

GEOLOGY OF PARTS OF MONROE,
RANDOLPH AND ST. CLAIR COUNTIES

OKAW FORMATION

Copied from manuscript by Stuart Weller,
written circa 1920.

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OKAW FORMATION.

The Okaw¹ is the thickest one of the Chester formations in the

¹Weller, Trans. Ill. Acad. Sci., vol. 6, p. 127 (1914); also Ill. State Geol. Surv., Monog. I, p. 27, (1914).

Randolph County, and it includes the most typical beds of the "Upper Archimedes Limestone" of Shumard, and the "Kaskaskia limestone" of Hall. The name of the formation is derived from the Okaw or Kaskaskia river, good exposures being present in the Mississippi river bluffs both above and below the mouth of that stream, and the valley of the stream itself is excavated in the formation for more than twenty miles from its mouth.

The formation rests conformably upon the Ruma, and is made up of a series of alternating beds of limestone and shale, with some sandstone locally present near the top, which have an aggregate thickness of about 200 feet. The limestones are the most conspicuous members of the formation. They are variable in lithologic character and in thickness, some being nearly pure, light gray or bluish in color, more or less coarsely crystalline, others being more argillaceous, thick or thin bedded, with shaly partings. Conspicuous, white, oolitic limestone beds are present in the lower and more rarely in the upper portion of the formation, and not uncommonly some of the limestone beds which are not conspicuously oolitic show some scattered oolite grains when examined closely. All of these limestones are commonly free from chert, nearly all of the chert which has been observed in the formation being confined to a thin band of ten feet or less in thickness, about 90 or 100 feet from the base. Aside from this one conspicuous chert bed which is well exposed in the heads of the ravines south of Marigold, cherty limestone beds have been observed in only one or two localities.

The shales of the Okaw formation vary as much in character as do the limestones. Some beds are nearly pure argillaceous shales, others are highly calcareous, but at no locality in the formation, unless it be near the top, in association with some of the local sandstone beds, have any arenaceous shales been observed. Most of the shales are gray, bluish, or yellowish in color, but at a few localities a limited admixture of red or purple colors occur, although no such conspicuously variegated shale beds as are present in the lower formations, are known.

The exposures of the shale members of the Okaw formation are commonly obscured by the talus in the Mississippi river bluff sections, but in many of the ravines intersecting the bluffs, good clean sections are exposed. The limestones are well exposed, not only in the ravines, but also as more or less continuous ledges in the bluffs. Because of the lithologic character of the formation, the alternation of shales and limestones, the Okaw formation in the Mississippi river bluffs is not exposed in the high, nearly vertical escarpments which are so characteristic of the St. Louis limestone, but rather as steeply sloping hill sides upon which the limestone beds form terrace-like benches at intervals. In no one section in the region being described, is the entire thickness of the Okaw exposed, but the characters of the formation may be shown by combining a number of sections. The basal portion of the formation, with the underlying Ruma and the upper portion of the Paint Creek, is exposed in the small ravine intersecting the Mississippi river bluff in s.w. 1/4 sec. 4, T. 6 S., R. 8 W., about two and one-half miles below Modoc. In this section the following succession of beds is exposed.

Areal distribution and description. Because of the greater thickness of the Okaw formation, it occupies a much broader belt than any of the older members of the Chester group, but in the northern portion of the area mapped, the overlapping Pennsylvanian formations entirely cover it. The northernmost outcrops

of the formation occupy small, isolated areas entirely surrounded by the Pennsylvanian formations, their presence being due to the uneven nature of the pre-Pennsylvanian surface along the courses of the erosion channels in the present topographic surface. The northermost of such inlying areas, in the bed of West Fork creek, in n.e. 1/4 of s.e. 1/4, sec. 27, T. 1 S., R. 9 W., is very small, and the actual outcrop does not occupy an area of more than a few square yards. A much larger outcrop is present in the valley of the same creek, and in the lower portion of a tributary valley from the west, in n.e. 1/4 of sec. 2, T. 2 S. R. 9 W., about one and one-half miles north of Floraville. At this locality the limestones are well exposed in the bed of the creek, with Pennsylvanian strata resting upon them. The limestones are irregularly bedded and are more or less impure, with shaly partings. Fossils are not uncommon, a species of Zaphrentis being the most common form. Some of the beds contain great numbers of the axes of a species of Archimedes, a character which is indicative of the Okaw age of the beds, since that fossil is not common in the Chester formations older than the Okaw. Pterotocrinus plates have not been observed, however, and Agassizocrinus bases are not abundant, as might be expected in the basal Okaw where the beds probably belong. Other limestone outcrops are present in the valley of the same stream, in the west half of s.w. 1/4, sec. 6, T. 2 S., R. 8 W., and in a small tributary from the west in section 1 to the west, this area being about equal in size to that last described, and at one point a thickness of 20 feet of limestone is exposed. A very much smaller outcrop of Chester limestone, referable to the Okaw formation, is exposed beneath the bridge at the corner of the public road one and one-fourth miles southwest of Smithton, at the middle of the south line of the s.w. 1/4, sec. 5, T. 2 S., R. 8 W. Other small isolated outcrops have been observed in n.w. 1/4 of n.w. 1/4 sec. 13, T. 2 S., R. 8 W., a mile and one-half northwest of Paderborn, and in s.w. 1/4 of n.w. 1/4, sec. 13, T. 2 S., R. 9 W., a little over one-fourth mile west of Paderborn.

In the s.e. 1/4, sec. 29, T. 2 S., R. 8 W., about one and one-half miles northwest of Hecker, along a small valley tributary to Richland creek, there are a number of limestone outcrops in a small area, entirely surrounded by the Pennsylvanian, from which the following fossil fauna, very characteristic of the basal part of the Okaw, has been collected.

Other similar isolated patches of the Okaw limestone have been noted by E. W. Shaw northeast of Hecker, in n.e. 1/4 of s.w. 1/4, sec. 27, and in n.w. 1/4 of n.e. 1/4, sec. 33, T. 2 S., R. 8 W., in the valley of a small tributary to Richland creek.

In the lower portion of the valley of Prairie du Long creek, between two and three miles from its junction with Richland creek, the beginning of a continuous belt of the Okaw formation is exposed. It stretches eastward to the east side of the Okaw river, and probably extends a long distance northward in the Okaw valley beneath the alluvial deposits of that stream. East and northeast of Red Bud the glacial drift mantle is very thick over most of the area, and rock outcrops are scarce, but about a mile northeast of the town there are exposures of Pennsylvanian sandstone overlying the Okaw, and this outlier of the younger formation perhaps extends nearly to the Okaw river, as it has been mapped, although the actual outcrops are limited to the western margin.

The continuous belt of the Okaw formation extends southward to the Mississippi river bluffs, and the entire channel of the Okaw river, probably from New Athens or above, to the mouth of the stream lies in this formation. The average width of the belt is between six and seven miles, although along a line about two miles north of Evansville the width is as much as ten miles. In the Mississippi river bluffs the formation first appears about three miles above the Okaw river gap, and continues to the mouth of Marys river, although from about a mile above

Fort Gage to the southernmost exposure, the formation occupies only a narrow strip at the base of the bluffs, below the younger formations.

In the northwestern portion of the broad, continuous belt underlain by the Okaw formation, outcrops of the limestones and shales are present at many points along the courses of the streams, but south and southeast of a line passing east and then north from the city of Red Bud, to about the northeastern corner of sec. 3, T. 4 S., R. 8 W., to the Okaw river on the east and Horse Creek on the south, the glacial drift is generally from 50 to 100 feet or more in depth, and no rock outcrops are exposed. Within the northwestern area where scattered outcrops are present, the limestones are exposed in sec. 20, T. 3 S., R. 8 W., along a tributary of Prairie du Long creek which crosses the section diagonally from the n.w. $\frac{1}{4}$ of s.w. $\frac{1}{4}$ to s.e. $\frac{1}{4}$ of n.e. $\frac{1}{4}$, and to a less extent along the tributary which joins the last one after crossing diagonally the s.e. $\frac{1}{4}$ of the same section. North of Prairie du Long creek, from the localities just mentioned, the glacial drift covering is thick and no rock outcrops have been observed, although the Okaw formation probably underlies a considerable portion of the southern half of sec. 17, T. 3 S., R. 8 W.

In a small draw east of the public road from Red Bud to Hecker, north of the bridge over Prairie du Long creek, one of the limestone beds of the Okaw has been quarried for local use, and some of the shaly partings between the limestones are abundantly fossiliferous, and the following species have been recognized.

W 259

Along the Black Creek tributary to Richland creek which crosses the Red Bud-Hecker road in n.w. $\frac{1}{4}$ of n.w. $\frac{1}{4}$, sec. 33, T. 3 S., R. 8 W., tongue-like areas of the Okaw formation have been exposed by the cutting of the streams through the overlying Pennsylvanian sandstones, in the north fork as far as s.e.

1/4 sec. 30, and in the south fork as far as the n.w. 1/4 sec. 32, T. 3 S., R. 8 W., and while the bottoms of these valleys, especially that of the northern one, are much filled with alluvium, there are a number of limestone outcrops at intervals. By the roadside just south of the bridge, a calcareous shale member of the formation is exposed which is fossiliferous, and the following species have been identified from the locality.

W 255

Along a branch of the last mentioned stream, which flows south through ^{north?} the western part of the city of Red Bud, and then east to its junction with the branch from the north, the Okaw is well exposed at a number of points, from the n.e. 1/4 of n.e. 1/4, sec. 8, to the n.w. 1/4 of n.e. 1/4 sec. 4, T. 4 S., R. 8 W. The city of Red Bud has opened and operates a quarry for road material in the east bank of this creek just north of the Red Bud-Waterloo road leading west from the city. In this quarry from eight to twelve feet of blue, crystalline limestone with some shaly partings, are exposed. This limestone is near the base of the formation, it is fossiliferous and the following species of fossils have been collected and identified.

W 253

Along the same creek a small quarry has been opened about one-half mile north of the railroad station at Red Bud, east of the Red Bud-Hecker road. The limestone exposed at this locality lies a little higher in the formation than that in the city quarry. At the time it was visited the bottom of the quarry was filled with water, so the total thickness of limestone exposed could not be seen, but there is probably eight feet or thereabouts. The rock is a much lighter colored limestone than that in the city quarry, being nearly white. It is crystalline and abundantly fossiliferous, some beds being composed almost entirely of fragments of bryozoans and crinoid stems. One bed in the quarry is

somewhat impure, and is characterized by the presence of numerous, rounded, black pebble-like inclusions, which are probably phosphatic. The fossils are not well preserved, but the following species have been recognized.

W 254

Down stream from the quarry last mentioned, for about one-half mile to the next north and south road, there are a number of outcrops of limestone and calcareous shale, all more or less fossiliferous, but beyond this point the bottom of the valley is filled with alluvium.

In the upper portion of the valley crossing diagonally from northwest to southeast, the s.e. 1/4 sec. 28, T. 3 S., R. 8 W., and also in the s.w. 1/4 of s.w. 1/4, sec. 27, there are a number of outcrops of Okaw limestone, and in the east half of n.e. 1/4 sec. 34, T. 3 S., R. 8 W., near the mouths of two small valleys from the east, there are other outcrops. At these last localities the Okaw limestone beds are overlain by Pennsylvanian sandstones. The city of Red Bud is underlain by the Okaw limestone, and although there are no exposures except along the creek in the western part of the town, the dug wells which pass through the overlying drift mantle, invariably penetrate the limestones. One mile north-east of Red Bud, in n.e. sec. 3, T. 4 S., R. 8 W., a group of sink holes indicates the presence of limestones, and the Okaw limestone is actually exposed at a number of points.

Aside from the outcrops mentioned, the deep drift covering hides all the rock exposures between Red Bud and the Okaw river, but east of this stream the Chester formations are exposed at a number of points in the beds of some of the tributaries of the Okaw river just above where they enter the bottom lands. The northernmost of such outcrops are near the mouth of Dozaw creek, in n.W. 1/4 sec. 4, T. 3 S., R. 7 W., near the middle of the north half of the quarter-section.

8

Other outcrops are present in the same quarter-section, just south of the central portion of its southern half. Much more extensive outcrops occur in the bed of an unnamed creek in n.e. 1/4 of s.w. 1/4, and in n.w. 1/4 of s.e. 1/4 of the same section 4, where limestone with shaly partings is exposed almost continuously for the distance of nearly a quarter of a mile. In all these outcrops the strata exposed belong in the upper portion of the Okaw formation. Above the limestone there are a few outcrops of sandstone which are believed to be Pennsylvanian, although there is locally developed a thin sandstone member in the upper portion of the Okaw, and these sandstones may be that Okaw member.

West of Baldwin, in the lower portion of both of the forks of the tributary to the Okaw river whose mouth lies just north of the Mobile and Ohio railroad bridge, the upper portion of the Okaw formation, characterized by Archimedes and Pentremites sulcatus, is well exposed. In the north fork of the stream the outcrops continue at intervals for about one-half mile from the junction with the south fork, but in the south fork the last outcrop is beneath the railroad bridge.

In the creek about three-fourths of a mile south of the Mobile and Ohio railroad, the upper beds of the Okaw are exposed in the s.e. 1/4 of s.w. 1/4, sec. 16, and in n.e. 1/4 of n.w. 1/4, sec. 21, T. 4 S., R. 7 W. The outcrops consist of more or less argillaceous and crystalline limestones with shale partings, most of the beds being fossiliferous although the fossils are difficult to remove from the limestones. One shale bed less than a foot in thickness, contains great numbers of good examples of Pentremites sulcatus, and a few other species, as follows.

W 622

Another group of outcrops occurs in s.w. 1/4 of sec. 21, T. 4 S., R. 7 W. In the n.e. 1/4 of the quarter-section limited limestone and shale exposures are present in the bed of the creek, but in the s.w. 1/4 of the quarter-section

the beds are much better exposed in the Okaw river bluff, and in the short draw leading to the northwest. In this draw a series of calcareous shales and some limestones is exposed, the shales containing numerous specimens of Orthotetes kaskaskiensis in some horizons. In the river bluff the shales have slumped a great deal, and the ledges have been more or less completely covered by talus, but some of the beds are abundantly fossiliferous, and the following species have been collected lying loose upon the slope.

W 624

A single small outcrop of thinly bedded, siliceous limestone is present near the mouth of a short valley, in s.w. 1/4 of n.w. 1/4, sec. 5, T. 5 S., R. 7 W. It doubtless belongs in the upper portion of the Okaw formation although no fossils have been observed.

From Horse creek south, on the west side of the Okaw river, and from Plum creek south, east of the Okaw, the Pleistocene deposits are much less deep than north of these two streams, and outcrops of the underlying hard rocks are met with in most of the stream courses, all the way to the Mississippi bluffs.

At a spring west of the Red Bud-Ruma road, a little over one-half mile south of the bridge over Horse creek, in s.e. 1/4 of s.e. 1/4, sec. 29, T. 4 S., R. 8 W., and in the small valley crossing the northern portion of sec. 32, next south, the lower beds of the Okaw are well exposed and are abundantly fossiliferous. From the exposures at the spring the following species have been determined.

W 590

W 256

10

In the section exposed in the small valley south of the spring, there are about four feet of variegated shales at the base, which doubtless represent the upper portion of the Ruma formation, passing up into more calcareous gray shales. Higher up there are 20 feet or more of limestones in beds one foot thick or less, with shaly partings. These limestones are fossiliferous, some layers being especially filled with Productus ovatus and Diaphragmus elegans, some beds have many crinoid stems, and in other beds bryozoans are abundant, although Archimedes is not common as is usually the case in the lower Okaw. Some oolitic beds are present, but they are neither very thick nor conspicuous.

Good exposures of the lower Okaw are present in most if not all of the tributaries to Horse creek and Paint Creek, west of Ruma, in which the Ruma formation is exposed, and at one locality by the roadside, in s.w. 1/4 of s.e. 1/4, sec. 30, T. 4 S., R. 8 W., the following species of fossils have been collected.

W 602

In the two valleys leading to the north across the n.e. 1/4, sec. 1, T. 4 S., R. 9 W., and the n.w. 1/4, sec. 6, T. 4 S., R. 8 W., which join further north, the lower Okaw beds are exposed above the Ruma formation. In these localities the beds are characterized by an abundance of bases of Agassizocrinus, the spatulate, wing-plates of Pterotocrinus, and the axes of Archimedes, characteristics which have been met with very frequently in the lower Okaw beds. The limestones are in beds a foot, more or less, in thickness, with shaly partings, and the successive beds vary more or less in lithologic characters, and commonly the three fossil forms mentioned above are each abundant in separate beds.

In the bed and banks of Camp creek there are excellent Okaw exposures in n.w. 1/4 of s.w. 1/4 sec. 7, T. 4 S., R. 8 W., mostly limestones but with some shale beds containing numerous Pterotocrinus wing plates. At this locality some

of the beds are literally filled with bryozoans, and in one bed upon a surface of about square feet the following species of bryozoans and other fossils have been identified.

At this same Camp creek locality, one thin bed contains numerous, dark, pebble-like inclusions, apparently phosphatic, associated with numerous fossils which were waterworn before burial. Beds of similar character have been observed at a number of localities in the lower part of the Okaw formation, as in the quarry one-fourth mile north of Red Bud, and elsewhere, but it has not been possible to establish the exact equivalence of the beds at all points.

Excellent exposures of the lower portion of the Okaw occur in the northern part of the s.e. 1/4 of n.w. 1/4 sec. 18, T. 5 S., R. 8 W., in one of the branches of Camp creek, about two and three-fourths miles southwest of Ruma. At this locality the following section is exposed.

- 8. Limestone, crystalline in texture, with the exposed upper surface covered with great numbers of the "wing plates" of Pterotocrinus 1 foot.
- 7. Limestone, crystalline, irregularly bedded, with great numbers of Archimedes 6 inches.
- 6. Limestone, filled with fossils, the fauna comprising a prolific assemblage of brachiopods, gastropods, pelecypods, trilobites and bryozoa 1 foot.

- Zaphrentis sp.
- Pentremites pyriformis Say.
- Agassizocrinus (bases).
- Pterotocrinus (wing plates).
- Chilotrypa sp.

Stenopora sp.

Archimedes sp.

Polypora sp.

Lyropora sp.

Lyropora sp.

Orthotetes kaskaskiensis (McChesney.)

Productus ovatus Hall.

Diaphragmus elegans (Norwood and Pratten.)

Camarophoria explanata (McChesney.)

Rhynchopora ? perryensis Weller.

Spiriferina spinosa (Norwood and Pratten.)

S. Transversa (McChesney.)

Spirifer increbescens Hall, var.

S. leidyi Norwood and Pratten.

Martinia contracta (Meek and Worthen.)

Eumetria vera Hall.

Cliothyridina sublamellosa (Hall.)

Composita trinuclea (Hall.)

Girtyella brevilebata (Swallow.)

Sanguinolites sp.

Edmondia ? sp.

Nucula sp.

Leda sp.

L. sp.

Parallelodon sp.

P. sp.

Conocardium sp.

Myalina angulata Meek and Worthen.

M. sp.

Aviculopecten chesterensis Worthen.

Allorisma ? sp.

Cypricardinia sp.

Ptychomphalus sp.

P. sp.

Murchisonia sp.

Bellerophon sp.

B. sp.

Euphemus sp.

Patellostium sp.

P. sp.

Straparollus planidorsatus Meek and Worthen.

Holopea sp.

Orthonychia chesterensis Meek and Worthen.

Dentalium sp.

Enchostoma sp.

Orthoceras okawense Worthen.

O. randolphense Worthen.

O. sp.

Discitoceras sp.

D. sp.

Griffithides sp.

Helodus sp.

Petrodus sp.

5. Limestone, blue, crystalline, more or less irregularly bedded, with many fossils 3 feet.

Zaphrentis sp.

Pachylocrinus sp.

- Pentremites pyriformis Say.
- Archimedes swallowianus Hall.
- Orthotetes kaskaskiensis (McChesney.)
- Productus ovatus Hall.
- P. inflatus McChesnev.
- Pustula punctatus (Martin.)
- Diaphragmus elegans (Norwood and Pratten.)
- Spirifer spinosa (Norwood and Pratten.)
- S. transversa (McChesney.)
- Spirifer increbescens Hall, var.
- S. leidyi Norwood and Pratten.
- Martinia contracta (Meek and Worthen.)
- Eumetria vera Hall.
- Cliothyridina sublamellosa (Hall.)
- Composita trinuclea (Hall.)
- Myalina sp.
- Orthoceras sp.
- Griffithides sp.

- 4. Limestone, blue, crystalline, with many specimens
of Zaphrentis 6 inches
- 3. Limestone, irregularly bedded, similar to the
subjacent bed but more crystalline in texture,
bluer in color and with the fossils much more
conspicuous 3 feet.

2. Limestone, bluish-gray in color, with irregular knotty bedding, more or less earthy in texture.

The basal six inches with great numbers of

Agassizocrinus bases and plates, the upper

portion with many examples of Martinia 2 1/2 feet

Zaphrentis sp.

Pentremites pyriformis Say.

Agassizocrinus (bases)

Orthotetes kaskaskiensis (McChesney.)

Productus ovatus Hall.

Diaphragmus elegans (Norwood and Pratten.)

Camarophoria explanata (McChesney.)

Spirifer leidyi Norwood and Pratten.

Martinia sp.

Composita sp.

Straparollus planidorsatus Meek and Worthen.

Orthoceras sp.

Griffithides sp.

1. Shale, argillaceous, blue in color. Exposed 2 feet.

Just below the junction of the stream in which the last section occurs, with Camp creek, in a short tributary from the south, by the roadside in n.e. 1/4 of n.e. 1/4, sec. 17, T. 5 S., R. 8 W., the lower portion of the Okaw formation is again exposed, and the following species of fossils have been collected.

Zaphrentis sp.

Palaeacis cuneiformis Milne-Edwards

Pentremites pyriformis Say.

Agassizocrinus (bases).

Pterotocrinus (wing plates)

Chilotrypa sp.

Archimedes swallovianus Hall.

Polypora cestriensis Ulrich.

Lyropora divergens Ulrich.

Intrapora undulata Ulrich ?

Crania sp.

Orthotetes kaskaskiaensis (McChesney.)

Productus ovatus Hall.

Diaphragmus elegans (Norwood and Pratten.)

Rhynchopora ? perryensis Weller.

Spiriferina transversa (McChesney.)

Spirifer increbescens Hall, var.

S. leidyi Norwood and Pratten.

Eumetria vera Hall.

Cliothyridina sublamellosa (Hall.)

Composita trinuclea (Hall.)

Nucula sp.

Leda sp.

Conocardium sp.

Myalina angulata Meek and Worthen.

Aviculopecten sp.

A. sp.

Straparollus planidorsatus Meek and Worthen.

Enchostoma sp.

Griffithides sp.

17

Between Camp Creek and Horse Creek the Okaw beds outcrop at many points in the tributaries of the two streams, and at a number of localities collections of fossils have been secured. A mile and one quarter northeast of Ruma there are good exposures of oolitic and other limestones along a small creek crossing the s.e. 1/4 of s.e. 1/4, sec. 28, T. 4 S., R. 8 W. Some of these beds contain numerous examples of the spatulate wing plates of *Pterotocrinus*, a faunal character which is commonly met with in the lower Okaw. In the collection of fossils secured at this locality the following species have been identified.

W 620

Other good exposures of the *Pterotocrinus* bearing limestones are present one and three-fourths miles east of Ruma, in s.e. 1/4 of s.e. 1/4, sec. 34, T. 4 S., R. 8 W.

A little less than one-half mile southeast of Ruma, in s.e. 1/4 of n.e. 1/4 sec. 4, T. 5 S., R. 8 W., a bed of bluish Okaw limestone is exposed in the bed of a small creek just below the public road, from which a fauna very similar to that in the city quarry at Red Bud has been collected, containing large numbers of the brachiopod shell *Martinia contracta*. The completed list of species from this locality is as follows:

W 257

This *Martinia* fauna is apparently a persistent one in the basal part of the Okaw, and occupies a position a little below the beds containing such a great number of *Pterotocrinus* "wing plates".

At a number of points in the bed of Horse Creek in sections 1 and 2, T. 5 S., R. 8 W., the Okaw limestone is well exposed, and some of the strata are fossiliferous.

South of Camp creek, in a large tributary of that stream from the west, limestone and shale beds of the Okaw formation are well exposed. At one point where one of the branches of this stream crosses the line between sections 17 and 20, T. 5 S., R. 8 W., the following succession of beds occurs.

5. Shale, calcareous, with some limestone lenses
and bands. Abundantly fossiliferous 8 feet.

W 5-95

Zaphrentis sp.

Amplexus ? sp.

Pentremites pyriformis Say.

P. godoni DeFrance.

P. abbreviatus Hambach.

P. elegans Lyon.

Zeacrinus sp.

Hydreionocrinus sp.

Agassizocrinus (bases).

Pterotocrinus depressus Lyon and Casseday (wing plates.).

Fistulipora excelens Ulrich.

Stenopora tuberculata Prout.

S. sp.

Fenestella serratula Ulrich.

F. tenax Ulrich.

F. exigua Ulrich?

Archimedes swallowiana Hall.

Polypora cestriensis Ulrich.

P. tuberculata Prout.

P. radialis Ulrich ?

P. internodata Ulrich ?

Septopora subquadrans Ulrich.

- Glyptopora ? sp.
- Diaphragmus elegans (Norwood and Pratten.)
- Gamarophoria explanata (McChesney.)
- Spiriferina spinosa (Norwood and Pratten.)
- Spirifer leidyi Norwood and Pratten.
- Reticularia setigera (Hall.)
- Eumetria verneuilliana Hall.
- Cliothyridina sublamellosa (Hall.)
- Composita trinuclea (Hall.)
- Straparollus sp.
- Orthonychia chesterenses (Meek and Worthen.)
- Orthoceras sp.
- Discitoceras sp.

4. Shale, variegated red and blue in color, not calcareous	8 feet.
3. Shale, argillaceous, blue in color	6 "
2. Limestone, thin-bedded	1 "
1. Shale, argillaceous, thinly laminated, blue in color	12 "

This section is one of the few localities where variegated shales have been observed in the Okaw formation. Beneath the blue shale at the base of the section, there is an interval without outcrops of bed rock, but a short distance down stream a hard, dense limestone forms the floor of the creek and so continues for the distance of more than one-half mile. The unexposed interval between the limestone in the bed of the creek and the lowermost shale is approximately ten feet.

Other good outcrops of the Okaw limestone are exposed in the several valleys tributary to Camp Creek, heading in sec. 21, T. 5 S., R. 8 W., and flowing north and east.

In most of the valleys heading on the opposite sides of the ridge extending southeast from Marigold to Roots, the Okaw formation is well exposed. In the valleys to the west the Okaw is present only in the heads in the northern portion of the area, their lower portions being occupied by older formations, but a little less than two miles above Roots the older formations pass beneath the level of the Mississippi bottoms, and the Okaw formation constitutes the entire height of the Mississippi bluffs. In this region the basal portion of the formation, with the underlying Ruma and the upper portion of the Paint Creek, is exposed in the small ravine intersecting the Mississippi river bluff in s.w. 1/4 sec. 4, T. 6 S., R. 8 W., about half way between Roots and Modoc. In this section the following succession of beds is exposed.

18. Limestone, ledges more or less continuously exposed	19 feet.
17. Talus covered, probably shale	18 "
16. Limestone, with chert	3 "
15. Talus covered, probably shale	16 "
14. Limestone, ledges more or less continuously exposed, in part Eolitic and in part crystalline	19 "
W 227	
13. Talus covered, probably shale	17 "
12. Limestone ledge	1 "

- 11. Talus covered, probably shale 12 feet
- 10. Shale, argillaceous, bluish or yellow in
color 12 "
- 9. Limestone, crystalline, variable in texture 16 "

W 226

Okaw-Ruma contact.

- 8. Shale, the upper portion of the interval talus
covered, but with good exposures below of con-
spicuously variegated, red and blue, argillac-
eous shale 37 "

Ruma-Paint Creek contact .

¹
The portion of this section below the Ruma-Paint Creek contact has been described in connection with the discussion of the Paint Creek formation on page .

In the bluff sections the beds exhibit a gentle dip down the valley and a few rods above the mouth of the ravine in which the above section is exposed, and stratigraphically beneath the lowest of the described beds, the color of the soil in the highway and in the talus above the road, shows clearly the position of the characteristic red clay member of the Paint Creek formation. Of the beds exposed in the section the lower thirty feet constitute the upper portion of the Paint Creek formation. The succeeding 37 feet, which is variegated shale, so far as it is exposed, without sandstone, is the Ruma formation. The upper ^{133?} 123 feet of the section is Okaw, and the alternating character of the shale and limestone beds of the formation is well brought out by the outcropping limestone ledges which are exposed at intervals, with the intervening talus covered shale beds.

South of Marigold, in the three heads of Crooked creek, a tributary of the Okaw river, there are good exposures of a conspicuous oolite bed whose position is about 50 or 60 feet above the base of the Okaw formation. In the first of these ravines, in the northern part of sec. 29, T. 5 S., R. 8 W., the following succession of beds is exposed.

- ✓ 5. Limestone, white, oolitic, with numerous fossils,
the lower six feet not well exposed 18 feet.

W. 596

- 4. Limestone, crystalline, blue-gray in color, not continuously exposed, Archimedes common. Somewhere in the interval there is probably a chertbed about one foot thick 18 "
- 3. Unexposed, probably shale, the talus with numerous tumbled masses of limestone from above 30 "
- 2. Limestone, cross-bedded, crystalline, blue-gray in color. The outcrop is not a solid ledge, but is represented by tumbled masses because of the underlying shale 6 "
- 1. Shale, argillaceous, blue to variegated in color ... ? "

In the ravine heading in s.w. 1/4 sec. 29, T. 5 S., R. 8 W., the following section is exposed.

- 9. Chert bed, about one foot exposed, passing down into hard, cherty limestone 3 feet
- 8. Unexposed 6 "
- 7. Limestone, hard and crystalline 2 "

- 6. Shale, yellowish in color, probably blue when not weathered, with many bryozoans and some other fossils 6 feet

W 598

- 5. Unexposed 17 "
- 4. Limestone, blue, crystalline, non-oolitic 1 "
- 3. Unexposed 5 "
- ✓ 2. Limestone, white in color, conspicuously oolitic in texture. Fossiliferous 12 "

W 597

- 1. Limestone, hard, crystalline in texture, with shaly partings 10 "

In the next hollow south, heading near the middle of the east half of sec. 32, T. 5 S., R. 8 W., the following succession is exposed.

- 6. Limestone, massive beds, somewhat variable in texture 15 feet
- 5. Unexposed 14 "
- 4. Limestone, very cherty, with some nearly solid chert beds 12 "
- 3. Shale and unexposed interval, outcrop of shale for two feet only at the top, it is doubtless shale below with perhaps some thin limestone bands. The basal part of the interval may be occupied by the upper portion of the oolite below 48 "
- ✓ 2. Limestone, white, oolitic, fossiliferous 6 "

W 599

- 1. Limestone, hard and non-oolitic ? "

The oolite exposed in the three sections just described from south of Marigold, is undoubtedly the same, continuous bed, and is exposed again in the upper portions of the ravines heading on the west side of the ridge. About 40 feet above the oolite is a conspicuous chert bed associated with cherty limestone, which is about the only cherty horizon in the entire Okaw formation so far as observations have been made, and this bed also is exposed in a number of localities in the heads of the ravines west of the ridge.

In the area between the Okaw river and the Mississippi river bluffs, below Crooked Creek, rock outcrops are not so abundant as further north, but good exposures are present at intervals in the beds or banks of nearly all the streams. All of these outcrops belong in the Okaw formation, and at most of them the beds are more or less fossiliferous. The oolite bed is well exposed at one point a little more than one-fourth of a mile northwest of Roots, in the banks of an unnamed creek, near the line between s.e. 1/4 of s.w. 1/4, and s.w. 1/4 of s.e. 1/4 sec. 2, T. 6 S., R. 8 W., where the following species of fossils have been collected.

W 616

East of the Okaw River and south of Plum creek, only the middle and upper beds of the Okaw formation are exposed. In the eastern part of the city of Evansville a number of sink holes are present, in some of which the limestone is exposed, and in one a quarry has been opened to furnish rock for local use. The rock taken out is a white oolite, probably the same bed as that exposed south of Marigold, and the following species of fossils have been identified from it.

W 626

Northeast of Evansville the Okaw formation is exposed in all of the tributaries of the Okaw river and Plum creek from the south, between that town and Preston, although east of section 18, T. 5 S., R. 8 W., formations younger than the Okaw are exposed in the upper portions of the valleys. The uppermost member of the Okaw formation, consisting of a greater proportion of shales than are present in the beds below, with thin, bryozoan covered limestone layers, some of which contain black, rounded, probably phosphatic, pebble-like inclusions, besides some foreign pebbles, and many fish teeth, are especially well developed in some of the tributaries of Plum creek west of Preston. One of the best of these localities is situated about one mile west of Preston, in the southern part of s.e. 1/4 sec. 9, T. 5 S., R. 7 W., where the following species of fossils have been collected.

W 619

Some of the arenaceous beds which are present in this uppermost member of the Okaw formation, are poorly exposed in the upper part of the small valley crossing the eastern part of s.w. 1/4, sec. 18, T. 5 S., R. 7 W.

South of Evansville the limestone members of the Okaw formation are exposed at intervals in most of the tributaries of the Okaw river, but the country is so deeply drift covered that there are few if any outcrops exposing any great thickness of strata. The sink hole topography developed in places indicates the presence of limestone beneath the drift mantle, but actual rock outcrops are present in but few of the depressions. In the valley of Butter creek the Okaw formation extends eastward to within one-half mile of Walsh, and in some of the tributaries there are good exposures of the upper, shaly member of the formation, although the bed of the main stream is filled with alluvium for most of its length. One of the best of these upper Okaw exposures in the basin of Butter creek is about two miles southeast of Evansville, in the bank of a tributary from the northwest, in the s.w. 1/4 of n.w. 1/4, sec. 29, T. 5 S., R. 7 W., where the following species of fossils have been collected.

In the valley of Nine-mile creek the Okaw formation extends eastward into section 2, T. 6 S., R. 7 W., but here, as in Butter creek, the exposures are confined chiefly to the tributary valleys, the main valley being largely filled with alluvium. The outcropping strata are mostly confined to the upper, shaly member of the formation, although at a number of localities some of the more massive limestones beneath the shaly beds are exposed. In the s.w. 1/4 of s.w. 1/4 sec. 33, T. 5 S., R. 7 W., the upper shaly member is well exposed, and the following species of fossils have been collected.

W 618

Among the best exposures in the Nine-mile basin, are those in two tributaries from the south which cross the s.e. 1/4 sec. 4, T. 6 S., R. 7 W. In the lower part of these valleys massive beds of Okaw limestone are well exposed which are succeeded by a series of about 40 feet of shales, thin limestones, and arenaceous beds. A similar section is exposed in a tributary crossing the southern half of sec. 3, T. 6 S., R. 7 W.

In Little Nine-mile creek a finger-like extension of the Okaw formation reaches to the n.w. 1/4 sec. 16, T. 6 S., R. 7 W. The exposures are confined to the last mile of the distance, and are limited to the uppermost member of the formation, being shales, sandstone and limestone.

South from the junction of Nine-mile creek with the Okaw river the drift cover is thick, but the Okaw formation is exposed in small outcrops at numerous points, and in a few localities the outcrops are somewhat extensive. In the Okaw river bluff beside the Illinois Southern railroad track, about three-fourths of a mile above Collins (Missouri Junction), a limestone member of the formation has been quarried, and at this locality the following fossils fauna has been collected.

W 614

A few rods above the station at Collins there are other limestone outcrops, but they are much less extensive than at the quarry further north. One mile west of Ellis Grove, in s.w. 1/4 of n.w. 1/4 sec. 18, T. 6 S., R. 7 W., and in the s.w. 1/4 of n.e. 1/4 sec. 13, T. 6 S., R. 8 W., the limestones just below the upper shaly member of the Okaw formation are almost continuously exposed for a distance of about one-third of a mile in the bed of a stream tributary to the Okaw river, but beyond these outcrops the entire valley is filled with drift and alluvium to its mouth. There are numerous good exposures in Moccasin hollow, heading in s.w. 1/4, sec. 18, T. 6 S., R. 7 W., and about one-half mile from the mouth of the valley the white oolite beds near the middle of the formation are well exposed and have afforded the following species of fossils.

W 615

South of Ellis Grove the upper limit of the Okaw formation must extend nearly to the southern limits of the village, but the deep covering of drift obscures all the underlying hard rocks. Lower down in the valley, however, which originates in the south edge of the town, and in its tributaries, there are good exposures of some of the limestone members of the Okaw, at intervals all the way to its mouth just above Reiley Lake. In the valley whose mouth is at the lower edge of Reiley Lake, at a point about one-half mile from the river bluffs, there is a series of good exposures which include a part of the uppermost shaly and arenaceous member of the Okaw formation and also some of the more massive limestones beneath these beds.

From Reiley Lake southeastward along the Mississippi River bluffs, the Okaw formation is limited to a narrow band in the lower portion of the bluffs, and to finger-like extensions into the short ravines which intersect the bluffs. Because of the nature of the formation, an alternation of shaly beds with more massive limestones, the face of the bluff is a steep slope almost wholly talus covered, and grown up with underbrush. There are at intervals, limestone outcrops in the bluffs, but the best exposures are met with in the ravines, some of which are almost contin-

uous rock outcrops from the mouth to near the head.

A little above Fort Gage one of the limestone members of the Okaw formation outcrops for a distance of nearly one-half mile, in the bank of the Mississippi River. Opposite the railroad station at the same place, the bluff has been cleared of underbrush, and a limestone ledge is exposed at an elevation of 100 feet above the railroad track, where the following fauna has been collected.

W 211

Pentremites cf. elegans Lyon.

Archimedes swallovanus Hall.

Lyropora subquadrans Hall.

Septopora subquadrans Ulrich.

W 211

Diaphragmus elegans (Norwood and Pratten.)

Camarophoria explanata (McChesney.)

Spiriferina spinosa (Norwood and Bratten.)

Spirifer increbescens Hall. var.

Reticularia setigera (Hall.)

Eumetria vera Hall.

Composita trinuclea (Hall.)

Holopea ? sp.

Griffithides sp.

A little above the last mentioned ledge, at an elevation of 120 feet above the railroad track, is another and more extensively outcropping ledge, which is abundantly fossiliferous in places, and has furnished the following species.

Zaphrentis sp.

W 212 A

Asplexus sp.

Pentremites pyriformis Say.

Stenopora sp.

Fenestella (fragments)

Polypora sp.

Orbiculoidea sp.

Productus ovatus Hall.

Diaphragmus elegans (Norwood and Pratten.)

Camarophoria explanata (McChesney.)

Dielasma shumardana (Miller)

Girtyella indianensis (Girty.)

Spirifer increbescens Hall, var.

S. leidyi Norwood and Pratten.

Reticularia setigera (Hall.)

Eumetria vera Hall.

E. verneuilliana Hall.

Gliothyridina sublamellosa (Hall.)

Composita trinuclea (Hall.)

Edmondia sp.

Parallelodon sp.

Myalina sp.

Aviculopecten sp.

A. sp.

Mourlonia sp.

Bellerophon sp.

Orthonychia chesterense Meek and Worthen.

O. sp.

Platyceras sp.

Platyostoma ? sp.

Griffithides sp.

These fossiliferous ledges at Fort Gage must occupy a position 100 or more feet above the white oolite member of the formation, and are probably near the top of the massive limestone beds lying just beneath the upper, shaly and arenaceous member of the formation. In the several branches of the valley whose mouth is just below Fort Gage there are thick drift deposits, but the hard rocks do outcrop at intervals, and the Okaw formation occurs for a distance of one mile back from the bluffs.

At a locality about one mile below Fort Gage an attempt to open a quarry was made by the Illinois Southern Railroad at the time of its construction, but the rock proved to be too shaly for practical purposes. The beds excavated were in the uppermost, shaly member of the Okaw formation, and the following species of fossils have been collected from this locality.

In one of the short ravines about half way between Fort Gage and Menard, the following succession of beds is exposed.

- 15. Sandstone, fine-grained, cross-bedded, ripple-marked, yellow or light-brown in color, becoming somewhat more shaly above 47 feet.
- 14. No exposures 11 "

Palestine-Menard contact.

- 13. Limestone, compact, in beds a foot or less in thickness, and including some more or less irregular, concretionary masses of chert 49 feet
- 12. Talus covered 18 "

Menard-Okaw contact.

- 11. Limestone, fossiliferous 5 "

Zaphrentis spinulosa Edwards and Haime.

Productus ovatus Hall.

W 212 B

Diaphragmus elegans (Norwood and Pratten.)

Camarophoria explanata (McChesney.)

Dielasma sp.

Ballerophon sp.

Griffithides cf. granulosa Wetherby.

- 10. No exposures 44 "

- 9. Limestone, fossiliferous 4 "

Leptodictya tubularis n. sp.

Productus ovatus Hall.

W 213

Diaphragmus elegans (Norwood and Pratten.)

Camarophoria explanata (McChesney.)

Girtyella brevilobata (Swallow)

Spiriferina spinosa (Norwood and Pratten.)

Eumetria vera (Hall.)

- 8. Shale, lower portion talus covered 12 "

- 7. Limestone ledges, the several beds more or less fossiliferous, with one ledge forming a waterfall near the middle of the member. Collections

of fossils secured from the top, from 10 feet below
the top, and from the bottom of the member 1/2 feet

W 214

251

216

- 6. Limestone, thin-bedded with calcareous shales 7 feet.
- 5. Shale 6 "
- 4. Limestone ledges 5 "
- 3. Talus covered, with no exposures 39 "
- 2. Limestone ledge 1 "
- 1. Talus covered, with no exposures to the level of
the Iron Mountain Railroad track 10 "

In this section beds No. 1 to 11, a total thickness of 175 feet are undoubtedly Okaw, and the talus covered No. 12 may also be a member of that formation, although it is more likely to be the base of the formation above. Beds No. 8, 9, 10, 11, and perhaps 12, constitute the upper, shaly member of the formation, while the more continuous limestone outcrops below constitute the more massive limestone member next below. All the beds of the section belong above the white, oolitic limestone member of the formation which is exposed further north. Bed No. 13 in the section is the Menard limestone, and 14 and 15 are probably the Palestine sandstone, although the section may extend up into the Pennsylvanian.

Another excellent section through the upper half of the Okaw formation, is exposed in the ravine whose mouth is near the middle of the north line of sec. 15, T. 7 S., R. 7 W., one and one-half miles above the Southern Illinois Penitentiary at Menard. The succession of beds exposed is as follows.

- 7. Shale, poorly exposed in the bank of the creek ? feet.
- 6. Limestone, variable in lithologic character but dominantly bluish-gray in color, and dense in texture, for the most part in layers one foot, more or less in thickness, separated by shaly partings and with hummocky bedding planes. Twenty feet above the base of the ledge some beds are somewhat crystalline and crinoidal, and some loose slabs occur which are covered with delicate echinoid spines and some plates. Other slabs exhibit many fossil gastropods in section. Cherty layers are present, and some layers without chert are apparently siliceous. Fossils collected from the lower 15 to 20 feet 55 feet.

Menard-Okaw contact.

- 5. Shale, argillaceous, bluish-black in color, without fossils in lower part, the upper six to eight feet becoming more calcareous and with some fossils 40 "
- 4. Limestone, surface of ledge with imbedded black, phosphatic ? pebbles.
- 3. Limestone, thin-bedded, variable in lithologic character, but more or less crystalline, with at least one cherty band, the upper beds almost shaly, with numerous bryozoans 8 "

- 2. Shale, with minor limestone layers, exposed at intervals but much talus covered 45 feet.
- 1. Limestone, crystalline, light colored, gray to white, in thick ledges without shaly partings 60 "

In this section the lower 153 feet constitute the upper portion of the Okaw formation. The highest beds of the formation here exposed, include some 90 feet of strata which are dominantly shaly with some subordinate limestone bands, too much talus covered in this section to allow a detailed section to be made, but the same interval is well exposed in the newer quarry at the Southern Illinois Penitentiary at Menard. The thick limestone member at the base is the same bed as the more massive limestone mentioned in earlier sections, and is well exposed in the prison yard at Menard. It is the most massive and thickest limestone member in the Okaw formation and has its greatest development in the neighborhood of Chester.

The section exposed in the newer quarry at Menard, outside the prison yard, is as follows.

- 13. Limestone, conglomeratic, blue-gray to brown, irregularly thin bedded and more or less cross-bedded, crystalline in texture, with many more or less fragmentary fish teeth. The included pebbles are most abundant at the base, they are mostly dark, irregularly rounded, smooth, phosphatic ? nodules, with some bits of shale and other material. Fossils collected at the base and at the top 6 feet.
Fauna from base of bed.
Crinoid stems.

- Fenestella sp.
- Lingula sp.
- Diaphragmus elegans (Norwood and Pratten.)

Spirifer increbescens Hall, var.

Conularia chesterensis Worthen ?

Fish teeth, fragmentary, abundant.

Fauna from top of bed.

W 193

12. Shale, calcareous, fossiliferous 2 1/2 feet.

Meekopora clausa Ulrich.

Stenopora tuberculata (Prout.)

Fenestella serratula Ulrich.

Archimedes laxis Hall.

Polypora cestriensis Ulrich.

Septopora subquadrans Ulrich.

Orthotetes kaskaskiensis (McChesney.)

Spirifer increbescens Hall, var.

Composita trinuclea (Hall.)

11. Limestone, hard, blue, mostly compact with conchoidal fracture, rather thin bedded with shaly seams 12 "

Productus ovatus Hall.

Diaphragmus elegans (Norwood and Pratten.)

Composita sp.

Pelecypod (undetermined)

10. Shale, yellowish when weathered, blue when fresh, with a thin limestone band 0 to 1/4 inches thick about the middle. Above the limestone band numerous bryozoans 5 "

W 189

- | | | |
|--|---------|--------|
| 9. Limestone, thin-bedded with bands of shale | 7 feet | Vienna |
| | | TS |
| 8. Sandstone, fine-grained, light-yellow in color,
more or less cross-bedded, with some fragments
of plant remains. Varying in thickness from 0
in south part of quarry to 14 feet at the
north end. | | |
| 7. Sandstone, thin-bedded and arenaceous shales | 6 " | |
| 6. Shale, blue, argillaceous | 4 1/2 " | T.S. |
| 5. Limestone | 1 1/2 " | GD |
| 4. Shale, partly covered | 3 " | |
| 3. Limestone | 1 1/2 " | |
| 2. Shale | 1 1/2 " | |
| 1. Limestone, only the upper surface exposed, at
level of floor in engine room. This is bed
No. 1 in the last section described, and is
continuous with the ledge quarried in the
prison yard. | | |

The limestone bed No. 1, in this section, is the same as bed No. 1 in the section last described, and is continuous with the ledge quarried in the prison yard. The exposed face of the quarry about 50 feet high, constitutes the upper, shaly member of the Okaw formation, and it is exposed in greater detail at this locality than anywhere else in the region studied. The section as described was made at the time when the quarry was first opened, but since that time the excavation has been carried back into the bluff where the beds have not been subjected to the weathering exhibited on the surface, and the beds do not appear to be so different in character as in the earlier stages in the development of the quarry.

In both of the valleys leading back from the prison yard at Menard, the Okaw formation is exposed at intervals for over one-half mile from the river bluffs. Above the south gate at the penitentiary another detailed section has been studied, the following succession of beds being recognized.

- 11. Shale, yellowish in color, more or less fissile with a few harder bands an inch or more in thickness 12 feet 6 in.

Fauna W 196 (basal part)

- Pterotocrinus cf. depressus Lyon and Casseday.
- Hydreionocrinus sp. (spine plates of ventral sack).
- Agassizocrinus dactyliformis Roemer (?), (base).
- Stenopora tuberculata (Prout).
- Fenestella serratula Ulrich.
- Archimedes terebriformis Ulrich.
- A. distans Ulrich.
- A. swallovanus Hall.
- Spirifer increbescens Hall, var.
- Composita subquadrata (Hall).

- 10. Limestone 3 feet 6 in.
- 9. Shale 3 "

Fauna W 197.

- Polypora approxinata Ulrich.
- Lyropora quincuncialis Hall (?)
- Fenestella serratula Ulrich (?)
- Archimedes terebriformis Ulrich.
- A. distans Ulrich.

A. sublaxus Ulrich.

Diaphragmus elegans (Norwood and Pratten).

Spirifer increbescens Hall var.

Reticularia setigera (Hall).

Cliothyridina sublamellosa (Hall).

C. cf. hirsuta (Hall).

Composita trinuclea (Hall).

8. Limestone, in several thin beds 1 foot 6 in.

Fauna W 198.

Productus ovatus Hall.

Diaphragmus elegans (Norwood and Pratten).

Spirifer leidy Norwood and Pratten

Reticularia setigera (Hall).

Eumetria vera (Hall).

Cliothyridina cf. hirsuta (Hall).

7. Limestone, one solid ledge 2 feet.

6. Shale, a parting of buff-colored, apparently
magnesian material 6 in.

5. Limestone, in several beds, thinner below, becoming
thicker-bedded above 7 "

4. Shale with limestone, abundantly fossiliferous..... 1 " 6 "

Fauna W 195.

Zaphrentis spinulosa Edwards and Haime.

Pterotocrinus depressus Lyon and Casseday.

P. acutus Wetherby.

P. bifurcatus Wetherby.

Agassizocrinus dactyliformis Roemer (?) (bases).

Pentremites sulcatus Roemer.

Spirorbis sp.

Stenopora rudis Ulrich.

Lyropora subquadrans Hall.

Archimedes terebriformis Ulrich.

A. distans. Ulrich.

A. communis Ulrich.

A. compactus Ulrich.

Dichytrypa n.sp.

Spirifer increbescens Hall, var.

Spiriferina transversa (McChesney).

Reticularia setigera (Hall).

Eumetria vera (Hall).

Cliothyridina sublamellosa (Hall).

Composita trinuclea (Hall).

Fish teeth (Cochleodonta).

3. Limestone 3 feet 6 in.
2. Shale, yellow, gritty, with many fossils 6 in.

Fauna W 194.

Eupachycrinus sp.

Agassizocrinus dactyliformis Roemer (?), (bases).

Pentremites tulipaformis Hambach.

P. turbinatus Hambach.

Archimedes swallovanus Hall.

A. meekanus Hall.

Diaphragmus elegans (Norwood and Pratten).

Reticularia setigera (Hall).

Eumetria vera (Hall).

Composita trinuclea (Hall).

1. Limestone, massive, quarry beds in prison
yard Exposed 37 feet, 6 in.

40

In this section bed No. 1 is the top of the massive limestone beneath the upper shaly member of the formation, but the thirty-six feet of beds, Nos. 2 to 11, does not include the whole of the upper member, its upper portion being covered with talus.

Between Menard and Chester the higher beds of the Okaw are well exposed in a short ravine, for the distance of about four-fifths of a mile back from the river, and just south of the mouth of this ravine there is a good exposure of sandstone which belongs near the base of the upper member of the formation. In the ravine situated in the eastern portion of the city of Chester, whose mouth is a little below the Iron Mountain Railroad station, there are other good exposures extending back for one-half mile from the river bank.

In the ravine just below Cole's Mills, in the lower part of the city of Chester, a massive limestone, the continuation of the quarry ledge in the prison yard at Menard, extends to an elevation of about 23 feet above the Iron Mountain railroad tracks. This bed is followed by the upper shaly member of the formation, which is more arenaceous in this section than in any of those further north, so far as they have been examined. Between this section and the mouth of Marys River most of the short ravines intersecting the bluffs, but the more the upper portion of the Okaw formation is exposed in/conspicuous rock outcrops in the bluffs between these two points are of a higher formation, the Menard limestone. The last exposure of the Okaw, below Chester, outcrops in the west bank of Marys River just above the water level, above the bridge crossing the river near its mouth. The beds exposed here are shales and limestones belonging near the very top of the formation, and from them the following species of fossils have been collected.

4

Aside from these exposures of the Okaw formation along the Mississippi river bluffs, the top of the formation outcrops in the banks of one of the tributaries of Gravel creek from the south, about two miles north of Chester. The formation also occupies, without doubt, the bottom of the valley of Gravel creek for the distance of a mile or more, in sections 1 and 2[?]~~2~~, T. 7 S., R. 7 W., although all the hard rocks are buried beneath the alluvium. The outcrops are situated along the stream which crosses the north half of section 12, in a north-easterly direction, and consists of shales with some thin limestone bands, and from some beds near the top of the outcrop the following species of fossils have been collected.

W 641

At the mouth of the short tributary to Gravel creek, next west of the one last mentioned, there is a small outcrop of sandstone which is without doubt a bed in the uppermost shaly and arenaceous member of the Okaw.

Thickness. At no locality in the entire area which has come under observation, is there any exposure which includes the entire thickness of the Okaw limestone. The total thickness of the formation, therefore, has to be determined through the piecing together of a number of different sections. The lower portion of the formation, from its contact with the Ruma formation upward, is exposed in a number of localities along the eastern border of the outcrop, especially in the Mississippi river bluffs, and one of the best of such sections is that about half way between Modoc and Roots, which is described on page , In this section the top of the oolitic limestone member of the formation is essentially 77 feet above the Okaw-Ruma contact. Elsewhere in the same general portion of the area mapped, the position of the oolite bed seems to occupy approximately the same position, but nowhere else has so satisfactory a measured section been observed. It seems safe to consider that the thickness of the Okaw from the base of the formation to the top of the oolite member is in round numbers 75 feet.

*(blurred on copy)

In Moccasin hollow, nearly two miles below Roots, the same oolite member is exposed at an elevation of from 20 to 40 feet above the level of the Mississippi bottom, and at Fort Gage the dip of the strata has doubtless carried it to near or somewhat below the level of the river bank. The fossiliferous ledges in the bluff back of Fort Gage station occupy a position as high as 120 feet above the railroad track, and the elevation above the oolite must be at least as great. The position of the highest of the ledges at Fort Gage must be near the summit of the massive limestone member which continues along the bluff down the river, and is so well exposed in the prison yard at Menard, and the interval between the top of the oolite and the top of the upper limestone member may be assumed to be approximately 125 feet.

The thickness of the upper, shaly and locally arenaceous member of the formation is shown at a number of localities in the vicinity of Chester. In the section described on page , exposed in a short ravine between Fort Gage and Menard, beds Nos. 8 to 11, with a total thickness of 65 feet, certainly belong above the massive limestone member. In the section exposed in the ravine one and one-half miles above Menard, described on page , beds Nos. 2 to 5 constitute this part of the formation, with a thickness of 93 feet. In the newer quarry in the bluffs just above the prison yard at Menard, described on page , beds Nos. 2 to 13, with a thickness of 64 feet constitute this upper member, but in the section there may be a considerable thickness of shale, similar to bed No. 5 of the last section, which is not exposed. Certainly the top of bed No. 13 of the quarry section with its pebbles, phosphatic nodules and fish teeth, must be the equivalent of bed No. 4 in the ravine section. In the section at the south gate of the prison yard, 35 feet of beds above the massive limestone quarry ledge, are exposed, but still above these exposures there is an interval of 74

feet, talus covered for the most part, before any characteristic Menard limestone beds are exposed. It is by no means certain that these Menard limestone exposures occur at the bottom of that formation, but there must be a considerable portion of the upper member of the Okaw which is hidden, and its total thickness is doubtless essentially the same as in the other sections mentioned. The variations in these recorded thicknesses of the upper Okaw member, are from 64 to 93 feet, and a fair estimate of its average thickness may be assumed to be about 75 feet, and this corresponds in general with the topographic interval commonly occupied by the shaly and arenaceous beds in other portions of the region studied.

Combining these several thicknesses, the total thickness of the Okaw formation must be about 275 feet, and its maximum thickness may be even greater, perhaps as much as 300 feet. On the other hand there is some reason to believe that in some portions of the area which has been mapped, the thickness of the Okaw is not so great as indicated in these bluff sections which have been cited, and that a minimum thickness of 200 feet or perhaps less, may be present in some places.

The position of the Okaw oolite bed at Evansville is such as to suggest that the interval above it is considerably less than is indicated in the Mississippi River bluff sections below the mouth of the Okaw river, and it is possible that the formation does not maintain a uniform thickness throughout the entire area. The upper shaly member of the formation, however, is present wherever observations have been made, and if there is any great difference in thickness it would seem to be associated with the series of beds between the top of the oolite and the base of the upper shaly member. The situation is such as to suggest the possibility that the Okaw should perhaps be divided into two separate formations, separated by an unconformity due to an erosion interval during which the upper portion of the lower division was removed in a portion of the area studied, before the upper division, represented by the upper shaly member of the

formation as here described, was deposited. Another feature suggestive of such an unconformity, is the variable nature of the sandstone beds which are commonly present near the base of the uppermost member. The establishment of the suspicion in regard to the constitution of the Okaw formation, expressed above, has not been possible because of the thick covering of drift by which the hard rocks are partially or wholly hidden in Monroe and Randolph counties.