TOPOGRAPHY.

LOCATION.

The Ditney quadrangle is located in southwestern Indiana, its southern boundary being only 5 miles from the Ohio River. After its emergence and its northerner corner come about 9 miles from the Wabash River, which marks the boundary between the States of Indiana and Illinois. It embraces the area between latitude 38° on the south and 38° 30' on the north, and between longitude 87° on the east and 87° 30' on the west, and includes one-fourth of a square degree of the quadrangle. Its north and south length is about 54.4 miles, its breadth about 27.3 miles, and its area 937.6 square miles. It comprises four 90°-minute quadrangles—the Petersburg, Velpus, Bossville, and Depauw Spring—is, and includes an area of 500 feet or more from the Ohio, there is a difference of only 10 feet. The minor streams are passing out 5 or 6 miles south of the northwest corner and joining the Wabash at a point 15 miles west of its mouth. With respect to area drained, Little Pigeon Creek stands next to the Patoka River. Its drainage area, the southwestern quarter of the quadrangle, and has an extent of over 250 square miles. Figure Creek proper drains about two-thirds of the western half of the quadrangle.

Other streams of importance are Cypress Creek, draining a considerable area between Figure and Little Pigeon creeks in the southern portion of the quadrangle, and a number of small streams draining the northern edge of the quadrangle and flowing northward to the White River, just north of the quadrangle boundary.

The minor streams show a somewhat radical arrangement about a point a little southeast of the center of the quadrangle, a region which in general is the highest within its limits. The southward-flowing streams as a whole are somewhat longer and have greater volume than those flowing northward, the difference probably being due to the shorter distance to the Ohio. The minor streams are shorter, and their consequent increased grade, by reason of which they eat out back farther into the upland.

Before the advent of the great ice sheet which, in relatively late geologic time, crossed the norther portion of the quadrangle and the region to the north, the rivers showed in their broader relations, a somewhat similar pattern to the present. As the ice sheet approached, the streams were forced to flow through, and their consequent increased grade, by reason of which they cut back farther into the upland.

The rocks exposed at

DERIVATION OF THE ROCKS.

The Ditney quadrangle is divided into two distinct types of topography: (1) Rugged uplands, which are best developed in the vicinity of the older drainage system, especially in the eastern half of the area, and includes one-fourth of a square degree of the quadrangle, the resulting relief depending, therefore, upon the relations of the surface to the bedrock formations in the southwestern part of the area.

Drainage.

All of the drainage from the surface of the Ditney quadrangle finds its way to the Ohio River, the streams of the southern half flowing south and emptying into the Wabash River, while those of the northern half flow first into the Wabash, a few miles south of the quadrangle, and thence south to the Ohio. The largest stream in the drainage within the limits of the Patoka quadrangle. This stream enters the area from the east, about 10 miles south of the northeast corner, and flows from south to north through a linear valley, passing out 5 or 6 miles south of the northeast corner and joining the Wabash at a point 15 miles west of its mouth.

The Wabash River from east of Velpus to beyond three is widely and irregularly divided. The valleys of the Wabash, the White, and the most of the other streams that were forced to flow through, have reached as far south as the west-central portion of the quadrangle.
the disappearance of the ice are of still less importance.

The older consolidated rocks, on the other hand, reach a thickness in southwestern Indiana of several hundred feet, though probably a thickness of not more than 400 feet is exposed at the surface of the quadrangle. These exhibit many alternations of sandstones, shales, limestones, coals, etc., but they may be grouped by their lithologic characters into five formations, which, in ascending order, are the Brann, Petersburg, Millersburg, Somerville, Ditney, and Inglefield. All of them belong to the Pennsylvanian or "Coal Measure" series of the Carboniferous period. The general characters and relative thickness are described in some detail in the following paragraphs, and are shown graphically in the geologic column at the end of the folio.

General geologic relations.—While in a broad way it is possible to reduce the geologic basis of the Mississippi region to one of two physiographic basins, the former has less unity than the latter. During very early geologic time, however, and throughout many subsequent geologic periods, the larger part of the central portion of North America was covered by a broad sea, which extended from the area of the Gulf of Mexico northwestward to the region of the Great Lakes, and stretched from near the eastern limits of the Appalachian Mountain system on the east to the Rocky Mountain region on the west. Over the bottom of this broad sea there were deposited beds of sedimentary rocks, including limestones, shales, sandstones, and conglomerates, the limestones predominating among the lower beds and the sandstones among the upper, and the whole probably reaching a total thickness of from 4000 to 6000 feet. These rocks were originally deposited in a horizontal position, but were afterward subjected in places to broad, gentle warps, giving rise to broad, low rock domes from whose crests the rocks dip gently away into basins that are equally extensive and equally shallow. The Ditney quadrangle, including all or a part of the eastern part of the county of Pikeville, shows the basin of such a kind, but the rocks dip more generally from all directions in the "coal" formations of the eastern basin.

CATIONOGENOUS ROCKS.

Pennsylvanian rocks.—The Brann formation includes the series of sedimentary rocks, alternating sandstones, with occasional shales, limestones, and coals, extending from the heart of the Lakefield sandstone ("Potteville") of the Indiana geologic survey lateral to the bottom of the Petersburg coal, a part of the Petersburgh formation, and the Brann coal. The sandstones, some of them several feet thick, are included within its limits, making it an important coal in several areas.

Although the Petersburg formation includes all beds from the top of the Somerville to the bottom of the Petersburg coal, it is generally separated into two great members: the upper, or lower part of the formation, "coal" formations, and the lower part of the formation, "coal" formations, and the lower part of the formation, "coal" formations. The general geologic relations of the various members of the Petersburg formation are of considerable economic importance.

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Evidence obtained outside the limits of the quadrangle shows that there was probably an erosion interval between the deposition of the Ditney formation and the overlying Illinoian till. Though not usually apparent from a superficial study of the drift, a detailed examination of its structure and general distribu- 
tion are such that it seems impossible to accept the drift as a single sheet formed by one ice advance, but there are in reality several distinct drift sheets, each of which represents a separate ice advance. The intervals of deposition or disappearance of ice in the advances are made apparent by the presence of soils, by beds of peat and marl, and by the weathering of certain zones now buried in the drift. The sheets themselves differ markedly in extent, and often in color, substance, and other physical properties, and in many cases these differences, together with the gradual ridges marking the various portions of the ice, resulted in the differentiation of the Drift period in North America into nine divisions, as follows:

5. Illinoian glaciation.
7. Lowan glaciation.
9. Pre-Illinoian glaciation.

The gravelly plains west of the southern part of the quadrangle, though the existence of an earlier one is not clear. A small zone of the Illinoian till shows the weathered and stratified materials of the Wisconsin stage are, however, well represented in the area.

The deposits which in North America characterize the Pleistocene period as a whole are of three classes, and embrace (1) those whose deposition was associated, either directly or indirectly, with the presence of the great ice sheets which at several stages during the period covered large portions of the northern half of the continent, (2) those which were deposited through the ordinary influences of wind and water in the intervals between the sheets of ice, and (3) those which have been deposited by similar agencies since the melting of the ice, and that in the midst of the drift deposits has continued through more than a single stage.

GLACIAL AND INTRIGLACIAL DEPOSITS.

Deflations, a group of deposits of materials which have been picked up or dragged along on the bottom of the ice sheet during its overlying drifts, may also be recognized.

The only or more probably lignitic material of the last well, occurring as it does over 100 feet in the east-west road at the point where it crosses the level of the Patoka flats. It is recognized, however, that in either case it is also possible to show that the lignite and marl zones simply mark time intervals in a compound drift sheet.

Possibly *Pro-Illinoian* drift.—As a number of the known limits of Illinoian till, there are shown on the Arval Geology map deposits of highly oxidized sands and gravels containing rolled pebbles of quartz and fragments of flint and Jasper, supposedly derived from the Wisconsin drift, but these outcrops at the top of the Illinoian till are not sharp, and it is possible that the drifts here shown as separate and distinct are only parts of the Wisconsin stage.

Section of sands and gravels under a 10-foot coating of loess, near the level of the Patoka flats. It is recognized, however, that in either case it is also possible to show that the lignite and marl zones simply mark time intervals in a compound drift sheet.

Possibly *Pre-Illinoian* drift.—A number of the known limits of Illinoian till, there are shown on the Arval Geology map deposits of highly oxidized sands and gravels containing rolled pebbles of quartz and fragments of flint and Jasper, supposedly derived from the Wisconsin drift, but these outcrops at the top of the Illinoian till are not sharp, and it is possible that the drifts here shown as separate and distinct are only parts of the Wisconsin stage.

The question whether the yellow sand may not represent the pumpings of a hydraulic dredge has been raised, but the present condition of the exposures is such that this question could not be decided with certainty, and the long period which has elapsed since the normal stage of the canal makes it impossible to obtain trustworthy information in regard to its construction. The irregularities in the stratification are suggestive of dredging, but the general occurrence and apparent relations to the other beds make it probable that the sand is a natural deposit, laid down by the outflow of glacial waters during a late stage of the Illinoisian sequence. If so, it is not regarded as belonging to an earlier stage of the drift sheet, and the invasion is not clear.

At a point some 5 miles west of Wheeling, and outside the limits of the quadrangle, a clay with the outer pebbles stained a bit, the probable characterizing the Illinoisian drift was found overlying a true loess carrying the common low fossils, which in turn rested on an oxidized drift sheet. It could not be determined, however, whether both of the superficial deposits included in the Illinoian beds were to be regarded as Illinoian or whether the lower belongs to an earlier stage of glacial occupation.

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The till sheet deposited beneath ice of that invasion by the melting of the basal detritus layer, or by the chemical weathering and leaching of rock, was distributed over the surface of the bedrock, which was generally exposed, except in areas of till deposition. The matrix or the till thus deposited contained regolith consisting of soil, weathered rock, and unconsolidated sediments. The till sheet was deposited mostly by glacial erosion and deposition processes, and it was generally thick and extensive. The till sheet was covered by ice and acted as a barrier to the movement of water. The till sheet was commonly several feet thick, and it contained a variety of materials, including sand, silt, clay, and gravel. The till sheet was later eroded and modified by various processes, including glacial erosion, weathering, and deposition.

The till sheet was deposited on a surface that had been previously glaciated, and it was deposited in layers that varied in thickness and composition. The till sheet was deposited in a variety of environments, including river valleys, lakeshores, and coastal areas. The till sheet was later modified by various processes, including glacial erosion, weathering, and deposition.

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about 70 per cent of silica, largely quartz, and a
third of loess from near Pittsburgh, just west of the quadrangle, are given below.

The top sample (No. 1) is from a point 10
inches, the second (No. 2) from a point 22
inches, and the third (No. 3) from a point at least 10 inches below the surface. The analyses were made for the Indiana geological survey and first appeared in its Twentieth and Twenty-first Annual Reports.

<table>
<thead>
<tr>
<th>Component</th>
<th>No. 1</th>
<th>No. 2</th>
<th>No. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>72.87</td>
<td>6.75</td>
<td>1.05</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>15.10</td>
<td>53.48</td>
<td>1.05</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>2.21</td>
<td>7.29</td>
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</tr>
<tr>
<td>CaO</td>
<td>0.15</td>
<td>0.39</td>
<td>0.26</td>
</tr>
<tr>
<td>MgO</td>
<td>0.39</td>
<td>0.15</td>
<td>0.10</td>
</tr>
<tr>
<td>K₂O</td>
<td>0.32</td>
<td>0.52</td>
<td>0.10</td>
</tr>
<tr>
<td>Na₂O</td>
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<td>2.05</td>
<td>1.25</td>
</tr>
<tr>
<td>TiO₂</td>
<td>0.01</td>
<td>0.05</td>
<td>0.01</td>
</tr>
<tr>
<td>Total</td>
<td>100.05</td>
<td>100.01</td>
<td>100.07</td>
</tr>
</tbody>
</table>

The amount of calcium carbonates (CaCO₃) present largely depends upon the amount of weathering to which the loess has been subjected, and consequently the calcium carbonates is present in minimum amounts near the surface. In the deposits of the CO₂ of the CaCO₃, at New Harmony, a few miles west of the limits of the quadrangle, there has been 0.25 per cent.

In color the loess is ordinarily buff or brown, but gray, yellow, and red are common colors. Meteorite is very common. The gray colors are usually found some distance below the surface, but are sometimes within a foot or two of the top of the surface layer, in areas in which the loess has been weathered only moderately. In the Dityne region the loess of a bright-red type occurs as a thin, only outcrops, in the vicinity of the Dityne escarpment. The color is mostly reddish brown but, gradually, becomes lighter upward, frequently in the thicker part of the deposit.
They are the highest and youngest of the solidified rocks of Indiana.

The thickness of the entire series, from the Cambrian to the close of the Carboniferous, is probably 4500 or 5000 feet, of which, in the Indiana region, considerably more than half is limestone, the conditions being in marked contrast to those existing near the edges of the sea to the northwest, where the deposits were composed largely of sand and shale materials.

The sedimentary rocks of the basement did not take place uniformly over the whole of the basin. Even at the beginning of the Cambrian period islands existed, it is believed, in the south central part of Missouri, and possibly elsewhere, in the great continental sea, and local uplifts, possibly in some cases accompanied by slight folding, brought similar islands into existence from time to time at other points as deposition progressed. Of these the one most intimately related to the region of the Ditney quadrangle, together with the still larger island in southern Missouri, which had in the course of time become considerably enlarged, formed the opposite shores of a broad embayment or strait extending from western Kentucky across southwestern Illinois, Indiana, Michigan, southern Ohio, and extending with the northwestern extension of the interior sea in western Mississippi and Missouri. It was in this embayment that the Carboniferous rocks of the Ditney region were laid down.

Uplift and Folding.-The sedimentary beds were originally in an essentially horizontal position throughout the entire region. The Cambrian beds were deposited. At the close of the Carboniferous period there were further uplifts of both the eastern and western parts of the basin. The intermediate area, constituting what is now known as the Illinois-Indiana coal basin, was perhaps a continuation of the straits in southern Missouri, which had in the course of time become considerably enlarged, and polluted the opposite sides of a broad embayment or strait existing in the interior sea as far north as southeastern Missouri and Iowa. It was in this embayment that the Carboniferous rocks of the Ditney region were laid down.

Drainage of the peneplain.---Though no deposits other than the coal and till have been found on the crests of the peneplain in the Ditney quadrangle, together with the Independence Mountains and southwestward along the western margin to Alabama, a surface which is probably equivalent to the Lexington Plain of Kentucky, and is thought to have been formed in early Tertiary times.

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Peppermint and Early Cenozoic Rivers.

Period of development.

Subsequent to the uplift which followed the deposition of the Carboniferous rocks, and which raised them above the level of the sea in which they had been deposited, there appears to have been no further incursion of the sea into the region under consideration until there, as now recorded, the history of the form of rocks. It is only in the land form, or the topographic region following erosion, that evidence of the preceding events is to be looked for, and as each new set of topographic features is formed only at the expense of older ones, it is only the later ones that are left to tell of the events that have taken place.

Formation of Tertiary peneplain.---No sooner had the Carboniferous rocks been uplifted above the surface of the sea by the further uplifting of the Cincinnati anticline than erosion set in and began its work of reducing the surface to its former level. It is probable that at first erosion did not keep pace with uplift, and an elevation of some prominence may have resulted. As the elevation of the surface of the land increased, the wave energy of the water increased, and the material worn away by the sea was transported and deposited in the basins along the coasts, instead of at the crests of the promontories, where it had once stood, and the basin-like area was left to tell of the events that have taken place.

The Tertiary or early Pliocene depositional steps.---Following the period of Tertiary erosion, during which the land was reduced to a level lower than at any time since the Devonian period, the elevation was increased, and the sea began to draw back, the coasts being preserved nearly at the same level as at present, and the streams flowing along the coast. The streams flowed into the sea at their mouths, and the surface of the land was generally low, but with the beginning of the Tertiary era, the entire surface of the land was reduced to a level nearly that of the present; the bed of the sea was then left, and the area now occupied by the Great Plains of that time was formed.

Drainage of the peneplain.---Though no deposits other than the coal and till have been found on the crests of the peneplain in the Ditney quadrangle, together with the Independence Mountains and southwestward along the western margin to Alabama, a surface which is probably equivalent to the Lexington Plain of Kentucky, and is thought to have been formed in early Tertiary times.

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and spread over broad flats along the drainage lines, from which it was picked up, transported, and redeposited by the wind as a mantle over the general surface of the uplands.

The Illinois River, like most of the other streams of the region, has cut down through a crept-up valley floor, leaving a deposit of silt and sand and gravel along its valley, which is much broader than the valley floor of the Wisconsin stage. The deposits of gravel are separated from the Wisconsin stage deposits by a maximum of about 15 feet.

The deposits of the Wisconsin stage in the vicinity of Petersburg show a thickness of about 70 feet, while the general westward-deepening of the valley floor is shown by the fact that the thickness of the deposits is much greater in villages to the west and northwest of Petersburg, and much less in villages to the east and southeast. The thickness of the deposits in the vicinity of Petersburg is shown to be about 70 feet by the section published by the Geological Survey of Illinois, but the thickness is not known in the vicinity of Mount Sterling, where the deposits are much more extensive.

It is believed locally that the coal worked at or near the surface at Arvandale and between Window, Rock Creek, and Millersburg, is the Petersburg coal, but this is not true, as the Petersburg coal has not been worked in these localities.

The Petersburg coal is worked for purposes of shipment. The Petersburg mine is located on the east side of the Illinois River, near the mouth of the Iroquois River, and is the largest coal mine in the state. The Petersburg coal has a rank of about 48.5 per cent. of volatile matter, and a carbon content of about 75.5 per cent. The ash content is about 1 per cent. The sulfur content is less than 1 per cent.

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favorable for wells are the low anticlinal swells, is possible that similar if not greater pools may produce. It has since been cleaned out and supplies of both gas and oil, the latter sometimes

Economic Geology sheet. The following discussion is based mainly on that report. A new sheet shows a rock pressure of 585 pounds. A new location has been made at several points west of Cup Creek (west of Picketville), and at the Taylor mine at Selvin. So far as known no tests of the clay have been made.

Fire clay.—The clays of the coal-bearing rocks give promise of being suitable for the manufacture of brick. The clay beneath the Petersburg coal in the southeastern portion of the quadrangle is apparently a mixture of loess, sand, and common building brick are obtained from the clay beneath the Petersburg coal in the southeastern portion of the quadrangle. As a rule they are not per-

The clays of the coal-bearing rocks make a vitrified brick of superior grade. Thin limestones, usually not more than 3 or 5 feet in thickness, are common in the central portion of the quadrangle. In a few places shales were seen that seemed to be quite as good as the common limestones, but they are too thin to be worked profitably on a large scale.

The soil of the Ditney quadrangle may be divided into five groups: (1) Silt loams (of the river bottoms; (2) soils of the terraces or second bottom; (3) loess; (4) till or bottom drift; and (5) alluvial soils. Each will be considered in turn.

Soils of the river bottoms.—In this group is included the soils of the lowest portion of the river bottoms, or those subject to at least annual overflow. In the quadrangle they are best developed along the Patoka River, where they reach a thickness of several miles in places. Similar soils occur in the Little Pigeon, Bluegrass, and Cypress creeks and other streams. The soils generally consist of clay or almost impalpably fine sands, which are whitish in color and "cold," being saturated with water in the winter and spring months and parched by drought in summer. Although portions of the bottom lands have long been under cultivation, large areas still remain forested. They are usually covered with a dense undergrowth of dogwood, sumac, and alder, with a scattering of oak and hickory. South of the Patoka River the forests are generally consist of pine and pine woods, with a scattering of oak and hickory.

The soils of this quadrangle are excellent for the cultivation of all crops except potatoes and tobacco. Wells in the rock on narrow ridges or on the edges of steep cliffs are usually dry throughout several months each year, and many of the shallow wells in other situations, in both rock and till, are dry at times. Cisterns are used in many instances, but the supply is small and is insufficient for any but domestic purposes, and hauling water is the only feasible method of securing a supply. The best soils of the area. The broad loam-covered surface of the uplands, and afford some of the best soils of the area. The broad loam-covered