Preliminary Table of Paleozoic Formations.

SYSTEM.	SERIES.	FORMATION.	THICKNESS.		MEMBER.	THICKNESS.
Pennsylvanian.	Coal Measures. Conglomerate Measures.					
Mississippian.	Lower Carboniferous Shales, Sandstones and Limestones. Waverly.					
Devonian.		Ohio black shales.	20-135			20-135
		Boyle limestones.	0 47		(West-Central Ky., Sellersburg. Jeffersonville. Geneva.	0-47
Silurian.	Niagaran.	Crab Orchard.	110 to 180	Alger.	Estill. Waco. Lulbegrud.	65-120 8-10 10-13
				Indian Fields.	Oldham. Plum Creek.	10-14 5
		Clinton.	13-19		Brassfield.	13-19
Ordovician.	Cincinnatian.	Richmond.	140-210		Saluda.	20-40
				Versailles.	Whitewater. Liberty.	70-100
					Waynesville.	50-70
		Maysville (Lorraine.)	280	Kentucky river limestone of N. S. Shaler.	Arnheim. Mount Auburn. Corryville. Bellevue. Fairmount.	50 20 60 20 80
				Upper Garrard	Mount Hope.	50
		Eden.	160-260	Lower Garrard.	Paint Lick.	40-60
				Million (Upper Winchester.)	Middle Eden. Lower Eden.	120 to 200
		Utica.	0-3		Fulton.	0-3
		Cynthiana.	40-90	(Lower Winchester.)	Point Pleasant. Greendale.	40-90
	Jessamine (Mohawkian.)	Lexington (Trenton.)	275		Perryville. Paris. Wilmore. Logana. Curdsville.	0-35 75 125 10 30
		High Bridge (Stones River.	400		Tyrone. Oregon. Campnelson.	50 25 285
	Canadian.				Not exposed in Kentucky.	

THE CHIEF DIVISIONS OF THE PALEOZOIC ROCKS OF KENTUCKY.

The superficial soils, clays, sands, and gravels of Kentucky are underlaid chiefly by Paleozoic rocks. Tertiary strata occur in the western part of the State, west of the Tennessee river. The Irvine clays, sands, and gravels of Powell, Estill, Clark, Madison, Garrard, and Lincoln counties have been referred provisionally to the Neocene, the upper half of the Tertiary. Similar local deposits of Tertiary age may occur elsewhere in the State, but in general it may be said that all of the more solid rocks of Kentucky, with their interbedded clays and shales, are of Paleozoic age. These Paleozoic rocks are classified under the following divisions, named in descending order:

PENNSYLVANIAN, including, in descending order:

2. The Coal Measures.
1. The Conglomerate Measures (or Pottsville).

MISSISSIPPIAN, or Lower Carboniferous, including, in descending order:

3. Shales, sandstones, and limestones corresponding to the Chester, etc.
2. Limestones, including St. Genevieve, St. Louis, etc.
1. The Waverly formation, using this name in the sense employed by former reports of the Ohio and Kentucky Surveys, and not as originally defined by Prof. O. Briggs, Jr. (First Annual Report of the Geological Survey of Ohio, 1838, page 80.)

DEVONIAN, including, in descending order:

2. The Devonian Black Shale, known on the eastern side of the Cincinnati geanticline as the Ohio shale, and on the western side as the New Albany shale. The United States Geological Survey has utilized the name Chattanooga shale for exposures of this shale in Eastern Kentucky, as far north as Clark county.

1. The Devonian limestones. In Ohio these limestones include, in descending order:
   c. The Delaware limestone.
   b. The Columbus limestone.
   a. A comparatively unfossiliferous section of limestone, for which no distinctive name has been proposed as yet.

   For these three Devonian limestones of Ohio the name *Scioto* limestone would be very appropriate. Since the exact equivalency of the Devonian limestones of east-central Kentucky has not yet been determined, the name *Boyle* limestone will be used for the latter provisionally, because some of the thickest sections of Devonian limestone in Kentucky occur in Boyle county, and in the immediately adjacent counties.

SILURIAN, equivalent only to the Upper Silurian of former reports of the Kentucky Survey. Including, in descending order:

2. The Monroe formation, including the Greenfield limestone of Ohio and adjacent parts of Kentucky.
1. The Niagaran series of rocks, including, in descending order:
   b. The Crab Orchard division of the Niagaran, consisting chiefly of clays; referred to the Niagara group in former reports of the Kentucky Survey.
   a. The Brassfield limestone; referred to the Clinton group in former reports of the Kentucky Survey.

ORDOVICIAN, equivalent only to the Lower Silurian of former reports of the Kentucky Survey. Including, in descending order:

2. The Cincinnatian series of rocks; referred to the Hudson River group in former reports of the Kentucky Survey. These include:
   d. The Richmond formation.
   c. The Maysville formation, approximately equivalent to the Lorraine of New York.
   b. The Eden formation, including, at the base, strata equivalent to the Utica of New York; and

a. The Cynthiana formation, including the lower half of the Winchester limestone as originally defined by Marius H. Campbell.

1. The Jessamine series, corresponding approximately to the Mohawkian rocks of New York. This includes:

b. The Lexington formation, corresponding to the Trenton rocks of former reports of the Kentucky Survey; and

a. The High Bridge formation, belonging to the Stones River group of Tennessee, and including the rocks identified as Birdseye and Chazy in former reports of the Kentucky Survey.

In the preceding classification no attempt has been made to indicate in any manner the relative importance of the various divisions and subdivisions. The chief aim has been merely to indicate their relative order of succession.

If the superficial soils, clays, sands, and gravels of Kentucky were removed, the Pennsylvanian and :Mississippian, collectively called the Carboniferous formations, would form by far the greater part of the surface of the State; according to estimate, about 70 per cent. Next in importance, as far as the area of exposure is concerned, would be the Ordovician, covering about 20 per cent. of the surface. Most restricted of all would be the areas of exposure of the Devonian and Silurian rocks, which, together, would form only between 3 and 4 per cent. of the total area of the State.

By far the greater part of the Devonian exposures of Kentucky consist of the Devonian black shale. The area of outcrop of the Devonian limestone is too narrow to be represented accurately on a map of ordinary size. On this account the United States Geological Survey has not attempted to distinguish between the Devonian limestone and the Silurian formations in Madison and adjacent counties (Richmond folio, No. 46, 1898), but has mapped them together under the name *Panola* formation. The rocks identified with the Richmond formation in this Richmond folio include not only the Richmond formation as originally defined by E. O. Ulrich (including, in descending order, the Saluda, Versailles, Waynesville, and Arnheim beds), but also almost all of the Maysville formation, omitting only

the Mount Hope bed, at the base. The *Garrard* sandstone of the Richmond folio includes the Mount Hope bed at the base of the Maysville formation, and the upper division of the Eden beds. The Winchester limestone of the Richmond folio includes the Middle and Lower Eden beds and all of the Cynthiana formation.

In Ohio, the upper part of the Cynthiana division was called by Prof. Orton the Point Pleasant bed.

Ulrich, Bassler, and others have drawn the line of separation between the Cincinnatian and underlying series of rocks at the base of the Eden formation, beneath the Fulton layer with its Triarthrus becki fauna. In the classification here presented the line is placed at the base of the Cynthiana formation, in deference to the opinions of Mr. John M. Nickles, who recently has investigated the Cynthiana or Lower Winchester formation for the Kentucky Survey. (Bulletin No.5.)

The Minor Subdivisions Adopted in this Report.

MISSISSIPPIAN.

In Ohio, the following subdivisions of the Mississippian have been adopted, named in descending order:

g. Maxville limestone,
f. Logan formation,
e. Black Hand formation,
d. Cuyahoga formation,
c. Sunbury shale,
b. Berea grit,
a. Bedford shale.

No attempt has been made as yet to trace any of these formations to any considerable distance southward from the Ohio river. It is not known whether the considerable body of soft clays at the base of the Waverly formation of Kentucky is exactly conterminous with the Bedford shale of Ohio. On this account the name Linietta clay was adopted, provisionally, from a

famous exposure at the Linietta Springs, southwest of Junction City, in Boyle county, Kentucky, before its identity with the New Providence shale of southern Indiana was ascertained.

Phosphatic nodules often are very abundant at the base of these clays and form a very characteristic horizon.

DEVONIAN.

In northern Ohio, the Devonian Black shale or Ohio shale has been divided, in descending order, into

c. The Cleveland shale,
b. The Chagrin formation, and
a. The Huron shale.

It is not known whether any of these subdivisions can be identified in Kentucky. Possibly the gigantic fish remains found in the Devonian Black shale east of Indian Fields, in Clark county, may eventually shed light on this question.

In Indiana, the Devonian limestones have been divided by Edward M. Kindle into three divisions, in descending order:

c. The Sellersburg beds,
b. The Jeffersonville beds, and
a. The Geneva limestone.

Of these, the Jeffersonville limestone corresponds approximately to the Columbus limestone of Ohio, while the Geneva limestone appears to occupy about the same position stratigraphically as the comparatively unfossiliferous section below the Columbus limestone, in Ohio.

The Sellersburg fauna has not been traced south of a railroad cut, a quarter of a mile south of Huber, sixteen miles south of the Ohio river at Louisville. In Ohio, the Delaware limestone has not been traced south of Columbus. The Devonian limestones of central Kentucky appear to be closely related to the Columbus limestone of Ohio and the Jeffersonville limestone of Indiana. In Indiana, the Geneva limestone appears to thin out southward before reaching the Ohio river. The Devonian limestones of Ohio are separated from the Devonian limestones of Kentucky by a broad area along the Ohio river, in which no Devonian limestones are known. Hence it is impossible to trace the divisions established in Ohio southward into Kentucky by stratigraphical means. Under these

circumstances, it, obviously, is impossible to determine whether any of the less fossiliferous beds at the base of the Devonian limestone section in Kentucky correspond to the comparatively unfossiliferous part at the base of the Devonian in Ohio, or not.

Several layers, apparently belonging to the Devonian limestone section of central Kentucky, deserve special consideration. One of these is a layer at the top of the section which frequently has a somewhat brecciated appearance. This appearance is believed to be due to pressure and to incipient yielding of rock without actual dislocations of the particles. Figures 2A and 2B on plate 8 give a very fair idea of the appearance of this rock when freshly broken. It is well exposed along the railroad cut, half a mile north of Junction City, in Boyle county, Kentucky, and it, therefore, has been called the *Duffin* rock or limestone.

Another interesting layer occurs at the base of the Devonian limestone section. It usually is strongly argillaceous, and frequently contains coarse sandy particles, some of which are black and nodular in character. This layer often is less than four inches in thickness, but frequently contains fish remains, including teeth and plates. In former reports of the Kentucky Survey, this layer was identified as Oriskany. It is well exposed along the railroad west of Preston, in Bath county; north of Berea, along the railroad, in Madison county; and at various localities near Indian Fields, in Clark county. The only available name for this rock appears to be *Kiddville* bed or layer, derived from a small hamlet, about a mile north of Indian Fields, near which a number of exposures occur, along the banks of Lulbegrud creek.

At several localities near Junction City, Crab Orchard, and e1sewhere, the peculiar organism believed to be a worm boring, known as Taonurus caudagalli, is found in the lower, less fossiliferous part of the Devonian limestone section. It has not yet been determined whether this organism indicates any particular horizon in the Devonian limestone section. At present this appears to be the case, notwithstanding the fact that the same borings occur in great numbers also at various horizons in the Waverly section.

SILURIAN.

In Ohio, the Niagaran division of the Silurian has been divided into the following subdivisions, named in descending order:

f. Hillsboro sandstone,
e. Cedarville limestone,
d. Springfield limestone,
c. West Union limestone,
b. A formation identified with the Niagara shales of New York, usually with a persistent layer of limestone at the base, known as the Dayton limestone. Although these so-called shales consist of a considerable thickness of soft clays or clay shales in the southern part of the State, farther north and northwest, toward Xenia, Dayton, and Eaton, these clays are replaced by a much smaller section of thin limestones separated by partings of clay.
a. A. limestone formation identified with the Clinton of New York.

In southern Indiana, the following subdivisions of the Niagaran are recognized:

e. Louisville limestone,
d. Waldron clay,
c. Laurel limestone,
b. Osgood clay, with some limestone,
a. A limestone formation identified with the Clinton of New York.

These subdivisions may be traced from southern Indiana southward as far as Raywick, in Marion county. No Niagaran exposures occur between Raywick and Stanford, in Lincoln county. Northeast of Stanford, along the eastern side of the Cincinnati geanticline in Kentucky, the Niagaran consists chiefly of limestones near the base, overlaid by a section of strata consisting chiefly of clay. The more continuous section of limestones at the base of the Niagaran have been identified in former reports of the Kentucky Survey with the Clinton of New York. The overlying clays are a southern continuation of the great mass of clays and clay shales in southern Ohio which have been

identified with the Niagara shales of New York, now known as the Rochester shales. The southern extension of these clays, in central Kentucky, were appropriately named the Crab Orchard shales, although this term was not defined with sufficient accuracy to determine what layer the author intended should form the base of these shales. As far as may be determined from the evidence at hand, these Crab Orchard clay shales correspond stratigraphically to the southern extension of the Osgood clay shales, on the western side of the Cincinnati geanticline.

For the more continuous limestone section, at the base of the Niagaran division of the Silurian, hitherto identified with the Clinton of New York, the name Brassfield limestone is proposed. The term Crab Orchard shales has been redefined, and, for purposes of more exact study, the following subdivisions have been proposed, named in descending order:

Crab Orchard division.....
- Alger formation.....
  - Estill clay.
  - Waco limestone.
  - Lulbegrud clay.
- Indian Fields formation
  - Oldham limestone.
  - Plum creek clay.
- Brassfield limestone.

Where the Waco limestone horizon can not be distinguished the name *Flades* clay may be used so as to include both the Waco and Estill horizons.

Special consideration of the various divisions and subdivisions of the Niagaran of east-central Kentucky is deferred to a later part of this bulletin.

CINCINNATIAN.

The Cincinnatian formations of Ohio, Indiana, and Kentucky include great thicknesses of rock, shale, and clay, so that, in order to designate with greater exactness the location of individual layers or of the smaller sets of layers which for any reason may be of special interest, it has been found necessary to divide the groups already mentioned into still smaller subdivisions, named in the following list in descending order:

Richmond formation.....	Saluda bed.	
	Versailles bed.....	Whitewater division.
		Liberty division.
	Waynesville bed.	
Maysville formation.....	Arnheim bed.	
	Mount Auburn bed.	
	Corryville bed.	
	Bellevue bed.	
	Fairmount bed, including Tate layer in upper half.	
	Mount Hope bed.	
Eden formation.....	Paint Lick bed, or Upper Eden.	
	Million bed.....	Middle Eden.
		Lower Eden.
	Fulton, or Triarthrus becki layer.	
Cynthiana formation.....	Point Pleasant bed.	
	Greendale bed.	

Of these formations, only the upper or Richmond formation will be of interest in connection with the present bulletin, since this is the formation upon which the Silurian formations rest.

THE CINCINNATI GEANTICLINE.

When rocks are traversed by long cracks and the strata on opposite sides of the crack are displaced by slipping, so that corresponding layers no longer are opposite to each other, they are said to be faulted, and the cracks are known as faults. Sometimes the displacement along these faults is of considerable dimensions, the layers on one side of the crack being found more than a thousand feet above or below the corresponding layers on the other side. Vertical displacements of these dimensions do not occur in central Kentucky, but several faults with displacements between 100 and 300 feet are known to exist, and some of these faults may be traced for a considerable distance across the State. One of these, known as the Kentucky River Fault, may be traced for a distance of forty miles a little south of west, across the southern ends of Clark and Jessamine counties. Another fault passes across the southern part of Garrard county, five miles south of the railroad passing through Paint Lick, and crosses Lincoln county south of Stanford and north of McKinney, in a direction also south of west. Other faults

follow very different directions. One of these, five miles east of Richmond, has a southeasterly direction.

In addition to faults, the rocks of the State are traversed also by various folds. Some of these are local. Others can be traced for long distances. Sometimes the folds and faults cross each other, so that the same area may be affected by more than one series of folds and faults.

Among the folds, one is preeminently dominant, since it affects the rocks of almost the entire State, extending northward into Ohio and Indiana, and southward to the southern boundaries of Tennessee. It is known as the Cincinnati geanticline. The crest or axis of this fold enters Kentucky from Ohio, east of Cincinnati, near the line between Pendleton and Bracken counties, and, traversing the State in a diagonal direction, enters Tennessee south of Burksville. From this crest or axis the rocks dip eastward, as far as the eastern margin of the State, and westward as far, at least, as Daviess, McLean, and Muhlenberg counties. On the eastern side of the crest, the rocks dip southeast toward Virginia. In the more northern parts of the State, west of the crest, the rocks dip westward, toward the southern part of Illinois. In the more southern parts of the State, possibly owing to a subsidiary line of folding whose axis extends in an east and west direction, the dips on the western side of the geanticline appear to swing around toward the northwest. Comparatively little accurate geological work has been done in this southwestern area as yet, but it is known that the western part of the State is traversed by some considerable faults, and probably by some folds.

A fold affecting rock over so wide a territory often is called a geanticline, in order to distinguish it from folds of much smaller dimensions, which receive the much more commonly used name of anticlines. In Ohio, this geanticline is known as the Cincinnati geanticline, Cincinnati being the most prominent city any where near the crest of the fold.

The crest or axis of the Cincinnati geanticline does not maintain the same general elevation along its entire length. Its greatest elevation, in Kentucky, appears to be south of Nicholasville, in Jessamine county. From this area the axis of the fold gradually sinks both toward the north and the south. It is estimated that from Lexington to the northeastern corner of

Pendleton county, on the Ohio river, the dip of the top of the Lexington limestone is almost 475 feet, au average dip of six feet per mile. From Nicholasville southward to Junction City, the dip is estimated at approximately 400 feet, a dip of almost seventeen feet per mile. From Junction City southward to the Cumberland river, the dip probably exceeds 250 feet, an average of about five feet per mile. Southward, from the Cumberland river toward Rutherford county, in central Tennessee, the continuation of the axis of the Cincinnati geanticline rises more than 700 feet.

Owing to the relatively low elevation of the axis of the Cincinnati geanticline in southern Kentucky, the fold has been regarded, at times, as made up of two domes, to the northern of which Prof. Arthur M. Miller has given the name Jessamine dome, while the southern culmination of the axis has been called the Rutherford dome. It should be remembered, however, that the structure in reality is that of a geanticline, and that the so-called domes are merely the areas of highest elevation along the axis of folding.

The dip, of course, is much greater down the sides of the geanticline than along its axis. Prof. Arthur M. Miller has shown that the elevation of the top of the Lexington limestone near Brannon Station, in Jessamine county, is 1,050 feet above sea level, while near Drennon Springs, toward the mouth of the Kentucky river, it is 430 feet, a drop of 620 feet in fifty miles, or a dip of 12.4 feet per mile. If these measurements had been made directly down the flanks of the anticline, a much greater dip would have been shown. It has been estimated, for instance, that from Lexington to Louisville, a distance of seventy miles, the dip is more than 1,500 feet, by far the greater part of this dip, 1,300 feet, occurring between Lawrenceburg and Louisville, a distance of fifty miles, or a dip of twenty-six feet per mile. In the same manner the dip from Lexington to Irvine, a distance of about thirty-six miles, has been estimated at fully 1,000 feet, a dip of twenty-eight feet per mile. These dips of twenty-six and twenty-eight feet per mile down the sides of the geanticline certainly are in great contrast with those along the crest of the fold, the dip from Lexington to the northeastern corner of Pendleton county being only six feet per mile, and that from Junction City to the Cumberland river,

five feet per mile. The considerable dip of seventeen feet per mile in the relatively short distance between Nicholasville and Junction City unquestionably has some connection with the line of faulting extending along the Kentucky river and with other minor faults not yet carefully investigated. The general effect of this faulting has been to place the strata south of Jessamine and Mercer counties at a considerably lower elevation than the corresponding strata north of the same. It probably is faulting rather than dip which accounts for the rapid sinking of the axis between Nicholasville and Junction City. The total lowering of the axis between Nicholasville and the Cumberland river is only nine feet per mile. Even the faults along the flanks of the geanticline appear to be of such a character as to leave the strata toward the crest of the geanticline at relatively higher elevations. Very few of these faults have been studied with any degree of care. In case of many of the minor folds not even the directions of the axes have been determined. Under these circumstances the more exact structure of the Cincinnati geanticline, in Kentucky, may be said to be still comparatively unknown.

Areas of Exposure of the Paleozoic Rocks of Kentucky.

If a considerable number of leaves of a book were moderately folded lengthwise, and then placed approximately horizontally upon a table, the axis of the fold would extend from the top to the bottom of the page, and from this axis: the leaves would dip both to the right and the left. In this position, to an observer looking vertically downward, only the surface of the uppermost leaf would be visible. If, however, a number of incisions were made with a penknife, by roughly cutting through the uppermost leaves, the lower leaves would be exposed along the margins and lower parts of these cuts. In this state, the book would illustrate readily what would result if a series of approximately horizontal rock layers were gently folded and raised above the level of the sea. At first only the uppermost layers of rock would be exposed, but in the course of time, after streams and rivers had cut valleys into rocks, some of the underlying

layers also would become visible. The oldest rocks would be exposed along the bottom of the deepest valleys.

In the cases of streams cutting their channels transversely across the entire width of the fold, the lowest strata would be reached at the bottom of the channels in that part of their course which was directly beneath the crest of the fold. For instance, the lowest strata exposed in the State of Kentucky are found at the bottom of the gorge of the Kentucky river, near Camp Nelson, in the southern part of Jessamine county. The lowest strata exposed along the Licking river are exposed at the bottom of the channel somewhere between Falmouth and the mouth of North Fork. The lowest strata exposed along the Ohio river are seen east of Moscow. Both up and down stream from these localities, successively overlying beds are exposed at the river's edge. (See map opposite title page.)

If, now, with a sharp knife held horizontally, a considerable portion of the upper part of the fold formed by the leaves of the book were cut away, the lowest leaves would be exposed for considerable distances along the axis of the fold, directly beneath its former crest, and the overlying leaves would be found on each side of the fold, at successively greater distances from its axis. In this state, the book would readily illustrate what would result if the upper parts of a fold were removed by weathering, especially if the part remaining were reduced to a comparatively level, or only moderately undulating, plain. Those strata which belong lowest in the series would be exposed along that part of the surface which lay directly beneath the former crest of the fold,* and relatively overlying strata would come to the surface at approximately the same elevations, but at a greater distance from the former crest of the fold. The outcrops of the strata would form bands approximately parallel to the length of the fold; with the relatively lowest rocks forming the central band, and the overlying rocks occurring on both sides, but at successively greater distances from this band. In the case of folds whose flanks still show a considerable elevation above the surrounding country, the anticline structure may be recognized readily without the assistance of any considerable geological study. But in the case of folds which have been reduced by weathering to a comparatively level plain, the earliest

*See Plate B, Fig. 3, page 125

due to the anticline structure may be offered by the peculiar symmetrical arrangement of the strata, in long bands on opposite sides of the fold, the oldest strata along the middle of the fold, following the crest, the more recent strata on either side at successively greater distances from the axis.

If the original crest of the fold had varied considerably in altitude, rising at some points to considerable heights, and dipping thence for considerable distances toward both ends of the fold, the lines of outcrop of the various strata would have been more nearly oval or oblong. The oldest strata would be exposed in a central area underlying that part of the original crest of the fold which had attained the greatest elevation, and around this central area the relatively overlying beds would be arranged in successively more distant oval or oblong bands. This is the structure characterizing Kentucky and the adjacent parts of Ohio and Indiana.

The oldest rocks of the State, the High Bridge and Lexington formations, form a central area occupying the Bluegrass region of Kentucky, including the territory between Frankfort, Georgetown, Paris, Winchester, Nicholasville, Danville, Harrodsburg, and a considerable part of the immediately surrounding country. Surrounding this central area is the great band of Cincinnatian rocks, whose outer boundaries reach Bardstown and Lagrange, Kentucky; Madison, Versailles, Connersville, and Richmond, in Indiana; Eaton, Dayton, Xenia, Wilmington, and Sardinia, in Ohio; and Maysville, Owingsville, Richmond, and Stanford, in eastern Kentucky. It will be noticed that this band widens enormously on the northern and northwestern sides of the central area, occupied by the High Bridge and Lexington series. The general area of outcrop of these Ordovician strata, the High Bridge, Lexington, and Cincinnatian rocks, is shown on the map facing the title page of this bulletin. Here the area left in white represents the area of outcrop of the Ordovician strata of Ohio, Indiana, and the north-central part of Kentucky, with the exception of that small part of the map which represents the country south of Chicago, Lebanon, and Stanford, where the Ordovician rocks frequently are overlaid directly by Devonian strata. In the areas covered by the small dots, Silurian rocks occur, either exposed at the surface, or covered by Devonian and later formed strata. The general direc-

tion followed by the axis of the Cincinnati geanticline in Kentucky is indicated by the legend printed across the lower part of the map. The dotted line, extending from that point on the map marked Chicago to Frankfort, Boyd, Paris, Lancaster, and Stanford, is not intended to limit the axis of the fold, but to indicate that part of the State in which it is believed that the Devonian formerly rested directly upon the Ordovician, the Niagran strata being absent. Since the delimitation of this area, north of Chicago, Lebanon, and Stanford, is merely theoretical and not based upon a sufficient number of verified data, this feature of the map is offered rather us an interesting suggestion, than as a well established fact.

In Kentucky, the Silurian formations form a narrow band bordering the exterior edge of the Ordovician area. From Stanford this band extends northward to the Ohio river at a point fully ten miles east of Maysville; thence it continues into Ohio to a point about fifteen miles west of Columbus, widening rapidly north of the Ohio river. North of Eaton, Dayton, and the point west of Columbus, the Silurian covers almost the entire western section of the State, as far north as Toledo and Sandusky, with the exception of the extreme northwestern corner of the State, and several small areas east of Bellefontaine. Westward, the Silurian may be traced across the northern part of Indiana to Illinois and Wisconsin. Farther south, in Indiana, the western line of exposure extends from Peru to Kokomo, Noblesville, Rushville, Greensburg, and Madison. It crosses the Ohio river at Louisville, and from this point Silurian strata may be traced as far south as Raywick, west of Lebanon, Kentucky. Between the exposures several miles east of Raywick and those three miles south of Stanford, the Silurian formations are absent, the Devonian strata, when present, resting directly upon the Ordovician.

The Devonian formations, in Kentucky, form narrow bands similar to those of the Silurian just described, but across the south-central part of the State, between Raywick, Lebanon, and Stanford, the line of outcrop practically is continuous. From Stanford, the band of Devonian rocks extends northward to Vanceburg, Kentucky, to Columbus and Bucyrus, Ohio, reaching Lake Erie at Huron and Vermillion. Throughout this entire length it remains a remarkably narrow and characteristic band,

easily recognized, and has formed one of the most valuable horizon markers for the geologist.

North of Raywick, the Devonian formations may be traced to Louisville, and thence to Columbus, Indianapolis, and Lafayette, to Rensselaer, in the northwestern part of the State of Indiana. Here again it forms a very characteristic band, although broader than in the State of Ohio.

At distances still more remote from the area of outcrop of Ordovician strata occur first the Mississippian strata, and then the Pennsylvanian formations, or Coal Measures.

The special field of investigation covered, in a preliminary manner, by this bulletin, is the distribution and stratigraphical arrangement of the Silurian clays along the eastern side of the Cincinnati geanticline, in Kentucky. Since it was impossible, in the brief time devoted to field work, to examine thoroughly all parts of this territory, attention was confined chiefly to that part of the band of Silurian rocks lying between Stanford and Owingsville, and more especially to that part of this area lying between Moberly, Panola, Irvine, Clay City, and Indian Fields. The extension of the stratigraphy worked out in this more limited area to the entire area between Stanford and Owingsville has been attended with some difficulties which have not been fully conquered. The solution of the various problems involved must depend upon future field work. Advantage was taken, however, of the numerous notes accumulating during this preliminary survey, to give all information available regarding the limestones, accompanying the Silurian clays, the Devonian limestones overlying the Silurian formations, and such other information as was thought might prove of interest at this early stage of progress of the Survey.