Proceedings of the Iowa Academy of Science

Volume 21 | Annual Issue Article 26

1914

Iowa's Great Period of Mountain Making

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IOWA'S GREAT PERIOD OF MOUNTAIN MAKING.

BY CHARLES KEYES.

It is a fact almost too well known to state here that the most important single problem in earth-study with which we have to deal in Iowa is that of exact mapping of the different rocky formations. Unlike the cases in the majority of states, the work in this state is vastly simplified by the fact that there has been apparently little orogenic disturbance in the region, and the geological terranes of fundamental consequence mainly belong to a single geologic era. Calling the problem somewhat simple does not by any means signify that the labor of discrimination and tracing of the formation boundaries is easy, or that it is not highly varied.

The basis upon which Iowa geologists have to work is almost entirely Paleozoic in age. This general rock-sequence is very complete—as much so, perhaps, as any other Paleozoic section of our continent.

In Iowa there are two special conditions which rather severely limit close mapping of the Paleozoic formations. These are the presence everywhere over the state of a thick mantle of glacial till, associated with which are heavy deposits of loess, and, in the western half of the state, the occurrence of a great sheet of Cretacic sediments. The difficulties presented by the presence of the glacial deposits are fairly well overcome. In the case of that part of the state covered by the Cretacic formations in addition to a great overburden of drift, little or nothing has heretofore been done to elucidate the present structural attitude and the stratigraphic and taxonomic affinities of the underlying terranes.

There are, moreover, some of the broader relationships of the several formations that have not been taken into account and this fact makes the various associated problems which have come up still harder to solve. These features are more than state-wide in character. In extent they are really provincial rather than local, and certain of them are of continental proportions. It is to some of these aspects that attention is here briefly directed.

By peeling off, as it were, the Cretacic covering in the western one-third of the Iowa area, the entire Mesozoic floor is laid bare, and the Paleozoic formations then constitute the bedrock of the whole state. By what is essentially the same thing, elimination of the glacial and Cretacic

coverings is accomplished by plotting the deep-boring records and other data. Part of these are made available through Professor Norton's recent report on the underground water supplies; but a large portion of the data is derived from sources to which he did not have access. All of these data are checked by the results of recent field-work. In addition, examination of the rocks of neighboring states throws much light upon the problems long regarded as too intricate to be solved within state borders alone.

On the general geologic map of Iowa the Paleozoic formations are distributed in relatively narrow belts trending in a northwest direction across the northeastern one-third of the state. Very singularly, it has always seemed, these belts abruptly terminate at the north soon after leaving the state boundary. For many years I have longed to know what becomes of these belts; and to learn the exact reason of this rather peculiar and unlooked for circumstance. During the past summer I found out. While on the geological excursions which followed the sessions of the Twelfth International Geological Congress which convened in Canada I had special opportunities to examine the Paleozoic sections of Manitoba, and under the guidance of those who had long worked in the field. There the same narrow belting of the same formations occurs and, as farther south, the strike is northwest. The Canadian Paleozoic area is separated in central Minnesota from the Iowan Paleozoic field by a broad Pre-Cambric area.

These Pre-Cambric rocks form the core of a rather notable arch, the axis of which runs northeast and southwest. This anticline is one of large proportions and extends from the east shore of Lake Superior to South Dakota, where, as a canoe-shaped form, it plunges beneath the post-Paleozoic deposits of the Great Plains region. The exposure of Sioux quartzite constitutes its western nose.

It is against the south slope of the sharp Siouan anticline that the belted Paleozoic terranes of northeastern Iowa are upturned and cut off. The eastern margin of the vast Cretacic field crosses the same line so that there is apparently no westward extension of the five groups of formations, if it ever existed, at least on the surface of the ground. On the other, or north, side of the anticline the same belts reoccur, as already stated.

Bearing in mind the position of this marked anticline, an arch between the center of which and the limbs there is a stratigraphic interval of more than 5,000 feet, it is obvious that the Paleozoic belts originally did not really terminate against it in southern Minnesota, but rather

extended over it and were continuous with the Canadian belts. This being the case, it is equally obvious that the Iowan belts should not only not terminate against the arch in eastern or southeastern Minnesota, but should continue westward along the strike of the arch, but beneath the Cretacic covering. This is found actually to accord with recently observed facts. A cross section (figure 7), drawn to a scale indicates the actual amount of tilting displayed at the present time,

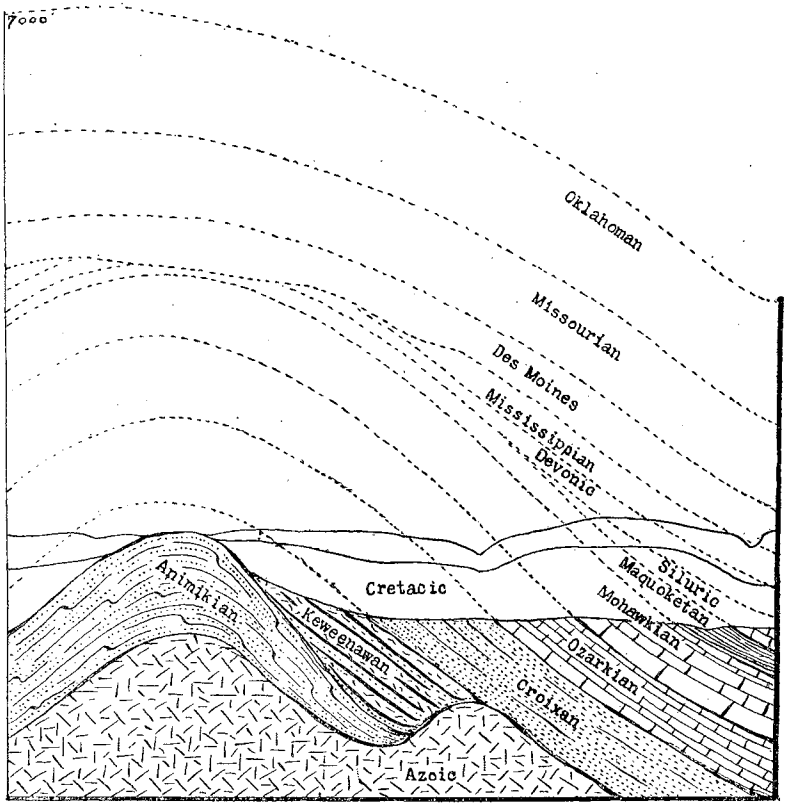


Fig. 7. Section showing strata removed from Siouan anticline.

with the part originally present, but removed during Mid-Cretacic time, represented by dotted lines.

By reconstructing the many well-sections and other deep-boring records, and correlating them in cross section, and then roughly mapping them on the Cretacic floor, it is found that all of the five belts actually turn sharply westward in eastern Minnesota and, crossing again into Iowa, extend southwestward into South Dakota and Nebraska. The Devonic and Ordovicic belts appear to pass under Sioux City. At any

rate, they are so steeply upturned in the great truncated arch that their outcrop on the Cretacic floor is relatively narrow. The areal distribution of these various belts is indicated on the accompanying sketch-map of the state (plate XXI). The boundaries of the formations are located about as accurately as are the similar lines in much of the region nearer the Mississippi river.

Several other points incidentally brought out are of great interest. The areal extent of the Missourian series, or Upper Coal Measures, is probably not more than one-half as large as it has been commonly supposed to be. On the Missouri river this formation does not appear to extend north of Harrison county. The limestone outcrops in the Boyer valley, between Logan and Woodbine, seem to belong to no other than the familiar basal member of the Missourian series—the Bethany limestone.

Contrary to all previous conceptions, there appears to be but a small part of the present Cretacic area in Iowa immediately underlain by the Productive Coal Measures, or Des Moines series. The pre-Cretacic outcroppings appear in a narrow band scarcely a dozen miles in width extending southwest from Fort Dodge to a point on the Missouri river about twenty miles above Council Bluffs. The entire northwestern part of the state thus appears to be without Productive Coal Measures beneath the Cretacic beds.

A third instructive point suggested by the present inquiry is its bearing upon the age and deposition of the Fort Dodge gypsum, about which there has always been warm controversy. It is conclusively shown by the evidence here presented that if the Oklahoman and Cimarronian beds (so-called Permo-Carboniferous and Permian) of Kansas ever existed so far into Iowa territory as Fort Dodge they were at least 2000 feet above the floor of the gypsum deposits; and were never continuous with them.

It may not be out of place to say a word here on the age of the great Siouan anticline and the physiographic significance of the Cretacic floor. Since all of the Paleozoic formations take part in the arching, while the Cretacic rocks do not, it is quite evident that the main movement or uprising occurred in Early Mesozoic time. At the beginning of Comanchan deposition (Early Cretacic), when this part of the continent was land area, the country was again completely baseleveled, the Siouan arch as well as the lower lands. Upon this even plain, worn out on the bevelled edges of the ancient strata, which was then gradually carried beneath sea-level sediments were laid down during Mid Cretacic times.

These are the deposits which cover the northwestern portion of our state and out of which peeps the crestal remnant of the old arch, called by us the Sioux Quartzite area.

The Siouan mountains were rapid in formation and rapid in decline. At the time of their highest stage they probably stood 3,000 to 4,000 feet above the surrounding country. They were greatly diversified. In the Black hills, the Ozarks, and the Appalachians of today we find their nearest counterparts.

With the recognition of a great orogenic interval within the limits of our State there is added to the general geologic column a new section of very great importance. In the same region new chapters are inserted at the base of the general rock section. These together with other important modifications and intercalated features recently made known renders at this time a revision of previous diagrams particularly instructive. This chart is given below.

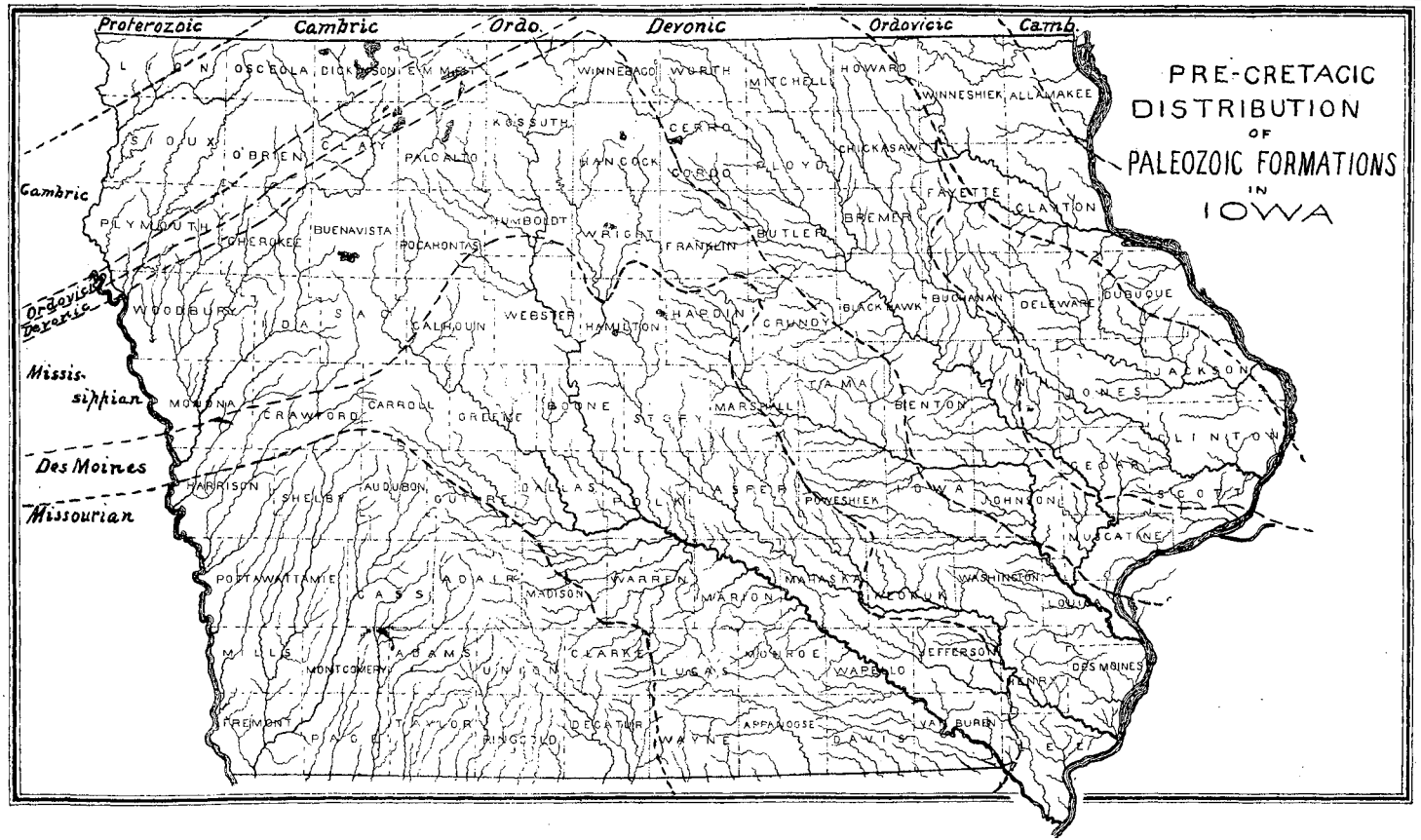
REVISED GENERAL GEOLOGIC SECTION OF IOWA ROCKS.

Eras	Periods	Sub-p.	Series	Terranes	Thickness	Rocks
Cenozoic	Quaternaric	Late	*Recent*	Alluvium	25	Clays, sands
		Mid	*Pleistocene*	Wisconsin	30	Till
				Peoria	1	Soils
				Iowa	30	Till
				Sangamon	1	Soil
				Illinois	100	Till
				Yarmouth	1	Soil
				Kansas	200	Till
				Afton	40	Sands
				Nebraska	30	Till
		Early	*Epicene*	Dubuque	10	Clays (geest)
	Tertiaric	Late	*Pliocene*	Interval		Unconformity
		Mid	*Miocene*	Riverside	50	Sands
				Dodge	100	Shales
		Early	*Eocene*	Interval		Unconformity
Mesozoic	Cretacic	Late	*Montanan*	Unrepresented in state.		
		Mid	*Coloradan*	Niobrara	150	Limestones
				Hawarden	125	Shales
				Crill	100	Limestones
				Woodbury	150	Shales
			Dakotan	Ponca	25	Sandstones
				Sergeant	75	Shales
				Nishnabotna	200	Sandstones
		Early	*Comanchan*	Interval		Unconformity
	Jurassic			Interval		
	Triassic			Interval		
Paleozoic	Carbonic	Late	*Oklahoman*	Unrepresented in state.		
		Mid	*Missourian*	Atchison	300	Shales
				Forbes	25	Limestones
				Platte	125	Shales
				Plattsmouth	30	Limestones
				Lawrence	100	Shales
				Stanton	20	Limestones
				Parkville	100	Shales
				Thayer	75	Shales
				Bethany	50	Limestones
			Des Moines	Marais des Cygnes	300	Shales
				Henrietta	100	Limestones
				Cherokee	250	Shales
			Arkansan	Interval		Unconformity
			Tennessean	Pella	30	Shales
				St. Louis	50	Limestones
				Verdi	100	Sandstones
						Unconformity
		Early	*Mississippian*	Spergen	10	Limestones
				Warsaw	65	Shales
				Keokuk	75	Limestones
				Burlington	125	Limestones
				Chouteau	50	Limestones
						Unconformity

REVISED GENERAL GEOLOGIC SECTION OF IOWA ROCKS—Concluded.

Eras	Periods	Sub-p.	Series	Terranes	Thickness	Rocks
Paleozoic			*Waverlyan*	Hannibal	75	Shales
				Louisiana	10	Limestones
				Saverton	60	Shales
				Grassy	50	Shales
				Chattanooga		Unconformity
	Devonic		*Chemungan*	Lime Creek	125	Shales
		Late	*Senecan*	Lucas	25	Limestones
				Coralville	30	Limestones
				Rapid	35	Limestones
				Solon	25	Limestones
				Tully		Unconformity
		Mid	*Erian*	Fayette	75	Limestones
				Independence	20	Shales
				Otis	10	Limestones
				Coggan	15	Dolomites
		Early	*Oriskanian*	Interval		Unconformity
	Silluric	Late	*Goweran*	Bertram	35	Dolomites
				Anamosa	60	Dolomites
				LeClaire	70	Dolomites
		Mid	*Niagaran*	Monticello	100	Dolomites
				Hartwick	80	Dolomites
				Colesburg	30	Dolomites
				Sabula	50	Dolomites
		Early	*Alexandrian*	Interval		Unconformity
	Ordovicic	Late	*Maquoketan*	Brainard	125	Shales
				Atkinson	40	Limestones
				Clermont	15	Shales
				Elgin	75	Shales
		Mid	*Mohawkian*	Galena	225	Dolomites
				Decorah	30	Shales
				Platteville	100	Limestones
		Early	*Minnesotan*	Glenwood	15	Shales
				St. Peter	100	Sandstones
	Cambric	Late	*Ozarkian*	Shakopee	75	Dolomites
				New Richmond	25	Sandstones
				Oneota	150	Dolomites
		Mid	*Croixan*	Jordan	100	Sandstones
				St. Lawrence	50	Dolomites
				Dresbach	150	Sandstones
				Hinckly	600	Sandstones
		Early	*Georgian*	Interval		Unconformity
Proterozoic	Superioric	Late	*Keewenawan*	Corson		Diabases
				Hull	475	Porphyries
				Tipton	425	Sandstones
		Mid		Interval		Unconformity
		Early	*Animikian*	Split-rock	75	Slates
				Sioux	500	Quartzites
				Jasper	30	Conglomerates
	Selkirkic			Interval		Unconformity
Archeozoic				Unrepresented in state.		
Azoic					500	Gneisses Schists

PLATE XXI


Proterozoic
Cambric
Ordo.
Devonic
Ordovicic
Camb.
PRE-CRETACIC
DISTRIBUTION
OF
PALEOZOIC FORMATIONS
IN
IOWA
Cambric
Ordovicic
Devonic
Missis-
sippian
Des Moines
Missourian
LYON
OSCEOLA
DICKINSON
EMMET
KOSSUTH
WINNEBAGO
WORTH
MITCHELL
HOWARD
WINNESHIEK
ALLAMAKEE
SIOUX
O'BRIEN
CLAY
PALO ALTO
HANCOCK
CERRO GORDO
FLOYD
CHICKASAW
PLYMOUTH
CHEROKEE
BUENA VISTA
POCAHONTAS
HUMBOLDT
WRIGHT
FRANKLIN
BUTLER
BREMER
FAYETTE
CLAYTON
WOODBURY
IDA
SAC
CALHOUN
WEBSTER
HAMILTON
HARDIN
GRUNDY
BLACKHAWK
BUCHANAN
DELAWARE
DUBUQUE
MONONA
CRAWFORD
CARROLL
GREENE
BOONE
STORY
MARSHALL
TAMA
BENTON
JONES
JACKSON
CLINTON
HARRISON
SHELBY
AUDUBON
GUTHRIE
DALLAS
POLK
JASPER
POWESHIEK
IOWA
JOHNSON
MUSCATINE
POTTAWATTAMIE
CASS
ADAIR
MADISON
WARREN
MARION
MAHASKA
KEOKUK
WASHINGTON
LOUISA
MILLS
MONTGOMERY
ADAMS
UNION
CLARKE
LUCAS
MONROE
WAPELLO
JEFFERSON
HENRY
DES MOINES
FREMONT
PAGE
TAYLOR
RINGGOLD
DECATUR
WAYNE
APPANOOSE
VAN BUREN
DAVIS

SERIAL SUBDIVISION OF THE EARLY CARBONIC SUCCESSION IN THE CONTINENTAL INTERIOR.

CHARLES KEYES.

As the taxonomic consideration of the Early Carbonic formations of the American continent has proceeded during the quarter of a century just passed, complication, rather than simplification, has taken place. Systematic arrangement of the terranes has become less rather than more clearly defined. The recent attempt to amplify one of the subordinate divisional titles so as to cover the whole has been attended by rather incongruous consequences. Small real advancement has resulted from mere change in nomenclature. Bureaucratic authority has been unable to take the place of fact, and its dictates have been as unfortunate, as they have been unsatisfactory and unreal.

That present custom is as unsatisfactory as it is inexpressive of actual genetic relationships between the various terranes represented on the American continent is amply indicated by a number of incidents. For example, Chamberlin and Salisbury[1] propose to give the Early Carbonic interval a taxonomic rank righer than it has been the custom to do, and to have it represent a periodical division, thus paralleling it with Carbonic itself, Cambric or Cretacic. Both Schuchert[2] and Ulrich[3], in recent arguments, strongly support either restriction of the term Mississippian, as now widely applied in America, or abandonment of it altogether. They suggest also new subdivision.

Were the Early Carbonic rocks of the continental interior reviewed anew today, without reference to any arrangement or subdivision already proposed, it is quite likely that a tripartite scheme would be, without much discussion, adopted. Upon grounds faunal, genetic, lithologic, stratigraphical, structural, diastrophic and paleogeographical, there is close agreement upon at least two major divisional lines. It so happens that these lines also correspond to the early subdivision deliminations. If, without too much disturbance in nomenclature and conception, these subdivisions can be readily used and the various local sections adapted to them, great and permanent advancement in provincial stratigraphy will have been made. This appears possible.

[1]Text-book of Geology, Vol. II, p. 160, 1906.
[2]Bull. Geol. Soc. America, Vol. XX, p. 548, 1910.
[3]Ibid., Vol. XXII, p. 608, 1911.

The two divisional lines which are most striking in the Early Carbonic sequence of the Mississippi valley are those at the base of the Burlington or Chouteau limestone and at the bottom of the St. Louis limestone. Both of these lines were pointed out by Owen[4] as early as 1852. Upon strictly faunal grounds, they were especially defined by me[5] in 1889. Two years later Williams[6] also recognized them and proposed new titles for the faunas of these subdivisions thus suggested. In 1892 I again[7] distinctly called attention to the same lines and also another of subordinate importance. Lately Schuchert[8] and Ulrich[9] propose still another grouping of the formations but draw the line of separation at or near the base of the St. Louis limestone. In the Iowa section, as lately reviewed,[10] I do not especially emphasize any subserial grouping.

In view of the fact that in late years two new criteria have come to have a dominant influence in stratigraphic classification and the faunal standard is largely displaced, the conception of rational grouping of terranes is somewhat changed. These two factors are diastrophic record and paleogeographical distribution. The two division lines here noted happen to be products of both diastrophic movement and paleogeographical limitation. They mark provincial effects, not continental or universal changes. The sections which they limit therefore have a taxonomic rank that is neither higher nor lower than that of series.

The three series thus demarcated are already designated by special names which, with slight modification in scope, may be appropriately retained.

The nethermost set of terranes corresponds to the section which in Ohio was early defined as the Waverly formation, in Michigan as the Marshall group, in Illinois and Iowa as the Kinderhook beds, and in Missouri latterly as the Chouteau section. Since the main and most widely distributed limestone section constitutes the middle series, the term Mississippian is appropriately restricted to it; and this also is very nearly Winchell's original use of the title. The lately proposed name, Tennessean, for the uppermost series, is useful and valid because the term Ste. Genevieve was already preoccupied for one of the subordinate limestones.

Little need be said here concerning the Waverlyan or the Tennessean series. Regarding the term Mississippian, a word or two may not be

[4]Rept. Geol. Surv. Wisconsin, Iowa, and Minnesota, p. 92, 1852.
[5]Am. Jour. Sci., (3), Vol. XXXVIII, p. 186, 1889.
[6]Bull. U. S. G. S., No. 80, p. 169, 1891.
[7]Bull. Geol. Soc. Vol. III, p. 263, 1892.
[8]Ibid., Vol. XX, p. 548, 1910.
[9]Ibid., Vol. XXII, p. 608, 1912.
[10]Iowa Geol. Surv., Vol. XXII, p. 154, 1913.

out of place. The formations of the Rocky mountains, which are commonly called by this title, probably represent little more than the Burlington and Keokuk limestones of the continental interior. Hence, the use of the term in a somewhat restricted sense is not out of place and will give rise to but small confusion.

As it now appears, the correlation of the Iowa section of Early Carbonic, with other characteristic sections, is given below:

CORRELATION OF EARLY CARBONIC TERRANES.

	Iowa.	Missouri.	Illinois.	Indiana.	Ohio.	Pennsylvania.
	Unconformity	Unconformity	Unconformity			
	Wanting	Chester Sh.	Chester Sh.	Birdville Sh.		
	Wanting	Kaskaskia Li.	Kaskaskia Li.	Tribune Li.		
	Wanting	AuxVases Ss.	Cypress? Ss.			
TENNESSEAN.	Wanting	Ste. Genevieve	Ohera Li. Rosiclare Li. Fredonia Li.	Mitchell Li.	Maxwell Li.	Greenbrier Ss.
	Pella Sh.					
	St. Louis Li.	St. Louis Li.	St. Louis Li.			
	Verdi Ss.					
	Unconformity		Unconformity			
	Spergen Li.	Spergen Li.	Spergen Li.	Spergen Li.		
	Warsaw Sh.	Warsaw Sh.	Warsaw Sh.	Warsaw Sh.		
	Keokuk Li.	Keokuk Li.	Keokuk Li.	Keokuk Li.	Logan Ss.	Pocono Ss.
	Montrose Ch.	Montrose Ch.	Montrose Ch.			
MISSISSIPPIAN.	Burlington Li.	Burlington Li.	Burlington Li.			
	Chouteau Li.	Chouteau Li.	Chouteau Li.			

WAVERLYAN.						
	Unconformity?	Unconformity?	Unconformity?			
	Hannibal Sh.	Hannibal Sh.	Hannibal Sh.	New Providence	Cuyahoga	Grainger Sh.
	Louisiana Li.	Louisiana Li.	Louisiana Li.	Rockford Li.		(Upper part)
	Saverton Sh.	Saverton Sh.	Chattanooga		Sunbury Sh.	
					Berea Ss.	Chattanooga Sh.
	Grassy Sh.	Grassy Sh.		New Albany Sh. (Upper part)	Bedford Sh.	
					Cleveland	
	Unconformity	Unconformity	Unconformity			