.

Orдовик (ORDOVICIAN) Rocks
Stratigraphic Section No. 14

Kisinger Bluff along Osage River near the NW corner NE\(\frac{1}{4}\) sec. 7, T. 40 N., R. 22 W., Benton County, Missouri, about 1.5 miles north of Warsaw.

The Chouteau limestone is not exposed as reported by Moore (1928, pp. 128-130). The fauna he listed as typical of the Chouteau is from the Sedalia dolomite. The Sedalia contains an unusual amount of limestone at this locality. The upper 2 feet of the formation consists of very fossiliferous gray dolomite. The Spirifer zone of the Burlington limestone is not present here. The base of the Burlington is marked by a massive siltstone bed 5 feet thick composed of a large amount of reworked material from the Sedalia dolomite.

Figure 23 was taken at this locality.

Stratigraphic Section No. 15

Road cut along U. S. highway 66 in the SE\(\frac{1}{4}\) sec. 22 and the SW\(\frac{1}{4}\) sec. 23, T. 30 N., R. 19 W., Webster County, Missouri, 1 mile north of Northview.

Approximately 2 feet of the Chouteau limestone is exposed south of U. S. highway 66 and along the west side of the side road to Northview. This is the thickest exposure found of the Northview formation. It is considerably thicker here than on Ball Hill (locality 16). This is, by far, the best exposure of the Northview formation in the Northview area.
Stratigraphic Section No. 15

Limestone, gray, finely crystalline, thin irregularly bedded, crinoidal.

Shale, tan, silty.

Siltstone, tan, dolomitic, single bed.

Shale, tan, dolomitic, silty.

Siltstone, tan, dolomitic, medium to thin-bedded.

Shale, tan, dolomitic, silty.

Siltstone, tan, dolomitic, medium to thin-bedded, vermicular.

Shale, tan, silty.
Stratigraphic Section No. 16

North bluff of Ball Hill on south side of James River at the junction with Turnbo Creek in the north part of sec. 5, T. 29 N., R. 19 W., Webster County, Missouri.

Osagian Series

Burlington limestone

Undifferentiated

Bed 7. Limestone, gray, coarsely crystalline, massive, crinoidal; contains no chert. 23.0

Unconformity

Reeds Spring limestone

6. Limestone, gray, finely crystalline to dense, thin to medium-bedded; contains lots of thin lenticular chert nodules. 54.5

St. Joe (Pierson) limestone

5. Limestone, dark gray to tan, finely crystalline, medium-bedded. 6.5

4. Limestone, gray to brown, dense, thin-bedded. 4.0

Unconformity

Kinderhookian Series

Sedalia dolomite

3. Dolomite, tan, slightly silty, finely crystalline, thick-bedded. 14.5

Northview formation

2. All covered at this locality. 41.5

Chouteau (Compton) limestone

1. Limestone, gray, finely crystalline, thin irregularly bedded, crinoidal. 8.0

Total 152.0

The Chouteau limestone is exposed in the bed of James River a short distance upstream from the Turnbo Creek junction. The Northview formation is very poorly exposed, and it is much thinner here than at locality 15. The St. Joe (Pierson) limestone is not nearly as thick here as it is at Turner, Greene County (locality 18).

This is the same locality that Moore (1928, pp. 118, 119) gives as Bridwell's Hill. The Kaskuk limestone is not present here as reported by Weller (Moore, 1928, p. 118).
Stratigraphic Section No. 17

Bluff along the west side of James River in the SE\textsuperscript{4} sec. 21, T. 29 N., R. 20 W., Greene County, Missouri.

Sixteen feet of typical gray, thin-bedded Chouteau limestone is exposed here resting on Ordovician rocks. All the index fossils of the Chouteau limestone may be collected at this locality. Only the lower few feet of the Northview formation are in place above the Chouteau limestone.

Stratigraphic Section No. 18

Road cut at Turner, Greene County, Missouri.

This is the best exposure of the beds that Weller referred to the Pierson limestone (St. Joe of this report). It is not far from Weller's type locality.

Figures 11, 12, 17, and 18 were taken at this locality.

Stratigraphic Section No. 19

Road cut in the NE\textsuperscript{3} sec. 27, T. 29 N., R. 21 W., Greene County, Missouri.

The Physetoorinus ventricosus zone of the Burlington limestone is exposed here. Agaricocrinites planoconvexus (Hall) is very abundant.

Figure 24 was taken at this locality.
Stratigraphic Section No. 18

- Limestone, tan, silty, finely crystalline, thick-bedded, crinoidal; contains more and larger chert nodules than zone below.

- Limestone, gray, dense, medium to thin-bedded; contains about one half as much chert as limestone.

- Limestone, brown, dense, medium-bedded; contains numerous layers of chert nodules.
Stratigraphic Section No. 20

Quarry of Ash Grove Lime and Portland Cement Company at Galloway, Greene County, Missouri.

Approximately 60 feet of Burlington limestone, all belonging to the Pentremites elongatus-Dizygoocrinus rotundus zone, is exposed in this quarry. More excellently preserved fossils may be collected from this quarry than from any other locality in southwestern Missouri.

Figures 29 and 30 were taken at this locality.

Stratigraphic Section No. 21

Road cut along U. S. highway 65 just south of South Dry Sac Creek in the SE¼ sec. 32, T. 30 N., R. 21 W., Greene County, Missouri.

Approximately 20 feet of highly cherty limestone are exposed in this road cut. All beds exposed are referred to the Physetocrinus ventricosus zone of the Burlington limestone.

Stratigraphic Section No. 22

Quarry of Garrett Construction Company located 1/2 mile north of Kearney and Benton Streets in the northern part of Springfield, Greene County, Missouri.

Seventy-six feet of Burlington limestone is exposed in this quarry. Excellently preserved fossils may be collected from the upper 5 to 10 feet of highly weathered limestone. Fossils from this upper zone are all representatives of the Pentremites elongatus-Dizygoocrinus rotundus zone.

Figures 26 and 27 were taken at this locality.
Stratigraphic Section No. 23

Quarry of Ash Grove Lime and Portland Cement Company (old Marblehead quarry) located at 700 E. Phelps Street in the middle part of Springfield, Greene County, Missouri.

More than 90 feet of Burlington limestone is exposed in this quarry. The upper part contains index fossils of the Pentremites elongatus-Dizygoocrinus rotundus zone.

Figure 28 was taken at this locality.

Stratigraphic Section No. 24

Quarry of Horton Stone Company in the SW corner of sec. 27, T. 29 N., R. 22 W., Greene County, Missouri, at the SW corner of Springfield.

Forty feet of limestone assigned to the Pentremites elongatus-Dizygoocrinus rotundus zone of the Burlington limestone is exposed here.

Stratigraphic Section No. 25

Road cut along U. S. highway 60 just west of Wilson Creek in the SE1/4 sec. 31, T. 29 N., R. 22 W., Greene County, Missouri.

Approximately 20 feet of Burlington limestone is exposed here. Typical index fossils of the Pentremites elongatus-Dizygoocrinus rotundus zone were collected from the limestone.
Stratigraphic Section No. 26

Road cut along Missouri highway 13 approximately 1 mile northwest of Crane, Stone County, Missouri.

At this locality is exposed 61 feet of cherty Burlington limestone. The Reeds Spring contact could not be found here, but I estimated that the lowest exposed beds were not more than 15 to 20 feet above the contact. The lower 20 to 25 feet of exposed rock contains typical index fossils of the Physetocrinus ventricosus zone.

Stratigraphic Section No. 27

Railroad cut approximately 1½ miles southeast of Crane, Stone County, Missouri.

Sixty-two feet of typical Reeds Spring limestone is exposed at this locality. Neither the underlying St. Joe limestone nor the overlying Burlington limestone could be found nearby.

Stratigraphic Section No. 28

Quarry owned by Ross Pernell in the NE corner SE¼ SE¼ sec. 26, T. 29 N., R. 25 W., Lawrence County, Missouri, about one-fourth mile south of Halltown.

Twenty-eight feet of pure, coarsely crystalline, highly crinoidal gray limestone is exposed in this quarry. The limestone contains no chert. I found no diagnostic fossils at this place, but the lithology is most typical of the upper Burlington. Therefore, the limestone at this locality is questionably referred to the Pentremites elongatus-Dizygocrinus rotundus zone of the Burlington limestone.
Stratigraphic Section No. 29

Quarry along creek near the center of the SW¼ sec. 25, T. 28 N., R. 27 W., Lawrence County, Missouri.

In speaking of this locality, Moore, Fowler, and Lyden (1939, p. 9) said:

In a section just west of Mt. Vernon 20 feet of Burlington is overlain disconformably by Keokuk (with basal chert conglomerate).

I agree with this interpretation.

Stratigraphic Section No. 30

Abandoned W.P.A. quarry in the NW¼ sec. 26, T. 28 N., R. 27 W., Lawrence County, Missouri.

A total of 34 feet of rock is exposed in this quarry. The lower 28 feet consists of coarsely crystalline, highly crinoidal, gray limestone that contains numerous elliptical white chert nodules. *Pentremites elongatus* Shumard, *Athyris lamellosa* (L'Eveille), and *Spirifer grimesi* Hall were found in the limestone. The chert is typical Burlington chert. This lower 28 feet of limestone is referred to the *Pentremites elongatus*–*Dizygocrinus rotundus* zone of the Burlington limestone.

The upper 6 feet of exposed rocks consists of massive beds of brown, blocky chert separated by thin limestone beds. This 6 feet of rock is referred to the Keokuk limestone.

The sequence exposed at this locality is the same as at Stratigraphic section No. 29.
Chert, gray to white, fossiliferous; occurs in irregular beds about 6 inches thick. Six beds of gray, crinoidal limestone are present.

Limestone, gray, coarsely crystalline, medium to thick-bedded, crinoidal; contains lots of white chert nodules. Many Pentremites zone index fossils are present.
Stratigraphic Section No. 31
Bluff along the north side of Spring River near the center of the east line sec. 20, T. 26 N., R. 26 W., Lawrence County, Missouri, at the U. S. highway 60 bridge across Spring River.

Ninety feet of typical Reeds Spring limestone is exposed at this locality.

Stratigraphic Section No. 32
Lime quarry at Pierce City, Lawrence County, Missouri.

Moore (1928, p. 222) described the 46 feet of limestone exposed at this quarry, and I agree with his interpretation that these rocks should be referred to the Keokuk limestone.

Stratigraphic Section No. 33
Abandoned quarry owned by John Smerdon along Clear Creek near the center of the SW¼ sec. 30, T. 26 N., R. 28 W., Lawrence County, Missouri.

Approximately 30 feet of typical Keokuk limestone is exposed here. A number of complete camarate crinoids and blastoids were collected from the lower 15 feet.

Stratigraphic Section No. 34
Quarry at Cave Springs in the NE¼ SE¼ sec. 26, T. 28 N., R. 29 W., Jasper County, Missouri.

The 46.5 feet of limestone exposed in this quarry is all Keokuk in age. The upper 15 feet is much more cherty than the underlying limestone.
Stratigraphic Section No. 35

Abandoned quarry of the Marblehead Lime Company on the west bluff of Spring River, 1 mile north of Sarcoxie in the SW¼ SE¼ sec. 5, T. 27 N., R. 29 W., Jasper County, Missouri.

Moore (1928, p. 214) gave a stratigraphic section from this locality. I believe that all the rocks exposed, including the Short Creek oolite member and overlying beds, should be referred to the Keokuk limestone. I collected specimens of *Macrocrinus cf. jucundus* (Miller and Gurley) and *Actinocrinites* sp. from Moore's bed 3.

Stratigraphic Section No. 36

Quarry of Carthage Marble Corporation near the center of the NW¼ sec. 33, T. 29 N., R. 31 W., Jasper County, Missouri, just north-west of Carthage.

I refer the 61 feet of limestone exposed in this quarry to the Keokuk limestone. Moore (1928, p. 245-247) studied this same strata from near-by localities, and concluded that the limestone in the Carthage area is Warsaw in age.

Stratigraphic Section No. 37

Railroad cut just east of the Kansas City Southern Railroad bridge across Center Creek in the SW corner NE¼ sec. 9, T. 28 N., R. 33 W., Jasper County, Missouri.

See accompanying plotted section.
Stratigraphic Section No. 37

Limestone, tan, finely crystalline, very thin-belled; contains numerous thin layers and nodules of white blocky chert.

Shale, yellow, silty, limestone, light to dark gray silted, medium crystalline, crinoidal.

Chert, white, blocky, layers 3 to 6 inches thick; contains thin layers of tan limestone.

Limestone, gray, medium crystalline, medium-belled, crinoidal; contains numerous layers of white blocky chert.

Limestone & chert, thin beds.

Limestone, gray, finely crystalline, medium-belled, six inch chert bed near middle.
Stratigraphic Section No. 38

Abandoned quarry in Opossum Hollow in the SE\textsuperscript{4} NE\textsuperscript{4} sec. 33, T. 29 N., R. 33 W., Jasper County, just north of Joplin.

Moore (1928, pp. 215-218) gave a stratigraphic section from this locality. The Short Creek oolite is 4 feet thick and it is well exposed. Forty-one feet of limestone is exposed below the Short Creek oolite, and more than 6 feet of limestone is exposed below it. Moore referred the beds below the Short Creek oolite to the Keokuk limestone, and the beds above the Short Creek to the Warsaw limestone. I refer all beds exposed to the Keokuk limestone.

Stratigraphic Section No. 39

Creek cut and quarry on south side of Shoal Creek in the SW corner sec. 28, T. 27 N., R. 33 W., Newton County, Missouri, about one-half mile below Grand Falls.

The upper 54 feet of the Reeds Spring limestone is exposed at this locality. The lower 22 feet does not contain very much chert; it is very similar in lithologic characters to the St. Joe limestone.

The Grand Falls chert is not present in the section at this locality.

The lower 102.5 feet of the Keokuk limestone is well exposed in the quarry.
Stratigraphic Section No. 40

Abandoned quarry of Phenix Marble Company at Phenix, Greene County, Missouri.

All the index fossils for the *Pentremites elongatus-Dizygoocrinus rotundus* zone were collected from the upper part of the Burlington limestone.

This is the only locality in Greene County where I found the Keokuk limestone.

Stratigraphic Section No. 41

Abandoned quarry of the Ash Grove Lime and Cement Company in the center NE 1/4, NW 1/4 sec. 29, T. 30 N., R. 24 W., Greene County, Missouri, just southwest of Ash Grove.

Approximately 40 feet of typical gray crinoidal cherty Burlington limestone is exposed here. Many complete fossils, including all the index fossils of the *Pentremites elongatus-Dizygoocrinus rotundus* zone, were collected from the upper 15 feet. Accordingly, all beds exposed are referred to the *Pentremites elongatus-Dizygoocrinus rotundus* zone of the Burlington limestone.

Moore (1928, pp. 187, 188) referred the limestone at this locality to the upper Burlington.

The Keokuk limestone is not present in the Ash Grove area.
Limestone, gray, coarsely crystalline, massive; contains two layers of white chert nodules in upper part, quarried for building stone.

Layer of white chert nodules.

Limestone, gray, coarsely crystalline, massive; contains a few white chert nodules in upper part, quarried for building stone.

Layer of fossiliferous white chert nodules.

Limestone, gray, medium crystalline, massive; contains numerous white chert nodules in upper part, quarried for building stone.

Layer of white chert nodules.

Limestone, gray, medium crystalline, massive; contains very little chert, quarried for building stone.

Massive chert bed.
Stratigraphic Section No. 42

Quarry one-half mile northwest of Everton in the SE corner NW\(^2\)
sec. 8, T. 30 N., R. 25 W., Dade County, Missouri.

Thickness, feet

Osagian series

Burlington limestone

<table>
<thead>
<tr>
<th>Bed</th>
<th>Description</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Limestone, gray, finely crystalline, thin-bedded, fossiliferous.</td>
<td>10.0</td>
</tr>
<tr>
<td>8</td>
<td>Limestone, gray, finely crystalline with coarsely crystalline highly crinoidal streaks; contains some chert nodules.</td>
<td>12.5</td>
</tr>
<tr>
<td>7</td>
<td>Limestone, gray, finely crystalline, very massive.</td>
<td>20.25</td>
</tr>
<tr>
<td>6</td>
<td>Layer of chert nodules.</td>
<td>0.75</td>
</tr>
<tr>
<td>5</td>
<td>Limestone, gray, finely crystalline, crinoidal.</td>
<td>3.0</td>
</tr>
<tr>
<td>4</td>
<td>Massive chert lens.</td>
<td>0.5</td>
</tr>
<tr>
<td>3</td>
<td>Limestone, gray, finely crystalline, massive, crinoidal in streaks.</td>
<td>9.0</td>
</tr>
<tr>
<td>2</td>
<td>Limestone, gray, finely crystalline, massive; contains numerous chert nodules.</td>
<td>5.0</td>
</tr>
<tr>
<td>1</td>
<td>Limestone, gray, finely crystalline, massive, crinoidal in streaks</td>
<td>14.0</td>
</tr>
</tbody>
</table>

Total: 75.00
Stratigraphic Section No. 43

Abandoned quarry in the NE¼ NE¼ sec. 2, T. 30 N., R. 27 W., Dade County, Missouri.

Forty feet of gray, coarsely crystalline, highly crinoidal, sparsely cherty limestone is exposed here. It is difficult to find identifiable fossils at this place, but I found Actinocrinites sp., Macrocrinus verneuilianus (Shumard), Spirifer grimesi Hall, Athyris lamellosa (L'Eveille), and Dictyoclostus burlingtonensis (Hall). The limestone exposed at this quarry is referred to the Pentremites elongatus-Dizygoocrinus rotundus zone of the Burlington limestone.

Stratigraphic Section No. 44

Quarry 300 yards south and east of Pump Spur on the St. Louis-San Francisco Railroad in the NE¼ SW¼ sec. 32, T. 31 N., R. 27 W., Dade County, Missouri.

See the description of the St. Louis limestone for a discussion of the rocks exposed in this quarry.

Stratigraphic Section No. 45

Outcrop at McCubbin Bridge across Horse Creek in the NW¼ NE¼ sec. 6, T. 31 N., R. 28 W., Dade County, Missouri, and quarry owned by Harold Mammen approximately 50 yards west of McCubbin Bridge.

See the description of the St. Louis limestone (p. 110) for a discussion of the rocks exposed at this locality.

Stratigraphic Section No. 46

Quarry owned by John and Jewell Smith near the SE corner SW¼ NW¼ sec. 25, T. 32 N., R. 30 W., Barton County, Missouri.

Approximately 14 feet of gray to blue finely crystalline Keokuk limestone is exposed in this small quarry. Orthotetes keokuk (Hall) is abundant. No chert is present in the exposed rock. The limestone is somewhat petrolierous.
Stratigraphic Section No. 47

Two quarries, one on each side of Cedar County highway A just south of Horse Creek in the SW₁₄ sec. 17, T. 34 N., R. 28 W., Cedar County, Missouri.

A total of 22 feet of Keokuk limestone is exposed at these two quarries. Archimedes sp. was collected from the upper part of the quarry on the west side of the road. The upper 4 feet of rock exposed in the quarry on the east side of the road consists of yellow, thin-bedded, platy siltstone. Just below this siltstone is a brown dolomite bed 2 feet thick in which Spirifer keokuk Hall is extremely abundant. This bed is correlated with a similar Spirifer keokuk zone at locality 44.

Stratigraphic Section No. 48

Road cut just east of the Missouri highway 64 bridge across Sac River in the center NE₁₄ SW₁₄ sec. 11, T. 34 N., R. 26 W., Cedar County, Missouri.

See accompanying plotted section.

Stratigraphic Section No. 49

Abandoned W.P.A. quarry on the north side of U. S. highway 54 just west of Fly Creek, in the NE₁₄ SW₁₄ sec. 25, T. 36 N., R. 29 W., Vernon County, Missouri.

Approximately 17 feet of Keokuk limestone is exposed at this small quarry. A very peculiar reworked zone 3 feet thick consisting of tan to brown limestone occurs in about the middle of the exposure. This zone contains a large number of dense gray limestone concretions. Most of them are elliptical shaped and the largest I saw was 11 inches thick, 24 inches wide, and 33 inches long.
Stratigraphic Section No. 48

**ORDOVICIAN Rocks**

**NORTHVIEW**

- **Lower**
  - Shale, tan, slightly dolomitic, highly silty in zones.

**CHOUTEAU**

- Limestone, gray to tan, silty, finely crystalline, thin irregularly bedded, crinoidal.

**BURLETON**

- Bactonius Zone
  - Limestone, gray with brown streaks, silty, coarsely crystalline, medium to thick-bedded, crinoidal.
  - Limestone, gray to tan, medium crystalline, medium to thick-bedded, crinoidal.
  - Limestone, brown, finely crystalline, two beds.

**SEDALIA**

- Dolomite, tan to brown, calcareous in upper part, highly silty in lower part, finely crystalline, thick to medium-bedded.

**NORTHVIEW**

- **Upper**
  - Shale, tan, silty.
  - Siltstone, tan, dolomitic
  - Siltstone, tan, dolomitic, single bed, contains a few very small nodules of drusy quartz
  - Shale, tan, slightly dolomitic, silty.
  - Siltstone, tan, slightly dolomitic, single bed.
Stratigraphic Section No. 50

Quarry of Morris-Moss Lime Company on Jack Sturgin's farm near the SE corner SW\(\frac{1}{4}\) SW\(\frac{1}{4}\) sec. 8, T. 36 N., R. 28 W., St. Clair County, Missouri.

Thirty-three feet of Keokuk limestone is exposed in the quarry and adjacent exposure along Walnut Creek. Identifiable fossils are very scarce. *Spirifer keokuk* Hall is present.

Stratigraphic Section No. 51

Bluff along the east side of Clear Creek in the W\(\frac{1}{2}\) NE\(\frac{1}{4}\) sec. 31, T. 37 N., R. 28 W., St. Clair County, Missouri.

The Burlington limestone is not typically developed here. The upper part of the exposure consists almost entirely of dolomite, except for one zone of blue limestone. The Burlington beds exposed here are correlated with similar strata at localities 52, 58, and 59.

Stratigraphic Section No. 52

Abandoned quarry of Belvoir Lime Company on the east bank of Osage River in the NE\(\frac{1}{4}\) SE\(\frac{1}{4}\) sec. 26, T. 38 N., R. 30 W., Vernon County, Missouri.

The Burlington limestone is not typically developed. Its lithologic characters are very similar to the Burlington limestone exposed at localities 51, 58, and 59. I did not find any identifiable fossils.
Stratigraphic Section No. 51

BURLINGTON

Undifferentiated

Dolomite, tan, silty, finely crystalline, medium to thin-bedded, fossiliferous.

SEDALIA

Dolomite, tan, silty, porous, finely crystalline, medium-bedded; contains layers of individual chert nodules.

Dolomite, tan, silty, porous, finely crystalline, massive; fossiliferous; contains a few chert nodules.

Dolomite, tan, calcareous, porous, silty, finely crystalline, medium-bedded, fossiliferous.

Dolomite, tan, calcareous, silty, finely crystalline, medium-bedded, fossiliferous.

Dolomite, tan, silty, porous, finely crystalline, massive; fossiliferous; contains calcite vein fillings.

Dolomite, tan, silty, porous, finely crystalline, medium-bedded; fossiliferous.

Limestone, gray, medium crystalline, medium to thin-bedded, fossiliferous.

Limestone, gray, medium crystalline, medium to thin-bedded, fossiliferous.

Limestone, light gray, finely crystalline, thin-bedded, fossiliferous.

Limestone, tan, silty, porous, finely crystalline, thick-bedded, fossiliferous.

Limestone, blue to tan, highly dolomitic, silty, finely crystalline, massive; contains calcite vein fillings.

Limestone, blue, dolomitic, silty, finely crystalline, massive.

Dolomite, tan, silty, porous, finely crystalline, medium-bedded.

Dolomite, tan, silty, porous, finely crystalline, medium-bedded.

Dolomite, tan, silty, porous, finely crystalline, medium-bedded.

Dolomite, tan, silty, porous, finely crystalline, medium-bedded.
Stratigraphic Section No. 52

Dolomite, brown, calcareous, finely crystalline, medium-bedded.

Limestone, brown to blue; contains numerous calcite vein fillings.

Dolomite, brown, finely crystalline, thick-bedded; contains numerous vein fillings and individual crystals of calcite.

Dolomite, brown, calcareous, porous, finely crystalline, medium-bedded, fossiliferous; contains some chert nodules in lower part.

Limestone, brown, finely crystalline, medium-bedded, crinoidal.

Limestone, blue to tan, dolomitic, finely crystalline, single bed.

Limestone, gray, medium, crystalline, single bed, crinoidal.

Limestone, gray, finely crystalline, thick-bedded, fossiliferous, contains some chert nodules.

Limestone, gray, silty, medium crystalline, thick-bedded, crinoidal.
Stratigraphic Section No. 53

Bluff along the south side of Osage River near center sec. 5, T. 37 N., R. 28 W., St. Clair County, Missouri.

The Chouteau limestone is poorly exposed. The Sedalia dolomite is thicker here than at any other locality studied. Quartz geodes are very abundant in the cherty zone of the Sedalia dolomite.

Stratigraphic Section No. 54

Road cut near center SW¼ sec. 18, T. 37 N., R. 27 W., St. Clair County, Missouri.

The Chouteau limestone is absent at this locality, and the Sedalia dolomite rests unconformably on Ordovician rocks.

Stratigraphic Section No. 55

Bluff at Sac-Osage Heights along Osage River near center II2 SE¼ sec. 8, T. 37 N., R. 26 W., St. Clair County, Missouri, about one-fourth mile north of Roscoe.

The Spirifer zone is most typically developed at this locality. Spirifer cf. centronatus is extremely abundant. Other forms present include Brachythyris suborbicularis (Hall), Rhynchopora persinuata (Winchell), Spirifer mundulus Rowley, S. rowleyi Weller, and S. vernonensis Swallow. All of these forms occur in the lower beds of the Batocrinus calvini-Uperocrinus longirostris zone, but they are much more abundant in the Spirifer zone.
Stratigraphic Section No. 53

**ORDOVICIAN Rocks**

**CHOUTEAU**

Limestone, gray, thin-bedded, crinoidal.

**SEDALIA**

Dolomite, brown, silty, porous, crinoidal. *Crypto-\textit{blastos} roemeri*, *Chonetes glenparkensis*, *Leptaena analoga*, *Spirifer insculptus*, *S. louisianensis*, *S. osagensis*.

Dolomite, brown, silty, porous, massive, crinoidal.

Dolomite, brown, silty, porous, crinoidal; contains abundant chert nodules.

Dolomite, brown, silty, dense; contains abundant chert nodules and quartz geodes. *Brachythyris chouteauensis*, *Dictyoclostus sedaliensis*, *Spirifer insculptus*, *S. louisianensis*, *S. osagensis*.

Dolomite, brown, silty, porous, crinoidal; contains abundant chert nodules.
Stratigraphic Section No. 55

SEDA LIA

Siltstone, tan, dolomitic, medium-bedded.

Dolomite, tan, silty, dense, thin to medium-bedded.

Dolomite, brown, silty.

BURLINGTON

Batocrinus-Uperocrinus Zone

Limestone, gray, coarsely crystalline, medium-bedded, fossiliferous.

Spirifer Zone

Limestone, gray, thin-bedded, fossiliferous.

Dolomite, tan, silty, porous, massive, fossiliferous.

Siltstone, tan, dolomitic, thin-bedded, soft.

Cherty Zone

Dolomite, tan, silty, dense, thin-bedded; contains abundant lenticular chert nodules.

Siltstone, tan, dolomitic, thin-bedded, soft.
Composite section in the vicinity of Osceola, St. Clair County.

A nearly complete section of Burlington limestone is exposed in the Hunt-Bullard quarry in the NE¼ NW¼ SE¼ sec. 18, T. 38 N., R. 25 W. The lower Burlington Beds are better exposed in a railroad cut two blocks east of the dam in the town of Osceola and in a road cut in the SW¼ sec. 9, T. 38 N., R. 25 W. The cherty zone of the Sedalia dolomite outcrops at the east end of the dam across Osage River at Osceola. The lower Sedalia and Chouteau formations are not exposed in the Osceola area, but I obtained information about them from core hole No. 1, site No. 1 of the U. S. Army Engineers located in the SW¼ SE¼ NE¼ sec. 19, T. 38 N., R. 25 W.

The Chouteau and Sedalia formations are typically developed in the Osceola area. A complete sequence of lower Burlington beds is present. A dark-blue, distinctively nodular algal-like limestone bed occurs at the top of the Cryptoblastus melo zone. This bed weathers more rapidly than the underlying and overlying limestone, forming a prominent indentation in the bluffs. It is an excellent marker bed over a wide area. The basal part of the Cactocrinus proboscidialis zone is cavernous just above the nodular algal-like bed. Moore (1928, pp. 186, 187) listed a large fauna from the white chert in the Cactocrinus proboscidialis zone from the quarry that is now the Hunt-Bullard quarry. The base of the Physetocrinus ventricosus zone in the Hunt-Bullard quarry is marked by a peculiar cross-bedded limestone containing a large amount of angular chert fragments.
This conglomeratic limestone seems to indicate a stratigraphic break of some sort; but its base is very flat, not irregular as might be expected. Moore (1928, p. 186) described the stratigraphic section at this locality, and he questionably referred the beds above this hiatus to the Keokuk limestone. I obtained the following species from recently weathered surfaces in this quarry above the hiatus, all of which are typical representatives of the *Physetocrinus ventricosus* zone of the Burlington limestone:

- *Agaricocrinites planoconvexus* (Hall)
- *Acorocrinus parvus* (Shumard)
- *Cactocrinus glans* (Hall)
- *Eutrochocrinus christyi* (Shumard)
- *Macrocrinus koninchi* (Shumard)
- *Physetocrinus ventricosus* (Hall)
- *Uperocrinus pyriformis* (Shumard)
- *Rhipidomella burlingtonensis* (Hall)

Figures 21 and 22 were taken at the Hunt-Bullard quarry.
Stratigraphic Section No. 57

Road cut on northeast side of hill in the NE¼ sec. 8, T. 38 N., R. 24 W., about three-quarters of a mile northeast of Corbin, St. Clair County, Missouri.

All the rocks at this locality are well exposed in one continuous section. The chert in the cherty zone of the Sedalia dolomite is abundantly fossiliferous. The nodular, algal-like limestone bed at the top of the Cryptoblastus melo zone is well developed. The Spirifer zone is not present.

Stratigraphic Section No. 58

Exposure along creek near the center of the north line of sec. 16, T. 37 N., R. 25 W., St. Clair County, Missouri.

See Stratigraphic Section No. 59.

Stratigraphic Section No. 59

Road cut near the center of the NW¼ sec. 27, T. 37 N., R. 25 W., St. Clair County, Missouri.

The Burlington limestone exposed at localities 58 and 59 consists almost entirely of brown, silty dolomite, very similar to the dolomite of the Sedalia. The lithology at these localities is similar to that of the same strata at localities 51 and 52. I collected one specimen of Macrocrinus verneuilianus (Shumard) from a limestone bed in the dolomite at locality 59.
Limestone, gray, to reddish brown, medium crystalline, crinoidal. *Coelocrinus extensus*, *C. multi brachiatus*, *Coelocrinus ventricosus*.

Dolomite, brown, dense.

Limestone, light buff, silty, fossiliferous.

*Cryptoblastus roemerii*

Siltstone, yellow, dolomitic, soft.

Shale, light brown.

Limestone, brown, calcareous, dense, thin-bedded.

Siltstone, yellow, dolomitic, thin-bedded, soft.

Shale, light brown.

Dolomite, brown, dense, contains scattered calcite fillings and very little chert.

Limestone, gray, coarsely crystalline, massive, crinoidal.

*Osagian-Kinderoookian Contact*

Dolomite, brown, dense.

Siltstone, yellow, dolomitic, thin-bedded, soft.

Shale, light brown.

Limestone, gray, nodular, algal-like, soft.

Limestone, gray, medium crystalline, thick-bedded, crinoidal.

Dolomite, brown, dense.

Limestone, gray, medium crystalline, thick-bedded, crinoidal.
Stratigraphic Section No. 60

Exposure in the bottom of the road ditch along the south side of U. S. highway 54 just at the east edge of Collins, St. Clair County, Missouri.

See Stratigraphic Section No. 61.

Stratigraphic Section No. 61

Road cut along U. S. highway 54 in the NW$_1^4$ sec. 7, T. 36 N., R. 23 W., Hickory County, Missouri.

The Batocrinus calvini-Uperocrinus longirostris zone is typically developed at localities 60 and 61.

Stratigraphic Section No. 62

Quarry in the NE$_1^2$ NW$_1^4$ sec. 19, T. 40 N., R. 22 W., Benton County, Missouri.

The Chouteau limestone is faulted up against the Batocrinus calvini-Uperocrinus longirostris zone of the Burlington limestone. The fault has a vertical displacement of at least 30 feet. This is a normal fault with a strike of north 34 degrees east. The Chouteau and Burlington limestones both are fossiliferous and typically developed.

Stratigraphic Section No. 63

Road cut along Missouri highway 83 in Roaring River State Park, Barry County, Missouri.

See Stratigraphic Section No. 64.
Stratigraphic Section No. 64

Road cut along Missouri highway 90 at Noel, Missouri.

The St. Joe limestone rests unconformably on the Chattanooga shale at localities 63 and 64. The Chattanooga shale, St. Joe limestone, and Reeds Spring limestone are well exposed and typically developed.