DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

GEOLOGIC ATLAS

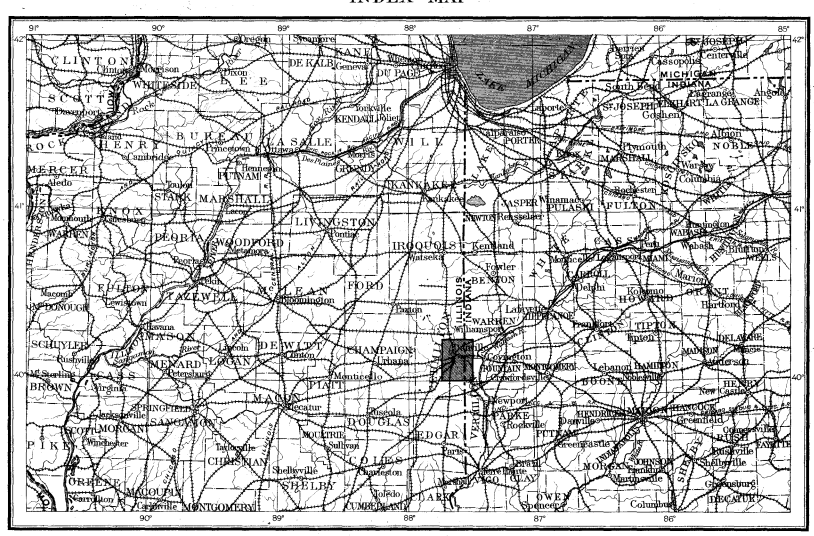
OF THE

UNITED STATES

DANVILLE FOLIO

ILLINOIS - INDIANA

INDEX MAP



SCALE: 40 MILES-1 INCH

AREA OF THE DANVILLE FOLIO

LIST OF SHEETS

DESCRIPTION | TOPOGRAPHY | HISTORICAL GEOLOGY | ECONOMIC GEOLOGY | COLUMNAR SECTIONS

FOLIO 67 | LIBRARY EDITION | DANVILLE

WASHINGTON, D. C.

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GEORGE W. STOSE, EDITOR OF GEOLOGIC MAPS   S. J. KÜBEL, CHIEF ENGRAVER

1900

EXPLANATION.

The Geological Survey is making a geologic map of the United States, which necessitates the preparation of a topographic base map. The two are being issued together in the form of an atlas, the parts of which are called folios. Each folio consists of a topographic base map and geologic maps of a small area of country, together with explanatory and descriptive texts.

THE TOPOGRAPHIC MAP.

The features represented on the topographic map are of three distinct kinds: (1) inequalities of surface, called *relief*, as plains, plateaus, valleys, hills, and mountains; (2) distribution of water, called *drainage*, as streams, lakes, and swamps; (3) the works of man, called *culture*, as roads, railroads, boundaries, villages, and cities.

Relief.—All elevations are measured from mean sea-level. The heights of many points are accurately determined, and those which are most important are given on the map in figures. It is desirable, however, to give the elevation of all parts of the area mapped, to delineate the horizontal outline, or contour, of all slopes, and to indicate their grade or degree of steepness. This is done by lines connecting points of equal elevation above mean sea-level, the lines being drawn at regular vertical intervals. These lines are called *contours*, and the uniform vertical space between each two contours is called the *contour interval*. Contours and elevations are printed in brown.

The manner in which contours express elevation, form, and grade is shown in the following sketch and corresponding contour map:

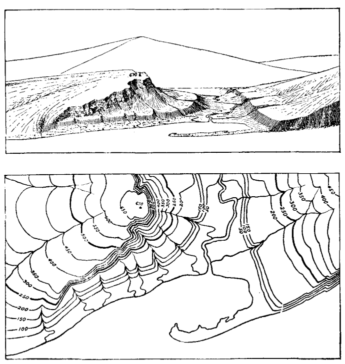

Fig. 1.—Ideal sketch and corresponding contour map.

The sketch represents a river valley between two hills. In the foreground is the sea, with a bay which is partly closed by a hooked sand-bar. On each side of the valley is a terrace. From the terrace on the right a hill rises gradually, while from that on the left the ground ascends steeply in a precipice. Contrasted with this precipice is the gentle descent of the left-hand slope. In the map each of these features is indicated, directly beneath its position in the sketch, by contours. The following explanation may make clearer the manner in which contours delineate elevation, form, and grade:

1. A contour indicates approximately a certain height above sea-level. In this illustration the contour interval is 50 feet; therefore the contours are drawn at 50, 100, 150, 200 feet, and so on, above sea-level. Along the contour at 250 feet lie all points of the surface 250 feet above sea; and similarly with any other contour. In the space between any two contours are found all elevations above the lower and below the higher contour. Thus the contour at 150 feet falls just below the edge of the terrace, while that at 200 feet lies above the terrace; therefore all points on the terrace are shown to be more than 150 but less than 200 feet above sea. The summit of the higher hill is stated to be 670 feet above sea; accordingly the contour at 650 feet surrounds it. In this illustration nearly all the contours are numbered. Where this is not possible, certain contours—say every fifth one—are accentuated and numbered; the heights of others may then be ascertained by counting up or down from a numbered contour.

2. Contours define the forms of slopes. Since contours are continuous horizontal lines conforming to the surface of the ground, they wind smoothly about smooth surfaces, recede into all reentrant angles of ravines, and project in passing about prominences. The relations of contour curves and angles to forms of the landscape can be traced in the map and sketch.

3. Contours show the approximate grade of any slope. The vertical space between two contours is the same, whether they lie along a cliff or on a gentle slope; but to rise a given height on a gentle slope one must go farther than on a steep slope, and therefore contours are far apart on gentle slopes and near together on steep ones.

For a flat or gently undulating country a small contour interval is used; for a steep or mountainous country a large interval is necessary. The smallest interval used on the atlas sheets of the Geological Survey is 5 feet. This is used for regions like the Mississippi delta and the Dismal Swamp. In mapping great mountain masses, like those in Colorado, the interval may be 250 feet. For intermediate relief contour intervals of 10, 20, 25, 50, and 100 feet are used.

Drainage.—Watercourses are indicated by blue lines. If the stream flows the year round the line is drawn unbroken, but if the channel is dry a part of the year the line is broken or dotted. Where a stream sinks and reappears at the surface, the supposed underground course is shown by a broken blue line. Lakes, marshes, and other bodies of water are also shown in blue, by appropriate conventional signs.

Culture.—The works of man, such as roads, railroads, and towns, together with boundaries of townships, counties, and States, and artificial details, are printed in black.

Scales.—The area of the United States (excluding Alaska) is about 3,025,000 square miles. On a map with the scale of 1 mile to the inch this would cover 3,025,000 square inches, and to accommodate it the paper dimensions would need to be about 240 by 180 feet. Each square mile of ground surface would be represented by a square inch of map surface, and one linear mile on the ground would be represented by a linear inch on the map. This relation between distance in nature and corresponding distance on the map is called the scale of the map. In this case it is "1 mile to an inch." The scale may be expressed also by a fraction, of which the numerator is a length on the map and the denominator the corresponding length in nature expressed in the same unit. Thus, as there are 63,360 inches in a mile, the scale "1 mile to an inch" is expressed by $\frac{1}{63,360}$. Both of these methods are used on the maps of the Geological Survey.

Three scales are used on the atlas sheets of the Geological Survey; the smallest is $\frac{1}{250,000}$, the intermediate $\frac{1}{125,000}$, and the largest $\frac{1}{62,500}$. These correspond approximately to 4 miles, 2 miles, and 1 mile on the ground to an inch on the map. On the scale $\frac{1}{62,500}$ a square inch of map surface represents and corresponds nearly to 1 square mile; on the scale $\frac{1}{125,000}$, to about 4 square miles; and on the scale $\frac{1}{250,000}$, to about 16 square miles. At the bottom of each atlas sheet the scale is expressed in three different ways, one being a graduated line representing miles and parts of miles in English inches, another indicating distance in the metric system, and a third giving the fractional scale.

Atlas sheets and quadrangles.—The map is being published in atlas sheets of convenient size, which are bounded by parallels and meridians. The corresponding four-cornered portions of territory are called *quadrangles*. Each sheet on the scale of $\frac{1}{250,000}$ contains one square degree, i. e., a degree of latitude by a degree of longitude; each sheet on the scale of $\frac{1}{125,000}$ contains one-quarter of a square degree; each sheet on the scale of $\frac{1}{62,500}$ contains one-sixteenth of a square degree. The areas of the corresponding quadrangles are about 4000, 1000, and 250 square miles, respectively.

The atlas sheets, being only parts of one map of the United States, are laid out without regard to the boundary lines of the States, counties, or townships. To each sheet, and to the quadrangle it represents, is given the name of some well-known town or natural feature within its limits, and at the sides and corners of each sheet the names of adjacent sheets, if published, are printed.

Uses of the topographic sheet.—Within the limits of scale the topographic sheet is an accurate and characteristic delineation of the relief, drainage, and culture of the district represented. Viewing the landscape, map in hand, every characteristic feature of sufficient magnitude should be recognizable. It should guide the traveler; serve the investor or owner who desires to ascertain the position and surroundings of property to be bought or sold; save the engineer preliminary surveys in locating roads, railways, and irrigation ditches; provide educational material for schools and homes; and serve many of the purposes of a map for local reference.

THE GEOLOGIC MAP.

The maps representing areal geology show by colors and conventional signs, on the topographic base map, the distribution of rock formations on the surface of the earth, and the structure-section map shows their underground relations, as far as known, and in such detail as the scale permits.

KINDS OF ROCKS.

Rocks are of many kinds. The original crust of the earth was probably composed of *igneous rocks*, and all other rocks have been derived from them in one way or another.

Atmospheric agencies gradually break up igneous rocks, forming superficial, or *surficial*, deposits of clay, sand, and gravel. Deposits of this class have been formed on land surfaces since the earliest geologic time. Through the transporting agencies of streams the surficial materials of all ages and origins are carried to the sea, where, along with material derived from the land by the action of the waves on the coast, they form *sedimentary rocks*. These are usually hardened into conglomerate, sandstone, shale, and limestone, but they may remain unconsolidated and still be called "rocks" by the geologist, though popularly known as gravel, sand, and clay.

From time to time in geologic history igneous and sedimentary rocks have been deeply buried, consolidated, and raised again above the surface of the water. In these processes, through the agencies of pressure, movement, and chemical action, they are often greatly altered, and in this condition they are called *metamorphic rocks*.

Igneous rocks.—These are rocks which have cooled and consolidated from a liquid state. As has been explained, sedimentary rocks were deposited on the original igneous rocks. Through the igneous and sedimentary rocks of all ages molten material has from time to time been forced upward to or near the surface, and there consolidated. When the channels or vents into which this molten material is forced do not reach the surface, it either consolidates in cracks or fissures crossing the bedding planes, thus forming dikes, or else spreads out between the strata in large bodies, called sills or laccoliths. Such rocks are called *intrusive*. Within their rock enclosures they cool slowly, and hence are generally of crystalline texture. When the channels reach the surface the lavas often flow out and build up volcanoes. These lavas cool rapidly in the air, acquiring a glassy or, more often, a partially crystalline condition. They are usually more or less porous. The igneous rocks thus formed upon the surface are called *extrusive*. Explosive action often accompanies volcanic eruptions, causing ejections of dust or ash and larger fragments. These materials when consolidated constitute breccias, agglomerates, and tuffs. The ash when carried into lakes or seas may become stratified, so as to have the structure of sedimentary rocks.

The age of an igneous rock is often difficult or impossible to determine. When it cuts across a sedimentary rock, it is younger than that rock, and when a sedimentary rock is deposited over it, the igneous rock is the older.

Under the influence of dynamic and chemical forces an igneous rock may be metamorphosed. The alteration may involve only a rearrangement of its minute particles or it may be accompanied by a change in chemical and mineralogic composition. Further, the structure of the rock may be changed by the development of planes of division, so that it splits in one direction more easily than in others. Thus a granite may pass into a gneiss, and from that into a mica-schist.

Sedimentary rocks.—These comprise all rocks which have been deposited under water, whether in sea, lake, or stream. They form a very large part of the dry land.

When the materials of which sedimentary rocks are composed are carried as solid particles by water and deposited as gravel, sand, or mud, the deposit is called a mechanical sediment. These may become hardened into conglomerate, sandstone, or shale. When the material is carried in solution by the water and is deposited without the aid of life, it is called a chemical sediment; if deposited with the aid of life, it is called an organic sediment. The more important rocks formed from chemical and organic deposits are limestone, chert, gypsum, salt, iron ore, peat, lignite, and coal. Any one of the above sedimentary deposits may be separately formed, or the different materials may be intermingled in many ways, producing a great variety of rocks.

Sedimentary rocks are usually made up of layers or beds which can be easily separated. These layers are called *strata*. Rocks deposited in successive layers are said to be stratified.

The surface of the earth is not fixed, as it seems to be; it very slowly rises or sinks over wide expanses, and as it rises or subsides the shore-lines of the ocean are changed: areas of deposition may rise above the water and become land areas, and land areas may sink below the water and become areas of deposition. If North America were gradually to sink a thousand feet the sea would flow over the Atlantic coast and the Mississippi and Ohio valleys from the Gulf of Mexico to the Great Lakes; the Appalachian Mountains would become an archipelago, and the ocean's shore would traverse Wisconsin, Iowa, and Kansas, and extend thence to Texas. More extensive changes than this have repeatedly occurred in the past.

The character of the original sediments may be changed by chemical and dynamic action so as to produce metamorphic rocks. In the metamorphism of a sedimentary rock, just as in the metamorphism of an igneous rock, the substances of which it is composed may enter into new combinations, or new substances may be added. When these processes are complete the sedimentary rock becomes crystalline. Such changes transform sandstone to quartzite, limestone to marble, and modify other rocks according to their composition. A system of parallel division planes is often produced, which may cross the original beds or strata at any angle. Rocks divided by such planes are called slates or schists.

Rocks of any period of the earth's history may be more or less altered, but the younger formations have generally escaped marked metamorphism, and the oldest sediments known, though generally the most altered, in some localities remain essentially unchanged.

Surficial rocks.—These embrace the soils, clays, sands, gravels, and bowlders that cover the surface, whether derived from the breaking up or disintegration of the underlying rocks by atmospheric agencies or from glacial action. Surficial rocks that are due to disintegration are produced chiefly by the action of air, water, frost, animals, and plants. They consist mainly of the least soluble parts of the rocks, which remain after the more soluble parts have been leached out, and hence are known as residual products. Soils and subsoils are the most important. Residual accumulations are often washed or blown into valleys or other depressions, where they lodge and form deposits that grade into the sedimentary class. Surficial rocks that are due to glacial action are formed of the products of disintegration, together with bowlders and fragments of rock rubbed from the surface and ground together. These are spread irregularly over the territory occupied by the ice, and form a mixture of clay, pebbles, and bowlders which is known as till. It may occur as a sheet or be bunched into hills and ridges, forming moraines, drumlins, and other special forms. Much of this mixed material was washed away from the ice, assorted by water, and redeposited as beds or trains of sand and clay, thus forming another gradation into sedimentary deposits. Some of this glacial wash was deposited in tunnels and channels in the ice, and forms characteristic ridges and mounds of sand and gravel, known as osars, or eskers, and kames. The material deposited by the ice is called glacial drift; that washed from the ice onto the adjacent land is called modified drift. It is usual also to class as surficial rocks the deposits of the sea and of lakes and rivers that were made at the same time as the ice deposit.

AGES OF ROCKS.

Rocks are further distinguished according to their relative ages, for they were not formed all at one time, but from age to age in the earth's history. Classification by age is independent of origin; igneous, sedimentary, and surficial rocks may be of the same age.

When the predominant material of a rock mass is essentially the same, and it is bounded by rocks of different materials, it is convenient to call the mass throughout its extent a *formation*, and such a formation is the unit of geologic mapping.

Several formations considered together are designated a *system*. The time taken for the deposition of a formation is called an *epoch*, and the time taken for that of a system, or some larger fraction of a system, a *period*. The rocks are mapped by formations, and the formations are classified into systems. The rocks composing a system and the time taken for its deposition are given the same name, as, for instance, Cambrian system, Cambrian period.

As sedimentary deposits or strata accumulate the younger rest on those that are older, and the relative ages of the deposits may be discovered by observing their relative positions. This relationship holds except in regions of intense disturbance; sometimes in such regions the disturbance of the beds has been so great that their position is reversed, and it is often difficult to determine the relative ages of the beds from their positions; then *fossils*, or the remains of plants and animals, are guides to show which of two or more formations is the oldest.

Strata often contain the remains of plants and animals which lived in the sea or were washed from the land into lakes or seas or were buried in surficial deposits on the land. Rocks that contain the remains of life are called fossiliferous. By studying these remains, or fossils, it has been found that the species of each period of the earth's history have to a great extent differed from those of other periods. Only the simpler kinds of marine life existed when the oldest fossiliferous rocks were deposited. From time to time more complex kinds developed, and as the simpler ones lived on in modified forms life became more varied. But during each period there lived peculiar forms, which did not exist in earlier times and have not existed since; these are characteristic types, and they define the age of any bed of rock in which they are found. Other types passed on from period to period, and thus linked the systems together, forming a chain of life from the time of the oldest fossiliferous rocks to the present.

When two formations are remote one from the other and it is impossible to observe their relative positions, the characteristic fossil types found in them may determine which was deposited first.

Fossil remains found in the rocks of different areas, provinces, and continents, afford the most important means for combining local histories into a general earth history.

Colors and patterns.—To show the relative ages of strata, the history of the sedimentary rocks is divided into periods. The names of the periods in proper order (from new to old), with the color or colors and symbol assigned to each, are given in the table in the next column. The names of certain subdivisions of the periods, frequently used in geologic writings, are bracketed against the appropriate period name.

To distinguish the sedimentary formations of any one period from those of another the patterns for the formations of each period are printed in the appropriate period-color, with the exception of the first (Pleistocene) and the last (Archean). The formations of any one period, excepting the Pleistocene and the Archean, are distinguished from one another by different patterns, made of parallel straight lines. Two tints of the period-color are used: a pale tint (the underprint) is printed evenly over the whole surface representing the period; a dark tint (the overprint) brings out the different patterns representing formations.

PERIOD.	SYMBOL.	COLOR.
Pleistocene	P	Any colors.
Neocene { Pliocene / Miocene }	N	Buffs.
Eocene (including Oligocene)	E	Olive-browns.
Cretaceous	K	Olive-greens.
Juratrias { Jurassic / Triassic }	J	Blue-greens.
Carboniferous (including Permian)	C	Blues.
Devonian	D	Blue-purples.
Silurian (including Ordovician)	S	Red-purples.
Cambrian	Є	Pinks.
Algonkian	A	Orange-browns.
Archean	AR	Any colors.

Each formation is furthermore given a letter-symbol of the period. In the case of a sedimentary formation of uncertain age the pattern is printed on white ground in the color of the period to which the formation is supposed to belong, the letter-symbol of the period being omitted.

The number and extent of surficial formations of the Pleistocene render them so important that, to distinguish them from those of other periods and from the igneous rocks, patterns of dots and circles, printed in any colors, are used.

The origin of the Archean rocks is not fully settled. Many of them are certainly igneous. Whether sedimentary rocks are also included is not determined. The Archean rocks, and all metamorphic rocks of unknown origin, of whatever age, are represented on the maps by patterns consisting of short dashes irregularly placed. These are printed in any color, and may be darker or lighter than the background. If the rock is a schist the dashes or hachures may be arranged in wavy parallel lines. If the rock is known to be of sedimentary origin the hachure patterns may be combined with the parallel-line patterns of sedimentary formations. If the metamorphic rock is recognized as having been originally igneous, the hachures may be combined with the igneous pattern.

Known igneous formations are represented by patterns of triangles or rhombs printed in any brilliant color. If the formation is of known age the letter-symbol of the formation is preceded by the capital letter-symbol of the proper period. If the age of the formation is unknown the letter-symbol consists of small letters which suggest the name of the rocks.

THE VARIOUS GEOLOGIC SHEETS.

Historical geology sheet.—This sheet shows the areas occupied by the various formations. On the margin is a *legend*, which is the key to the map. To ascertain the meaning of any particular colored pattern and its letter-symbol on the map the reader should look for that color, pattern, and symbol in the legend, where he will find the name and description of the formation. If it is desired to find any given formation, its name should be sought in the legend and its color and pattern noted, when the areas on the map corresponding in color and pattern may be traced out.

The legend is also a partial statement of the geologic history. In it the symbols and names are arranged, in columnar form, according to the origin of the formations—surficial, sedimentary, and igneous—and within each group they are placed in the order of age, so far as known, the youngest at the top.

Economic geology sheet.—This sheet represents the distribution of useful minerals, the occurrence of artesian water, or other facts of economic interest, showing their relations to the features of topography and to the geologic formations. All the formations which appear on the historical geology sheet are shown on this sheet by fainter color-patterns. The areal geology, thus printed, affords a subdued background upon which the areas of productive formations may be emphasized by strong colors. A symbol for mines is introduced at each occurrence, accompanied by the name of the principal mineral mined or of the stone quarried.

Structure-section sheet.—This sheet exhibits the relations of the formations beneath the surface. In cliffs, canyons, shafts, and other natural and artificial cuttings, the relations of different beds to one another may be seen. Any cutting which exhibits those relations is called a *section*, and the same name is applied to a diagram representing the relations. The arrangement of rocks in the earth is the earth's *structure*, and a section exhibiting this arrangement is called a *structure section*.

The geologist is not limited, however, to the natural and artificial cuttings for his information concerning the earth's structure. Knowing the manner of the formation of rocks, and having traced out the relations among beds on the surface, he can infer their relative positions after they pass beneath the surface, draw sections which represent the structure of the earth to a considerable depth, and construct a diagram exhibiting what would be seen in the side of a cutting many miles long and several thousand feet deep. This is illustrated in the following figure:

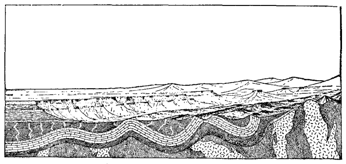

Fig. 2.—Sketch showing a vertical section in the front of the picture, with a landscape beyond.

The figure represents a landscape which is cut off sharply in the foreground by a vertical plane that cuts a section so as to show the underground relations of the rocks.

The kinds of rock are indicated in the section by appropriate symbols of lines, dots, and dashes. These symbols admit of much variation, but the following are generally used in sections to represent the commoner kinds of rock:

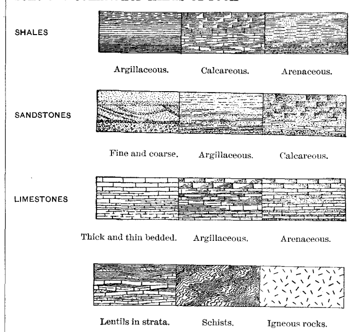

Fig. 3.—Symbols used to represent different kinds of rock.

The plateau in fig. 2 presents toward the lower land an escarpment, or front, which is made up of sandstones, forming the cliffs, and shales, constituting the slopes, as shown at the extreme left of the section.

The broad belt of lower land is traversed by several ridges, which are seen in the section to correspond to beds of sandstone that rise to the surface. The upturned edges of these beds form the ridges, and the intermediate valleys follow the outcrops of limestone and calcareous shales.

Where the edges of the strata appear at the surface their thickness can be measured and the angles at which they dip below the surface can be observed. Thus their positions underground can be inferred.

When strata which are thus inclined are traced underground in mining, or by inference, it is frequently observed that they form troughs or arches, such as the section shows. But these sandstones, shales, and limestones were deposited beneath the sea in nearly flat sheets. That they are now bent and folded is regarded as proof that forces exist which have from time to time caused the earth's surface to wrinkle along certain zones.

On the right of the sketch the section is composed of schists which are traversed by masses of igneous rock. The schists are much contorted and their arrangement underground can not be inferred. Hence that portion of the section delineates what is probably true but is not known by observation or well-founded inference.

In fig. 2 there are three sets of formations, distinguished by their underground relations. The first of these, seen at the left of the section, is the set of sandstones and shales, which lie in a horizontal position. These sedimentary strata are now high above the sea, forming a plateau, and their change of elevation shows that a portion of the earth's mass has swelled upward from a lower to a higher level. The strata of this set are parallel, a relation which is called *conformable*.

The second set of formations consists of strata which form arches and troughs. These strata were once continuous, but the crests of the arches have been removed by degradation. The beds, like those of the first set, are conformable.

The horizontal strata of the plateau rest upon the upturned, eroded edges of the beds of the second set at the left of the section. The overlying deposits are, from their positions, evidently younger than the underlying formations, and the bending and degradation of the older strata must have occurred between the deposition of the older beds and the accumulation of the younger. When younger strata thus rest upon an eroded surface of older strata the relation between the two is an *unconformable* one, and their surface of contact is an *unconformity*.

The third set of formations consists of crystalline schists and igneous rocks. At some period of their history the schists were plicated by pressure and traversed by eruptions of molten rock. But this pressure and intrusion of igneous rocks have not affected the overlying strata of the second set. Thus it is evident that an interval of considerable duration elapsed between the formation of the schists and the beginning of deposition of the strata of the second set. During this interval the schists suffered metamorphism; they were the scene of eruptive activity; and they were deeply eroded. The contact between the second and third sets, marking a time interval between two periods of rock formation, is another unconformity.

The section and landscape in fig. 2 are ideal, but they illustrate relations which actually occur. The sections in the structure-section sheet are related to the maps as the section in the figure is related to the landscape. The profiles of the surface in the section correspond to the actual slopes of the ground along the section line, and the depth of any mineral-producing or water-bearing stratum which appears in the section may be measured from the surface by using the scale of the map.

Columnar-section sheet.—This sheet contains a concise description of the rock formations which occur in the quadrangle. The diagrams and verbal statements form a summary of the facts relating to the character of the rocks, to the thicknesses of the formations, and to the order of accumulation of successive deposits.

The rocks are described under the corresponding heading, and their characters are indicated in the columnar diagrams by appropriate symbols. The thicknesses of formations are given under the heading "Thickness in feet," in figures which state the least and greatest measurements. The average thickness of each formation is shown in the column, which is drawn to a scale—usually 1000 feet to 1 inch. The order of accumulation of the sediments is shown in the columnar arrangement: the oldest formation is placed at the bottom of the column, the youngest at the top, and igneous rocks or other formations, when present, are indicated in their proper relations.

The formations are combined into systems which correspond with the periods of geologic history. Thus the ages of the rocks are shown, and also the total thickness of each system.

The intervals of time which correspond to events of uplift and degradation and constitute interruptions of deposition of sediments may be indicated graphically or by the word "unconformity," printed in the columnar section.

Each formation shown in the columnar section is accompanied by its name, a description of its character, and its letter-symbol as used in the maps and their legends.

CHARLES D. WALCOTT,
Director.

Revised June, 1897.

DESCRIPTION OF THE DANVILLE QUADRANGLE.

GENERAL RELATIONS.

Geographic position.

The Danville quadrangle receives its name from Danville, Illinois, the county seat of Vermilion County. It embraces the country lying between parallels 40° and 40° 15′ and meridians 87° 30′ and 87° 45′ and has an area of about 228 square miles. It is situated mainly in Vermilion County, Illinois, but extends about 1½ miles into Indiana and embraces parts of Warren and Vermilion counties in that State. This quadrangle is in a region of comparatively low altitude considering the fact that it is distant several hundred miles from the seaboard, the highest point being scarcely 760 feet and the lowest about 485 feet above tide. It is within the Mississippi Basin, about 200 miles east of the Mississippi River. It is situated in the great Illinois-Indiana coal field, near its northeastern margin, and contributes liberally to its output.

Altitude.

TOPOGRAPHY.

Rivers.

Drainage.—The streams in this quadrangle belong to the Wabash River system, which drains to the Ohio, and this in turn to the Mississippi. The Vermilion River is the avenue of discharge of the entire quadrangle, with the exception of a few square miles along the southern and eastern borders. This river is formed by the union of three streams, known as North Fork, Middle Fork, and Salt Fork. The name Vermilion River is commonly applied only to the portion below the junction of Middle and Salt forks.

Relief.—The surface of this quadrangle exhibits three distinct types of topography: prairies, ridges rising above the general level, and river valleys cut in the plain.

Prairies.

The prairies are particularly prominent in the region south and west of Vermilion River, and are also well developed east of that stream as far north as Danville. A small area of similar character is found in the vicinity of Batestown and Hillery, and the northwest corner of the quadrangle extends a short distance into the broad expanse of prairie which lies mainly north of this quadrangle.

Ridges.

Crossing this territory from northeast to southwest is a low, broad ridge, which has an elevation of about 90 feet above the prairie in the vicinity of Danville. As seen from the south this ridge is rather prominent, but on its northern flank the level of the prairie is only slightly below the crest of the ridge.

Valleys.

Crossing indifferently the prairies and the ridge are deep valleys carved by Vermilion River and its principal tributaries. In some respects these are the most conspicuous features of the topography; they have destroyed much valuable farming land of the prairies through the sharp backward cutting of the minor streams, and they have been decided barriers to easy transportation; but, on the other hand, they have opened excellent geologic sections, in which are shown the beds of coal that make this region so important economically. The valleys are generally narrow, but frequently swell out into broad amphitheaters a mile or more in width. They vary in depth from 50 to 150 feet, and their walls are generally steep and sometimes precipitous.

GEOLOGY.

OUTLINE OF GEOLOGIC HISTORY.

SEDIMENTARY ROCKS.

Coal beds.

The rocks which underlie this quadrangle seldom appear at the surface; they are generally so deeply covered with clay and sand that their presence is not appreciated until they are reached by the drill in prospecting for mineral deposits or for water. South of the latitude of Danville, however, the rocks may be seen at many points in the bluff along the streams, in almost perpendicular cliffs of shale or shaly sandstone. Coal beds are of common occurrence in such exposures, and even under the heavily drift-covered plain they have been revealed by the drill in a number of places. The entire rock series exposed at the surface and extending some distance below belongs to that portion of the geologic column known as the Carboniferous system. Beneath the coal-bearing rocks the drill reveals the presence of heavy beds of limestone, but they are not seen at the surface in this quadrangle.

The coal-bearing rocks occupy a broad, shallow syncline, the center of which is some distance southwest of Danville. As a result of this structure the rocks in this quadrangle have a very gentle southwesterly dip, toward the center of the basin.

EVENTS OF MESOZOIC AND EARLY CENOZOIC TIME.

Emergence of the land area.

After the deposition of the Carboniferous rocks, which must have occurred in some body of water, the crust of the earth was raised in the Appalachian region and this area became dry land. In this condition it was subjected to the varying vicissitudes of a land surface for many geologic periods, but there is little evidence now existing to show the changes through which it passed.

Before the advent of the great ice sheet which modified the larger part of the surface of Indiana and Illinois, the surface of the Danville quadrangle was reduced to a gently rolling country, with a relief of less than 200 feet. The valleys were rather broad and the slopes were gentle, the entire topography strongly resembling that of southern Indiana, beyond the limit of glacial ice.

PLEISTOCENE.

Glacial history.

The mantle of drift which covers the indurated rocks of Canada and the northern part of the United States bears evidence of much complexity in its history. Instead of a single deposit formed by one ice advance, it is now known that several distinct drift sheets are present which represent a succession of ice advances. The intervals of deglaciation or disappearance of ice between these ice advances are made apparent by the presence of soils and of beds of peat and marl and other effects of life, and also by the weathering of certain zones now buried in the midst of the drift deposits; while the sheets themselves differ markedly in extent and in physical constitution. In fact, the criteria for separating the drift deposits into distinct sheets are fully as reliable as the criteria for separating the indurated rocks into distinct formations. How far to the north the ice melted back, or, in other words, how extensive was the deglaciation, has not yet been fully determined for any of the intervals, but the ice is known to have withdrawn in each case nearly if not quite to the northern border of the United States, while in the most prolonged intervals it may have nearly or quite disappeared from Canada. For reasons not yet fully understood, the lines of flow of successive ice fields are in some cases far from coincident, so that in places the later ice field extended beyond the limits of its predecessor, while in other places it fell short of its predecessor's limits. These features alone would suggest that there had been more than one ice invasion, but their testimony is strengthened by the corroborative evidence of the buried soils and weathered zones.

The deposits of the later ice invasions have so greatly concealed those of preceding ones that the knowledge of the older deposits is somewhat meager and is confined largely to their outlying portions. Enough is known, however, to make clear certain distinctive characteristics in each drift sheet. These distinctive characteristics have been found helpful in drawing the line between contiguous drift sheets where the soil and weathered zone of the older drift surface had been removed by the later advance of the ice. These differences are in some cases merely differences in texture or in color, but often there is found a striking contrast in the kinds of rock present in the two drift sheets, a certain rock being rare or wanting in one sheet but abundant in the other.

Moraines.

The divisions of the drift series just mentioned are stratigraphic and are thus similar to the usual divisions of the indurated rocks. But there are present in the drift deposits peculiar features not found in other deposits, and these have been made a basis for subdivisions. The features referred to are moraines or massive ridges of drift, built up by the ice at its margin. These ridges recur at frequent intervals in passing north from the extreme edge of a given sheet of drift, and mark places of halting, and perhaps of readvance, which interrupted the melting away of the ice field. These morainic ridges have in some cases been formed in rapid succession and constitute a morainic system. Indeed, in Illinois there is a decided tendency to such grouping of the moranic ridges, as will appear below.

The sheets of drift formed by each of the ice invasions, the soils and weathered zones formed between the drift sheets, and the moraines and morainic systems of each drift sheet have received geographic names from localities where they are well displayed, in conformity with the prevailing custom of naming the indurated rock formations. The following outline includes the several drift sheets and deglaciation intervals recognized in North America.

OUTLINE DESCRIPTION OF THE DRIFT SHEETS AND INTERVALS.

Stage 1.—The oldest drift sheet (pre-Kansan), including perhaps the Albertan of Dawson. The limits of this sheet may be inside those of the Kansan in Iowa and neighboring States.

Stage 2.—The Aftonian soil and weathered zone. This soil was first recognized and brought to notice at Afton, Iowa, where it separates the Kansan drift from the pre-Kansan. Its distribution is mainly west of the Mississippi River.

Stage 3.—The Kansan drift sheet. This drift sheet is found mainly west of the Mississippi River. Its western limit is in Kansas and Nebraska and its southern limit in central Missouri. Possibly a sheet of similar age occurs at the base of the drift in northern Illinois, but the evidence is far from decisive.

Stage 4.—The Yarmouth soil and weathered zone. In western Illinois and eastern Iowa the Kansan drift sheet is overlapped by a later sheet, the Illinoian, which covers a soil and weathered zone that had been formed on the older till sheet. The evidence of this interval was first discovered at Yarmouth, in southeastern Iowa, from which the name has been derived. This stage of weathering and soil formation appears to have antedated the first glaciation of the region of which the Danville quadrangle is a part.

Stage 5.—The Illinoian drift sheet. This sheet is so named because of its extensive development in Illinois outside the limits of the Wisconsin and Iowan drift sheets. It extends apparently to the glacial boundary in western Ohio, Kentucky, Indiana, and Illinois, and forms the eastern border of the driftless area in southern Wisconsin and northwestern Illinois. It extends but a few miles west of the Mississippi River. In the Danville quadrangle it apparently constitutes the basal portion of the drift.

Stage 6.—The Sangamon soil and weathered zone. This soil and weathered zone separates the Illinoian drift sheet from the next sheet of drift, the Iowan, and its associated loess. The soil is a conspicuous feature (long ago described by Worthen) in the Sangamon Valley of Illinois, from which it takes its name. It is also a well-known feature of the drift of eastern Illinois and western Indiana in the vicinity of the Danville quadrangle.

Stage 7.—The Iowan drift sheet and associated silt deposits. This sheet, which is so named because of its wide extent in Iowa outside the Wisconsin drift, is elsewhere largely concealed beneath that drift. It is exposed to view outside the Wisconsin sheet, however, in a few counties in northwestern Illinois and southwestern Wisconsin. Associated with it is a silt deposit widely known as loess, which extends far beyond the limits of the Iowan drift, overlapping the outlying portions of earlier drift sheets and extending down the Mississippi Valley to the Gulf of Mexico. The Iowan drift probably falls short a few miles of reaching the Danville quadrangle, but its associated silt or loess should underlie the Wisconsin drift in this quadrangle unless removed by erosion and the Wisconsin glaciation.

Stage 8.—The Peorian soil and weathered zone. This interval of deglaciation receives its name from Peoria, Illinois, near which city its weathering is well displayed. In addition to the presence of the soil and weathered zone, evidence of this interval is found in the great dissimilarity of the outline of the borders of the two drift sheets which it separates and also in a change in the attitude of the land, by which drainage conditions became greatly inproved.

Stage 9.—The Wisconsin drift, with its several morainic systems. This drift sheet is so named because of its excellent development in the State of Wisconsin, where it was first separated from earlier drift sheets by Prof. T. C Chamberlin. It extends southward into Illinois as far as Shelbyville and Paris, or 30 to 35 miles beyond the southern limit of the Danville quadrangle.

Illinois glacial lobe.

In each of the ice invasions above outlined, the portion of the great ice field which covered the quadrangle under discussion is known as the Illinois glacial lobe. The axis of movement for this lobe appears to have been along the basin of Lake Michigan, from which it extended southwestward into Illinois and spread into neighboring portions of Wisconsin and Indiana. It even pushed a few miles beyond the Mississippi into Iowa at the culmination of the Illinoian stage of glaciation. Its border on the east is at the driftless portion of southern Indiana, which extends a few miles north of Bloomington, Indiana. Its limits on the west are at the driftless area of southwestern Wisconsin and northwestern Illinois, south of which they are marked by a marginal ridge or moraine which lies within a few miles of the Mississippi River from near Clinton, Iowa, down to St. Louis, Missouri. The Danville quadrangle is situated east of the middle of this lobe.

In the Illinoian and Iowan drift sheets of the Illinois glacial lobe moraines are comparatively insignificant features, the greater part of the drift surface being exceedingly flat, but in the Wisconsin drift several prominent morainic systems were developed, which form a rudely concentric series in northeastern Illinois and western Indiana. These, given in regular order of development, from the outermost moraine to the border of Lake Michigan, are as follows:

MORAINIC SYSTEMS OF THE WISCONSIN DRIFT.

1. The Shelbyville morainic system. This constitutes the outermost system of the Wisconsin series in the Illinois lobe and receives its name from the city of Shelbyville, which stands at the southwestern point of the morainic loop In this system is included the Cerro Gordo moraine, which coalesces with the main member for a few miles east of Shelbyville, but is elsewhere distinct.

2. The Champaign morainic system. This system includes a series of small drift ridges which are separated into three distinct members in southeastern Champaign and neighboring portions of Vermilion, Edgar, and Douglas counties, Illinois. From the city of Champaign northwestward there is but a single ridge, and this apparently passes under the Bloomington system a few miles east of Bloomington. The line of the inner ridge of this system crosses the southern part of the Danville quadrangle, but is very ill defined in that portion of its course. From the Wabash Valley eastward also the ridges are feebly developed.

3. The Bloomington morainic system. This is the most prominent morainic system in the Illinois lobe. It usually has two important members, and in places each of these becomes separated into two ridges, thus making a system of four well-defined ridges. The city of Bloomington stands on the outermost ridge of the system. The northern part of the Danville quadrangle contains the double ridge of the outer member. It is coalesced into a single ridge in the western part of the quadrangle, but in the eastern portion the double phase is well displayed, the valley of Stony Creek being between the two crests. A few miles north of the Danville quadrangle the double ridge of the inner member is well displayed, the village of Hoopeston and the headwater portion of North Vermilion River being between the two crests.

4. The Marseilles morainic system. This consists of a bulky ridge, which only in places assumes a double or multiple crest. It is crossed by Illinois River at the village of Marseilles, from which the name is derived. It encircles the Morris Basin, a low-lying tract at the head of Illinois River.

5. The Kankakee morainic system and associated bowlder belts. The ridges and bowlder belts of this system lie just outside the Valparaiso system from Kankakee northward, but diverge rather widely from it in passing east from Kankakee, their course being south of east, while the Valparaiso bears north of east into Indiana.

6. The Valparaiso morainic system. This system received its name from Valparaiso. Indiana, which stands on the crest of its main member. It is a very bulky system, forming the elevated tract which lies east of Fox River and north of the Kankakee in northeastern Illinois and northwestern Indiana.

7. The Lake Border morainic system. As the name implies, this system of morainic ridges sweeps around the head of Lake Michigan.

Time intervals between moraines.

The intervals between the morainic systems of this series were apparently much briefer than those between the drift sheets above outlined. There may have been some readvance of the ice in connection with the development of each morainic system, but as no decisive evidence of weathering occurs at the level of the base of the later moraines it is doubtful if the oscillations of the ice front were of great consequence. There is perhaps an exception in the case of the Kankakee ridges and bowlder belts. They seem to have been formed by an ice lobe whose axis of movement was decidedly out of harmony with that of the Marseilles and Bloomington systems. The concealment of the western part of the Champaign morainic system beneath the Bloomington also suggests a shifting of the axis of movement and an interval of greater length than that which separated the Champaign from the Shelbyville. It should not be inferred, therefore, that the several systems had a strictly rhythmical development. On the contrary, the halts seem to have been irregular.

The moraines or marginal ridges outlined above constitute only a small part of the Wisconsin drift of the Illinois glacial lobe and are given special attention because of their significance in an interpretation of the glacial history of the

Moraines and sheets deposited simultaneously.

Danville quadrangle. It is probable that a sheet of drift was deposited over much of the territory between a given moraine and the Lake Michigan Basin at the time that moraine was forming, for the ice carried only a meager portion of its drift to its extreme margin. In the Illinois lobe the moraines are but the thickened margins of sheets of drift which become gradually thinner in passing toward the Lake Michigan Basin. This is well shown by an examination of the Shelbyville drift sheet. At the main ridge it has a thickness of about 100 feet, but upon passing northward to the border of the Champaign system it decreases to less than half that amount. In the Champaign system another ridged margin appears, north of which there is a tapering sheet combined with the Shelbyville sheet. These pass beneath the Bloomington morainic ridges and are supplemented north of these ridges by the tapering Bloomington drift sheet. In all probability, therefore, the plain in Iroquois County north of the Bloomington morainic system carries deposits made by the ice during the formation of the Shelbyville and Champaign morainic systems as well as the Bloomington, while the plain south of the Bloomington system, a part of which falls within the Danville quadrangle, carries deposits made during the Shelbyville and Champaign substages of glaciation.

DESCRIPTIVE GEOLOGY.

ROCKS OF THE CARBONIFEROUS PERIOD.

Relation of quadrangle to the coal field.—All of the rocks appearing at the surface within the limits of this quadrangle belong to the Coal Measures, hence it is important to consider the relation which this area sustains to the coal field as a whole. The coal field, of which the Danville quadrangle forms only a small part, occupies portions of the States of Illinois, Indiana, and Kentucky. The territory embraced within it is shown by the line pattern in fig. 1, and the Danville quadrangle by the rectangle of solid black. It is thus seen that the quadrangle lies upon the northeastern border of the field, in a sort of projecting angle that extends into Dupage County, Indiana.

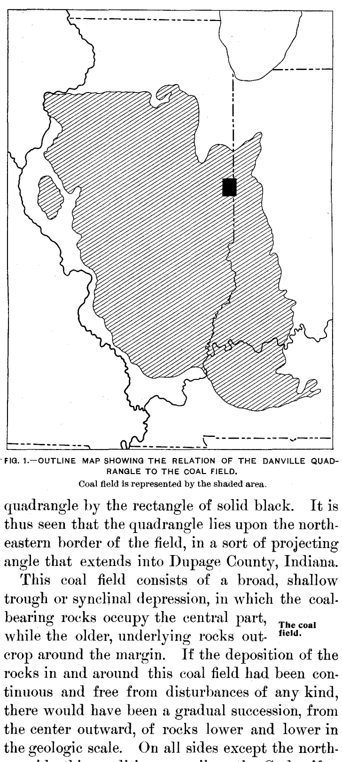

FIG. 1.—OUTLINE MAP SHOWING THE RELATION OF THE DANVILLE QUADRANGLE TO THE COAL FIELD.
Coal field is represented by the shaded area.

The coal field.

This coal field consists of a broad, shallow trough or synclinal depression, in which the coal-bearing rocks occupy the central part, while the older, underlying rocks outcrop around the margin. If the deposition of the rocks in and around this coal field had been continuous and free from disturbances of any kind, there would have been a gradual succession, from the center outward, of rocks lower and lower in the geologic scale. On all sides except the northern side this condition prevails—the Carboniferous rocks of the basin are succeeded by Devonian, and these in turn by rocks of Silurian age. On the northern side the coal-bearing rocks rest directly upon strata of various ages ranging downward from Carboniferous to lower Silurian. This is called an overlap, and it was produced by the elevation of the sea floor above the level of the water, the erosion of this surface down to a nearly level plain, its subsidence below the level of the water, and, finally, the deposition of coal-bearing rocks upon it at the bottom of the sea, or of fresh-water lagoons. The southward extent of this overlap beneath the coal basin has not been determined, but, as will be described later, it extends, with little diminution in amount, at least as far south as the Danville quadrangle.

Overlap.

Structure of the coal field.—Although the coal-bearing rocks lie in a trough-shaped depression in the older strata, the width of the trough is so great, when compared with the depth, that the rocks appear to lie horizontal. It is only by the comparison of sections in widely separated localities that the true dip of the rocks and the structure of the basin are apparent. In a small portion of the territory, like the Danville quadrangle, dips are generally so slight as to be unrecognizable, and that which appears to be dip in a coal bed is frequently not due to structure, but to change in thickness of some of the adjacent beds.

Dips of the coal beds.

The two sections A–B and C–D on the Columnar Section sheet show some of the irregularities and also the dips of the strata in this region. The sections are constructed mainly from drill records, and hence are generally accurate as far as the coal beds are concerned. The correlation of the coal outcropping at "Hanging Rock" on Vermilion River and on Coal Branch with the coal bed penetrated by the drill in several of the deep wells is a matter of some doubt, but the probabilities seem to be in its favor, hence it will be adopted provisionally. On this supposition the steepest dip in the quadrangle is between Coal Branch and the head of Trosper Branch, in a nearly westerly direction. Beyond the limit of this steep dip the rocks are nearly horizontal, the apparent dips being generally caused by the variations in thickness between certain well-marked strata.

Character and thickness of the rocks.—The strata exposed at the surface in the Danville quadrangle are prevailingly argillaceous or shaly. Occasional beds of sandstone and impure limestone are seen, but they are usually lenticular in form, and change in character from place to place, so that they can not be identified in different parts of the field. The geologic column of rocks, as interpreted by Prof. F. H. Bradley, was published in Volume IV of the Geological Survey of Illinois. This section is fairly accurate for the strata exposed along Vermilion River, but on account of the variability in thickness and character of the strata it does not agree with sections obtained in other parts of the field. The variation in thickness of the interval between the Danville and Grape Creek coal beds in the southern part of the quadrangle is well understood by all who have had occasion to search for these coal beds, and it seems highly probable that similar changes occur in other localities and affect different parts of the geologic column.

Columnar sections.

On account of the above-mentioned facts, it is impossible to give an exact general columnar section of the coal-bearing rocks which underlie the Danville quadrangle. The best sections of the strata from the Danville coal down to the bed showing on Coal Branch are probably those obtained by the diamond drill in the vicinity of Danville. Fig. 5 represents a bore hole made by the Ellsworth Coal Company 2 miles west of the city of Danville. The log of this well was published in Volume VII of the Geological Survey of Illinois, and from it the section is compiled. Fig. 4 represents the section reported by Mr. John Beatty from a well drilled in 1886 by the Diamond Prospecting Company in sec. 21, T. 19 N., R. 11 W., about 2½ miles southeast of Danville. Fig. 3 is the section obtained in a deep drilling by the Himrod Coal Company at the Pawnee mine in 1894–95, as reported by Mr. H. H. Keefer, superintendent.

Correlation of the sections.

There is obvious similarity in the principal features of these sections, so that they may be correlated with considerable certainty, but the minor members vary so much in detail that it is difficult, if not impossible, to find any resemblances between them. The Danville and Grape Creek coal beds are easily identified in all of these sections. Below the latter there is a thickness of from 105 to 125 feet of shale, more or less sandy, but in all cases without coal or carbonaceous matter. Following this heavy shale is a bed of black shale 7 or 8 feet in thickness, which is very pronounced in all of the sections. From 75 to 85 feet below the black shale occurs a prominent coal horizon, but the coal itself is so badly broken up with shale partings as to be of little value. This coal bed is regarded as the equivalent of the one showing on Coal Branch and at "Hanging Rock" on Vermilion River. The interval between the black shale and the coal bed near the base of the section is variable in the extreme. In figs. 4 and 5 it is characterized by two small coal beds, but the Pawnee section (fig. 3) shows no indication of coal in this interval. It seems probable that this horizon may yield coal at many points, but the amount will probably be small and not valuable commercially. The lower coal bed is likewise uncertain and variable, and on the whole is of doubtful value.

The sections obtained by the drill show very little solid rock above the Danville coal bed, but in other localities shale to the thickness of 80 feet is exposed above this horizon. This is particularly well shown in the river bluffs about the junction of Salt and Middle forks of Vermilion River.

The information concerning the rocks below the limits of the detailed sections is much more meager, for it rests entirely upon two wells drilled about 1886 in the vicinity of Danville. These wells were drilled in search of oil, but as none was found, there has been no further prospecting in this field. Fig. 6 represents the well drilled at the city waterworks. Its section, recorded by the owners, is as follows:

Section of well at city waterworks, Danville.

		Thickness of stratum, in feet.	Depth, in feet.
1.	Soil	10	10
2.	Soapstone	285	295
3.	Coarse sandstone	10	305
4.	Soapstone	10	315
5.	Sandstone	100	415
6.	Soapstone	15	430
7.	Gray sandstone	10	440
8.	Blue sandy shale	80	520
9.	Quartz, or pebble rock	10	530
10.	Sandy shale	145	675
11.	Hard gray limestone	30	705
12.	Sandstone	30	735
13.	Blue clay shale	30	765
14.	Pebble, or flint rock	30	795
15.	Hard blue shale	90	885
16.	Gray sandstone	40	925
17.	Hard blue shale	45	970
	Light-green shale	30	1000
18.	Black slate	75	1075
19.	Limestone	74	1149

The limestone at the bottom of the well is labeled "Trenton" in the record preserved by the owners, hence it is probable that they believed they had reached the oil-bearing stratum and had found it barren.

Fig. 7 represents the section obtained in the well at Danville Junction. It was drilled for the same purpose and by the same company as the well just described. The record, furnished by the owners, is as follows:

Section of well at Danville Junction.

		Thickness of stratum, in feet.	Depth, in feet.
1.	Glacial drift	175	175
2.	Hard black slate and coal	6	181
3.	Drab soapstone	20	201
	Dark-blue soapstone	42	243
4.	Coarse white sandstone	10	253
5.	Coal	6	259
6.	Blue clay, or soapstone	75	334
7.	Hard, flinty rock	2	336
8.	Dark-blue slate	35	371
9.	Brown soapstone	20	391
	Red clay	11	402
10.	Soft white sandstone	68	470
11.	Red clay	20	490
12.	Coarse brown sandstone	27	517
	Fine brown sandstone	40	557
	Fine white sandstone	30	587
13.	Dark-blue clay	73	660
14.	Hard pebble rock	10	670
15.	Fine white clay	36	706
16.	Hard pebble rock	6	712
17.	Dark-blue shale	96	808
	Soft, light-blue shale	65	873
	Soft, dark-blue shale	18	891
18.	Red shale	62	953
19.	Light-green shale	57	1010
20.	Hard gray limestone	25	1035
21.	Black slate	90	1125
22.	Hard gray limestone	51	1176
	Coarse, soft limestone	10	1186
	White and dark limestone	160	1346
	Soft white limestone	12	1358
	Light and dark limestone	342	1700
23.	White sandstone	35	1735
24.	Clay shale	110	1845
25.	Hard gray limestone	26	1871
	Dark-blue limestone	65	1936
26.	Hard blue shale	57	1993
27.	Reddish limestone	15	2008

Fortunately for one who wishes to make comparisons, the driller noted a coal bed in this well at a depth of 259 feet. This is undoubtedly the same coal horizon that shows near the bottom of each of the detailed sections, and it serves to connect this section with the local features of the stratigraphy. At a depth of 1035 feet the bed of black shale was encountered which shows in the first well, and at 1125 feet the drill entered the limestone which was struck in the bottom of the first well and pronounced Trenton. This bed was pierced and it was found to have a thickness of 575 feet. Below this were alternating shales and limestones to the bottom of the well.

The interpretation of these sections is not possible without the assistance of sections from neighboring localities where the succession is unbroken and clearly understood. The nearest well section is that of the Lodi salt well. Fig. 8 shows this section as reported by Mr. E. T. Cox in the First Annual Report of the Geological Survey of Indiana, 1869. This section shows the same variable Carboniferous series as the Danville wells, but there is still no trace of the Carboniferous limestone. The same black shale was found at a depth of nearly 1000 feet, with the same limestone underlying it that was found previously, but the section is not complete and hence affords no standard for comparison.

A typical section.

A type section is obtained a little farther east, at Rockville, Parke County, Indiana. Fig. 9 shows the section at this point. To a depth of 350 feet the rocks consist of surface drift and Coal Measures. Below that, in typical development, is the Carboniferous limestone, with a thickness of 175 feet. Below the limestone there are about 600 feet of shales and sandstones belonging to the Waverly or Knobstone formation. This is followed in regular succession by the Devonian black shale, which is one of the best horizon markers in the oil field of Ohio and Indiana. Below this are the Niagara and associated limestones, having an aggregate thickness of 370 feet. The regular sequence continues, and the next shale bed, having a thickness of 470 feet, is undoubtedly the Hudson and Utica shales. Lastly the Trenton limestone appears, near the bottom of the well.

It is plainly apparent that the black shale which is present in all of the deep well sections here given is of Devonian age. With this fact established, it is also apparent that the underlying limestone is not Trenton, but that it belongs to that group of which, in this region, the Niagara limestone is the most prominent member. The shales and limestones lying below this bed belong to the Hudson-Utica group, but it is difficult to determine whether the reddish limestone noted at the base of the section is Trenton or not. A well at Champaign, 30 miles west of Danville, struck the undoubted Trenton at a depth of 663 feet. The alternating shale and limestone beds above this resemble strongly the beds of similar character in the well at Danville; therefore it seems probable that the last-mentioned well stopped a little short of the heavy Trenton limestone.

Absence of Carboniferous limestone.

The rocks above the Devonian black shale contain no individual beds that are identifiable, hence the correlation of the strata in the various sections is extremely difficult to make. The Carboniferous limestone is well developed in the section at Rockville, but it is absent from the sections farther west. This has been accounted for on the supposition that it changed in character in that direction from a clearly marked bed of limestone to sandstone and shale. This explanation would, of course, account for its absence, but it is not in accord with other well-known facts. The Carboniferous limestone is well developed all around the coal basin except on the northern side, where the rocks of this horizon were removed long ago by erosion. If, then, this limestone changes to shales and sandstones in western Indiana, it is a local change, for the bed is of normal composition on the farther side of the coal basin. The unconformity by erosion and overlap in the northern part of the coal field has not been considered in this connection. In that part of the basin the Coal Measures rest upon all beds from the Carboniferous limestone to the St. Peters sandstone, and presumably this condition extends underneath the basin itself. This change is in a westerly direction, and the disappearance of the limestone in western Indiana is in the same direction, consequently the supposition that both are due to the same cause is more probable than that which attributes the disappearance of the limestone to a change in character by which it remains unrecognized. The cutting out of this bed is accomplished between Rockville and Lodi, Indiana.

Divisions of the Coal Measures.

The disappearance of this limestone leaves the Coal Measures in contact with the Waverly or Knobstone formation, and the rocks of each are so similar in composition that, in the absence of coal beds, it is almost impossible to separate them. In the recent survey of the coal field of Indiana, Mr. Ashley has arranged the Coal Measures into divisions which are separated by the horizons of well-known coal beds. Division 1 includes all of the rocks from the base of the series to the horizon of coal No. 2. There is considerable sandy material in this division and it is regarded as equivalent to the Millstone grit. In the well sections here represented it is difficult to locate this division, but it probably corresponds with a generally sandy formation 180 feet in thickness which was struck in the well at Danville Junction (fig. 7) at a depth of 400 feet. Connecting the sections, lines of possible correlation have been drawn from the base of this sandstone to the top of the Carboniferous limestone in the Rockville section. Its location in these sections does not agree with the determinations made by the Indiana geologists, but there is so much uncertainty on this point, even amongst those intimately acquainted with the field, that it is allowable to draw provisional lines of correlation as indicated.

Divisions 2, 3, 4, and 5 are grouped in this part of the field. They are represented in the section at Danville Junction by the interval between the sandstone and the coal bed 260 feet below the surface. This bed of coal is equivalent to the lowest coal in the detailed sections, figs. 3, 4, and 5.

Division 6 extends from this coal horizon to that of the Grape Creek coal, or coal No. 6, as it is generally known in this vicinity. The character of the rocks and the coals in this division has been discussed at some length, hence it is not necessary further to describe this division.

Division 7 includes all of the rocks lying between the Grape Creek and the Danville coal beds. This also has been fully described on a previous page.

Division 8 includes most of the rocks above the Danville coal bed in this region.

Difficulties of correlation.

These divisions made in the Indiana field depend upon the identification of certain coal beds or coal horizons. Under the most favorable conditions this is a difficult problem, but in the coal field of which the Danville quadrangle is a part the conditions are far from the best for the identification of coals. In the first place there is no parallelism between the coal-bearing strata and those upon which they rest. The sediments forming the Coal Measures were laid down upon a more or less uneven floor, and on that irregular surface coal swamps developed wherever conditions permitted, but presumably the swamps were relatively small and of local occurrence. Under such conditions of local development of the lower coal deposits and of the lack of harmony between the coal-bearing series and that upon which they rest, the identification of the various coal beds which occur normally low in the series becomes most troublesome, if indeed it is not impossible.

If the coal beds were usually accompanied by roof shales bearing fossil plants, as they are in some localities, it might be possible to correlate widely separated outcrops of coal, or at least to determine to what general part of the series certain beds belong. The series, however, is generally barren of fossil plants and consequently the latter can not be depended upon for correlation purposes. The roof shales of the Grape Creek coal bed are an exception to the general rule, for they contain an abundant and distinctive flora. Mr. David White has examined small collections from the Himrod and Kellyville No. 2 mines and his report upon them may be found on a subsequent page.

The Illinoian part of the coal field is so deeply covered with glacial drift that it is generally impossible to trace the strata along their outcrops, hence most of the information regarding them must be obtained from prospect borings and mine shafts. In the limited territory embraced in the Danville quadrangle this is a comparatively simple matter, for the productive territory has been thoroughly prospected, but in other parts of the field prospect holes and mines are so far apart that the principal beds in their sections can be correlated only in an arbitrary manner.

From the consideration of all of these facts it seems almost impossible to extend into Illinois the system of classification used in the adjoining State, or in fact to use any system which depends upon the identification of the coal beds over a wide extent of territory.

In the work previously done in Illinois there was no attempt to subdivide the coal-bearing strata into formations, but the whole was regarded as one series—the Coal Measures. In this series the various beds of coal were designated by numbers, which began at the lowest coal and extended upward. According to this system the Grape Creek bed is known as No. 6 and the Danville bed as No. 7. Such a system is very simple and easily applied if the coal beds are regular throughout the basin or have distinctive features whereby they may be recognized in distant parts of the field. The objections against the extended application of this system are fully as strong as those against the Indiana system, for with the existence well established of an unconformity by erosion and overlap at the base of the series it is almost certain that there is irregularity and variability both in the thickness and in the geographic distribution of the coal beds, and hence the system will fail in its practical application.

The writer is not familiar enough with the entire coal basin to suggest a plan of geologic representation that will meet all the requirements, but from the data at present available it seems inadvisable to attempt the subdivision of the coal-bearing series into formations. The general plan of the United States Geological Survey is to divide strata into lithologic units, to which geographic names are assigned. In this field the coal-bearing rocks have the appearance of being a lithologic unit, hence they will be considered as belonging to one formation, but the limited knowledge of that formation will not permit the assignment of a definite name at the present time. The coal-bearing rocks, therefore, will be considered simply as Coal Measures until a wider knowledge of the limits and character of the formation is attained.

*Fossil plants.**—The small collection of fossil plants enumerated below was obtained from the roof of the Grape Creek coal at the Pawnee shaft and at Kellyville mine No. 2. The matrix is a gray argillaceous shale, often breaking in conchoidal fracture. The very distinct and beautiful carbonized plant remains are often somewhat oblique to the bedding, thus indicating a relatively rapid process of silting. Many of the fragments bear evidence of driftage.

The species present in the collection made by Mr. Campbell are as follows:

Pseudopecopteris, indeterminable fragment.
Pecopteris dentata Brongn.
Pecopteris Strongii Lx. ?
Pecopteris (Scolecopteris) ovatifolia n. sp.
Alethopteris Gibsoni Lx.
Callipteridium Grandini (Brongn.) Lx.
Neuropteris rarinervis Bunby.
Neuropteris ovata Hoffm.
Neuropteris plicata [Lx.].
Linopteris obliqua (Bunby.) Pot.
Odontopteris longifolia Lx. ?
Megaphyton insignis (Lx.) Gr'Ey.
Megaphyton Grand 'Euryi Lx.
Asterophyllites equisetiformis (Schloth.) Brongn.
Annularia ramosa Weiss.
Annularia sphenophylloides (Zenk.) Gut.
Sphenophyllum emarginatum Brongn.
Sphenophyllum oblongifolium (Germ.) Ung.
Macrostachya fertilis (Lx.) D. W.
Lepidodendron Tijoui Lx. (?)
Lepidophyllum hastatum Lx.
Lepidophyllum missouriense D. W.
Lepidocystis vesicularis Lx.
Sigillaria camptotænia Wood.
Trigonocarpum grande Lx.

* By David White.

This florula is at once recognizable as belonging to the Productive Coal Measures. But two species, *Annularia ramosa* and *Lepidocystis vesicularis*, have been found in the uppermost portion of the Pottsville formation, and they are not characteristic of that horizon. On the other hand, the observed stratigraphic occurrence of several of the species strongly points to a position well up in the Coal Measures groups.

As compared with the floras of the older formations of the Appalachian Upper Carboniferous, the Grape Creek plants are conspicuously younger than those of the lower division of the Kanawha formation, while the presence of such species as *Pecopteris ovatifolia*, *Callipteridium Grandini*, *Alethopteris Gibsoni*, *Neuropteris plicata*, *Sphenophyllum oblongifolium*, and *Lepidophyllum hastatum*, clearly refer the flora to a stage higher than the upper portion of the Kanawha formation, or the Clarion group of the Allegheny series. In fact, an examination of the vertical range and of the association of the species in the Allegheny series, whose floral succession is better understood, shows that the flora in hand can, at the earliest, hardly antedate the Freeport group, the uppermost division of that series. Certain peculiar phases exhibited by several of the species are corroborative of a reference to this or even to a still higher group. Such are the very large and obtuse-pinnuled form of *Pecopteris dentata*, the dilated pinnules of *Neuropteris ovata*, the elongate *Odontopteris*, and the large form of *Annularia sphenophylloides*.

Correlation by fossil plants.

Although the collection in hand is small, we may safely conclude that the horizon of the Grape Creek flora is not lower than the Freeport group on the one hand, while granting that it may, on the other hand, eventually be found to lie at a somewhat higher stage in the as yet paleobotanically unknown Conemaugh series. Nothing more definite in the way of paleontological correlation of the flora is feasible until standard paleontological sections of the Conemaugh and Monongahela series for comparison shall have been made. As tending to oppose so high a reference as the Pittsburg coal, it may, however, be noted that the somewhat scant material in hand from near that horizon seems to present a more advanced development than that of our flora, while apparently lacking very many of the common Allegheny types, such as *Neuropteris rarinervis*, *Sigillaria camptotænia*, and the large *Trigonocarpa*.

In the Interior or trans-Mississippi basin little is known of the floras above the Cherokee division of the Des Moines series. However, from such data as have been obtained it appears probable that the closest affinities of the flora under consideration will be found in the lower portion of the Missourian, or possibly in the uppermost Des Moines.

The composition of the Grape Creek flora indicates a stage in the lower Stephanian of the Old World. The latter division of the European Coal Measures appears, in the present stage of our knowledge of the fossil floras, to correspond to the Monongahela and Conemaugh series, together, perhaps, with the Freeport group of the Allegheny series of the eastern United States, and to the Missourian, with perhaps the upper portion of the Des Moines, of the Interior basin.

PRE-PLEISTOCENE CONDITIONS.

A type of the pre-Glacial conditions.

There was probably sufficient breaking down and erosion of the surface of the Carboniferous rocks before the Glacial period to give this region an appearance similar to that of the neighboring unglaciated portions of the Coal Measures in Indiana, the kinds of rocks, the general altitude, and the relation of the drainage lines being very similar in the two districts. The unglaciated district referred to presents low, irregular hills and ridges that rise usually 100 to 150 feet above the bordering valleys. The bluffs present very gradual slopes and the valley bottoms are broad. Streams which drain only a few square miles flow in valleys with bottoms one-fourth mile or more in width, while the large streams occupy valleys several miles wide. The Ohio on the border of southwestern Indiana has a valley 6 to 8 miles wide, with a rock floor about 75 feet below the present stream and bluffs that rise scarcely 100 feet above the water. The valley of the Wabash in its lower course is even broader than that of the Ohio above the junction of these streams, and the bluffs also are low, with gradual or receding slopes. Similar features are found on the lower courses of all the tributaries of the Wabash in southwestern Indiana and southeastern Illinois which chance to fall within a district so thinly covered with drift that the pre-Glacial valleys and ridges are open to inspection.

A drift-covered old surface.

The Danville quadrangle, being but a short distance back from the valley of a large pre-Glacial stream (the Wabash Valley), there should be concealed beneath its coating of drift a series of broad valleys connecting with the Wabash Valley, separated by low uplands rising perhaps 150 to 200 feet above the rock floor of the valley bottoms. The glacial deposits have so great thickness within the quadrangle that the region has been filled to a level higher than the tops of the old divides, so that the present surface offers no suggestion as to the position of either valleys or ridges, which can be determined only by the height of the outcropping ledges of rock along the river bluffs and by such wells as have been sunk deep enough to reach bed rock.

Topography of the old surface.

In a general way the rock surface is very regular in the upland south of the river. There is a variation of a little more than 30 feet, and the slopes are gentle, showing that the topography of that time was well matured. The highest areas are situated on the south and west sides of the quadrangle. On the south side the rock floor has an altitude of nearly 630 feet above sea level. This altitude holds northward along the line of the Georgetown and Danville pike to within a mile of Vandercook. From this ridge the rock floor slopes in either direction, sharply toward the river on the east, and gently toward Catlin and the Wabash Railroad on the west. On the western edge of the quadrangle, near the junction of Salt and Middle forks, the surface of the rock is approximately at the same elevation as along the Georgetown and Danville pike. Between these two slightly elevated ridges there is a low, flat valley, which was probably once occupied by a small tributary branch of the ancient Vermilion River.

Old valley of the Vermilion.

The narrowness and the rocky character of the valley of Vermilion River clearly indicate that the present course of the stream is of recent date and that it does not necessarily correspond with any drainage line which existed in pre-Pleistocene time. It is not known positively that any drilled wells have yet reached the bottom of the valley in which flowed the old Vermilion River, but its position is indicated by the great depth of drift found in the well at Danville Junction. The altitude of the rock floor at this point is 435 feet above the level of the sea. The well recently drilled at the Soldiers' Home reached solid rock at an altitude of 480 feet, and a well drilled a number of years ago near the depot at Grape Creek reached the rock floor at about 470 feet above sea level. These wells show a much lower rock surface than that which is found south of the river, and they are also slightly below the level of the rock floor northeast of Danville. Three wells in Newell Township reached the rock at an altitude of about 530 feet, one at 528 feet, one at 520 feet, one at 515 feet, and one at 480 feet. From these figures it will be seen that there is a rather deep valley in the vicinity of Danville Junction, and presumably this valley extends southeastward along the course of Stony Creek and Vermilion River to the mouth of Grape Creek. The sharp, rocky gorge which the river enters on leaving the great alluvial amphitheater at this point shows that the course of the old stream must have been different from that which the river occupies at present. The drill hole at Grape Creek station is located on the extreme western edge of the valley, and consequently it is doubtful whether it represents the full depth of the old channel in this vicinity. Unfortunately there has been no drilling in the center of this wide flat, and one can only surmise the depth to which the rocky strata have been eroded. The old valley turned at this point and presumably pursued an easterly direction beyond the margin of this quadrangle.

A readjusted drainage.

There is no evidence of reversal or any such decided change in the drainage of this region. It is simply a case of readjustment to new conditions along practically the same lines that the streams occupied before the advent of the ice. During the time of maximum glaciation the streams were probably entirely arrested by the ice, but upon its retreat they formed along lines of least resistance, which in this case appear to have been nearly in their former courses. The ice front occupied a nearly east-west position, hence the southern parts of the valleys would be open first, and here the streams generally formed. When the ice had retreated to about the position of Danville the water from its melting front found a channel along the present course of the Vermilion, more than halfway up the rocky side of its old valley. Toward the south the high rock floor interposed a barrier to the pathway of the stream, but it pursued its course parallel to that highland and just at its foot. Doubtless the streams were at first located upon glacial drift only; as time advanced they eroded their channels and encountered the solid rock, but their pathway was selected and they persisted in it despite the solid rock through which they had to cut, even though only a short distance to the northeast there was a channel already cut through the solid rock to a greater depth than the one which they now occupy. The pre-Pleistocene river flowed east and probably joined the Wabash, and the modern stream has followed in nearly the same course.

An old valley of a tributary of the Vermilion.

North and west of Danville the old topography is not so easy to study, for the creeks have not yet cut down to solid rock except in the immediate vicinity of Danville, and only a few wells have reached the original rock floor. There seems to be a general depression in this rocky floor along a line running directly northwest from Danville, for in sec. 16, T. 20 N., R. 12 W., solid rock was struck at an altitude of 470 feet, while in sec. 32, T. 21 N., R. 12 W., a well reached the rock at an altitude of 525 feet. It seems probable, therefore, that the western fork of the old river entered this territory near where the present Middle Fork enters, flowed southeast, and north of Danville joined another fork which occupied a slight depression along approximately the present line of North Fork.

This rather extensive drainage system in the northern part of the quadrangle is responsible for the lowness of the rocky floor in that region, and hence is indirectly responsible for the deep filling of drift that occurs there and for the absence of the coal beds which are so important in the territory south of the river. In the extreme northeastern part of the quadrangle the height of the rock floor is not known, since all of the deep wells in that section have failed to reach solid rock. It shows, however, along Wabash River in the vicinity of Covington at an altitude of about 500 feet, hence it seems probable that it is about the same in the vicinity of State Line.

Coal beds worn away.

The sudden termination toward the east of the productive coal, as shown on the economic map, is due to the erosion of the rocks and the coal beds to a plane below the level of the latter. The outlines are only approximately correct, and hence do not represent the actual rugosities of the pre-Pleistocene topography. In Danville the coal beds are similarly cut away by early erosion, so that the beds which are prominent along the river bluff on the southwestern side of the city are not present in the northeastern part. In this locality the change is very abrupt and striking and its existence has been verified again and again by the many wells that have been sunk below the level of the coal beds without encountering solid rock.

PLEISTOCENE FEATURES.

Illinoian drift.—The Kansan and pre-Kansan drift sheets have not as yet been identified with certainty among the deposits of the Illinois glacial lobe. The oldest drift known to occur here is the Illinoian, and this extends beyond the Danville quadrangle about 150 miles, to the limits of glaciation in Illinois and Indiana. As already noted, it is overlain within this quadrangle by Wisconsin drift, which conceals it except in the valleys of the principal streams.

Buried soil rare here.

The Danville quadrangle does not show so clearly the succession of drift deposits as do the neighboring parts of Illinois. On the north, east, and west of this quadrangle there are numerous instances of the occurrence of buried soils and fossiliferous silt, probably loess, between the Wisconsin and Illinoian drift sheets, but no exposures of these soils or silts were discovered within its limits, and there are very few instances reported of the penetration of buried soil in the wells. The fragmentary nature of the exhibit seems to indicate that the ice sheet at the Wisconsin stage removed much of the soil and silt. It also seems to have removed quite extensively the oxidized surface portion of the Illinoian drift sheet. This removal of the oxidized part of the lower sheet makes it somewhat difficult to determine the border lines between the Wisconsin and the Illinoian drift, either in the exposures along the streams or in the wells, for the two drifts present similar rock constituents and similar variations in color. But the Illinoian drift is to a marked degree indurated by cementation with lime, while the Wisconsin is usually soft and loose. The difference in induration seems to be, for this area, the best criterion for separating the drift sheets, and yet this will in places fail or yield unsatisfactory results.

In this as in other districts where both drifts are present, the Illinoian, being the older sheet, is largely found as a filling in the pre-Glacial valleys, and it has but a meager representation on the old uplands; while the Wisconsin drift, being deposited on a surface that had been rendered smooth, makes a more uniform sheet over uplands and valleys. Being of considerable depth throughout, it has the appearance of contributing the main part of the drift, for the old valleys lie largely below present stream level; yet it probably is but little more bulky than the Illinoian.

Thickness of the drift sheets.

If we may judge from the neighboring districts, where the soils are well preserved between the Wisconsin and Illinoian drift, the thickness of the Wisconsin is generally 35 to 60 feet on the plains and 80 to 120 feet on the moraines; while the Illinoian sheet ranges from almost nothing on parts of the old uplands to nearly 300 feet in the deepest of the old valleys. In the immediate vicinity of the Danville quadrangle the thickest drift yet found is only about 250 feet, and this probably is more largely Illinoian than Wisconsin. An illustration of this is found in a boring west of Eugene, Indiana, just outside the limits of the quadrangle, which failed to reach rock at a depth of 241 feet and is largely through a hard or partially cemented blue bowlder clay or till, thought to be Illinoian. Another boring of about the same depth east of Bismarck, Illinois, and just north of the limits of the quadrangle, passed through a bluish-black muck at about 60 feet, which probably marks a soil horizon at the top of the Illinoian drift. This muck is also found at about 90 feet beneath the moraine in the northeastern part of the quadrangle.

Composition of the Illinoian drift.

Throughout the quadrangle the Illinoian drift is composed largely of stony clay or till, there being probably less than 10 per cent of assorted material (silt, sandy gravel, and cobble). In the till there is a liberal admixture of small stones with the clay, but bowlders are not numerous. Their scarcity may be understood from the fact that, out of the hundreds of deep wells that have been driven or bored into the till, only a very few have struck bowlders so large that they could not be pushed aside by the drill or auger. The exposures along streams also show only an occasional bowlder.

Sources of the till.

An inspection of the till reveals the fact that the bowlders are very largely crystalline rocks of Canadian derivation, though limestones from the Silurian formations of northern Illinois and Wisconsin are also found. The smaller stones embrace large numbers of fragments of limestone as well as of crystalline rocks. The clayey matrix seems to be derived largely from the shales of the Coal Measures, though it contains also pulverized limestone and many small fragments of crystalline rocks. The gravel and cobble deposits which are interbedded with the till contain about the same proportion of limestone and crystalline rocks as is found in the stones of smaller size in the till, as is to be expected, since the gravel and cobble are derived from the same source as the till and differ from it chiefly in lacking the finer ingredients. The sand and silt beds, like the clayey matrix of the till, contain considerable pulverized limestone, as well as fragments of shale and of crystalline rocks.

Colors of the till.

The till shows marked variation in the color of its clayey matrix, though the predominating color, in both the Illinoian and the Wisconsin sheet, is blue-gray. The deposit showing the most conspicuous variation from the prevailing tint, and having a color which does not seem to be due to oxidation, is a pink till, which is frequently found below the blue-gray till or at the same horizon with it. The color is very similar to that of a Coal Measures shale which outcrops at many places along Salt Fork and the lower courses of Middle and North forks, and there is little doubt that the till owes this color to the presence of the shale in its matrix. There are several exposures along Hungry Hollow, northwest of Danville, where the pink shale and the pink till may be seen in close association. The most extensive exposure of this pink till noted is on a west tributary of North Fork, in sec. 7, T. 20 N., R. 11 W. For nearly one-eighth of a mile it forms the base of the bluff to a height of 10 or 15 feet above the bed of the ravine. Above it there are about 30 feet of blue-gray till, separated from the pink till by a definite horizontal band of cobbles and bowlders. As this pink till is commonly found either at the base of the drift or at considerable depth, it probably belongs to the earlier or Illinoian drift. But since the Illinoian also includes a large amount of blue-gray till, and as the pink till is found to pass horizontally into blue-gray till in many of the exposures, this color distinction should not be depended upon to separate the Illinoian from the Wisconsin drift.

A black clay.

Occasionally a nearly black clay is found at or near the base of the drift, which, like the pink till, seems to be derived from Coal Measures shale. An excellent exposure of such a clay is found at a road grading on the southern bluff of Hungry Hollow, about a mile above its mouth; and a disintegrated black shale bearing a striking resemblance to this clay may be seen, in situ, in the same bluff only a few rods distant. The black clay embedded in the drift has several feet of brown till and sandy gravel beneath it, separating it from the underlying rock. There are lumps or masses of it several feet long and a few inches thick embedded at different levels up to a height of 15 feet or more above the rock. In this connection it may be remarked that there is an exposure on the northeastern bluff of Vermilion River, a short distance southeast of the southeast corner of the quadrangle, showing a mass of Coal Measures sandstone several feet thick and several square rods in extent embedded in the till. When first observed it was mistaken for rock in situ, but upon closer examination it was found to be underlain by the blue-gray till of the drift. These instances serve to show how largely the color and the constitution of the drift may be affected by the incorporation of local rock material into it.

Beds within the till.

Turning now to deposits which are associated with the till, it is found that they include beds of assorted material of various degrees of coarseness, from cobble down to fine silt or clay, and that they occur at all depths in the till. If these beds of associated material were at the surface their extent might be accurately determined, but since they are buried beneath heavy deposits of till their extent has not been determined, even approximately. It is known only that the wells and the banks or bluffs of streams show but a small amount of assorted material compared with the amount of till. The general presence of large supplies of water in the sand and gravel struck by wells in the midst of the drift seems to indicate that these deposits may have frequent connection with one another beneath the surface and that they are also connected with porous surface deposits which take in the water. In some parts of the glaciated area there are extensive sheets of water-bearing sand and gravel at definite horizons, but within the Danville quadrangle no definite horizons of water-bearing beds have been discovered. The most conspicuous one noted is in the vicinity of Catlin, and this occupies an area of only about a square mile.

Beds of sand or gravel.

As a rule the assorted material included in the Illinoian drift within this quadrangle is sand or fine gravel, there being a much smaller amount of coarse gravel and cobble than occurs in the northern portions of Illinois and Indiana and in Wisconsin and Michigan. In many places the sand, though water bearing, is too fine to be readily screened by the pump strainer and may perhaps be more properly denominated silt. The majority of wells, however, strike into either coarse sand or fine gravel to obtain water. These water-bearing beds of sand and gravel contain a sufficient amount of limestone to render the water hard.

Silt beds.

The beds of silt associated with the till are even less perfectly known than the beds of coarser assorted material, for they are in many cases as dry as the till and are not discriminated from it, whereas the sand and gravel are generally water bearing and are recognized in well drilling. Well drillers often report "beds of clay without grit," which in all probability are deposits of silt. The outcrops of silt deposits along valleys are few and of small extent, but the valleys are largely in the upper part of the drift, and well sections suggest that silt deposits may be more extensive in the lower than in the upper part.

Sangamon soil.—The studies in the Danville quadrangle have failed to bring to light any exposures of the Sangamon soil in the bluffs of streams. The overlying loess also has not been found. Furthermore, there are only a few well records that suggest the presence of this soil, and these are not wholly reliable. Were it a question, therefore, whether the loess and the soil which it covers extended to the Danville quadrangle these results might reasonably be taken as negative evidence that the quadrangle lies outside their limits. But since the limits of the loess and the underlying Sangamon soil are known to be far to the south, there is no question that the soil and loess once covered the entire quadrangle, and that they are still present in places which escaped the abrading action of the Wisconsin ice sheet. This is abundantly shown by records of wells and by occasional stream exposures in districts bordering the Danville quadrangle, and it is not improbable that the soil and loess may occur very extensively within its limits without having come to notice. The scarcity of exposures and the few accurate well records available leave nearly all the quadrangle in question on this point. It should be borne in mind that even where streams cut down to a level sufficiently low to expose the soil and loess their bluffs are so obscured by vegetation and by talus that scarcely one-hundredth part of their face is clearly exposed to view, and these exposures constitute probably less than one-ten-thousandth of the surface of the quadrangle.

A weathered zone between drift and loess.

An examination of the numerous exposures of the Sangamon soil which are found outside the limits of the Wisconsin drift to the south of this quadrangle brings to light evidence of the lapse of a long interval between the deposition of the Illinoian drift and the Iowan loess. This is shown not only by the accumulation of humus, but also by the more forcible evidence presented by surface leaching. The till has been leached to a depth of several feet, losing not only its fine calcareous rock flour, but also its limestone pebbles, so that a pebble of this class is rarely found within 3 or 4 feet of the surface. Beneath this depth limestone pebbles become gradually more numerous, and below 6 to 8 feet the calcareousness of the clayey matrix is noticeable. As this surface portion is similar in other respects to the lower part of the till, it can scarcely be questioned that it once contained a similar proportion of limestone pebbles and calcareous rock flour.

Thickness of the Iowan silt.

Iowan silt or loess.—The loess or silt which covers the Sangamon soil outside the limits of the Wisconsin drift is traceable throughout the district bordering the Mississippi River. It is directly connected with the Iowan till of northwestern Illinois as well as that of eastern Iowa, and appears to be a dependency of the Iowan drift sheet. It varies greatly in thickness, if wide areas are considered, but is systematic in that it shows a tendency to become thick along the great rivers and thin on the divides. On the borders of the Illinois and Mississippi rivers there are belts having a thickness of 30 to 50 feet, and on the Missouri River a much greater thickness is reached. But on the borders of the Wabash Valley it averages but 10 or 15 feet. On the divides between the streams it often becomes reduced to less than 5 feet. It is probable that the Danville quadrangle, being near the Wabash, had nearly the average thickness found along that valley, or about 10 feet. The deposit was therefore much less in amount than the Illinoian drift, and so thin that the advancing ice sheet might easily have incorporated nearly all of it in its own drift.

Character of the silt.

Mechanical analyses of specimens of this silt from the portion of Illinois immediately outside the border of the Wisconsin drift sheet have been made under the direction of Prof. Milton Whitney, of the Department of Agriculture. He finds that the grains seldom exceed a diameter of one-tenth of a millimeter, or the grade called fine sand, and most of the grains fall below one-twentieth of a millimeter. Where grains exceed one-tenth of a millimeter they are usually concretions of iron oxide. More than half of the deposit is made up of grains falling between one-twentieth and one-hundredth of a millimeter. The following table sets forth the results of three of these analyses.

Mechanical analyses of the Iowan silt in eastern Illinois.

Diameter, in millimeters.	Conventional name, etc.	Galatia; 1-18 inches.	Near Greenup; 2-15 inches.	Moweaqua; 2-18 inches.
		Per cent.	*Per cent.*	*Per cent.*
2- 1	Fine gravel	0.00	0.30	0.00
1-.5	Coarse sand	0.00	1.05	0.08
.5-.25	Medium sand	0.02	3.42	0.77
.25-.1	Fine sand	0.30	3.30	0.11
.1-.05	Very fine sand	5.21	6.47	4.88
.05-.01	Silt	57.75	55.48	52.50
.01-.005	Fine silt	12.78	11.70	12.15
.005-.0001	Clay	20.36	14.90	22.10
	Total mineral matter	96.42	96.62	92.59
	Organic matter, water, loss	3.58	3.38	6.61
	Loss by direct ignition	6.01	3.11	5.73

Chemical analyses of the loess have been made by Prof. W. A. Noyes from two samples collected near Terre Haute, Indiana, only a few miles south of the limits of the Wisconsin drift, and these probably illustrate well its constitution near the Wabash River. The results of these analyses are given below. The first sample is from a point 10 inches and the second from a point 22 inches below the surface. The analyses were made for the Indiana Geological Survey and first appeared in its Twenty-first Annual Report.

Analyses of Iowan silt from near Terre Haute, Indiana.

Constituent.	No. 1.	No. 2.
	Per cent.	*Per cent*
SiO_2	79.77	72.87
Al_2O_3	9.95	11.25
Fe_2O_3	3.39	6.75
TiO_2	.70	.95
CaO	.67	.69
MgO	.26	1.06
Na_2O	1.08	.39
K_2O	2.05	2.26
H_2O	2.55	4.24
Total	100.42	100.46

Peorian soil.—The Peorian soil as displayed in the type locality near Peoria, Illinois, seems to mark a less prolonged interval than the Sangamon. The humus stain is meager and the leaching of the surface part of the loess is far less than that of the leaching of the Illinoian drift in the Sangamon inter-glacial stage. Whether the black earth or clay found in a few wells in the Danville quadrangle belongs to the Peorian or to the Sangamon can scarcely be decided. It is found, however, that in the neighboring districts where the records are more complete and the number of instances much greater, the best-defined buried soil is at the Sangamon horizon, the soil being directly underlain by till. This fact renders it probable that in the Danville quadrangle the Sangamon rather than the Peorian soil has been noted in well records.

Topographic effects of the drift.

Wisconsin drift.—It is the Wisconsin drift that gives the Danville quadrangle its topographic expression as well as its agricultural conditions. By referring to the topographic map it will be seen that the portion south of the latitude of Danville is largely a plain, there being only a few small ridges and knolls dotting its surface. The topography of the portion north of Danville, on the other hand, is in large part undulating. In this region are the prominent ridges which form the outer or southern portion of the Bloomington morainic system. Two distinct ridges appear in the northeastern part of the quadrangle, which are separated by the narrow sag or plain through which Stony Creek flows. On the west side of North Vermilion River these unite in a single broad ridge. The margin of the ice appears to have held its position in this western part of the quadrangle, while it withdrew in the eastern part from the south to the north ridge.

A typical drift surface.

The strong morainic belt and its bordering nearly featureless plains here displayed are illustrative of classes of drift topography that are widely prevalent from Illinois eastward through Indiana and Ohio. The plains between the moraines are usually dotted with as few drift knolls as occur on the plains in this quadrangle, while the moraines often have as great relief and as pronounced topographic expression as here exhibited. The most conspicuous exception is found in the Champaign morainic system, and the weakest portion of one of its members chances to fall within the Danville quadrangle. The inner and weakest member or ridge of this Champaign system is traceable from Champaign eastward into Vermilion County nearly to the western border of the Danville quadrangle, passing south of the villages of Sidney, Homer, and Fairmount and constituting the water parting between Salt Fork of Vermilion and the north tributaries of Little Vermilion River. Near Fairmount it breaks up into a range of knolls, one of the most prominent being "Blue Mound" in sec. 11, T. 18 N., R. 13 W. These knolls become so scattering and so low upon passing eastward into the Danville quadrangle that it would be misleading to call them a moraine. Yet they serve to connect the definite ridge that leads up nearly to the western border of the quadrangle with an equally definite one that sets in just south of the quadrangle, in sec. 27, T. 18 N., R. 11 W., and they constitute a faint representation of the position of the ice margin at a certain stage. As only a small number of these knolls exceed 10 feet in height, they are imperfectly represented on the topographic sheet. Enough of them are shown, however, to indicate that the belt runs eastward from the western border of the quadrangle to the vicinity of Kellyville and thence southeastward to the well-defined ridge that sets in just outside the quadrangle, in sec. 27, T. 18 N., R. 11 W. They are scattered over a strip 2 or 3 miles wide. The most prominent knoll is "Sandusky Hill," immediately south of Catlin; it is 35 or 40 feet in height. Aside from this there are few that rise 20 feet above the plain.

Kames.

There are a few knolls within the Danville quadrangle that are not included in either the Champaign or the Bloomington morainic system. Three such knolls are to be seen near Hillery, about 4 miles west of Danville; another is found about one-half mile southeast of Rileysburg, Indiana, and several occur between Vermilion River and the State line, 3 to 5 miles south of Rileysburg. These knolls may be classed as kames, since they include a large amount of sand and gravel with the till. In this connection it may be remarked that some of the knolls near Catlin, which are included in the Champaign morainic system, contain a large amount of gravel and sand and may be properly classed as kames. This is the case with the most prominent one, "Sandusky Hill." The kames here, as elsewhere, may be found either on moraines or on till plains.

Features of the Bloomington moraine.

Upon examining the Bloomington morainic belt more in detail it will be found that it presents an irregular, somewhat wavy surface, with oscillations of 10 to 20 feet or more in nearly every 40 acres of the surface. The forest-covered portion presents sharper knolls than the prairie portion, a feature that is probably due to forest protection from frost and fire as well as from the action of small streams. There may, however, have been an original difference in the sharpness of the knolls. There is a marked relief on the southern or outer border of the moraine. It will be noted that the plain immediately south stands about 650 feet above tide, while the moraine, within a mile north from the border of the plain, rises, as a rule, slightly above the 700-foot contour, and there attains about as high an altitude as at points farther back from the plain. There is a similar relief in the ridges on each side of the sag through which Stony Creek has its course. But the relief is not so conspicuous at the northern border of the morainic belt, there being in places a gradual merging into the plain, and nowhere is there so marked a difference in altitude between the moraine and the plain as on the southern border, the plain at the north being about 30 feet higher than the one on the south.

The Wisconsin drift of this quadrangle, like the Illinoian, is composed largely of stony clay (till), both in the plain and in the morainic or undulating portion. The most striking difference between it and the underlying Illinoian, as already indicated, is the degree of induration or cementation, the Wisconsin being as a rule much softer and easier to penetrate with auger or spade than the Illinoian. The till of the moraines seems to be a trifle more stony than that of the plains, a difference that seems attributable to the removal of a larger proportion of the silt from the morainic drift.

Bowlders.

Surface bowlders abound on both of the ridges of the Bloomington morainic belt for 2 or 3 miles east from North Vermilion River, but with this exception the surface of the portion of this morainic belt within the quadrangle is not very bowldery. Bowlders also abound in a small area on the southwestern side of Vermilion River just below Danville, but are not numerous on other parts of the plain or non-morainic portion of the quadrangle. The surface bowlders are almost wholly crystalline rocks of Canadian derivation, of which granite far outnumbers all other classes, but within the till there are occasional large blocks of limestone, which were probably derived from neighboring ledges in northeastern Illinois, only 50 to 75 miles distant. The smaller stones of this drift sheet, like those of the Illinoian, embrace large numbers of rocks of comparatively near derivation, as well as granites and other crystalline rocks of distant derivation.

Pockets of sand and gravel in the till.

Aside from the occasional kames or knolls of gravel and sand, the Wisconsin drift of this quadrangle carries numerous small pockets or local accumulations of gravel and sand in the midst of the till, which are filled with water and supply the shallow or dug wells. The amount of these deposits is, however, much less than that of the till. In a well 30 feet in depth there is ordinarily but a few inches of sand and gravel, the excavation being almost wholly till. The movement of glacial water in connection with the deposition of this portion of the Wisconsin sheet and with the melting away of the ice sheet seems to have been remarkably feeble. This inference is sustained by the nature of the outwash from the Bloomington morainic system, as appears below.

Oxidation of the drift surface.

In this drift sheet oxidation has changed the color of the surface portion from blue-gray, the common tint, to yellow or brown. The depth to which this change extends is usually but 10 or 15 feet on the morainic ridges, and somewhat less on the prairies. The surface leaching has been sufficient to remove the calcareous rock flour to a depth scarcely half as great as the depth of oxidation, but it has not removed the limestone pebbles to any appreciable extent. In this respect the surface here is in contrast with the leached surface portion of the Illinoian drift, where, as above indicated, pebbles as well as rock flour have been leached away to a depth of several feet. This feature strongly supports the view that the time since the disappearance of the Wisconsin ice sheet from this region is briefer than the time that elapsed between the withdrawal of the Illinoian ice sheet, with attendant exposure of the Illinoian drift to atmospheric action, and the advent of the Iowan glaciation, when the soil and leached surface which had formed on the Illinoian drift became covered with the Iowan silt or loess.

A bed of fine clay.

Surface silt.—On the plain immediately south of the Bloomington morainic belt the till is capped by a deposit of silt or nearly pebbleless clay having a depth of several feet, which within a distance of 2 or 3 miles south of the border of the moraine decreases to but a foot or two, and in the southern part of the quadrangle is scarcely sufficient to conceal the surface bowlders. The ridges of the Bloomington morainic belt within this quadrangle and the plain north of them carry scarcely any silt on their surfaces. This silt deposit has been referred by Professor Bradley to the loess,* but it evidently is much younger than the main loess deposits, for the latter are older than the Wisconsin drift. It is probably of complex origin. The thickest portion being situated on the outer border of the Bloomington morainic belt, it is natural to infer that it is an outwash from the ice sheet during the formation of the moraine. The validity of this inference is not, however, beyond question. The thin portion can scarcely be accounted for in this way, since it lies higher than the heavy portion, and upon ground that seems likely to have been above the level of glacial waters that were flowing toward the main avenue of discharge, the Wabash River. That portion may, however, have been deposited as an outwash from the ice in its retreat across the southern part of the quadrangle before drainage lines had been opened, and hence somewhat earlier than the Bloomington morainic belt. A supplementary if not alternative agency is found in the wind, and this may still be adding to the thickness of the deposit, especially in very flat places, where erosion is of little effect.

Wisconsin valley-gravel.—Throughout much of the region covered by Wisconsin drift the valleys leading away from the moraines carry deposits of gravel and sand which were laid down by the dirt-laden streams that issued from the ice. The degree of coarseness of the material varies greatly from place to place, and is thought to indicate the strength of the stream current. The strength of the current would evidently vary with the volume of the stream and the rate of fall or gradient of its bed. On portions of the ice margin where the valleys had not been opened to receive the glacial drainage directly, the water would spread out over the plain and carry sediment to form an outwash apron until some valley was reached through which its waters could find a discharge.

A belt of gravel.

In the Danville quadrangle the Vermilion Valley afforded a line of escape to the Wabash for tributaries that headed at the ice margin, and certain beds of gravel and sand along it appear to have been deposited directly by these glacial streams. By referring to the geologic map it may be seen that at the outer border of the Bloomington morainic belt the gravel fills the interval between Vermilion River and Stony Creek, making a belt nearly 2 miles wide, which gradually narrows upon passing down the valley. The discharge seems to have been more vigorous here than along the remainder of the ice margin lying within the quadrangle. There was so little gravel discharged from Middle Fork that it has been largely removed by the later action of the stream. Possibly, as already indicated, the silt which lies along the outer border of the moraine between Middle and North forks, and also east of Danville, is largely the outwash from the ice. The flatness of the surface is such that vigorous drainage could scarcely be expected except at points where valleys connected directly with the ice margin.

It is evident that gravel deposition continued in North Fork and Middle Fork valleys down to the time when the morainic belt which crosses their headwaters was forming, for the gravel remains in conspicuous terraces up to the points where these streams emerge from this later morainic belt. Instances may be seen near the north edge of the Danville quadrangle. It seems not improbable that the streams flowing from this later moraine contributed also to the gravel

*Geology of Illinois, Vol. IV, 1870, p. 242.

deposits found south of the outer belt of the Bloomington system, though perhaps only a minor part.

There is evidence that the deposition began while the ice stood at the outer belt. About 2 miles above Danville, in sec. 30, T. 20 N., R. 11 W., there are gravelly deposits along the western side of North Fork which seem to extend from the plain surface of the terrace back into the undulating surface of the moraine, after the habit of moraine-headed terraces, as if that had been the starting point of a glacial stream. There is also a large admixture of cobble and even larger stones with the gravel at the place, which suggests that the source of supply (the ice sheet) was close at hand. The remnants of the gravel filling farther up the valley are at a slightly lower altitude and are composed of finer material than that at this place.

Date of the gravel deposits.

The material of this terrace consists of a fine gravel which in places becomes sandy. The gravel is seldom cemented, though it contains a large amount of calcareous material in both coarse and fine particles. In a few places it reaches a depth of 30 feet, but is usually only 10 or 15 feet in depth. It commonly rests upon an eroded till surface, but occasionally extends to the Coal Measures. There is generally a bed of fine sand or silt covering this gravel to a depth of 1 to 4 feet, which seems referable to sluggish waters in the closing stages of deposition. Such a silt capping is a common feature on the Wisconsin valley-gravels.

Drainage development.—An inspection of the topographic map will make it evident that the drainage lines are in a youthful stage. There are perhaps 75 of the square-mile sections, or about one-third the number included in the quadrangle, in which no drainage lines are represented, and nearly every section in the quadrangle contains extensive uneroded tracts. In most cases the bluffs are abrupt and the original level of the drift surface is preserved almost to the brow of the bluff. It is estimated that an area of not more than 30 square miles of the 228 included in the quadrangle has been materially affected by erosion since the ice left it, and yet this quadrangle includes the lower course of an important tributary of the Wabash, where the streams have the advantage of rapid fall. There has been a very insignificant amount of erosion in the headwater portion of the same drainage system. The southern part of Catlin Township, in the southwestern part of the quadrangle, represents the practically unmodified condition which wide areas of the drift surface display in neighboring parts of Illinois and Indiana. This immature condition of the drainage system is, however, characteristic only of the region within the limits of the Wisconsin drift, the drainage systems on the Illinoian drift being far better developed.

Respecting the courses selected by the streams, it will be observed that Vermilion River has taken a somewhat direct course across a remarkably level drift plain from Danville down to Wabash River. The courses of North Fork and Middle Fork in their passage through the Bloomington morainic belt were probably determined by sags or channels formed in connection with the deposition of the drift and the melting away of the ice. The meandering of the valley of Middle Fork seems to indicate that the stream was obliged to find a course among the knolls and ridges of the moraine, and is a feature which does not favor the view that a well-defined channel had been opened by subglacial waters. The comparatively small amount of glacial outwash at its point of emergence from the moraine leads to the same conclusion. North Fork, on the other hand, crosses the morainic belt in a somewhat direct course, such as a subglacial stream would naturally develop. The large amount of glacial outwash at the point where North Fork leaves the moraine may also sustain the interpretation of subglacial drainage. The westward course of Stony Creek through the northeastern part of the quadrangle was determined by the sag between the two morainic ridges. Its selection of the course southward through the outer moraine instead of westward between the moraines into North Fork seems to indicate that the ice left a suitable channel for it across the moraine. Possibly some of the material in the gravel plain which heads at the moraine north of Danville was brought in through this channel. The courses of the small tributaries appear to have been governed by some detail of slope or by slight depressions in the drift surface, except perhaps a few very small streams which have worked back across a level plain from the valleys into which they discharge.

Courses of the streams.

As the valley gravel along the Vermilion rests upon a terrace, there must have been stream excavation prior to the gravel deposition. The depth of the excavation was nearly 50 feet in the vicinity of Danville, and seems to have been still greater toward the mouth of the river, while the width exceeds that of the modern valley, as may be seen by reference to the geologic map. Similar excavation is also found in valleys farther west that lead away from the Bloomington morainic belt, notably on tributaries of the Illinois River. In these valleys, as in the Vermilion, there are trains of valley gravel which head in the Bloomington morainic system. In each of these valleys the amount of erosion seems greater than streams having the present drainage area would have produced in the interval between the Champaign and Bloomington substages of glaciation, an interval so brief that aside from these valleys one can scarcely detect a difference in the stage of drainage development upon passing from the Champaign to the Bloomington drift sheet. The manner in which the excavation occurred is not yet clear. Possibly a stream adequate to effect this erosion was in operation between the Champaign and Bloomington substages in connection with the melting ice sheet. The water which flowed from the ice sheet may have dropped its burden of sediment before reaching the lower course of the Vermilion and taken on the power to erode in that part of the valley. The volume of water may thus have been far greater than that of the modern stream, and the work may have been accomplished in comparatively short time. The question is one, however, on which further light is needed.

Erosion by glacial streams.

It will be observed that the main drainage ways of the Danville quadrangle present marked irregularity in the size and form of their valleys, there being in places wide, low bottoms extending from bluff to bluff; in other places noticeable terrace remnants, with narrow, low bottoms; and in still other places only slight terraces and narrow, low bottoms. These irregularities appear to be due in part to variations in the texture of the formations in which the valleys have been excavated, the broad, low bottoms being found where there has been excavation in soft or easily eroded material, either drift or shale, and the narrow parts being largely confined to places where the bluffs are of somewhat resistant rocks.

The wide expanse of the Vermilion Valley opposite Grape Creek evidently marks the place where a pre-Glacial drainage line is entered; but the expansions on Salt Fork and on Middle Fork, near the west border of the quadrangle, seem to be due to weakness in the shale which forms a large part of the bluffs in this locality. The narrowness of Vermilion Valley below the Grape Creek expansion, and the narrowness of the trench cut in the terrace in the vicinity of Danville, are each attributable to the resistance offered by rock ledges; so also are the narrow gorges in the sharp bends of North Fork just above Danville.

The terraces are conspicuous chiefly where there is drift in the upper part and rock in the lower part of the bluffs, though they also occur where the bluffs are entirely of drift. The principal terrace on the main streams is capped with gravel, and it seems to bear a definite relation to the ice sheet at a time when it still stood at the Bloomington morainic belt. The most conspicuous remnant of this main terrace within the quadrangle lies between Vermilion River and Stony Creek, from Danville down to the point where the creek enters the river, the course of the creek being near the eastern side of the terrace, while the river follows nearly the western border.

RECENT FEATURES.

Alluvium.—The deposits previously considered are somewhat closely connected with glaciation, but the alluvium, as here considered, is entirely the product of modern streams, subsequent to the final disappearance of the ice sheet. It is distributed along the flood plains or low bottoms of the principal streams and merges into the talus of the valley slopes and of the headwater portions of the tributaries. The alluvium is really an apron of talus which has been spread out by the stream on its flood plain. Having this derivation, it presents a mixture of fragments of rock of all sizes, from coarse blocks which have fallen from cliffs or rolled down steep ravines to the finest silt or clay, deposited where the stream is most sluggish. Since the streams of this quadrangle have a comparatively rapid fall they have carried much of the fine sediment beyond the limits of the quadrangle, leaving in the river bottoms a loose deposit of great agricultural richness. Much fine walnut timber has been obtained from these alluvial bottoms, and they are now largely under cultivation.

Stream deposits.

Soils.—In a glaciated region such as the Danville quadrangle, considerable variation in the character of the soils is to be expected. A mixture of several kinds of rocks of all degrees of coarseness could scarcely develop a uniform soil, such as results from the disintegration of but one rock formation. Any one class of soil is therefore liable to show considerable variation. As to classes, the soils may be separated into (1) silt or clay soil, (2) sandy soil, (3) gravelly soil, and (4) bowlder-clay soil. Silt or clay soil is found not only where the bowlder clay is covered with a silt deposit, but also along the bottoms of some of the valleys. Sandy soil is generally confined to the valleys or their immediate borders. Gravelly soil appears on the slopes of some of the kames, as well as on portions of the terraces and bottoms of the valleys. Bowlder-clay soil characterizes much of the Bloomington morainic belt and the portions of the bordering plains where surface silt is very thin or is wanting.

The kind of vegetation which has occupied a region also seems to have considerable effect on the soil. The soils in a prairie region, being comparatively unprotected from frost action and from sunlight, are made loose from the heaving that results from freezing and thawing, while those in the forest, being protected by a coating of leaves and kept in the shade, not only suffer less heaving and loosening, but even become "puddled" or more compact as a result of this protection. It is thought that this quadrangle affords a striking illustration of the effect of vegetation on the soil. The prairie portion has a comparatively open soil, into which humus has penetrated to a depth of several inches, giving it a rich black color, while the forest-covered portion, even though formed apparently from the same kind of deposit, is much more compact and has so little humus in its soil that it presents at the top an ashy or pale-gray color and changes to brown or yellow at much less depth than the prairie soil.

Effect of vegetation on soils.

In respect to fertility the entire quadrangle, with the exception of a few gravelly or sandy strips, possesses a productive soil. The upland silt and the valley alluvium, as well as the bowlder clay, seem to be sufficiently varied in rock constituents to furnish all that is needed on the mineralogical or chemical side. But in the matter of porosity, which is a very important factor in determining fertility, the prairie portions of these several classes of soil have the advantage, and command a higher price. A map showing the distribution of the forest and prairie is therefore a better guide to the fertility of the soil than the geologic map, which shows the several classes of drift found at the surface. It should be stated, however, that, owing to the tendency to heave by freezing and thawing, the soil of the prairie district is not so well adapted to the growth of winter wheat as that which was occupied by the forest. Fruits of the orchard and the garden and vegetables have been grown with success on the prairie as well as on the forest-covered portions. The growth is generally more rank on the prairie, but in amount and quality the fruit is not superior to that of the wooded portion. Indeed, it is thought that the rankness of growth has a disadvantage in the case of trees, by rendering them more liable to winter killing. In general it may be said that, for crops which mature in a single season, the prairie is more productive than the wooded tracts, but for those which must be carried through the winter the latter is preferable.

A productive soil.

Vegetation.—This quadrangle is situated on the border between the forest-covered region of the eastern United States and the great prairie of the interior. This border is irregular because of strips of forest which extend along streams for long distances into the prairie region. The quadrangle embraces such a strip of forest that extends northwestward from the Wabash along the Vermilion and its main tributaries about to the west border of Vermilion County, Illinois. The great prairie lies on either side of this strip of forest and extends eastward nearly to the Wabash River, in Warren and Vermilion counties, Indiana.

The distribution of forest and prairie within the quadrangle, as determined by the Government Land Survey, is as follows: The prairie covers about 42 square miles in the southwestern portion, about 13 square miles in the northwestern, and about 45 square miles in the northeastern, amounting to about 100 square miles, and leaving about 128 square miles of forest within the quadrangle. The greater part of the forest originally consisted of oaks of various kinds, but largely of white oak. There were, however, strips of walnut, poplar, and elm along the river valleys and also on the borders of the prairie. The part of the Bloomington morainic belt east of North Fork was largely occupied by walnut, but the part west of North Fork carried a mixture of oak with walnut, poplar, elm, etc. Only a small part of the walnut and poplar now remains, as most of the trees have been cut and converted into lumber. Much of the oak has been cleared for firewood and also for lumber, and a large part of the original forest area is now under cultivation.

Forest and prairie.

MINERAL RESOURCES.

COAL.

The principal mineral resource of this quadrangle is coal. Three or more beds are known to underlie this territory, but it is probable that only two of these are of sufficient thickness to be classed as workable. These beds are locally known as the Danville or No. 7 coal and the Grape Creek or No. 6 coal. The areas of best development of these coal beds do not coincide, and it is a popular saying in the vicinity of Danville that where one is of good thickness and quality the other is too thin to mine or too impure to put upon the market.

Danville coal.—The Danville coal lies from 20 to 80 feet above the Grape Creek bed and its probable extent is shown on the Economic Geology sheet. Owing to the deep cutting of Vermilion River in pre-Pleistocene time, this coal bed is confined principally to the southwestern half of the quadrangle. In the southern part of the quadrangle the eastern limit of the coal is along a somewhat irregular line extending from a short distance east of Georgetown to Danville. This limit was determined by pre-Pleistocene erosion. Since that time the ice sheet has extended down from the north across this territory several times, grinding down the highest points, filling the inequalities, and leaving the surface with little resemblance to its former appearance. At present there is no indication on the surface of the eastward extent of the Danville coal, but its presence has been determined by numerous test holes drilled in search of the lower coal.

From the point where the Danville coal bed shows in the river bluffs, a short distance below the Wabash Railroad bridge, its outcrop may be traced continuously up the Salt Fork to near the mouth of Butler Branch, where it dips slightly beneath the level of the river, but it reappears in the bottom of the river in sec. 17, T. 19 N., R. 12 W. From this point it continues just above water level to the margin of the quadrangle. It is entirely beneath water level on Middle Fork, but it has been reached in a number of places by mines and prospect holes as far north as sec. 31, T. 21 N., R. 12 W.

At Danville this coal bed is exposed all along the river front in the southwestern quarter of the city, but in passing toward the northeast it soon disappears, having been cut out in the formation of the old pre-Glacial valley of Vermilion River. This coal was once worked by stripping near the waterworks and also at the mouth of Hungry Hollow, but so far as known it extends no farther north along this stream. Little information is available regarding the occurrence and condition of this coal bed in the deeply drift-covered region between North and Middle forks. Its approximate northeastward limit is shown on the map, but the exact position of the boundary line in secs. 15, 22, 23, 26, 35, and 36, T. 20 N., R. 12 W., has never been ascertained. Coal has been reported from a number of deep wells in Blount and Newell townships, and while these beds can not be connected with any degree of certainty, it seems probable that they belong to this horizon. They will be described later in the discussion of the thickness of the Danville bed.

The Danville coal is thin along the southern margin of this quadrangle, consequently it has not been well prospected. Below Georgetown it is reported to have a thickness of about 3 feet 6 inches. West of this point and near the station of Riola it is said to be only 2 feet in thickness. From the evidence available it seems to be not over 3 feet 8 inches in thickness as far north as Westville. At the Pawnee mine it has a thickness of 5 feet, but the coal is impure and of little value. Professor Bradley reports this coal bed as showing at Lafferty's bank, on Grape Creek, with a thickness of over 5 feet. The exact location of this bank is not known, but an old opening was observed near the public road in sec. 32, T. 19 N., R. 11 W., that is undoubtedly upon this coal bed and is probably the one referred to by Professor Bradley. From this point north to Danville it holds a thickness of about 6 feet, as shown by several test holes and by the old mine at Vandercook. It is now almost impossible to see this coal in the vicinity of Danville. It has been extensively stripped in this region and now its outcrop is marked by heaps and ridges of refuse, but the coal itself is not visible. This coal has been mined and prospected along Salt Fork from Danville to Butler Branch. Throughout this distance its thickness is about 6 feet. A short distance above Danville an opening was observed which measures 6 feet 2 inches. Farther up the stream a cliff exposure shows the following section:

Section of Danville coal on Salt Fork.

	Feet.	Inches.
Coal	5	6
Bone		1
Coal, blacksmith		9
Total	6	4

The Danville coal has been opened at two points on Butler Branch, where it is reported to have a thickness of 6 feet in each case. On Salt Fork near the western edge of the quadrangle it is reported to have a thickness of from 5 feet 6 inches to 6 feet. On Salt Fork a mile or two above this territory there are extensive strippings where the coal runs about 6 feet in thickness.

In passing up Middle Fork this coal bed dips rapidly to about 80 or 90 feet below water level in sec. 5, T. 19 N., R. 12 W. A little west of this section and beyond the limit of the quadrangle there is a mine in which the coal is reported to average about 5 feet 6 inches in thickness. From this point it rises to about 50 feet below water level in the northeast quarter of sec. 29, T. 20 N., R. 12 W. At this point it is reported to have a total thickness of about 6 feet, with a thin parting of slate, about one-fourth of an inch thick, above the blacksmith coal, which ranges in thickness from 5 to 6 inches. In the next section north this coal is reported to have a thickness of 6 feet and to lie 90 feet below water level. In sec. 16, T. 20 N., R. 12 W., it is reported with the same thickness and about 20 feet lower than at the last-described place. In this region the coal is very irregular in altitude; it seems to lie in rolls or waves. Beyond the last-mentioned locality there has been some coal reported, but it is doubtful whether it is the Danville coal bed.

Coal has been struck northeast of Danville in several wells which have penetrated the rock to depths of 20 or 30 feet. None of the wells have gone below the coal bed, hence it is difficult to say to what horizon it belongs. It ranges in altitude from 450 to 490 feet above sea level. Its position is therefore intermediate between the Danville coal as it shows in the city and the coal bed reported from the deep well (see fig. 7) at Danville Junction. If it is the last-mentioned coal, the strata rise toward the northeast, and if it is the former or Danville coal, they dip in that direction. South of the river the rocks and associated coal beds are almost free from undulations, but upon passing up Middle Fork the Danville coal dips rapidly, so that in sec. 5, T. 19 N., R. 12 W., it is almost 100 feet lower than at the mouth of Butler Branch. It seems probable that this synclinal depression extends in an east-west direction; if it does, it is probable that it has depressed the Danville coal to the level indicated northeast of Danville. Little is known regarding the thickness and extent of the coal in this region. In every case it has been reported from near the upper surface of the rock floor. Since the pre-Glacial rock surface is somewhat irregular, it seems probable that this coal bed has suffered extensive erosion and will be found only in isolated localities of restricted area. For this reason successful mining is doubtful; at least mining should not be attempted without thorough prospecting in advance.

Grape Creek coal.—This is the most important coal bed in the Danville quadrangle, but its best development is restricted to a rather small territory lying along the southwestern side of the old valley of Vermilion River. The eastern limit of this coal bed is sharply defined by the pre-Glacial erosion of the rock floor below the horizon of the coal. The present surface gives no indication of the limit of the coal, but this has been obtained with considerable certainty by developments in the ravines which cut deep enough to reveal solid rock, and by numerous prospect holes drilled in search of the coal. In the valley of Grape Creek and in general along Vermilion River from Grape Creek nearly to Danville this coal shows in outcrop in so many places that it may be said to show continuously. Beyond the point indicated the coal can be seen in a number of places, but it is generally thin and has received little attention. The area of workable coal can not be accurately delimited with the data at hand, but it is represented approximately by the heavy shading on the Economic Geology sheet.

Near Riola station this coal is reported to be 6 feet 4 inches thick. East of Georgetown it was found 84 feet below the Danville coal, and with a thickness of 5 feet 2 inches. In this quadrangle it holds an almost constant thickness of over 5 feet as far north as the Wabash Railroad. The reported measures in this territory range from 4 feet 9 inches to 9 feet. It is the prevailing opinion that the best coal lies in the eastern half of the territory described, and all but one of the large mines are located in that section. Many test borings in the western part of Georgetown Township and the southwest corner of Danville Township show a body of fine coal, generally over 6 feet thick, running with great regularity in thickness and composition throughout the area. The exact line upon which this coal thins below workable proportions is not known, but it passes south of Vandercook and north of Catlin. At the former locality the Grape Creek coal is reported to have shown a thickness of 2½ feet in the deep shaft which was sunk there several years ago. South of this place it thickens rapidly to nearly 9 feet in a distance of 1¼ miles. At Catlin its average thickness is reported to be about 6 feet 6 inches. North of this point no section of this coal bed has been obtained until Butler Branch is reached, within 1 mile of Salt Fork, where it has been penetrated by the drill 22 feet below the Danville coal and 2 feet in thickness. Here again is a reduction in thickness of over 4 feet in about 1½ miles. The exact limit of workable coal can not now be determined, but the heavy shading on the Economic Geology sheet shows approximately the area underlain by coal of workable thickness.

The westward dip of the rocks carries this coal nearer and nearer the waters of Salt Fork west of Danville, until, near the eastern edge of sec. 12, T. 19 N., R. 12 W., it dips below the level of the stream, but it reappears in sec. 11 and extends for nearly half a mile at about the level of the water. Above this point it is not known at the surface in this quadrangle. In thickness and section the coal is variable along this stream. About due north of Vandercook it was seen in one outcrop 40 inches in thickness, and in another it gives the following section:

Section of Grape Creek coal on Salt Fork.

	Feet.	Inches.
Dirty coal	1	
Coal	1	8
Shale		2
Coal	2	5½
Total	5	3½

On North Fork this coal bed continues thin as far as it is known. Its normal section is about 25 inches, as is shown in an outcrop directly west of the waterworks. Generally over the northern half of the quadrangle there is no information regarding the Grape Creek coal. It may be present over much of this territory, but judging from the form and size of the area of known workable coal it seems probable that it is not of commercial importance north of Danville.

Coal mines.—There are several very extensive coal mines in this quadrangle. In the early days of the development of this field the Danville coal supplied the bulk of the output, but in recent years the production from this coal bed has diminished and the Grape Creek bed has decided preeminence in coal production in Vermilion County.

According to the report of the State Inspector of Mines for 1898, Mine No. 2 of the Kellyville Coal and Coke Company, located at Kellyville, had an output for that year of 248,872 tons, ranking second in the State in point of production; and Mine No. 3 of the same company, located at Westville, is credited with a production of 235,220 tons and is given fourth rank in the list of State mines. The Pawnee mine, located in sec. 5, T. 18 N., R. 11 W., and the Himrod mine, in sec. 9, same township and range, are the property of the Himrod Coal Company, which stood second only to the Kellyville Company in the coal production of Vermilion County in 1898. Other large operators on the Grape Creek coal bed are the Westville Coal Company, located 1 mile southwest of Westville; the Catlin Coal Company, operating at the town of the same name; and the Brookside Coal and Mining Company, on Grape Creek.

The largest mining plant in operation on the Danville coal bed is that of the Economy Coal and Mining Company, 2½ miles west of the city of Danville. On Salt Fork just above the western limit of this quadrangle is a large mine on the Danville coal, and there is also one near the west line of sec. 5, T. 19 N., R. 12 W. In sec. 29, T. 20 N., R. 12 W., a mine equipped with steam hoisting apparatus is operating on the same coal, but it has no railroad connection, hence its output is limited to the demands of the surrounding region.

In addition to the above-described mines, which have a large output and are equipped with steam hoisting apparatus, there are a great number of small mines on both coal beds, worked by hand or horse power. In the early development of this region most of the coal was gained by stripping the soil and rock from above its outcrop. In the vicinity of Danville almost the entire line of exposure of the coal has been thus extensively worked. The most available strippings have been exhausted, and now the amount of cover is generally too great to warrant its removal, but a great many small shafts and slopes have been opened for the purpose of supplying the local trade. Most of such mines are transient enterprises, working this year and abandoned next; hence their location upon the map is not of very great importance.

Several small mines have been operated on the lowermost coal of the series on Coal Branch, but the bed is so badly broken by partings of black slate as to have little importance, especially in the immediate vicinity of the fine body of coal of the Grape Creek bed.

CLAY.

The glacial clays of this quadrangle have been extensively used in the manufacture of drain tile. The level prairie lands of this region are very much improved by underground drainage, and there has been a strong demand for tile for this purpose. These clays, which abound almost everywhere, have been found to make excellent porous tile, and plants for its manufacture have been established at a number of places.

At Danville a company is engaged in the manufacture of vitrified brick, the raw material for which is obtained from a bed of sandy shale that outcrops at the foot of the bluff on the point between Salt and North forks of Vermilion River.

GRAVEL.

The surface clay and soil of this region form very bad roads in wet weather unless they are macadamized with broken stone or gravel. The former can be obtained here only by shipment, hence the latter is the main dependence.

The gravel in the terraces of the Vermilion Valley in and below Danville is generally rather fine for road ballast, though several pits have been opened for procuring that material. Those now drawn from are mainly on the east side of Stony Creek near the mouth of Lick Creek. In some places the sandier parts of the deposits have been screened for plasterers' use. An extensive pit of this sort is opened just north of the mouth of Lick Creek.

A gravel suitable for road ballast has been found on the south side of the east-flowing portion of Vermilion River above Danville, one large pit being opened about a mile northwest of Vandercook and another opposite Batestown.

The only kame that has been opened extensively for gravel is "Sandusky Hill," south of Catlin. The material is a rather sandy gravel. Slight excavations in other kames have shown a material too sandy for road ballast.

UNDERGROUND WATER.

Shallow dug or open wells.—The most common wells within this quadrangle are the open or dug wells. They usually have a diameter of 3 to 5 feet and a depth of 10 to 35 feet. In many cases they strike a bed of water-bearing sand or gravel which has sufficient extent to afford an adequate supply of water for household or farm use in the driest seasons. But in parts of the quadrangle the wells find only weak veins of water, either in bowlder clay or in sand or other assorted material, and consequently are not to be depended upon in the dry seasons. The wells which penetrate only bowlder clay are naturally much weaker than those which strike beds of sand or gravel. Their supply comes from the absorption or collection of the ground water in the immediate vicinity of the excavation, while wells which strike sand or gravel are likely to have wide absorption areas.

Throughout much of the southern half of the quadrangle the shallow wells are sufficiently strong to meet the needs of the residents, and deeper wells are comparatively rare. But in the northern half, especially along the Bloomington morainic belt, they have been to a great extent supplanted by tubular wells 50 to 200 feet in depth. The subjoined table will illustrate these statements.

In the city of Danville there are two classes of shallow wells, each of which is somewhat different from the wells on the uplands. One class is located in the gravel terrace between Stony Creek and Vermilion River and penetrates sand and gravel from top to bottom, while the other class is located in Stony Creek Valley and penetrates till before entering sand and gravel. They are each 20 to 30 feet in depth.

The water in the shallow wells is ordinarily sufficiently free from contamination to be wholesome and safe for household use. It is also sufficiently free from sulphur, salt, and other objectionable matter to be of pleasant taste, but it is, as a rule, rather hard. These wells are liable to contamination when they are situated in barnyards, or when, as is often the case, the housewife empties the kitchen slops near them. In some cases the wells receive these slops without much filtering. Perhaps the greatest danger from contamination is found in the city of Danville. The wells which obtain water at the base of the gravel on the terrace are still largely used in the southeastern part of the city, but in the northern and western parts they have been supplanted, to a great degree, by the waterworks supply, which is pumped from the North Fork of Vermilion River. These abandoned wells have in many cases been converted into cesspools, and it seems probable that these are drained through the part of the city where wells are still in use. Although there are strong grounds for suspecting contamination of the wells in use, it was not learned that any sickness had resulted from such contamination.

By many citizens of Danville the present waterworks supply is also considered unsafe, because Vermilion River becomes very low in dry seasons, so that the water must be pumped from nearly stagnant pools. This has led to an investigation of available supplies from wells, and attention has naturally turned to the wells in Stony Creek Valley, just noted, some of which are very strong. An objection urged to the use of these wells is the presence of a large cemetery within half a mile up the creek from the best wells, though on the opposite bluff. At the cemetery there are gravel deposits 10 or 15 feet in depth, from the base of which springs issue into Stony Creek Valley. But as a compact clay sets in above the level of the creek bed and extends some distance below it, separating the surface gravel from the water-bearing gravel in which these wells are found, the latter may not be contaminated by cemetery drainage. It is probable also that nearly all of the cemetery drainage escapes along the creek, so on that account, even if there were no clay cover for the lower gravel, there would be only a slight chance of contamination from that source. The chances certainly seem to be very much less than of the contamination of wells in the southern part of the city by the cesspools in the northern part. It is unfortunate that the cemetery site should have been located on the upstream side of the city, where it would suggest a source of contamination, for perhaps no other adequate supply from wells will be found within a convenient distance.

Tubular wells.—The supply from this class of wells depends scarcely at all upon the ground around the well mouth. They are usually so deep as to be independent of local or even of seasonal rains. Commonly their supply is derived from deposits of gravel or sand which are interbedded with the sheets of till, but in some cases they extend into the underlying Coal Measures before striking water. They are supposed to be fed from surface outcrops of the water-filled beds in localities not far distant, or, in the case of wells in rock, through joints or other openings in the overlying drift deposits. They usually show a marked rise above the level at which water is struck, and in a few cases they overflow.

Since these wells are apparently supplied from water which has been absorbed in the region near that in which they are located, it might be supposed that they would be more seriously affected by seasonal variation in the rainfall. They seem, however, to be in a zone of saturation, so far beneath the surface that no droughts can reach them, unless greater aridity should become prevalent. The water may be in many cases several months, or even years, in passing from the surface of the ground to the beds in which the wells are found. This seems to be indicated by the amount of mineral matter which the waters carry in solution. In most of the wells the water, besides being hard, is somewhat chalybeate, slightly sulphurous, and slightly saline. It is often called "mineral water" to distinguish it from the water of the shallow wells, in which hardness is the only mineral property that is noticeable. An analysis of water from one of the tubular wells at Potomac, Illinois, a few miles north of the Danville quadrangle, made at the laboratory of the University of Illinois, shows that chlorine in the form of chlorides forms 29 parts per million of the water. This is pronounced by the analyst to be in no way due to contamination, and is, in all probability, taken up, like the lime and iron and sulphur, from the stony material of the water-bearing beds.

The water from one tubular well located within the Danville quadrangle has been shipped for medicinal purposes. The well, known as the "Henrietta Springs," is on a farm about one-half mile south of Snider post-office. Its depth is only 75 feet, and the water does not overflow. So far as known, no analysis has been made, but the water is strongly chalybeate. The present owner, J. Marbles, reports that no sale has been made for some time, as the well is inconveniently located for shipping water. The well may probably be duplicated at many points in that region, and its notoriety is due to advertising the beneficial effects which certain invalids have thought resulted from the use of the water. The water from these tubular wells appears to be as wholesome as that from the shallow wells, and the occurrence of this strong supply of water in parts of the quadrangle where shallow wells are difficult to obtain is a great boon to the residents.

Dr. Arthur W. Palmer, Professor of Chemistry at the University of Illinois, has made several hundred analyses of water from such wells as appear in the Danville quadrangle, and reports as follows concerning the water of shallow and tubular wells.*

> In appearance and in palatability the two classes of water present marked differences The waters from shallow wells are well aerated, and are clear, sparkling, cool, and of agreeable taste; those from the deeper wells, on the other hand, contain little or no oxygen, possess in many cases a disagreeable taste due to the presence of marsh gas, accompanied occasionally by minute quantities of sulphuretted hydrogen, and are either turbid or become turbid quickly on exposure to air, owing to the oxidation of the iron carbonate which they contain and the consequent precipitation of insoluble ferric compounds. The precipitating particles are often so minute as to be at first indistinguishable except from the color which they impart to the water, and after a short exposure to the air the water becomes opalescent, then decidedly turbid; finally a brown deposit similar to iron rust is produced, and after this has separated the water becomes clear and colorless. Although these unpleasant characteristics of the deep drift waters give rise to much prejudice and objection to their general use for drink, nevertheless, from the sanitary standpoint, they are usually to be preferred to the clear and palatable waters of the shallow wells, since the evidence of numerous analyses shows that they are far less subject to pollution with refuse animal matter than are the latter.

The tubular wells which obtain a supply from the Coal Measures are comparatively few and the water is generally not so hard as in the wells obtained from the glacial drift. The strongest wells of this class of which information was obtained are situated in secs. 21, 22, and 23, T. 20 N., R. 11 W., about 3 miles northeast of Danville, but weak ones are distributed over all parts of the quadrangle, as may be seen by reference to the subjoined table. The Coal Measures ordinarily contain, in their upper portions, rather compact shale instead of porous sandstone, and are therefore not a promising source of water supply.

A great majority of the tubular wells within this quadrangle are located on the Bloomington morainic belt, nearly every section on that belt now carrying one or more of them. There are also a few such wells south of the Bloomington belt, in Danville and its vicinity, and in the eastern part of the quadrangle, and a few in the southwestern part. Statistics concerning a large number of these wells are given in the table which follows.

Many of the tubular wells are reported to be very strong, but their capacity has seldom been measured. Some wells are decidedly weak, so that the owners are obliged to use care in preventing the windmills by which their water is usually drawn from causing a waste of the supply. Their weakness differs from that of the shallow wells in being constant instead of being confined to seasons of drought. While most of the wells are adequate to supply the needs of a small stock farm, it is doubtful if many can be found whose capacity would be sufficient to supply the city of Danville, or even such an institution as the Soldiers' Home, located near there. At the time work was begun on the Soldiers' Home several wells were sunk on the grounds, but, though they were pronounced strong by the well driller and would supply the needs of a farmer, they were entirely inadequate for the demands of the Home. They are far weaker than one of the shallow wells in Stony Creek Valley at Danville, which, as indicated by the table below, shows no sign of exhaustion when pumped at the rate of 750 gallons a minute.

*Chemical Survey of the Water Supplies of Illinois; Prel. Rept. to University of Illinois, 1897, pp. 52–53.

Flowing wells.—Flowing wells from the drift are obtained in large numbers in neighboring parts of eastern Illinois, but only a few have been obtained within the limits of this quadrangle. The village of Myersville, situated in the North Vermilion Valley, about a mile north of the north boundary, has several wells 145 to 156 feet in depth, which overflow, in some cases at a rate of 12 to 15 gallons per minute from a pipe with orifice only 1¼ inches in diameter. At the village of Potomac, a few miles from the northwest corner of the quadrangle, there are about 100 flowing wells, some of which will flow 60 gallons a minute, and it is estimated that 100 more have been obtained on farms in the vicinity of that village. There are also flowing wells in southern Vermilion County, Illinois, only a few miles south of the quadrangle.

The only flowing wells from the drift within the limits of the quadrangle, so far as learned, are a few near its northern edge, in the valley of North Vermilion River, and some very shallow fountains in ravines on the farm of W. P. Smoot (sec. 23, T. 20 N., R. 12 W.), in the midst of the Bloomington morainic belt. A flowing well in the valley of Middle Vermilion River, in sec. 5, T. 20 N., R. 12 W., is scarcely one-fourth of a mile west of the border of the quadrangle. Only one of these wells exceeds 100 feet in depth, that of Allen Wood, in North Vermilion Valley. Three others are about 50 feet, and the remainder but 15 to 35 feet, in depth. Those which are but 15 to 35 feet in depth may be fed from the immediate vicinity of the wells; but the deeper ones, like the tubular wells above described, seem to be fed from more remote sources. Indeed, wells of this class apparently differ from the ordinary tubular wells simply in being located at a sufficiently low altitude to permit a flow. In most cases the head is no greater than that of wells on higher ground which do not overflow. The question of head, therefore, pertains to both classes of wells, and may be next considered.

By reference to the subjoined table it will be seen that the head shown by the wells presents considerable variation, though there are areas several square miles in size in which it is very uniform. In the northern part of the quadrangle, and also for several miles farther north, the water usually rises to about 680 feet above tide; but in the valleys of Middle and North Vermilion rivers it is markedly lower. In the Bloomington morainic belt there is much variability, the range in the head being from about 690 feet down to 580 feet or less. As in the plain north of the morainic belt, the head is generally lower near Middle and North Vermilion rivers than at points some distance back from these streams. But there are instances of very low head some miles back, in the midst of districts where wells show much greater head. On the nearly level tract south of this morainic belt the head in the part west of Big Vermilion River shows a general increase from north to south, being but 635 to 640 feet just south of the morainic belt, while it is 665 to 670 feet in the southern part of the quadrangle. A few miles farther south, on the slope of the main ridge of the Champaign morainic system, it reaches 680 feet. The head in the portion of the plain east of Big Vermilion River shows a decrease instead of an increase in passing from north to south, being about 635 feet near the southern border of the Bloomington morainic belt and scarcely 620 feet in the southeastern part of the quadrangle.

In parts of the drift-covered portion of eastern Illinois the variations in head may be readily explained by nearness to or remoteness from the gathering ground. Such is the case in the great field of flowing drift wells found in Iroquois and Ford counties, the largest field of this kind in the State of Illinois. The water-bearing beds slope with the surface of the ground, away from the moraine which constitutes the chief area of intake, and their head becomes gradually less upon receding from the moraine. This explanation may apply to a portion of the Danville quadrangle, especially that lying south of Salt Fork and west of Big Vermilion River. It is probable that that area is fed by waters which are absorbed in the somewhat elevated Champaign morainic belt in the southern part of Vermilion County, and that the course of underground drainage is northward, in harmony with the surface slope. Some loss of head would result through friction in the underground passage. But it is thought that the loss of head may be due in the main to the drainage into the main valleys, Salt Fork and Big Vermilion River, for both of these streams cut entirely through the drift deposits.

In the portion of the quadrangle east of the Big Vermilion River, the decrease in the head, though in the opposite direction from that west of the river, is like it in being toward the main drainage lines and suggests that it is due to the discharge of water into the Big Vermilion and Wabash valleys, both of which have been cut through the drift into the underlying rock.

In the northern part of the quadrangle there seems to be a slight drawing down of the head in the vicinity of North and Middle Vermilion rivers, and this, as in the southern half of the quadrangle, may be due to the escape of the underground water into these valleys. The apparent influence of these valleys in depressing the head is shown in the accompanying sketch, fig. 2, which crosses a portion of the quadrangle from east to west near its northern border. The absorbing area for the northern part of the quadrangle probably extends from the Bloomington morainic belt northward, for, owing to the depth of Salt Fork Valley, the water absorbed in the southern part of the quadrangle can hardly be supposed to cross this valley into the northern part. Possibly this northern portion of the quadrangle lies also in the line of underground drainage from the somewhat elevated morainic belts in the northern part of Vermilion County. This suggestion does not, however, imply that the underground water beds have a southward dip or slope, but simply that, the nearest lines of escape for underground waters being southward, the accumulated waters may work toward the outlets, the hydrostatic pressure being sufficient to carry them over the inequalities found in the line of escape. The great strength of the flowing wells in the vicinity of Potomac, Illinois, at the southern border of one of these morainic belts, seems to support the view that the chief absorbing area is on the north rather than in the more distant morainic belt on the south. The gradual decrease in head in passing southward from Potomac down the Middle Vermilion Valley may be attributable to the southward escape of the underground water into that valley.

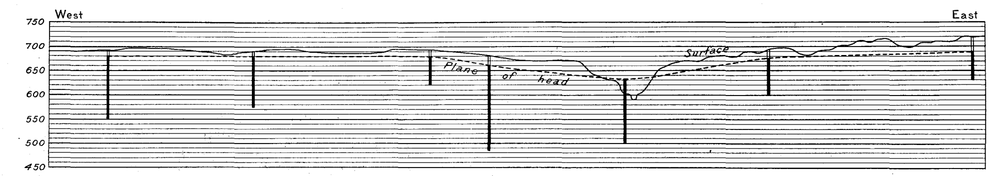

FIG. 2.—SECTION ACROSS A PORTION OF THE QUADRANGLE NEAR THE NORTH BORDER.
The heavy vertical lines indicate the heights to which water rises in wells, and illustrate the depression of the plane of head in the vicinity of Vermilion River.
Figures at the left refer to elevation (in feet) above sea. Horizontal scale same as map.

The very low head which is shown by some wells in the midst of the Bloomington morainic belt at points remote from the North and Middle Vermilion rivers may be difficult to explain. Defective work by the well driller is likely to account for some of this lack of head, for much depends upon the skill of the well driller in selecting the proper position for the pump strainer. It is not improbable, however, that the low head may in some cases be due to the peculiar arrangement of the water-bearing beds. The fact that the low head is found in the morainic or jumbled-up portions of the drift to a far greater degree than in the plain or less disturbed portions, at least suggests that a disturbance or a lack of continuity of the water-bearing drift beds may cause the low head.

The question whether there is a difference of head displayed by water veins from different beds in the drift has been considered, but the data relative to the head are seldom sufficiently precise to throw light on the matter. The most precise data found relate to an area lying outside the quadrangle, in the Potomac flowing-well district. A well in Potomac, on the property of W. C. Mesner, struck a water-bearing bed at 85 to 96 feet which has a head 18 inches above the well mouth, and another at 127 feet which has a head 6 feet above the well mouth. It is reported by citizens of Potomac that several other wells show a similar increase in passing from the upper to the lower vein of water. It is apparent that so slight an increase as is here shown would scarcely be detectible in wells which do not flow, and would be of little or no advantage unless a flow depended upon it.

The comparative head of wells terminating in the drift beds and those terminating in subjacent rock strata has also been considered, and it is found that the difference in head is usually very slight in neighboring wells of the two classes. The wells of moderate depth in rock, if near a deep drainage line, seem to be affected by it to about the same degree as wells that terminate in the drift. Referring to the table below, it will be seen that wells in sec. 5, T. 18 N., R. 10 W., and sec. 13, T. 18 N., R. 11 W., which are near stream valleys, show a much lower head than wells in sec. 13, T. 18 N., R. 12 W., and sec. 17, T. 19 N., R. 10 W., which are several miles distant from any deep valley. It is probable that the wells of this class obtain much of their supply by percolation of water from the drift into the rock, and if so the head should be essentially the same as in wells that terminate in the drift.

Two deep borings have been made at Danville, one in North Vermilion Valley to a depth of 1250 feet, the other at Danville Junction near the corner of Collett and Wellington streets. A flow of brackish water was obtained from the one in North Vermilion Valley, but the one at Danville Junction, being on ground about 80 feet higher, did not obtain a flow. The precise head of either well was not ascertained, though it seems to be but little above the level of the well in the valley, 530 feet. No use is made of either of the borings.

Tabulated well data.—In the table which follows, but few logs of the wells are given, for the reason that nearly every well is reported to have been sunk mainly through bowlder clay until the water-bearing bed was struck. Where weak water veins are known to have been struck at higher levels than the main vein, note is made of them in the table. In nearly all cases the main vein is very near the bottom of the well. In many cases no information could be obtained as to the kind of material in which the water is found, but where wells are strong it may safely be assumed that it is in sand or gravel. Where the head or the depth is only approximately known that fact is indicated in the table. In many wells these were determined with considerable precision at the time the windmill was attached.

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December, 1900.

TABULATED DATA CONCERNING WELLS IN THE DANVILLE QUADRANGLE.

COMPILED BY FRANK LEVERETT.

[Approximate depths and altitudes indicated by the letter a.]

LOCATION, OWNER, ETC.	ALTITUDE.	DEPTH.	HEAD.	WATER-BEARING BED.	REMARKS.
	Ft. above tide.	*Feet.*	*Ft. above tide.*		
T. 21, R. 10 W. Sec. 23, east part	720	120	680a	Gravel.	Reported by George Logan, well driller.
T. 21, R. 10 W. Sec. 24, west part	710	107	680a	Gravel.	Reported by George Logan, well driller.
T. 21, R. 10 W. Sec. 26, Wm. Kizer	690	50	680a	Sand.	Reported by George Logan, well driller.
Same section, Mrs. Mary Kizer	730	78	680a	?	Reported by owner.
Same section, W. J. Ashby	730	72	680a	?	Reported by owner.
T. 21, R. 10 W. Sec. 27, north part	730	142	680a	?	Reported by tenant.
T. 21, R. 11 W. Sec. 19, (Myersville and vicinity, several flowing wells).	630 640	145 156	650	Gravel between till.	Weak water veins at about 60 and 100 feet, main supply from near bottom. Water chalybeate and hard. Rate of flow reaches 12 to 15 gallons per minute from 1¼-inch pipe in the best wells, at altitude 640 feet A. T.
T. 21, R. 11 W. Sec. 20, Noah Young	680	175	660a	Sand.	Situated on upland plain.
Same section, Noah Young	650	80	660	Sand.	Well overflows, a weak stream.
Same section, Grant Wilson	680	188	660a	Sand.	Reported by George Taylor, well driller.
Bismarck, George Taylor	655	170	660	Sand between till.	The well penetrates: (1) Alluvium, 5 feet; (2) blue till, 35 feet; (3) reddish sand, with a flow of water, 40 feet; (4) blue clay, 90 feet.
Bismarck, S. W. Claypool	674	181	660	Sand and gravel.	Water from sand and gravel near bottom, below blue till.
T. 21, R. 11 W. Sec. 26, W. Burnside	700	75	680	Sand and gravel.	Reported by George Taylor, well driller.
T. 21, R. 11 W. Sec. 27, F. Starr	690	73	670	Sand and gravel.	Reported by George Taylor, well driller.
Same section, A. Cass	690	96	?	Sand.	Mainly till; weak veins at 35 to 40 feet.
T. 21, R. 11 W. Sec. 28, Ira Ingram	685	90	673	Gravel.	Mainly till. Reported by George Taylor.
T. 21, R. 11 W. Sec. 30, Allen Woods	615	110	633	Sand.	Weak flow; drift mainly till.
Same section, Leonard farm	635	180	?	?	Coal at 140 to 145 feet. Reported by A. Woods.
Same section, John Furay	660	130	?	?	Head much below surface. Reported by owner.
T. 21, R. 11 W. Sec. 33, J. I. Cunningham	690	70	670	?	Reported by George Taylor, well driller.
Same section, Z. Deck	690	70	670	?	Reported by George Taylor, well driller.
Same section, John Campbell	690	90	?	?	Reported by George Taylor, well driller.
Same section, Daniel Cox	680	100	655	?	Reported by George Taylor, well driller.
T. 21, R. 11 W. Sec. 34, W. Norse	720	94	680a	?	Reported by George Taylor, well driller.
Same section, George Huffman	710	77	676	?	Reported by George Taylor, well driller.
Same section, George Huffman	740	110	?	?	Reported by George Taylor, well driller.
Same section, Mrs. Starr	710	70	?	?	Reported by George Taylor, well driller.
T. 21, R. 12 W. Sec. 25, Prior Woods	630 630	44 16	635 635	Gravel below till.	Two wells with head 5 or 6 feet above surface, and moderate flow.
Same section, Allen Woods	675	195	669	Gravel at 60 feet.	Water supply is from a depth of 60 feet; shale and coal at about 160 feet.
Same section, Leonard farm	680	126	660	Gravel.	Information by tenant.
T. 21, R. 12 W. Sec. 26, Andrew White	690	72	678	Sand.	Information by owner.
Same section, at schoolhouse	690	72	?	Sand.	Information by Andrew White.
Same section, L. White	690	65	?	?	Information by Andrew White.
T. 21, R. 12 W. Sec. 29, V. Lane	690	100	?	?	Reported by Henry Gray, well driller.
Same section, C. Lane	690	145	676	?	Reported by Henry Gray, well driller.
T. 21, R. 12 W. Sec. 32, B. Crawford	660	255	?	?	Coal Measures shale at 105 feet; coal at about 200 feet. Water vein on same farm at 42 feet. Information by Henry Gray.
Same section, F. Crawford	670	90	657	?	Reported by Henry Gray.
T. 21, R. 12 W. Sec. 33, George Smith	690	115	680	?	Reported by Henry Gray.
T. 21, R. 12 W. Sec. 34, W. Henthorn	680	70	?	?	Reported by Henry Gray.
T. 21, R. 12 W. Sec. 36, Henry Woods	630	70	640	Gravel below till.	Well overflows. Reported by Allen Woods.
Same section, John White	630	35	640	Gravel below till.	Two wells overflow. Reported by Allen Woods.
Same section, John White	680	116	?	?	Well on upland; does not overflow.
T. 20, R. 10 W. Sec. 17, State Line, public well.	715	140a	660a	Fine sand.	Water-bearing sand too fine to screen struck at 67 feet; a coarser sand struck near bottom of well.
Same section, John Hoover	720	144	660a	Fine sand.	Fine water-bearing sand at 79 feet; coarser sand near bottom.
Same section, State Line tile factory	715	140a	660a	Sand.	Strong well from sand near bottom.
Same section, Mrs. Mary Daniels	710	90	660a	Sand.	Strong well from sand near bottom.
T. 20, R. 10 W. Sec. 18, Ephraim High	720	136	670a	Sand.	Strong well from sand near bottom.
Same section, Mrs. J. M. Adams	720	135a	660	Sand.	Strong well from sand near bottom.
Same section, John Makensom	710	144	?	?	Reported by John Hoover.
T. 20, R. 10 W. Sec. 19, O. P. Bird	710	128	?	?	Reported by John Hoover.
T. 20, R. 10 W. Sec. 20, Owen Wedgebury	700	125	?	?	Reported by owner.
Same section, Henry Clem	680	215	?	?	No hard rock was struck; drill passed through a black slush at about 165 feet. No water obtained, but a good well near by at 35 feet.
T. 20, R. 10 W. Sec. 21, Charles Adams	660	108	?	?	Strong well from sand near bottom.
T. 20, R. 10 W. Sec. 29, James Johnson	680	104	?	?	Reported by Henry Clem.
T. 20, R. 10 W. Sec. 30, Hiram Makensom	670	130a	?	?	Reported by John Hoover.
T. 20, R. 10 W. Sec. 31, Martin Currant	650	100a	625	Sand.	Reported by owner.
Same section, George Olehy	650	12	?	Gravel.	Very strong well. (Exceptional.)
Same section. Theodor Olds	650	96	?	Red sand.	Reported by Robert Brasker, well driller.
T. 20, R. 10 W. Sec. 32, Henry Radliffe	650	100a	620	Sand.	Reported by Robert Brasker, well driller.
Same section, T. D. Olds	650	105	620	Sand.	Reported by Robert Brasker, well driller.
T. 20, R. 10 W. Sec. 33, Peter Clem	650	85	645	Sand.	Reported by Robert Brasker, well driller.
T. 20, R. 11 W. Sec. 1, Austin Andrews	690	107	?	?	Reported by owner.
T. 20, R. 11 W. Sec. 3, Wm. Campbell	720	90	680	Sand.	Reported by George Taylor, well driller.
T. 20, R. 11 W. Sec. 5, Wm. White	660	140	585	?	Reported by owner.
T. 20, R. 11 W. Sec. 8, J. McGervin	660	100a	620	?	Reported by George Taylor, well driller.
T. 20, R. 11 W. Sec. 9, J. Lockport	720	126	680	Sand.	Reported by owner.
Same section, C. F. Conover	730	125	?	?	Reported by owner.
Same section, Mrs. Leonard	700	170	?	Sand.	Very weak well. Reported by owner.
T. 20, R. 11 W. Sec. 10, Mrs. Leonard	700	193	?	Rock.	Struck rock at 170 feet; very weak well.
Same section, Thomas Cox	720	120	680	Sand.	Reported by George Taylor, well driller.
Same section, Mr. Jenkins	730	125a	680	Sand.	Reported by George Taylor, well driller.
T. 20, R. 11 W. Sec. 11, Mrs. Z. Starr	710	110	670	Sand.	Reported by George Taylor, well driller.
T. 20, R. 11 W. Sec. 14, J. J. Campbell	645	90	638	Sand.	Reported by J. D. Campbell.
T. 20, R. 11 W. Sec. 15, A. Voorhees	700	144	660	Sand.	Drift in lower 40 or 50 feet is very hard. Reported by George Taylor, well driller.
T. 20, R. 11 W. Sec. 16, J. Clapp	680	65	?	Gravel.	Good well. Reported by owner.
Same section, S. Adams	680	69	?	Gravel.	Good well. Reported by owner.
Same section, A. Johnson	660	125	?	Gravel.	Good well. Reported by owner.
West part of same section, several wells	700	80a	?	?	Weak wells ranging from 35 to 80 feet in depth.
T. 20, R. 11 W. Sec. 17, Ezra Doan	660	132	620	Gravel.	Rock struck at bottom; water vein at 114 feet.
Same section, Mr. Haworth	670	135	?	Gravel.	Reported by owner.

LOCATION, OWNER, ETC.	ALTITUDE.	DEPTH.	HEAD.	WATER-BEARING BED.	REMARKS.
	Ft. above tide.	*Feet.*	*Ft. above tide.*		
Same section, near center	690	80	?	Gravel below till.	Three good wells at 60 to 80 feet.
T. 20, R. 11 W. Sec. 18, R. H. Conner	640	108	600	Gravel below till.	On gravel terrace, but penetrates till above water bed.
T. 20, R. 11 W. Sec. 19, John Phipps	690	140	600a	Gravel.	Water rises but little in the well.
Same section, E. H. Morrison	660	100	600a	Gravel.	A well near by, 28 feet deep, is much stronger.
T. 20, R. 11 W. Line of secs. 21 and 22, Philip Zorm and Joseph Phillips.	690	210	650	Sandstone.	Rock struck at 175 feet; water is soft.
T. 20, R. 11 W. Line of secs. 22 and 23, E. W. and L. P. Adams.	690	220	650a	Sandstone.	Rock struck at about 160 feet; water is soft.
T. 20, R. 11 W. Sec. 23, J. D. Campbell	650	108	636	Gravel.	Well at residence.
Same section, J. D. Campbell	680	148	?	Gravel.	Well in field
Same section, schoolhouse	680	117	?	Gravel.	Reported by J. D. Campbell.
Same section, Milton Berry	680	80	?	Sand.	Well was driven to 125 feet, but completed at 80 feet.
Same section, Perry Makensom	680	75	650	Gravel.	Well very strong.
Same section, Newell Makensom	670	60	630	Sand.	Weak well.
T. 20, R. 11 W. Sec. 24, A. N. Leneave	710	130a	?	Gravel.	Reported by John Hoover.
T. 20, R. 11 W. Sec. 26, A. Campbell	670	110	662	Gravel.	Another bored well on same farm is 85 feet and two dug wells 50 feet. The 110-foot well is the strongest.
T. 20, R. 11 W. Sec. 27, R. L. Howard	670	125	630	Sand.	Blue till, 40 feet; pink till to water vein near bottom. Another boring 170 feet found no water; it passed through a black material (shale ?) at 160 to 170 feet.
Same section, C. P. Cozatt	700	95	692	Gravel.	Reported by owner. A good well was obtained one-fourth mile north at 108 feet.
T. 20, R. 11 W. Sec. 28, Mrs. Sperry	700	117	635	Gravel.	Reported by C. P. Cozatt.
Same section, Mrs. Sperry	700	315	?	Rock.	A boring for coal entered rock at 180 feet and found coal at 210 to 220 feet.
T. 20, R. 11 W. Sec. 29, E. Winter	685	180	585	Gravel.	Reported by owner.
Same section, E. Osborn	675	183	600	Gravel and top of rock.	One water vein at 175 feet, another at 180 feet, penetrated coal at bottom of boring 6 inches
Same section, E. Raimer	700	176	580	Gravel.	Reported by owner.
Same section, J. W. Jones	665	120	620	Gravel.	Reported by owner.
Same section, W. Myers	660	190	595	Gravel	Terminated in gravel.
Same section, P. Leneave	670	128a	?	Gravel.	Reported by W. Myers.
Same section, Charles Keasler	675	128	?	Gravel.	Reported by owner.
Same section, Ira Weaver	670	65	?	Gravel.	Very strong well. Reported by owner.
T. 20, R. 11 W. Sec. 32, several wells	670a	100a	?	Gravel.	Several good wells at about 100 feet. Water mainly from 90 to 100 feet, but some from 50 feet.
T. 20, R. 11 W. Sec. 33, Jacob Hosch	700	93	?	Red sand.	Yellow till, 15 feet; soft blue till, 70 feet; red sand, 8 feet. One-fourth mile south a well has a strong supply of water at 60 feet.
T. 20, R. 11 W. Sec. 34, Andrew Hosch	690	116	?	Gravel.	Reported by Jacob Hosch.
Same section, Charles Shean	690	65	?	Gravel.	Reported by C. P. Cozatt.
T. 20, R. 11 W. Sec 35, S. T. Makensom	690	150	640	Gravel.	The upper 80 feet mainly clay, remainder sand and gravel. Well sunk deep to obtain large supply.
T. 20, R. 12 W. Sec. 1, Henry Swisher	690	150	?	?	Reported by owner.
Same section, T. A. Hoskins	690	45a	655	?	Reported by owner.
T. 20, R. 12 W. Sec. 5, Austin Juvinall	610	54	610	Sand.	Water barely rises to the surface.
T. 20, R. 12 W. Sec. 10, schoolhouse	675	155	?	?	Reported by Henry Gray, well driller.
Same section, George Beaver	675	155	635a	?	Reported by Henry Gray, well driller.
Same section, Milton Fairchild	685	77	?	?	Reported by Henry Gray, well driller.
Same section, W. Henthorn	680	70	?	?	Reported by Henry Gray, well driller.
T. 20, R. 12 W. Sec. 12, J. Johnson	660	65	?	Sand.	Boring was sunk to 165 feet without increasing supply.
Same section, Henry Finley	650	70	?	Sand.	Reported by J. Johnson.
T. 20, R. 13 W. Sec. 13, John Fugot	680	200	?	Black sand.	Stopped in black sand. A well near by got good supply of water in gravel at 75 feet.
Same section, F. Osborn	675	58	?	?	Good well completed at 58 feet after boring 70 feet.
Same section, O. B. Gravat	700	79	674	Gravel.	Reported by owner.
T. 20, R. 12 W. Sec. 14, W. B. McKinly	700	200	?	?	A poor well, but a good one 40 feet deep was obtained near it.
Same section, G. L. Fairchild	730	118	620	Gravel.	Reported by owner.
Same section, Mrs. English	700	240 75	?	Gravel.	Gas was struck near bottom in such amount that a new well only 75 feet deep was made near it.
T. 20, R. 12 W. Sec. 15, E. Cunningham	725	134	?	?	Reported by Henry Gray, well driller.
Same section, E. Cunningham	700	75	?	?	A well 75 feet deep has sulphur water, but one near by 58 feet deep has no sulphur.
Same section, Mrs. Warner	670	201	630	Sand.	Reported by Henry Gray, well driller.
Same section, J. W. Dodson	690	67	630	Gravel.	Reported by owner.
Same section, Henrietta Mineral Well; present owner, J. Marbles.	690	75	655a	Gravel.	Water chalybeate; has been sold for medicinal purposes.
T. 20, R. 12 W. Sec. 15	670 710	75 100	? ?	Sand and gravel.	Several good tubular wells at 75 to 100 feet.
T. 20, R. 12 W. Sec. 16, several wells	700a	90a	?	Sand and gravel.	Several good tubular wells at 80 to 100 feet.
Same section, Andrew Sinkhorn	670	155	?	?	Reported by Henry Gray, well driller.
Same section, coal boring	650a	203	?	?	Struck a 6-foot bed of coal at about 180 feet. Henry Gray, driller.
T. 20, R. 12 W. Sec. 21, Thomas Pierce	710	175	?	Sand.	Reported by owner that no rock was struck.
Same section, Dr. Moore	710	90	?	Sand.	Reported by Thomas Pierce.
T. 20, R. 12 W. Sec. 22, M. C. Cundoff	710	144	?	Gravel.	Strong well.
Same section, several wells	700 730	100 150	650a	Gravel and sand.	Several good tubular wells at 100 to 150 feet do not enter rock.
T. 20, R. 12 W. Sec. 23, W. Fairchild	720	195	?	Sand.	No rock struck; water bed at about 175 feet.
Same section, W. P. Smoot	700	96	680	Gravel.	Reported by owner. Shallow wells in ravines on same farm will overflow at about 680 feet A. T.
Same section, several wells	690 730	100 150	650a	Sand and gravel.	Several tubular wells from drift beds at 100 to 150 feet have head only about 650 feet A. T.
T. 20, R. 12 W. Sec. 24, Mrs. Parnell	690	95	?	?	Reported by tenant.
Same section, Jacob Radebaugh	690	80	?	?	Much gas in well. Does not reach rock.
Same section, several wells	680 710	100 130	650a	Sand and gravel.	Several tubular wells from drift beds at 100 to 130 feet.

TABULATED DATA CONCERNING WELLS IN THE DANVILLE QUADRANGLE.—Continued.

LOCATION, OWNER, ETC.	ALTITUDE.	DEPTH.	HEAD.	WATER-BEARING BED.	REMARKS.
	Ft. above tide.	*Feet.*	*Ft. above tide.*		
T. 20, R. 12 W. Sec. 25, O. G. Knight	690	144	600a	Fine sand.	Sand is so fine as to clog pump strainer; several unsuccessful well borings on same farm.
Same section, Johnson Knight	690	130	?	Sand.	Better well than preceding one.
Same section, Jacob Mead	690	147	610	Sand.	In sand below till. A well across road at Jacob Bailey's has similar section and head.
T. 20, R. 12 W. Sec. 26, several wells	680 700	75 130	610a	Sand and gravel.	Several tubular wells at 75 to 130 feet. Head is low.
T. 20, R. 12 W. Sec. 27, E. Allen	700	106 200	? ?	Gravel. Rock.	A coal boring entered shale at about 200 feet. A well was obtained in gravel at 106 feet.
Same section, Mr. Grimes's and other wells.	675	96 60	?	Gravel.	Wells on higher ground in same section are 60 to 90 feet in depth.
T. 20, R. 12 W. Sec. 35, J. S. Lee	690	115	635	Gravel.	Some good wells in this section at 75 to 90 feet.
Same section, Mrs. Lizzie Hughes	705	150	?	Gravel.	An exceptionally deep well for this section.
T. 20, R. 12 W. Sec. 36, F. Buy	690	125	590	Gravel.	Mainly through blue till. A well near by only 18 feet deep is strong.
T. 19, R. 10 W. Sec. 6, Frank Shafer	650	96	630a	Sand.	Reported by owner; mainly through blue till.
Same section, Isaac Currant	650	85	630a	Sand.	Reported by owner; mainly through blue till.
T. 19, R. 10 W. Sec. 7, Sam. Martin	650	65	637	Sand.	Strong well.
Same section, T. O. Talbert	650	60	630a	Sand.	Strong well; other good wells near at 30 feet.
T. 19, R. 10 W. Sec. 17, R. Peterson	650	182	638	Rock.	Soil and yellow till, 9 feet; gray till, 9 feet; dry red sand, 1 foot; hard, pebbly blue till, 40 feet; blue gravel with but little water, 5 feet; reddish clay, soapy, with few pebbles, 40 feet; ashy or gray pebbly clay, 10 feet; blue pebbly clay, 20 feet; reddish sandy clay, 26 feet; soft sandstone, 8 feet; shale, 1 foot; coal, 6 feet; brecciated bed, 6 feet.
T. 19, R. 10 W. Sec. 18, W. Olehy	645	140 60	635	Sand and gravel.	Deeper boring has little water; 60-foot well near by strong.
Same section, Rileysburg elevator	650	90	635a	?	Reported by William Martin.
T. 19, R. 10 W. Sec. 30, several wells	650	16	640	Sand.	Good wells at about 16 feet.
T. 19, R. 11 W. Sec. 1, schoolhouse	650	175	?	Fine sand.	Much fine sand; well is weak. Other wells near by, 20 to 30 feet in depth, are strong.
T. 19, R. 11 W. Sec. 2, S. Hancock	640	75	?	?	Reported by C. B. Brant.
T. 19, R. 11 W. Sec. 10, J. Hough	630	100	?	Silt.	Water from blue silt at 92 feet; shale struck at 100 feet.
T. 19, R. 11 W. Sec. 11, C. B. Brant	620	12	?	Gravel.	Very strong well; springs in vicinity.
Same section, Charles Schoering	640	60	610	Sand.	Well rather weak.
T. 19, R. 11 W. Sec. 12, George Villars	650	115	?	?	Reported by Robert Brasker, well driller.
Same section, George Walz	650	57	?	?	Well strong. Reported by owner.
T. 19, R. 11 W. Sec. 14, schoolhouse	630	170	?	Fine sand.	Well very weak; good well at neighboring farmhouse at 40 feet.
Soldiers' Home, near Danville	635	50a 370	615	Gravel.	Several wells obtain water in gravel below till about 50 feet. A boring 370 feet in depth obtained salt water.
Danville, Brewery	600	78 315	560 520	Gravel. Rock.	Four wells stop at top of rock; water is hard and chalybeate. Capacity each 20 gallons per minute. A boring 315 feet deep had lower head and poorer quality of water than the shallower wells.
Danville, Douglass Park	595	60	?	Gravel.	Two strong wells from gravel near bottom.
Danville, starch works in Stony Creek Valley.	575	50 70	560a	Gravel.	About 50 strong 2-inch wells 50 to 70 feet deep from gravel below till. Temperature 52° Fahr. Water rather hard.
Danville, Big Four Railway in Stony Creek Valley.	575	30a	560a	Gravel.	Very strong well from gravel below till. Water rather hard for boiler use.
Danville, C. & E. I. R. R. between Section street and Stony Creek.	575	32	560a	Gravel.	A well 24 by 30 feet yields 750 gallons per minute without signs of lowering after 24 hours' pumping. Is used by workmen at C. & E. I. shops. Water is from gravel below till and is hard.
Danville, C. & E. I. prospect borings	610 575	185 40	? ?	Clay. Clay.	Boring west of car shops. No water obtained; mainly blue till. Borings in Stony Creek Valley north of car shops obtained no water at depth of 40 feet.
Danville, Bowman street north of Seminary street.	620	70	......	Gravel.	Rock at bottom. Water from gravel below till.
Danville, corner of Anderson and Seminary streets.	620	89	570	Sand.	No rock reached. Water from sand below till. Some water at 60 feet.
Danville, corner of Bowman and Seminary streets.	620	59	585	Sand.	Head exceptionally high.
Danville, corner of Kimball and Wellington streets.	620	114	570	Rock.	Entered rock at 104 feet; weak vein in fine sand at 67 feet. Drift mainly till.
Danville, College street south of Main street.	615	114	570	Sand.	Black soil struck at about 90 feet, below which was water-bearing sand.
Danville, Columbus street south of Main street.	630	101	570	Sand.	Weak well.
Danville, Harrison street near Wabash R. R.	600	58	560	Sand.	Reported by owner, A. Bowman.
Danville, P. Yager, Vermilion street near English street.	600	63	540a	Gravel.	Entirely sand and gravel.
Danville, J. Foreman, Vermilion street near English street.	600	66	540a	Gravel.	Largely cemented gravel.
Danville, A. Hess, Oak street north of Fairchild street.	600	60a	540a	Gravel.	Upper 15 feet clay; remainder gravel and sand.
Danville, A. J. Woodbury, corner of Oak and Clay streets.	600	53	540a	Gravel.	Clay 30 feet; remainder gravel.
Danville, N. W. part, R. H. Carnahan, James Knight, and James Clark.	600	24	......	Top of coal.	Water comes in below gravel at top of coal.
Danville, Mrs. James Partlow, north part of city.	630	158	?	Rock.	In rock near bottom.
Danville, Roselawn addition	650	100a	?	Gravel.	Several wells about 100 feet, mainly through till. A few good wells at 20 or 30 feet.
Danville, N. W. part, F. Van Valkenburg.	630	35	?	Gravel.	Mainly through till.
Danville, N. W. part, J. Perry	630	60	?	Gravel.	Largely through gravel.
Danville, N. W. part, E. H. Palmer	630	45	?	Rock.	Rock struck near bottom.
West Danville, Sanford Bailey	610	28	?	Gravel.	Clay, 8 feet; gravel, 18 feet; till near bottom.
Batestown, several wells	640	20a	630	Gravel.	Good wells at 10 to 20 feet in gravel or sand below till.
One mile southwest of Batestown	655	15	640	Sandy gravel.	A well on a kame penetrated clay 4 feet and then sandy gravel to bottom.
Hillery and vicinity	650	15a	640	Sand.	Wells usually enter water-bearing sand below till at slight depth.
Catlin	655	12	645	Sand and gravel.	Many wells obtain a good supply at 10 or 12 feet.
West of Catlin, several wells	660	25	645	Gravel.	Wells usually penetrate 15 or 20 feet of till before striking water-bearing sand and gravel.
Northeast of Catlin, several wells	650	25	640	Sand or gravel.	Wells seldom exceed 25 feet, and obtain water in gravel or sand below till.
T. 18, R. 10 W. Sec. 5, Milton Beauchamp.	620	135	550	Rock.	Mainly till to 120 feet, coal at 120 to 126 feet. Water from shale below coal.
T. 18, R. 10 W. Sec. 7, J. M. Jones	635	60	618	Gravel.	Mainly through blue till.
T. 18, R. 11 W. Sec. 3, Mr. Boone	550	39	?	Sand.	In Hawbuck Creek Valley, probably in line of a pre-Glacial valley.
Kellyville, several wells	670	20	?	Sand.	Wells usually get water at 15 to 20 feet; shale entered at 40 feet.
Westville, several wells	675	15	?	Sand.	Wells usually about 15 feet; water from sand below till. Drift is about 80 feet.
South Westville, several wells	680	25	?	Sand.	Wells 20 to 30 feet are usually strong.
T. 18, R. 11 W. Sec. 13, Mrs. Annie Sheets.	615	130	525	Sandstone.	Rock entered at 90 feet. Surface sand 25 feet; remainder of drift mainly blue till.
T. 18, R. 11 W. Sec. 23, L. C. Underwood	680	36	?	Gravel.	On drift knoll. Well in sand and gravel entire depth.
T. 18, R. 11 W. Sec. 27, schoolhouse	680	203	?	Rock.	Drift, 80 feet. Well rather weak.
Georgetown, several wells	670	15 35	....	Gravel.	Wells seldom reach 35 feet before obtaining a good supply.
T. 18, R. 12 W. Sec. 3, Sandusky Hill	708	100a	?	?	A well on top of hill was sunk to a depth of about 100 feet, mainly through sand and gravel.
T. 18, R. 12 W. Sec. 4, Marion Burroughs.	672	81	670	Sand.	Mainly through blue till; sand at bottom.
Same section, R. O'Connell	675	98	?	Shale.	Well weak; shale entered at 92 feet.
T. 18, R. 12 W. Sec. 5, several wells	675a	30a	?	Gravel.	Good wells usually obtained at less than 35 feet, but one well in south part of section is 69 feet.
T. 18, R. 12 W. Sec. 8, W. Church	680	40 100	? ?	Gravel. Clay.	A good well from gravel below till at 40 feet. Another boring 100 feet in depth did not obtain water. Shale was entered at 80 feet.
T. 18, R. 12 W. Sec. 13, Dennis Clingan	680	90	663	Rock.	A prospect boring for coal struck water in rock at 90 feet. Coal was found at about 210 feet.
T. 18, R. 12 W. Sec. 15, R. Clipson	685	70	665	Gravel.	Mainly till; gravel near bottom.
Same section, Charles Barley	675	70	667	Gravel.	Mainly till; gravel near bottom.
T. 18, R. 12 W. Sec. 16, J. M. Douglass	696 690	45 100	680 ?	Gravel. Rock.	Good well from gravel below till; another boring 100 feet deep reached shale without obtaining water.
Same section, W. S. Douglass	690	70	?	Sand.	Mainly till; sand near bottom.
T. 18, R. 12 W. Sec. 22, David Barley	675	70	667	Gravel.	Mainly till; gravel near bottom.

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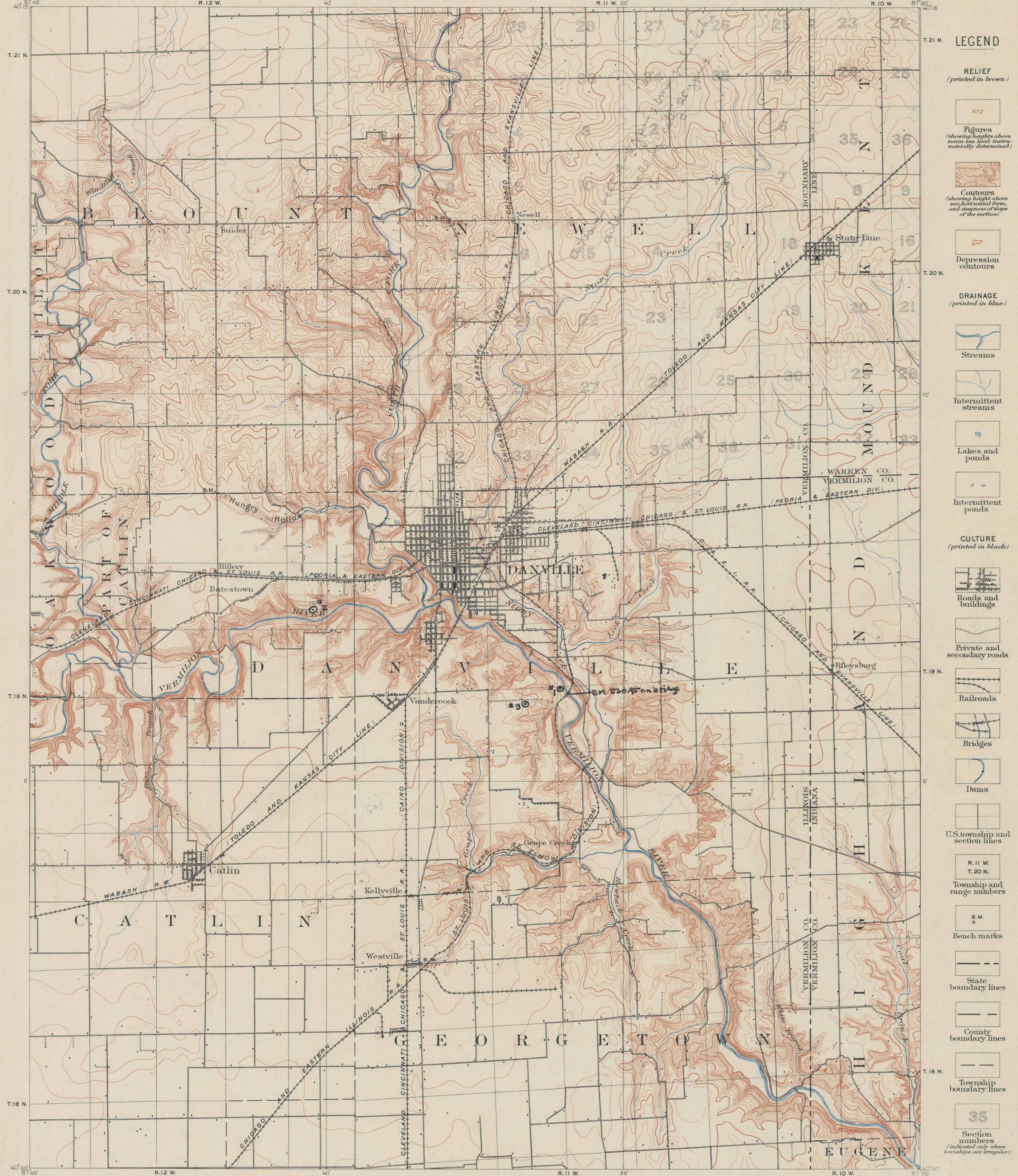
TOPOGRAPHIC SHEET

ILLINOIS–INDIANA
DANVILLE QUADRANGLE



Jno. H. Renshawe, Geographer in charge.
Control by U.S. Lake Survey and Geo. T. Hawkins.
Topography by W. J. Lloyd.
Surveyed in 1897.

Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 10 feet.
Datum is mean sea level.

Edition of Nov. 1900.

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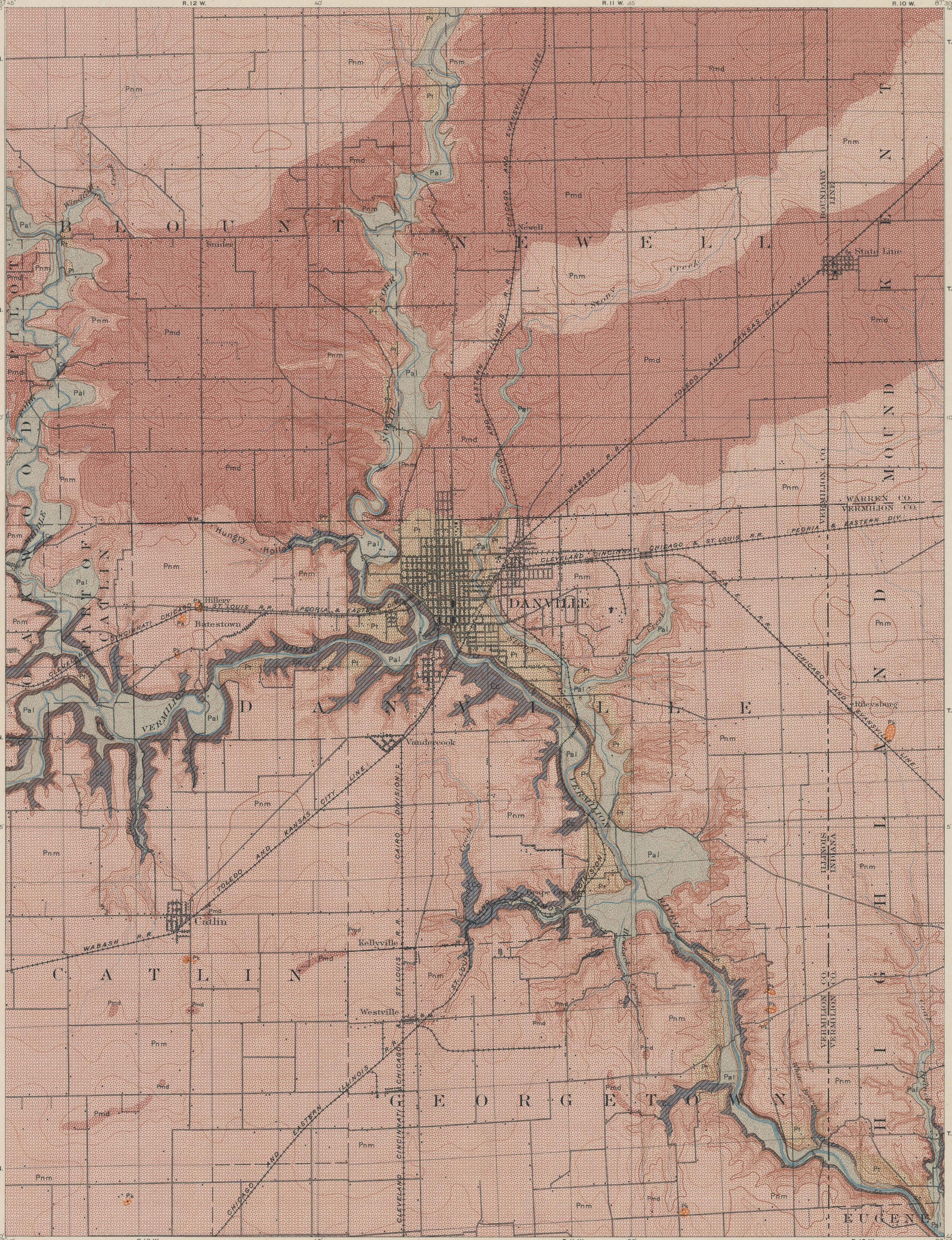
HISTORICAL GEOLOGY SHEET

ILLINOIS-INDIANA
DANVILLE QUADRANGLE



LEGEND

SURFICIAL ROCKS
(Areas of Surficial rocks are shown by patterns of dots and circles.)

PLEISTOCENE

Pal — Alluvium
(clay, sand, and gravel forming the flood plains and beds of streams)

Pt — Glacial terraces
(fine gravel deposited along the Vermilion River by water issuing from the ice sheet and preserved in terraces)

Pk — Kames
(small but sharp knolls composed largely of sand and gravel)

Pmd — Morainic drift
(largely till of a looser texture than the non-morainic drift; surface bowlders numerous in places and but little surface silt; forms ridges and rolling country)

Pnm — Nonmorainic drift
(largely stony clay with pockets and thin layers of sand and gravel and a thin surface capping of pebbleless clay; forms the upland plains and valley slopes)

SEDIMENTARY ROCKS
(Areas of Sedimentary rocks are shown by patterns of parallel lines.)

CARBONIFEROUS

Cc — Coal Measures
(shale, thin beds of sandstone, impure limestone, and coal beds)

Jno. H. Renshawe, Geographer in charge.
Control by U.S. Lake Survey and Geo. T. Hawkins.
Topography by W. J. Lloyd.
Surveyed in 1897.

Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 10 feet.
Datum is mean sea level.
Edition of Nov. 1900.

Geology by Marius R. Campbell and Frank Leverett.
Surveyed in 1899.

U.S. GEOLOGICAL SURVEY
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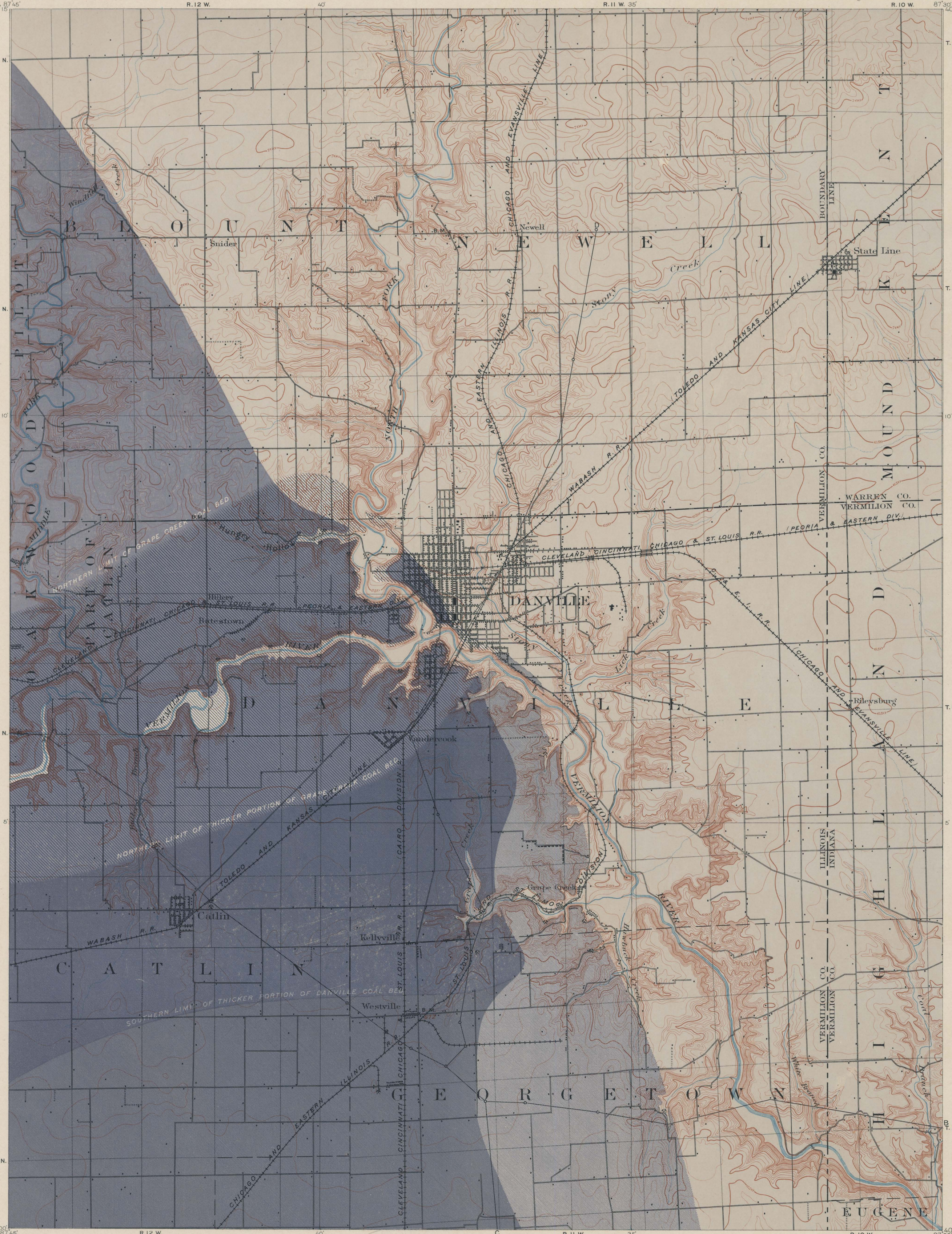
ECONOMIC GEOLOGY SHEET

ILLINOIS-INDIANA
DANVILLE QUADRANGLE



LEGEND

(Areas underlain by the two most important coal beds are indicated by dark colors and by patterns. The limits of the coal beds beneath the surface are only approximately determined)

CARBONIFEROUS

Danville coal bed
(darker color denotes greater thickness of coal)

Grape Creek coal bed
(denser pattern denotes greater thickness of coal)

(Area underlain by Carboniferous strata from which the Danville and Grape Creek coal beds have been eroded)

The lines AB and CD indicate the position of the sections shown in figures 10 and 11 on the columnar-section sheet. The circles along the lines of section mark the location of bore holes and mine shafts.

⚒ Coal mines

Jno. H. Renshawe, Geographer in charge.
Control by U.S. Lake Survey and Geo. T. Hawkins.
Topography by W. J. Lloyd.
Surveyed in 1897.

Scale $\frac{1}{62500}$

Contour interval 10 feet.
Datum is mean sea level.
Edition of Oct. 1900.

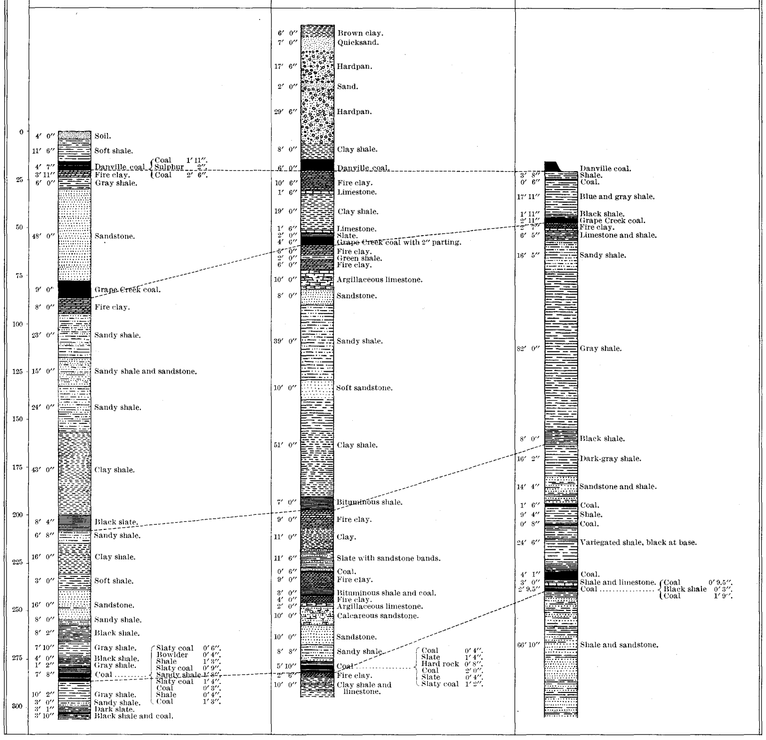
Geology by Marius R. Campbell.
Surveyed in 1899.

COLUMNAR-SECTION SHEET

DETAILED COAL SECTIONS DETERMINED BY DIAMOND DRILL.

SCALE: 1 INCH = 50 FEET.

FIGURE 3. Pawnee Mine. — FIGURE 4. Two and One-Half Miles Southeast of Danville. — FIGURE 5. Two Miles West of Danville.



GENERAL SECTION IN THE DANVILLE REGION.

SCALE: 1 INCH = 200 FEET.

FIGURE 6. Danville, Well at Waterworks. — FIGURE 7. Danville Junction. — FIGURE 8. Lodi, Indiana, Old Salt Well. — FIGURE 9. Rockville, Parke Co., Indiana.

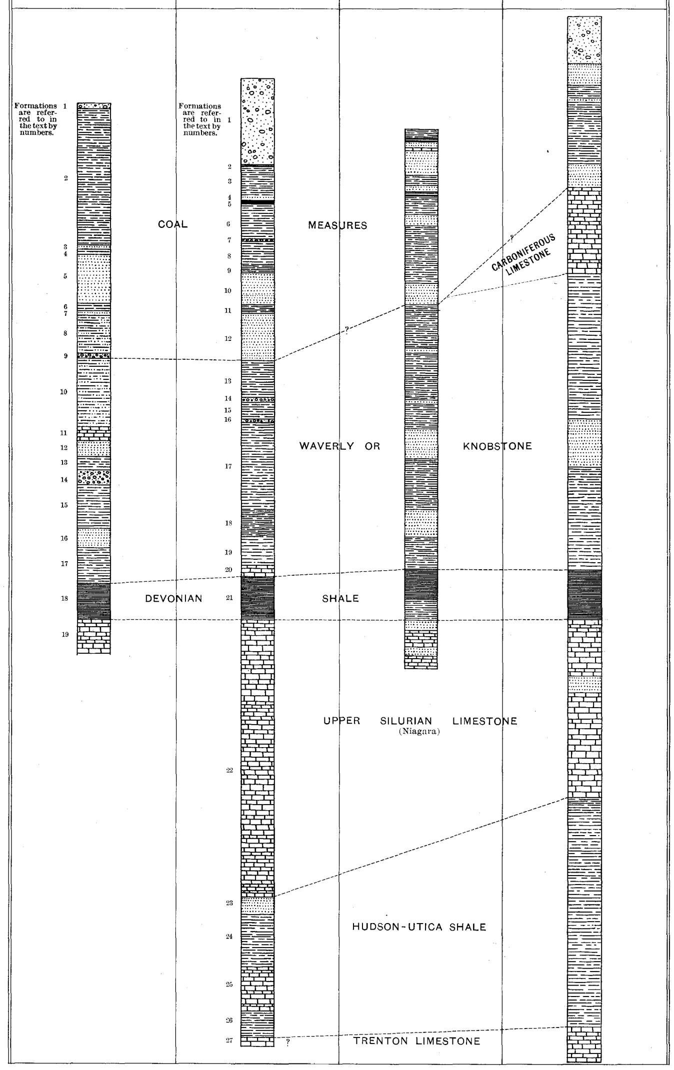


FIG. 10.—SECTION THROUGH CATLIN, GEORGETOWN, AND HIGHLAND TOWNSHIPS, ALONG LINE A–B ON ECONOMIC GEOLOGY SHEET.

HORIZONTAL SCALE: APPROXIMATELY 1 INCH = 1 MILE.

VERTICAL SCALE: 1 INCH = 300 FEET.

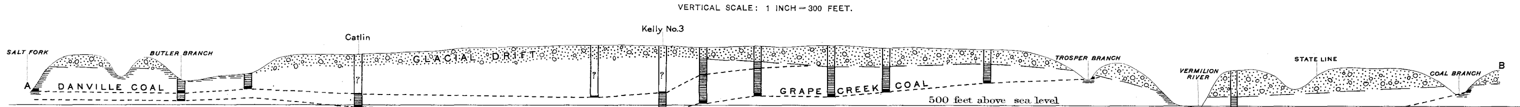
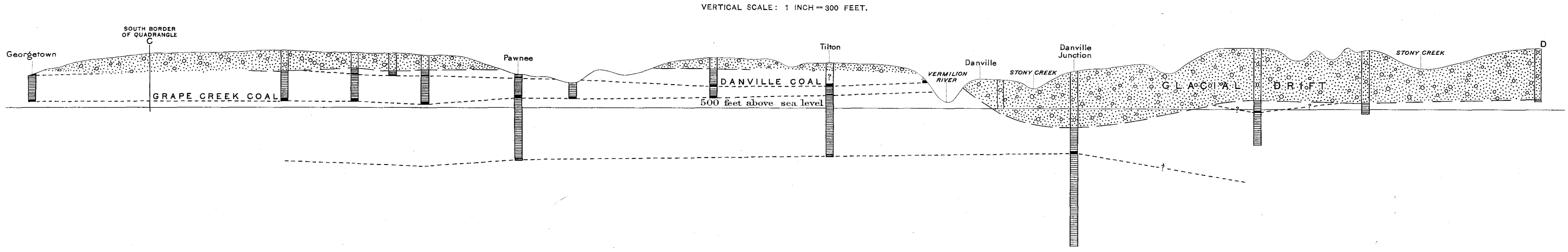


FIG. 11.—SECTION THROUGH GEORGETOWN, DANVILLE, AND NEWELL TOWNSHIPS, ALONG LINE C–D ON ECONOMIC GEOLOGY SHEET.

HORIZONTAL SCALE: APPROXIMATELY 1 INCH = 1 MILE.

VERTICAL SCALE: 1 INCH = 300 FEET.



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