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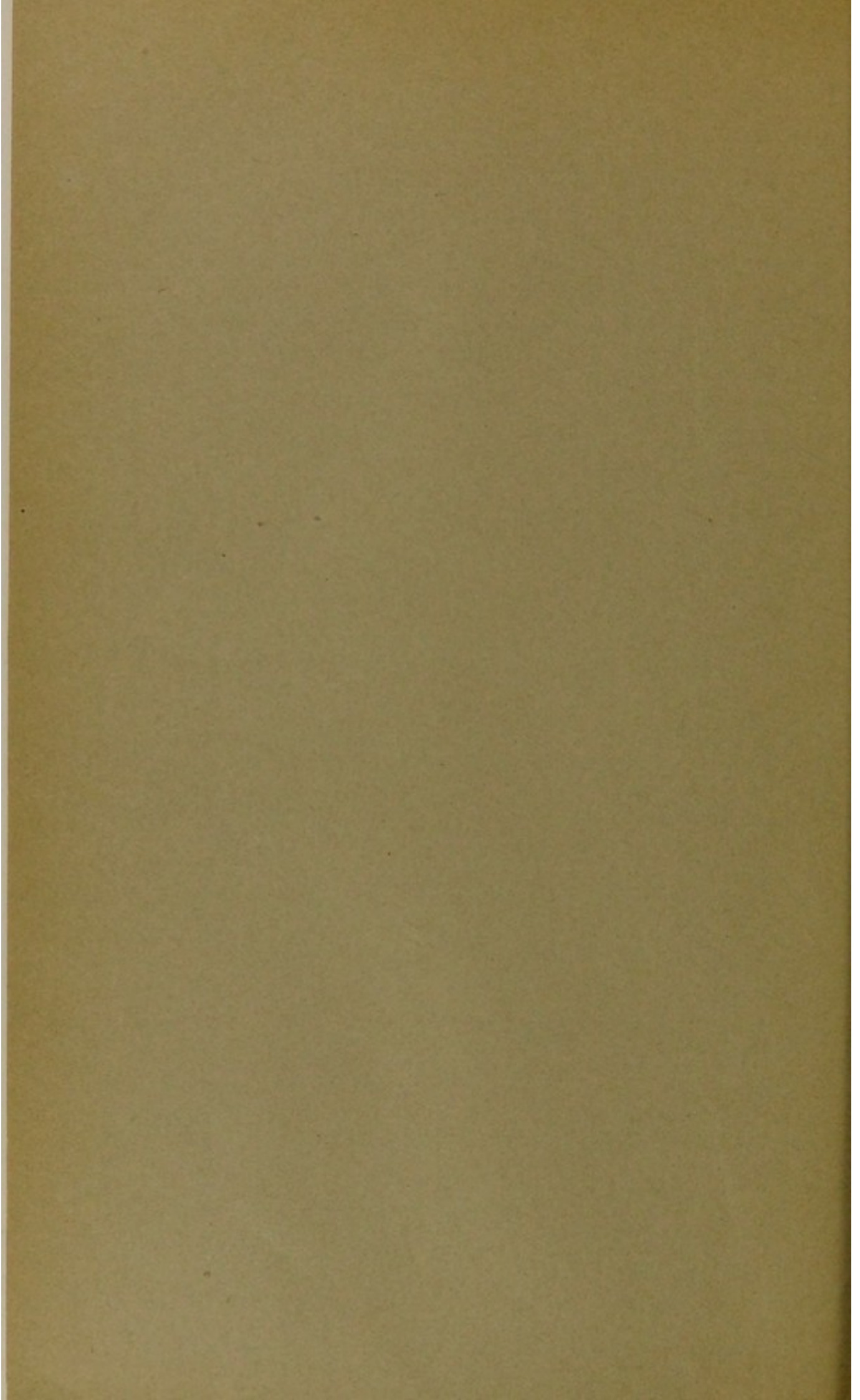
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ON THE LOWER PALEOZOIC STRATIGRAPHY OF
SOUTHWESTERN ILLINOIS.

By T. E. SAVAGE, University of Illinois.

(Abstract of a Thesis prepared for the Degree of Doctor of Philosophy, Yale University)





ART. XLVI.—*On the Lower Paleozoic Stratigraphy of Southwestern Illinois*; by T. E. SAVAGE, University of Illinois.

[Contributions from the Paleontological Laboratory of Yale University.]

THE following paper is a preliminary statement concerning the pre-Mississippian formations that occur in the southwest portion of Illinois. A monograph on the stratigraphy and paleontology of these terranes in the above mentioned area is being prepared by the writer for presentation as a thesis for the degree of Doctor of Philosophy at Yale University.

The field work on which the report is based was done during the summer of 1907, under the auspices of the Illinois Geological Survey; while the paleontological study was made at the Peabody Museum under the direction of Professor Charles Schuchert. The writer wishes at this time to acknowledge his indebtedness to the Director of the Illinois Geological Survey for assigning him to this very interesting piece of work, and to Professor Schuchert for his invaluable assistance in the study and interpretation of the faunas and the data that were collected.

The pre-Mississippian beds in this portion of the state underlie the surficial materials over an area 150 square miles in extent. They appear in the southwest corner of Jackson county, at the Back Bone and Bake Oven ridge; at the south end of Walker ridge; and at Bald Rock, and southward on the east side of the Big Muddy river. In Union and Alexander counties they extend from the flood plain of the Mississippi river eastward to the general line passing within about one mile west of the towns of Alto Pass, Mountain Glen, Jonesboro, and Mill Creek to a point nearly two and one-half miles southeast of Elco, whence the line separating the Devonian from the younger formations trends toward the southwest past the Diswood postoffice, to near the middle of section 28, Township 15 South, Range 2 West. Eastward they are bordered by Mississippian beds, while along the southern edge sands and clays of Tertiary age lie upon the flanks of these older formations. Occasional patches of Tertiary gravels occur within the region under discussion.

This small area is exceedingly interesting geologically because of the fact that some of the formations here represented do not appear further north anywhere in the Mississippi valley. The successive beds were deposited in a basin of the Interior or Mississippian sea which, during a great part of the time, was more or less separated from that in which the older strata in other portions of the state were laid down. Owing to its prox-

imity to Ozarkia this basin was subjected to vertical movements and therefore to variable conditions of sedimentation, very different from those that prevailed during the same time over the more northern areas.

Ordovician.

Galena-Trenton.—A thickness of 68 to 80 feet of this formation is exposed in Alexander county. It appears at two points adjacent to the Mississippi river where the waters of that stream have cut across low arches which bring the Galena limestone above the level of the water. One of these exposures is a short distance below Thebes, where a thickness of about 68 feet of limestone may be studied. The second fold crosses the river about two miles north of Thebes, just west of the village of Gale, where these limestones may again be seen on Little Rock Island.

The Galena formation is here a light colored, crystalline, non-magnesian limestone, in layers from a few inches to four feet in thickness, which are imperfectly exposed in the upper part. The lowest layers contain in abundance *Receptaculites oweni*, *Hebertella* near *occidentalis*, *Parastrophia hemiplicata*, *Platystrophia biforata*, *Rafinesquina alternata*, *Rhynchotrema inæquivalve*, *Strophomena emaciata*, *Triplecia* n. sp., and the trilobites *Bronteus lunatus*, *Bumastus trentonensis*, *Illænus americanus*, *Isotelus maximus* and *Platymetopus cucullus*. Eighteen feet above low water *Crania trentonensis*, *Cyrtolites ornatus*, *Plectorthis plicatella* and *Remopleurites striatulus* are associated with most of the above mentioned forms. In the middle and upper parts the white color is in places mottled with pink, and the fossils become much less abundant. *Receptaculites oweni* is still common, while *Crania trentonensis*, *Hebertella* near *occidentalis*, *Platystrophia biforata*, *Rafinesquina alternata*, *Rhynchotrema inæquivalve* and *Triplecia* n. sp., persist in diminished numbers. This facies of the Galena resembles, in its fossils and lithology, the Kimmswick limestone of Ulrich, also described by Weller from Jersey and Calhoun counties.* The basin in which it was deposited may have been somewhat separated from that which received the sediments of the more northern dolomite phase of the Galena.

Richmond-Maquoketa.—The beds provisionally referred to the Richmond have an aggregate thickness of 91 feet. This formation succeeded that of the Galena after a long land interval. All of the Utica and Lorraine deposits are wanting, and, seemingly, much of the Richmond is also absent. The formation in southwest Illinois consists of two members, 2a

* Weller, Illinois State Geological Survey, Bull. No. 4, p. 222.

and 2b of the general section described at the end of this article. The lower one (2a) is a sandstone or sandy shale—"Thebes sandstone and shale"—which is exposed along the flanks of the Thebes and Gale anticlines, and in the intervening trough. The materials are reddish-brown where weathered, and blue where not changed by the atmosphere. The lower part is a sandstone, thick bedded and in regular layers, which are well exposed at the east end of the railroad bridge at Thebes. In the upper half the layers are thinner and, where much weathered, appear decidedly argillaceous. This more shaly horizon is well exposed in the river bank three-fourths of a mile south of Gale. *Lingula* cf. *covingtonensis* occurs sparingly throughout the sandy shale of this member.

The upper member is a bed of fossiliferous, bluish shale (2b of the section). It is exposed in the bank of the river, and in a cut along the Illinois Central railway about three-fourths of a mile south of Gale, where it overlies the "Thebes sandstone and shale" member. The bed has a thickness of 18 feet, and contains *Cyclocystoides* n. sp., *Phylloporina* near *granistriata*, *Dalmanella testudinaria*, *Plectambonites sericea*, *Rhynchotrema inæquivalve?*, *Strophomena sulcata?*, *Zygospira recurvirostra*, *Conradella* near *fimbriata*, and species of *Isotelus* resembling *I. susæ* and *I. platycephalus*. The lithologic and faunal change from the Thebes sandstone member to this blue shale is abrupt, which may indicate a break between the two beds. The fauna reminds one much of the Black River formation, but as it occurs in, or immediately above, the Maquoketa series, and its life assemblage is not at all that of the overlying Cape Girardeau limestone, it seemed best to group it with the Thebes sandstone.

Neither of these members contain *Rhynchotrema capax*, the widely distributed guide fossil to the Richmond. Indeed, none of their fossils which have yet been determined are decisive markers, but the lithology and position of the beds, and their relation to known formations to the north and south, leads to their provisional reference to the Richmond until the complete study of the fauna and the wider study of their field relations shall determine definitely their stratigraphical position.

The above shales and sandstone do not extend so far north as does the underlying limestone. The sea in which they were deposited probably washed the shores of the Ozarkian land area a few miles to the west, which, during late Richmond time, was the source of the sediments that make up these terrigenous beds.

Middle Silurian.

Alexandrian.—The beds referred to this formation are exposed in Alexander county to a thickness of 44 feet. They

include the Cape Girardeau limestone and the overlying beds containing *Dalmanites danae* and *Whitfieldella billingsana*. The Cape Girardeau limestone is well exposed about two miles south of Thebes, in the bank of the river and along the streams in that immediate vicinity. It is also seen in a cut along the Illinois Central railroad, and in the river's bank, one and one-half miles north of Thebes. In the former locality this limestone is nearly 40 feet thick, and consists of black, fine-grained, brittle limestone, in thin layers which are often separated by narrow partings of dark, calcareous shale. This zone has a rich fauna which appears abruptly at this horizon. Among the forms are several species of crinoids, *Dalmanella* near *elegantula*, *Homæospira* n. sp., *Leptæna rhomboidalis*, *Rafinesquina mesacosta*, *Rhynchotretra* n. sp., *Schuchertella missouriensis*, *Zygospira* n. sp., *Cornulites tenuistriata*, *C. incurvus*, *Platystoma* near *niagarensis*, *Strophostylus* sp., *Acidaspis halli*, *Calymene* sp., *Cyphaspis girardeauensis* and *Encrinurus* sp.

At the exposure north of Thebes the Cape Girardeau limestone rests directly upon the fossiliferous blue shale (2b of section). This member is succeeded by a bed of dark gray limestone, oolitic in the upper part, which contains *Favosites* sp., *Stromatopora* sp., *Atrypa rugosa*, *Clorinda* n. sp., *Homæospira* n. sp., cf. *Hindella umbonata*, *Leptæna rhomboidalis*, *Platystrophia biforata*, *Rafinesquina mesacosta*, *Rhynchotretra* n. sp., *Schuchertella subplanus* (probably a coarse form of *S. missouriensis*), *Strophomena* sp., *Whitfieldella billingsana*, *Dalmanites danae*, *Dalmanites* sp., and *Lichas breviceps clintonensis*.

There are here no diagnostic fossils of the Richmond. The genera *Favosites*, *Stromatopora*, *Atrypa*, *Whitfieldella*, *Homæospira*, *Schuchertella* and *Clorinda* do not occur in American Ordovician strata, while *Atrypa rugosa* and *Lichas breviceps clintonensis* are indicative of the Silurian. On the other hand, the fauna is not directly related to that of the Clinton, from which formation it is separated by a marked erosional unconformity. Schuchert* cites a fauna from Edgewood, in eastern Missouri, collected by Ulrich, which corresponds closely with the above. Since there seems to be no direct time equivalent of these beds in the Ordovician or in the Silurian as generally defined, the horizons 3a to 3c are classed as Middle Silurian strata that more or less completely bridge the lost interval between the Cincinnati and the Clinton. For these beds the time term Alexandrian is proposed, from Alexander county, Illinois, where they are well exposed; the term to have the same rank as Cincinnati, which it immediately follows.

* Jour. Geol., vol. xiv, pp. 728, 729, 1906.

Silurian.

Clinton.—The limestone of this formation has here a maximum thickness of 75 feet. One-half mile southeast of Gale it immediately overlies the "Thebes sandstone and shale"; the shale member (2*b* of section) and all of the Alexandrian beds having been cut out by erosion prior to the deposition of the Clinton. One and one-half miles north of Thebes the Clinton limestone rests on the *Whitfieldella billingsana* member (3*c* of section), while two miles south of Thebes it immediately overlies the Cape Girardeau limestone (3*a* of section). The upper part of the Clinton (4*c*) consists of heavy bedded, pink or mottled limestone, 23 feet thick, which contains many small, immature brachiopods, besides *Plectambonites transversalis*, *Rafinesquina mesacosta*, *Spirifer* near *sulcata*, *Illænus* sp., and a few new species of *Orthoceras*. Below this pink limestone lie 6 feet of thin-bedded, dark gray limestone with narrow bands of chert (4*b* of section). The limestone layers contain *Favosites favosus*, *Halysites catenulatus*, *Stromatopora* sp., *Atrypa rugosa*, *Orthis* cf. *davidsoni*, *Orthis flabellites*, *Plectambonites transversalis*, and var. *elegantula*, *Stricklandinia triplesiana* and *Triplecia ortonii*. The above fauna corresponds with that of the Interior or Western Clinton, as described by Foerste from the region of Dayton, Ohio.

The lower portion of this formation (4*a*) is well exposed in the vicinity of Gale, and two miles further north, along Sexton Creek in the N.W. $\frac{1}{4}$ sect. 27, T. 14 S., R. 3 W., where it consists of 46 feet of thin-bedded, gray limestone, the layers of which are separated by narrow chert bands.

The thickness of the Clinton is variable. It does not exceed 29 feet in the exposure south of Thebes, while near Gale and along Sexton creek and in the river bluff two miles east of McClure the aggregate thickness is 75 feet. Where the formation is thinnest it is the lower and not the upper layers that are absent.

Devonian.

Helderbergian.—The rocks of Helderbergian age in Illinois correspond with the New Scotland formation of New York. They succeed the Clinton after an exceedingly long land interval, represented by all of the Silurian after the Clinton, and the Coeymans of the Lower Devonian. In New Scotland time the Interior or Mississippian sea was much more restricted than during the Clinton. According to an unpublished paleogeographic map of the time, by Schuchert, this sea extended as an embayment from the Gulf region as far north as Jackson county, Illinois. It spread west to Indian Territory and east as far as southeast Tennessee. It was separated by a land barrier from the Atlantic embayment (Cumberland basin) which

occupied parts of New York, Maryland, and northeastern Tennessee; and it is probable that the Kankakee barrier, as defined by Schuchert, prevented its spreading far to the north and northwest.

The New Scotland formation in Union and Jackson counties has an aggregate thickness of more than 160 feet. The lower portion, for a thickness of 100 feet, consists of shaly limestone with interbedded bands of chert. This phase is exposed in the lower part of Bald Rock, four miles southeast of Grand Tower, on the Big Muddy river. It appears in the east bluff of the Mississippi river for some distance south from this point. It makes up Tower Rock, in the Mississippi river channel, west of Grand Tower; and it is exposed in the quarry, and in the cut made by the Frisco Railroad company a short distance south and west of this rock. At the latter point were collected *Streptelasma recta*, *Dalmanella subcarinata*, *Leptæna rhomboidalis*, *Leptænisca adnascens*, *Meristella lævis*, *Spirifer cyclopterus*, *S. perlamellosus*, *Stropheodonta punctulifera*, *Hausmannia* sp., and *Phacops logani* var.

The upper 58 feet of the New Scotland formation is composed of light gray, heavy bedded, coarsely crystalline limestone. This facies is exposed in the south end of the Back Bone ridge where a fault brings it above the level of the floodplain. It forms the upper part of Bald Rock, where another fault has raised it to the level of the adjacent Chester limestone, of Mississippian age. It occurs in the east bank of Clear creek, in sections 23 and 24, T. 11 S., R. 3 W. The beds furnished *Aspidocrinus scutellæformis*, *Anoplothea concava*, *Eatonia singularis*, *Leptænisca concava*, *Megalanteris condoni*, *Meristella arcuata*? *Oriskania sinuata* n. var., *Spirifer concinnus*, *S. cyclopterus*, *S. macropleura*, *S. perlamellosus*, *Stropheodonta beekii*, *S. varistriata*, and variety *arata*, *Strophonella punctulifera*, *Uncinulus nobilis*? and *U. nucleolata*.

Oriskanian.—*Clear Creek cherts*, *Camden cherts.*—The Clear Creek formation consists of light grey to yellowish colored cherts that are usually in thin layers, but which in the lower part are sometimes three to five feet in thickness. At some points the cherts are thoroughly leached and decomposed, and occur as a fine white powder that can be dug with a shovel, and is utilized for commercial purposes.

This formation rests, with erosional unconformity, upon the New Scotland beds at the south end of the Back Bone ridge. It corresponds in age to the Camden cherts of western Tennessee. The beds represent deposits of the Upper Oriskany time, as is indicated by the interwedging of the upper chert layers with those of the basal portion of the succeeding Onondaga (see 6a to 6e of section). The chert formation has a thickness,

in Illinois, of about 237 feet. Fossils are somewhat rare in the lower portion, but in the middle, and especially in the upper, portion there is a rich fauna including *Michelinia*, n. sp., *Ambocælia* cf. *umbonata*, *Amphigenia curta*, *Anoplia nucleata*, *Anoplothea flabellites*, *A. fimbriata*, *Centronella glansfagea*, *Chonostrophia reversa*, *Cyrtina hamiltonensis*, *Eatonia peculiaris*, *E. cf. whitfieldi*, *Eodevonaria melonica*, *Leptostrophia perplana*, *Megalanteris condoni*, *Oriskania sinuata* n. var., *Pholidops terminalis*, *Rhipidomella musculosa*, *Spirifer worthenanus*, *S. duodenarius*, *S. macrothyris*, *S. hemicyclus*, *S. tribulis*, *S. cf. murchisoni*, *Schuchertella pandora*, *Acidaspis tuberculata*, *Odontocephalus arenarius* and *Phacops cristata*.

These Upper Oriskany beds were deposited near the north end of the Mississippian embayment, which at this time was even more contracted than during the Helderbergian. The basin was remote from, and not connected with, the New York-Maryland province. It covered western Kentucky and Tennessee, and lapped over the southeast corner of Missouri and the east side of Arkansas, spreading an arm across northern Alabama.

Onondaga.—The sedimentation of the Upper Oriskany time continued without a break into the Onondaga or Corniferous. The latter period was initiated by disturbances to the westward, in Ozarkia, which increased mechanical sedimentation in the Illinois area. These resulted for a time in the deposition, along the eastern shore of Ozarkia, of layers of sand containing Onondaga fossils alternating with the return of the Oriskanian limestone conditions. Eventually sand deposition prevailed and there was spread over the basin the basal sandstone of the Onondaga formation (7a of section), containing *Michelinia stylopora*, *Aulacophyllum* sp., *Amphigenia curta*, *Centronella glansfagea*, *Meristella* near *lentiformis*, *Rhipidomella musculosa*, *Spirifer duodenarius*, *S. macrothyris*, *Conocardium cuneus* and *Odontocephalus arenarius*.

Early in the Onondaga time an elevation in the southern portion of Union and in Alexander county put a stop to further deposition in these regions, while farther north, in Jackson county, sedimentation was uninterrupted.

At the cut through the Back Bone and at the Bake Oven, a short distance north of Grand Tower, there is exposed a continuous section of the Onondaga formation showing a thickness of 115 feet. The beds consist largely of light colored, regularly bedded, more or less crystalline limestone, which becomes arenaceous in the lower part. Fossils are abundant throughout the section.

The upper layers are marked by *Chonetes konickianus*, *Leptaena rhomboidalis*, *Pentamerella arata*, *P. papilionensis*,

Meristella rostrata, *Rhynchonella ginesi*, *Spirifer acuminatus*, *S. grieri*, *S. macra*, *Stropheodonta patersoni*, *Conocardium trigonale* and *Onychodus sigmoides*. In the lower part *Nucleocrinus verneuili*, *Coscium cribriformis*, *Centronella glansfagea*, *Leptæna rhomboidalis*, *Meristella barrisi*, *Pentamerella arata*, *Spirifer acuminatus*, *S. duodenarius*, *S. macrothyris*, *Stropheodonta patersoni*, *Dalmanites calypso*, *Odontocephalus ægeria* and *Onychodus sigmoides* are common.

During the Onondaga and the succeeding Hamilton time the warm waters from the Gulf region, with their successive faunas, spread towards the northeast across Illinois and Indiana, passing around the north end of the Cincinnati axis, and mingled with those of the eastern embayment in western New York. Such water connections permitted continued migrations within this sea, and accounts for the close correspondence between the various Middle Devonian faunas of southwestern Illinois and those of western Ontario and New York.

Hamilton.—Throughout Hamilton time the Kankakee barrier, or peninsula, extending from Ozarkia towards the northeast across Illinois, was largely effective in preventing the waters of the Interior or Mississippian sea from uniting with those of the Northwestern or Dakotan basin towards the northwest. As a result of this separation the deposits and the faunas of Hamilton time, in Illinois, belong to two distinct provinces. The phase of the Hamilton in the vicinity of Rock Island, and in Jersey and Calhoun counties, belongs to the Northwestern or Dakotan province; while that of southwest Illinois belongs to the New York province.

The New York faunal phase of the Hamilton is well developed in the south part of Union county, in the north half of sect. 34, T. 13 S., R. 2 W.; and further north in the N.E. $\frac{1}{4}$ of sect. 34, T. 11 S., R. 2 W. The formation is also represented in the upper beds near the north end of Back Bone ridge, in Jackson county.

At the first mentioned exposure there is at the base of the Hamilton 28 feet of yellowish-blue shale, which contains *Leiorhynchus limitare*. Both the character of the sediment and the fossils remind decidedly of the Marcellus shale of New York. This shale rests unconformably (erosional) upon the basal sandstone member (7a) of the Onondaga. It is succeeded by a few feet of limestone which, in places, is much leached and very fossiliferous; *Athyris spiriferoides*, *Delthyris sculptilis*, *Rhipidomella penelope*, *Spirifer granulosus* and *Stropheodonta concava* being very common. At points further north the lower beds of the Hamilton consist of dark colored, impure limestone which succeeds the Onondaga without any apparent break. The characteristic fossils of these layers are *Microcyclus discus*, *Athyris vittata*, *Eunella atten-*

uata, *Spirifer fornacula*, *Conocardium cuneus* and *Onychodus sigmoides*.

The middle portion of the Hamilton limestone is dark colored and evenly bedded, and contains *Ambocælia umbonata*, *Chonetes yandellanus*, *C. pusillus*, *Cranæna romingeri*, *Parazyga hirsuta*, *Pholidops oblata*, and *Spirifer pennatus*. Above this horizon occurs about 25 feet of yellowish-brown, impure siliceous limestone with few fossils. Near the top of the formation come in a few feet of hard, gray limestone containing *Chonetes coronatus*, *Rhipidomella vanuxemi*, *Spirifer audaculus*, *S. pennatus*, *Tropidoleptus carinatus* and *Vitulina pustulosa*.

Upper Devonian.—During Upper Devonian time the Mississippian sea continued to expand, spreading the materials of this formation more widely than the preceding. In the N.E. $\frac{1}{4}$ of section 34, T. 11 S., R. 2 W., the lower deposits of the Upper Devonian are conformable upon the Hamilton. There is here exposed a thickness of 33 feet of yellowish-brown (black where unweathered), siliceous shale or shaly limestone, cherty near the top, and marked by *Leiorhynchus globuliformis*, *L. mesacostalis*, *Reticularia lævis* and *Spirifer pennatus*. At other points the upper cherty phase is succeeded by 50 or more feet of greenish to black, almost barren shales. These siliceous and dark colored shales are probably the equivalent of the "calico rock," a mottled and leached, siliceous shale, present further south in Union and Alexander counties. They doubtless correspond with the Chattanooga Black Shale, Ohio Black Shale, New Albany Black Shale, and the Lower Portage beds of other states.

Conclusion.—The present studies have shown that the pre-Mississippian beds have a much wider distribution in southwestern Illinois than was formerly supposed. They have distinguished the presence of a bed of blue, fossiliferous shale (2b of section) containing the Cyclocystoides and Phylloporina fauna, immediately overlying the Thebes sandstone and shale horizon. They have demonstrated the presence, in this region, of Silurian beds corresponding with the Clinton formation in Ohio. They have shown that the massive crystalline limestone underlying the Clear Creek cherts, in Jackson and Union counties, belongs to the New Scotland formation of the Helderbergian. They have demonstrated the Upper Oriskany age of the Clear Creek cherts. They have disclosed the absence of the greater portion of the Onondaga formation in the southern portion of Union and in Alexander county; and they have shown that the Hamilton formation, in Union county, continues upward without a break into the Lower Portage beds of the Upper Devonian.

The general relations of the formations discussed above may be shown in a composite section as follows:

Generalized section of the pre-Mississippian strata in southwestern Illinois.

tem		Correla- tions.	Location of sections	Descriptions of horizons	
Devonian	Upper Devonian	New Albany Black Shale= Chattanooga Black Shale= Ohio Black Shale= Lower Portage, 86 feet.	N. E. 1/4 sec. 34, T. 11 S., R. 2 W. and S. E. 1/4 sec. 1, T. 13 S., R. 2 W.	10c. Greenish-blue shale, fossils almost none.....	29 ft.
				10b. Black shale with few fossils, but carrying nu- merous very small balls of iron pyrite from 1/8 to 1/2 inch in diameter.....	21 ft.
				10a. Brown to black, siliceous shale or shaly lime- stone with <i>Leiorhynchus globuliformis</i> and <i>Reticularia laevis</i>	36 1/2 ft.
	Late Middle Devonian	Hamilton, 70 feet.	N. E. 1/4 sec. 34, T. 11 S., R. 2 W., Union co. Sect. at Back Bone near Grand Tower	9c. Light gray, siliceous limestone, in part oolitic, characterized by <i>Chonetes coronatus</i> , <i>Cra- naena romingeri</i> , <i>Spirifer pennatus</i> , <i>S. audac- ulus</i> , <i>Tropidoleptus carinatus</i> and <i>Vitulina pustulosa</i>	7 ft.
				9b. Yellowish-brown siliceous or shaly limestone with few fossils.....	25 ft.
				9a. In the north are dark colored, fine-grained lime- stones with <i>Microcyclus discus</i> , <i>Chonetes yan- dellanus</i> , <i>Eunella attenuata</i> , <i>Parazyga hirsuta</i> , <i>Spirifer fornacula</i> and <i>S. pennatus</i> . In the south are gray or leached limestones with <i>Athyris spiriferoides</i> , <i>Delthyris sculptilis</i> , <i>Spirifer granulatus</i> , <i>Rhipidomella penelope</i> ...	38 ft.
		Marcellus, 28 feet	N. 1/2 sec. 34, T. 13 S., R. 2 W. Union county	8a. Rather soft shale weathering to a yellowish- brown color, with <i>Leiorhynchus limitare</i>	28 ft.
	Early Middle Devonian	Onondaga, 156-2/3 feet	Back Bone, Jackson county	The Onondaga is well developed in Jackson county, where it passes without a break into the Hamilton. In the southern part of Union county there is a break, and the Onondaga is represented only by the basal sandstone (7a of section). 7i. Heavy layers of very hard, gray, coarsely crys- talline limestone, containing corals, <i>Chonetes konickianus</i> , <i>Pholidostrophia iowensis</i> , <i>Product- ella spinulicosta</i> , and <i>Stropheodonta concava</i> . <i>Strophalosia truncata</i> is abundant in the lower half, while <i>Productella spinulicosta</i> is common in the upper part.....	26 ft.
				7h. Layer of dark colored limestone largely com- posed of <i>Chonetes konickianus</i> var.	3 5/6 ft.

Sys-tem	Correla-tions	Location of sections	Descriptions of horizons			
Devonian	Early Middle Devonian	Onondaga, 156-2/3 feet	Back Bone, Jackson county	7g. Thin-bedded, hard, gray limestone, layers 2-10 inches thick. Fossils rare; <i>Chonetes konickianus</i> var. present in the upper part and <i>C. pusillus</i> and <i>Stropheodonta concava</i> in the lower	15 ft.	
				7f. Hard, gray, impure limestone with few fossils..	21 ft.	
				7e. Dark gray, impure limestone with thin chert bands near the top. Fossils numerous, <i>Nucleocrinus verneuili</i> , <i>Rhynchonella gainesi</i> , <i>Meristella barrisi</i> , <i>Spirifer acuminatus</i> , <i>Stropheodonta patersoni</i> , etc.....	8 1/3ft.	
				7d. Dark gray, impure, fine-grained limestone. <i>Chonetes mucronatus</i> abundant in a zone near the middle. Other fossils are <i>Rhipidomella vanuxemi</i> , <i>Spirifer grieri</i> , <i>Stropheodonta patersoni</i> , <i>S. perplana</i> , and <i>Phacops cristata</i>	11 ft.	
				7c. Heavy layers of light gray, subcrystalline limestone. Fossils abundant. <i>Coscinium cribriformis</i> , <i>Centronella glansfagea</i> , <i>Spirifer duodenarius</i> , <i>S. macrothyris</i> and <i>Odontocephalus ægeria</i> present throughout	38 ft.	
				7b. Alternating layers of light gray, arenaceous, subcrystalline limestone and coarse-grained sandstone, containing <i>Centronella glansfagea</i> , <i>Meristella</i> near <i>lentiformis</i> , <i>Rhipidomella musculosa</i> , <i>Spirifer duodenarius</i> and <i>S. macrothyris</i>	15 1/2ft.	
				Union county	7a. Bed of more or less iron-stained sandstone, in places soft and friable, at other points cemented by a deposit of iron or silica, containing <i>Michelinia stylopora</i> , <i>Aulacophyllum</i> sp., <i>Centronella glansfagea</i> , <i>Spirifer duodenarius</i> , <i>S. macrothyris</i> and <i>Odontocephalus arenarius</i> ...	18 ft.
	Oriskanian	Upper Oriskany—Clear Creek Chert, Camden Chert, 237 feet	Schaffer's branch, 2 miles west of Jonesboro. N. W. 1/4 sec. 26, T. 12 S. R. 2 W. Union county		6e. Bed of light gray chert in layers 3-9 inches thick. <i>Amphigenia curta</i> , <i>Chonostrophia reversa</i> , <i>Eodevonaria melonica</i> , <i>Schuchertella pandora</i> and <i>Spirifer worthenanus</i> abundant.....	5 1/2 ft.
					6d. Reddish-brown, friable sandstone with <i>Michelinia stylopora</i> , <i>Zaphrentis</i> sp., <i>Amphigenia curta</i> and <i>Spirifer duodenarius</i>	2 5/6 ft.
					6c. Layers of light chert, 4-8 inches thick. <i>Anoplia nucleata</i> , <i>Chonostrophia reversa</i> , <i>Eodevonaria melonica</i> , <i>Schuchertella pandora</i> and <i>Spirifer worthenanus</i>	1 1/2 ft.
				6b. Reddish-brown, friable sandstone	2 ft.	

System	Devonian		Location of sections	Descriptions of horizons	
	Oriskanian	Helderbergian			
Upper Silurian or Silurian	Niagaran		Clinton—Dayton, Ohio Clinton, Interior or Western Clinton, 75 ft. 2 miles N. E. of Gale, N. W. 1/4 sec. 27, T. 14 S., R. 3 W., and 1/4 mile S. and S. E. of Gale, Alexander county	4c. Pink, mottled limestone in layers 10-45 inches thick, containing many small, immature brachiopods, with which occur <i>Plectambonites transversalis</i>, <i>Rafinesquina mesacosta</i> and <i>Spirifer</i> near <i>sulcata</i>..... 4b. Layers of gray to drab colored limestone, 2-6 inches thick, alternating with thin bands of chert, and characterized by such typical Clinton fossils as <i>Stricklandinia triplesiana</i>, and <i>Triplecia ortonii</i>..... 4a. Bed of tough, gray limestone in layers 3-8 inches thick, which are imperfectly separated by 2- to 4-inch partings of chert. Fossils rare..... 4a is wanting at some points in this area.	23 ft 6 ft 0-46 ft.
				A long break in sedimentation.	
Devonian	Helderbergian		Grand Tower, Rock, and Frisco, Jackson co. and Bald Rock, S. E. 1/4 sec. 23, T. 11 S. R. 3 W., Jackson co. in Mo.	5b. Heavy bedded, light colored, coarsely crystalline limestone with <i>Eatonia singularis</i>, <i>Spirifer macropleura</i>, <i>S. perlamellosus</i>, <i>Stropheodonta beekii</i> and <i>Strophonella punctulifera</i>..... 5a. Bed of impure, shaly limestone with bands and nodules of chert in the upper portion. <i>Dalmanella subcarinata</i>, <i>Meristella laevis</i>, <i>Spirifer cyclopterus</i>, <i>S. perlamellosus</i> and <i>Strophonella punctulifera</i>..... The horizon of 5a appears to belong immediately below 5b. It is doubtless present at Bald Rock and in the river bluff further south, but the fossils were not found at the latter points.	about 58 ft about 100 ft
	Oriskanian		Upper Oriskany—Clear Creek Chert, Camden Chert, 237 feet N. W. 1/4 sec. 10, T. 12 S., R. 2 W., Union co. N. E. 1/4 sec. 12, T. 12 S., R. 3 W., Union co. N. E. 1/4 sec. 36, T. 14 S., R. 2 W., Alexander co.	6a. Bed of light colored chert layers, in places alternating with impure siliceous limestone, and at other points composed wholly of chert bands. Fossils most abundant in the upper part. <i>Amphigenia curta</i>, <i>Anoplothea flabel-lites</i>, <i>Eatonia peculiaris</i>, <i>Eodevonaria melon-ica</i>, <i>Chonostrophia reversa</i>, <i>Schuchertella pandora</i>, <i>Spirifer worthenanus</i>, and <i>S. hemi-cyclus</i> common in the upper part..... In the southern part of Union county the lower chert layers are massive and contain but few fossils. In the pit worked by the M. and O. railroad, 1 1/2 miles north of Tamms, in Alexander county, may be seen an exposure of more than 100 feet in which few fossils were found.	225 ft
Devonian				A short break in sedimentation.	

Sys-tem		Correla-tions	Location of sections	Descriptions of horizons
Middle Silurian	Alexandrian	Cape Girardeau Limestone, about 44 feet	Along the river 1 1/2 miles north of Thebes, and also 1 mile south of Thebes, in Alexander county	A short break in deposition.
				3c. Coarse-grained, somewhat oolitic limestone, in layers 12-18 inches thick. <i>Atrypa rugosa</i> , <i>Rhynchotrema</i> sp., <i>Schuchertella subplanus</i> , <i>Whitfieldella billingsana</i> and <i>Lichas breviceps clintonensis</i> are common. 3 1/2 ft.
				3b. Fine-grained, dark colored shaly limestone, in layers 4-10 inches thick, characterized by <i>Rafinesquina mesacosta</i> , <i>Schuchertella subplanus</i> and <i>Dalmanites danæ</i> . 2 1/2 ft.
Lower Silurian or Ordovician	Cincinnatian	Richmond-Maquoketa, 91 ft.	East bank of Mississippi river 1/2 mile south of Gale, Alexander county. 2a in the south part of Thebes	3a. Cape Girardeau limestone: Fine-grained, black, brittle limestone, layers 1-4 inches thick, separated from each other by thin lenses or partings of calcareous shale on the surface of which are exposed Crinoids, <i>Rafinesquina mesacosta</i> , <i>Rhynchotrema</i> sp., <i>Schuchertella missouriensis</i> and <i>Cornulites tenuistriata</i> , etc. 33-38 ft.
				A probable short break in sedimentation.
				2b. Bed of grayish-blue shale in which 1-inch bands of more resistant calcareous shale occur 4-6 inches apart, bearing <i>Rhynchotrema inæquivalve</i> ?, <i>Strophomena sulcata</i> , <i>Zygospira recurvirostra</i> , <i>Conradella</i> sp., and <i>Isotelus</i> sp. 18 ft.
Lower Silurian or Ordovician	Mohawkian	Galena-Trenton, 68-80 ft.	East bank of Mississippi river, 3/8 mile south of Thebes; S. E. 1/4 sec. 17, T. 15 S., R. 2 W.	2a. Thebes sandstone and shale: Bluish to brown, shaly sandstone. In the lower part a sandstone in layers 1/2 - 2 1/2 feet thick; the upper portion thinner bedded with a larger admixture of shale. <i>Lingula</i> cf. <i>covingtonensis</i> the only fossil found. 73 ft.
				A long break in deposition.
				1a. Light gray, coarsely crystalline limestone, in regular layers 3-48 inches thick, the upper part characterized by the fossils <i>Receptaculites oweni</i> , <i>Herbertella</i> near <i>occidentalis</i> , <i>Platystrophia biforata</i> , <i>Plectorthis plicatella</i> , <i>Cyrtolites ornatus</i> and <i>Platymetopus cucullus</i> , while the lower is marked by <i>Receptaculites oweni</i> , <i>Rhynchotrema inæquivalve</i> , <i>Parastrophia hemiplicata</i> and <i>Triplecia</i> n. sp. 68-80 ft.

