DEPARTMENT OF THE INTERIOR
HUBERT WORK, SECRETARY
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

GEOLOGIC ATLAS
OF THE
UNITED STATES

GILLESPIE-MOUNT OLIVE FOLIO

ILLINOIS

BY

WALLACE LEE

SURVEYED IN COOPERATION WITH
THE GEOLOGICAL SURVEY OF ILLINOIS

WASHINGTON, D. C.
ENGRAVED AND PRINTED BY THE U. S. GEOLOGICAL SURVEY
GEORGE W. STOSE, EDITOR OF GEOLOGIC MAPS   S. J. KUBEL, CHIEF ENGRAVER
1926

GEOLOGIC ATLAS OF THE UNITED STATES.

UNITS OF SURVEY AND OF PUBLICATION.

The Geological Survey is making a topographic and a geologic atlas of the United States. The topographic atlas will consist of maps called *atlas sheets*, and the geologic atlas will consist of parts called *folios*. Each folio includes topographic and geologic maps of a certain four-sided area, called a *quadrangle*, or of more than one such area, and a text describing its topographic and geologic features. A quadrangle is limited by parallels and meridians, not by political boundary lines, such as those of States, counties, and townships. Each quadrangle is named from a town or a natural feature within it, and at the sides and corners of each map are printed the names of adjacent quadrangles.

SCALES OF THE MAPS.

On a map drawn to the scale of 1 inch to the mile a linear mile on the ground would be represented by a linear inch on the map, and each square mile of the ground would be represented by a square inch of the map. The scale may be expressed also by a fraction, of which the numerator represents a unit of linear measure on the map and the denominator the corresponding number of like units on the ground. Thus, as there are 63,360 inches in a mile, the scale 1 inch to the mile is expressed by the fraction $\frac{1}{63,360}$, or the ratio 1:63,360.

The three scales most commonly used on the standard maps of the Geological Survey are 1:31,680, 1:62,500, and 1:125,000, 1 inch on the map corresponding approximately to one-half mile, 1 mile, and 2 miles on the ground. On the scale of 1:31,680 a square inch of map surface represents about one-fourth of a square mile of earth surface; on the scale of 1:62,500, about 1 square mile; and on the scale of 1:125,000, about 4 square miles. In general a standard map on the scale of 1:125,000 represents one-fourth of a "square degree"—that is, one-fourth of an area measuring 1 degree of latitude by 1 degree of longitude; one on the scale of 1:62,500 represents one-sixteenth of a "square degree"; and one on the scale of 1:31,680 represents one-sixty-fourth of a "square degree." The areas of the corresponding quadrangles are about 1,000, 250, and 60 square miles, though they differ with the latitude, a "square degree" in the latitude of Boston, for example, being only 3,525 square miles and one in the latitude of Galveston being 4,150 square miles.

FEATURES SHOWN ON THE TOPOGRAPHIC MAPS.

The features represented on the topographic maps comprise three general classes—(1) inequalities of surface, such as plains, plateaus, valleys, hills, and mountains, which collectively make up the *relief* of the area; (2) bodies of water, such as streams, lakes, swamps, tidal flats, and the sea, which collectively make up the *drainage*; (3) such works of man as roads, railroads, buildings, villages, and cities, which collectively are known as *culture*.

Relief.—All altitudes are measured from mean sea level. The heights of many points have been accurately determined, and those of some are given on the map in figures. It is desirable, however, to show the altitude of all parts of the area mapped, the form of the surface, and the grade of all slopes. This is done by contour lines, printed in brown, each representing a certain height above sea level. A contour on the ground passes through points that have the same altitude. One who follows a contour will go neither uphill nor downhill but on a level. The manner in which contour lines express altitude, form, and slope is shown in figure 1.

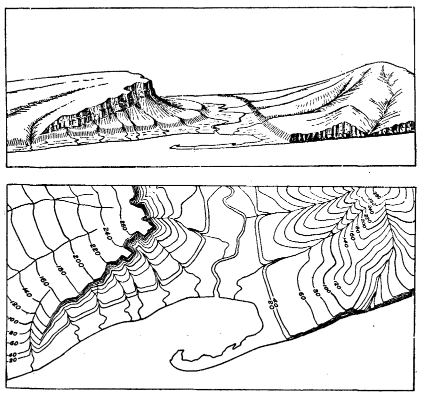


FIGURE 1.—Ideal view and corresponding contour map.

The view represents a river valley between two hills. In the foreground is the sea, with a bay that is partly inclosed by a hooked sand bar. On each side of the valley is a terrace. The terrace on the right merges into a gentle upward slope; that on the left merges into a steep slope that passes upward to a cliff, or scarp, which contrasts with the gradual slope back from its crest. In the map each of these features is indicated, directly beneath its position in the view, by contour lines. This map does not include the distant part of the view.

As contours are continuous horizontal lines they wind smoothly about smooth surfaces, recede into ravines, and project around spurs or prominences. The relations of contour curves and angles to the form of the land can be seen from the map and sketch. The contour lines show not only the shape of the hills and valleys but their altitude, as well as the steepness or grade of all slopes.

The vertical distance represented by the space between two successive contour lines—the contour interval—is the same, whether the contours lie along a cliff or on a gentle slope; but to reach 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 slopes.

The contour interval is generally uniform throughout a single map. The relief of a flat or gently undulating country can be adequately represented only by the use of a small contour interval; that of a steep or mountainous country can generally be adequately represented on the same scale by the use of a larger interval. The smallest interval commonly used on the atlas sheets of the Geological Survey is 5 feet, which is used for regions like the Mississippi Delta and the Dismal Swamp. An interval of 1 foot has been used on some large-scale maps of very flat areas. On maps of more rugged country contour intervals of 10, 20, 25, 50, and 100 feet are used, and on maps of great mountain masses like those in Colorado the interval may be 250 feet.

In figure 1 the contour interval is 20 feet, and the contour lines therefore represent contours at 20, 40, 60, and 80 feet, and so on, above mean sea level. Along the contour at 200 feet lie all points that are 200 feet above the sea—that is, this contour would be the shore line if the sea were to rise 200 feet; along the contour at 100 feet are all points that are 100 feet above the sea; and so on. In the space between any two contours are all points whose altitudes are above the lower and below the higher contour. Thus the contour at 40 feet falls just below the edge of the terrace, and that at 60 feet lies above the terrace; therefore all points on the terrace are shown to be more than 40 but less than 60 feet above the sea. In this illustration all the contour lines are numbered, but on most of the Geological Survey's maps only certain contour lines—say every fifth one, which is made slightly heavier—are numbered, for the heights shown by the others may be learned by counting up or down from these. More exact altitudes for many points are given in bulletins published by the Geological Survey.

Drainage.—Watercourses are indicated by blue lines. The line for a perennial stream is unbroken; that for an intermittent stream is dotted; and that for a stream which sinks and reappears is broken. Lakes and other bodies of water and the several types of marshy areas are also shown in blue.

Culture.—Symbols for the cultural features and for public-land land lines and other boundary lines, as well as all the lettering and the map projection, are printed in black.

FEATURES SHOWN ON THE GEOLOGIC MAPS.

The maps representing the geology show, by colors and conventional signs printed on the topographic map as a base, the distribution of rock masses on the surface of the land and, by means of structure sections, their underground relations so far as known, in such detail as the scale permits.

KINDS OF ROCKS.

Rocks are of many kinds. On the geologic map they are distinguished as igneous, sedimentary, and metamorphic.

Igneous rocks.—Rocks that have cooled and consolidated from a state of fusion are known as *igneous*. Molten material has from time to time been forced upward in fissures or channels of various shapes and sizes through rocks of all ages to or nearly to the surface. Rocks formed by the consolidation of molten material, or *magma*, within these channels—that is, below the surface—are called *intrusive*. An intrusive mass that occupies a nearly vertical fissure which has approximately parallel walls is called a *dike*; one that fills a large and irregular conduit is termed a *stock*. Molten material that traverses stratified rocks may be intruded along bedding planes, forming masses called *sills* or *sheets* if they are relatively thin and *laccoliths* if they are large lenticular bodies. Molten material that is inclosed by rock cools slowly, and its component minerals crystallize when they solidify, so that intrusive rocks are generally crystalline. Molten material that is poured out through channels that reach the surface is called *lava*, and lava may build up volcanic mountains. Igneous rocks that have solidified at the surface are called *extrusive* or *effusive*. Lavas generally cool more rapidly than intrusive rocks and contain, especially in their outer parts, more or less volcanic glass, produced by rapid chilling. The outer parts of lava flows are also usually made porous by the expansion of the gases in the magma. Explosions due to these gases may accompany volcanic eruptions, causing the ejection of dust, ash, lapilli, and larger fragments. These materials, when consolidated, constitute breccias, agglomerates, and tuffs.

Sedimentary rocks.—Rocks composed of the transported fragments or particles of older rocks that have undergone disintegration, of volcanic material deposited in lakes and seas, or of material deposited in such bodies of water by chemical precipitation or by organic action are termed *sedimentary*.

The chief agent in the transportation of rock débris is water in motion, including rain, streams, and the water of lakes and of the sea. The materials are in large part carried as solid particles, and the deposits they form are called mechanical. Such deposits are gravel, sand, and clay, which are later consolidated into conglomerate, sandstone, and shale. Some of the materials are carried in solution, and deposits composed of these materials are called organic if formed with the aid of life or chemical if formed without the aid of life. The more common rocks of chemical and organic origin are limestone, chert, gypsum, salt, certain iron ores, peat, lignite, and coal. Any one of the kinds of deposits named may be formed separately, or the different materials may be intermingled in many ways, producing a great variety of rocks.

Another transporting agent is air in motion, or wind, and a third is ice in motion, or glaciers. The most characteristic of the wind-borne or eolian deposits is *loess*, a fine-grained earth; the most characteristic of the glacial deposits is *till*, a heterogeneous mixture of boulders and pebbles with clay or sand.

Most sedimentary rocks are made up of layers or beds that can be easily separated. These layers are called *strata*, and rocks deposited in such layers are said to be *stratified*.

The surface of the earth is not immovable; over wide regions it very slowly rises or sinks with reference to the sea, and shore lines are thus changed. As a result of upward movement marine sedimentary rocks may become part of the land, and most of our land surface is in fact composed of rocks that were originally deposited as sediments in the sea.

Rocks exposed at the surface of the land are acted on by air, water, ice, animals, and plants, especially the low organisms known as bacteria. They gradually disintegrate, and their more soluble parts are leached out, the less soluble material being left as a *residual* layer. Water washes this material down the slopes, and it is eventually carried by rivers to the ocean or other bodies of water. Usually its journey is not continuous, but it is temporarily built into river bars and flood plains, where it forms *alluvium*. Alluvial deposits, glacial deposits (collectively known as *drift*), and eolian deposits belong to the *surficial* class, and the residual layer is commonly included with them. The upper parts of these deposits, which are occupied by the roots of plants, constitute soils and subsoils, the soils being usually distinguished by a considerable admixture of organic matter.

Metamorphic rocks.—In the course of time and by various processes rocks may become greatly changed in composition and texture. If the new characteristics are more pronounced than the old the rocks are called *metamorphic*. In the process of metamorphism the chemical constituents of a rock may enter into new combinations and certain substances may be lost or new ones added. A complete gradation from the primary to the metamorphic form may exist within a single rock mass. Such changes transform sandstone into quartzite and limestone into marble and modify other rocks in various ways.

From time to time during geologic ages rocks that have been deeply buried and have been subjected to enormous pressure, to slow movement, and to igneous intrusion have been afterward raised and later exposed by erosion. In such rocks the original structural features may have been lost entirely and new ones substituted. A system of parallel planes along which the rock can be split most readily may have been developed. This acquired quality gives rise to *cleavage*, and the cleavage planes may cross the original bedding planes at any angle. Rocks characterized by cleavage are called *slates*. Crystals of mica or other minerals may have grown in a rock in parallel arrangement, causing lamination or foliation and producing what is known as *schistosity*. Rocks that show schistosity are called *schists*.

As a rule, the older rocks are most altered and the younger are least altered, but to this rule there are many exceptions, especially in regions of igneous activity and complex structure.

GEOLOGIC FORMATIONS.

For purposes of geologic mapping the rocks of all the kinds above described are divided into *formations*. A sedimentary formation contains between its upper and lower limits either rocks of uniform character or rocks more or less uniformly varied in character, as, for example, an alternation of shale and limestone. If the passage from one kind of rocks to another is gradual it may be necessary to separate two contiguous formations by an arbitrary line, and the distinction between some such formations depends almost entirely on the fossils they contain. An igneous formation contains one or more bodies of one kind of rock of similar occurrence or of like origin. A metamorphic formation may consist of one kind of rock or of several kinds of rock having common characteristics or origin.

[Continued on inside back cover.]

When it is desirable to recognize and map one or more specially developed parts of a formation the parts are called *members* or by some other appropriate term, such as *lentils*.

AGE OF THE FORMATIONS.

Geologic time.—The largest divisions of geologic time are called *eras*, the next smaller are called *periods*, and the still smaller divisions are called *epochs*. Subdivisions of the Pleistocene epoch are called *stages*. The age of a rock is expressed by the name of the time division in which it was formed.

The sedimentary formations deposited during a geologic period are called a *system*. The principal divisions of a system are called *series*. Any aggregate of formations less than a series is called a *group*.

As sedimentary deposits accumulate successively the younger rest on the older, and their relative ages may be determined by observing their positions. In many regions of intense disturbance, however, the beds have been overturned by folding or their relations to adjacent beds have been changed by faulting, so that it may be difficult to determine their relative ages from their present positions at the surface.

Many stratified rocks contain *fossils*, the remains or imprints of plants and animals which, at the time the strata were deposited, lived in bodies of water or were washed into them or were buried in surficial deposits on the land. Such rocks are said to be fossiliferous. A study of these fossils has shown that the forms of life at each period of the earth's history were to a great extent different from the forms at other periods. Only the simpler kinds of marine plants and animals lived 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 forms that 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. If two sedimentary formations are geographically so far apart that it is impossible to determine their relative positions the characteristic fossils found in them may determine which was deposited first. Fossils are also of value in determining the age of formations in the regions of intense disturbance mentioned above. The fossils found in the strata of different areas, provinces, and continents afford the most effective means of combining local histories into a general earth history.

It is in many places difficult or impossible to determine the age of an igneous formation, but the relative age of such a formation can in general be ascertained by observing whether an associated sedimentary formation of known age is cut by the igneous mass or lies upon it. Similarly, the time at which metamorphic rocks were formed from the original masses may be shown by their relations to adjacent formations of known age; but the age recorded on the map is that of the original masses and not that of their metamorphism.

Symbols, colors, and patterns.—Each formation is shown on the map by a distinctive combination of color and pattern and is labeled by a special letter symbol.

Patterns composed of parallel straight lines are used to represent sedimentary formations deposited in the sea, in lakes, or in other bodies of standing water. Patterns of dots and circles represent alluvial, glacial, and eolian formations. Patterns of triangles and rhombs are used for igneous formations. Metamorphic rocks of unknown origin are represented by short dashes irregularly placed; if the rock is schist the dashes may be arranged in wavy lines parallel to the structure planes. Suitable combination patterns are used for metamorphic formations that are known to be of sedimentary or of igneous origin. The patterns of each class are printed in various colors. The colors in which the patterns of parallel lines are printed indicate age, a particular color being assigned to each system.

Each symbol consists of two or more letters. The symbol for a formation whose age is known includes the system symbol, which is a capital letter or monogram; the symbols for other formations are composed of small letters.

The names of the geologic time divisions, arranged in order from youngest to oldest, and the color and symbol assigned to each system are given in the subjoined table.

Geologic time divisions and symbols and colors assigned to the rock systems.

Era.	Period or system.	Epoch or series.	Symbol.	Color for sedimentary rocks.
Cenozoic	Quaternary	Recent; Pleistocene	Q	Brownish yellow.
	Tertiary	Pliocene; Miocene; Oligocene; Eocene	T	Yellow ocher.
Mesozoic	Cretaceous		K	Olive-green.
	Jurassic		J	Blue-green.
	Triassic		Ћ	Peacock-blue.
Paleozoic	Carboniferous	Permian; Pennsylvanian; Mississippian	C	Blue.
	Devonian		D	Blue-gray.
	Silurian		S	Blue-purple.
	Ordovician		O	Red-purple.
	Cambrian		Є	Brick-red.
Proterozoic	Algonkian		A	Brownish red.
	Archean		Æ	Gray-brown.

DEVELOPMENT AND SIGNIFICANCE OF SURFACE FORMS.

Hills, valleys, and all other surface forms have been produced by geologic processes. Most valleys are the result of erosion by the streams that flow through them (see fig. 1), and the alluvial plains that border many streams were built up by the streams; waves cut sea cliffs, and waves and currents build up sand spits and bars. Surface forms thus constitute part of the record of the history of the earth.

Some forms are inseparably connected with deposition. The hooked spit shown in figure 1 is an illustration. To this class belong beaches, alluvial plains, lava streams, drumlins (smooth oval hills composed of till), and moraines (ridges of drift made at the edges of glaciers). Other forms are produced by erosion. The sea cliff is an illustration; it may be carved from any rock. To this class belong abandoned river channels, glacial furrows, and peneplains. In the making of a stream terrace an alluvial plain is built and afterward partly eroded away. The shaping of a plain along a shore is usually a double process, hills being worn away (*degraded*) and valleys filled up (*aggraded*).

All parts of the land surface are subject to the action of air, water, and ice, which slowly wears them down, producing material that is carried by streams toward the sea. As this wearing down depends on the flow of water to the sea it can not be carried below sea level, which is therefore called the *base-level* of erosion. Lakes or large rivers may determine base-levels for certain regions. A large tract that is long undisturbed by uplift or subsidence is worn down nearly to base-level, and the fairly even surface thus produced is called a *peneplain*. If the tract is afterward uplifted it becomes a record of its former close relation to base-level.

THE GEOLOGIC MAPS AND SHEETS IN THE FOLIO.

Areal-geology map.—The map showing the surface areas occupied by the several formations is called an *areal-geology map*. On the margin is an explanation, which is the key to the map. To ascertain the meaning of any color or pattern and its letter symbol the reader should look for that color, pattern, and symbol in the explanation, where he will find the name and description of the formation. If he desires to find any particular formation he should examine the explanation and find its name, color, and pattern and then trace out the areas on the map corresponding in color and pattern. The explanation shows also parts of the geologic history. The names of formations are arranged in columnar form, grouped primarily according to origin—sedimentary, igneous, and metamorphic rocks of unknown origin—and those within each group are placed in the order of age, the youngest at the top.

Economic-geology map.—The map representing the distribution of useful minerals and rocks and showing their relations to the topographic features and to the geologic formations is termed the *economic-geology map*. Most of the formations indicated on the areal-geology map are shown on the economic-geology map by patterns in fainter colors, but the areas of productive formations are emphasized by strong colors. A mine symbol shows the location of each mine or quarry and is accompanied by the name of the principal mineral product mined or quarried. If there are important mining industries or artesian basins in the area the folio includes special maps showing these additional economic features.

Structure-section sheet.—The relations of different beds to one another may be seen in cliffs, canyons, shafts, and other natural and artificial cuttings. Any cutting that exhibits these relations is called a *section*, and the same term is applied to a diagram representing the relations. The arrangement of the beds or masses of rock in the earth is called *structure*, and a section showing this arrangement is called a *structure section*.

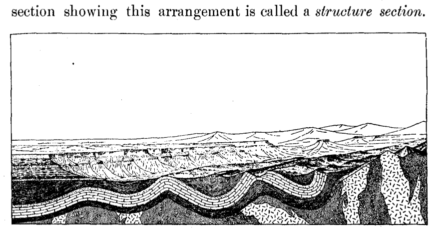


FIGURE 2.—Sketch showing a vertical section below the surface at the front and a view beyond.

The geologist is not limited, however, to natural and artificial cuttings for his information concerning the earth's structure. Knowing the manner of formation of rocks, after tracing out the relations of the beds on the surface he can infer their relative positions beneath the surface and can draw sections representing the probable structure to a considerable depth. Such a section is illustrated in figure 2.

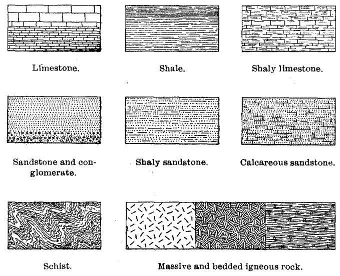


FIGURE 3.—Symbols used in sections to represent different kinds of rock.

The figure represents a landscape that is cut off sharply in the foreground on a vertical plane so as to show the underground relations of the rocks. The kinds of rock are indicated by appropriate patterns of lines, dots, and dashes. These patterns admit of much variation, but those shown in figure 3 are used to represent the commoner kinds of rock.

The plateau shown at the left of figure 2 presents toward the lower land an escarpment, or front, made up of sandstone, which forms the cliffs, and shale, which forms the slopes. The broad belt of lower land is traversed by several ridges, which, as shown in the section, correspond to the outcrops of a folded bed of sandstone that rises to the surface. The upturned edges of this bed form the ridges, and the intermediate valleys follow the outcrops of limestone and calcareous shale.

Where the edges of the beds appear at the surface their thickness can be measured and the angles at which they dip below the surface can be observed, and by means of these observations their positions underground are inferred. The direction of the intersection of the surface of a dipping bed with a horizontal plane is called its *strike*. The inclination of the bed to the horizontal plane, measured at right angles to the strike, is called its *dip*.

In many regions the beds are bent into troughs and arches, such as are seen in figure 2. The arches are called *anticlines* and the troughs *synclines*. As the materials that formed the sandstone, shale, and limestone were deposited beneath the sea in nearly flat layers the fact that the beds are now bent and folded shows that forces have from time to time caused the earth's crust to wrinkle along certain zones. In places the beds are broken across and the parts have slipped past each other. Such breaks are termed *faults*. Two kinds of faults are shown in figure 4.

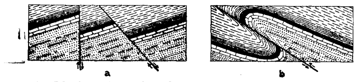


FIGURE 4.—Ideal sections of broken and bent strata, showing (a) *normal* faults and (b) a *thrust* or *reverse* fault.

At the right of figure 2 the section shows schists that are traversed by igneous rocks. The schists are much contorted, and the form or arrangement of their masses underground can not be inferred. Hence that part of the section shows only what is probable, not what is known by observation.

The section also shows three sets of formations, distinguished by their underground relations. The uppermost set, seen at the left, is made up of beds of sandstone and shale, which lie in a horizontal position. These beds were laid down under water but are now high above the sea, forming a plateau, and their change of altitude shows that this part of the earth's surface has been uplifted. The beds of this set are *conformable*—that is, they are parallel and show no break in sedimentation.

The next lower set of formations consists of beds that are folded into arches and troughs. The beds were once continuous, but the crests of the arches have been removed by erosion. These beds, like those of the upper set, are conformable.

The horizontal beds of the plateau rest upon the upturned, eroded edges of the beds of the middle set, as shown at the left of the section. The beds of the upper set are evidently younger than those of the middle set, which must have been folded and eroded between the time of their deposition and that of the deposition of the upper beds. The upper beds are *unconformable* to the middle beds, and the surface of contact is an *unconformity*.

The lowest set of formations consists of crystalline schists and igneous rocks. At some period of their history the schists were folded or plicated by pressure and intruded by masses of molten rock. The overlying beds of the middle set have not been traversed by these intrusive rocks nor have they been affected by the pressure of the intrusion. It is evident that considerable time elapsed between the formation of the schists and the beginning of the deposition of the beds of the middle set, and during this time the schists were metamorphosed, disturbed by the intrusion of igneous masses, and deeply eroded. The contact between the middle and lowest sets is another unconformity; it marks a period of erosion between two periods of deposition.

The section and landscape in figure 2 are ideal, but they illustrate actual relations. The sections on the structure-section sheet are related to the maps in much the same way that the section in the figure is related to the landscape. The profile of the surface in each structure section corresponds to the actual slopes of the ground along the section line, and the depth to any mineral-producing or water-bearing bed shown may be measured by using the scale given on the map.

Columnar section.—Many folios include a *columnar section*, which contains brief descriptions of the sedimentary formations in the quadrangle. It shows the character of the rocks as well as the thickness of the formations and the order of their accumulation, the oldest at the bottom, the youngest at the top. It also indicates intervals of time that correspond to events of uplift and degradation and constitute interruptions of deposition.

THE TEXT OF THE FOLIO.

The text of the folio states briefly the relation of the area mapped to the general region in which it is situated; points out the salient natural features of the geography of the area and indicates their significance and their history; considers the cities, towns, roads, railroads, and other human features; describes the geology and the geologic history; and shows the character and the location of the valuable mineral deposits.

GEORGE OTIS SMITH,
Director.

January, 1924.

DESCRIPTION OF THE GILLESPIE AND MOUNT OLIVE QUADRANGLES[1]

By Wallace Lee

INTRODUCTION

LOCATION AND GENERAL RELATIONS OF THE AREA

The area comprising the Gillespie and Mount Olive quadrangles, which in this folio is called the Gillespie-Mount Olive district, is limited by meridians 89° 30′ and 90° and parallels 39° and 39° 15′ and includes 463.34 square miles. It is in west-central Illinois (see fig. 1) and comprises considerable parts of Macoupin and Montgomery counties and a small part of Bond County. Carlinville, the county seat of Macoupin County, is 2 miles north of the north boundary of the Gillespie quadrangle, and Hillsboro, the county seat of Montgomery County, is at the east edge of the Mount Olive quadrangle.

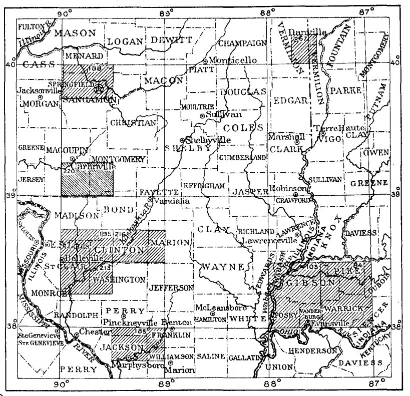


Figure 1.—Index map of southern Illinois and portions of adjacent States

The location of the Gillespie and Mount Olive quadrangles (No. 220) is shown by the darker ruling. Published folios describing other quadrangles, indicated by lighter ruling, are the following: Nos. 67, Danville; 84, Ditney; 105, Patoka; 185, Murphysboro-Herrin; 188, Tallula-Springfield; 195, Belleville-Breese; 213, New Athens-Okawville; 216, Carlyle-Centralia

In its geographic and physiographic relations the district forms a part of the Till Plains section of the Central Lowland province, a belt of comparatively low land that occupies the central part of the continent. (See fig. 2.)

CENTRAL LOWLAND PROVINCE

SURFACE FEATURES

The Central Lowland province, which is made up chiefly of glaciated plains, is bordered on the east by the Appalachian Highlands, on the south and southeast by the Interior Low Plateaus and the Ozark Plateaus of the Interior Highlands, and on the west and southwest by the Great Plains province. (See fig. 2.) It extends northward into Canada on the west side of the Laurentian Upland.

The province is not separated very sharply in physiographic character from the adjoining physiographic units, for it differs from most of them chiefly in the average altitude of its surface, although its extremes of altitude show a considerable range. The surface of Mississippi River in the southern part of the province is only about 300 feet above sea level, whereas the surface of the western part of the province rises to an altitude of 1,500 feet. The region is, however, well contrasted with the surrounding provinces in that it consists of a more or less dissected plain having an average altitude that is distinctly lower, ranging mostly from 500 to 1,200 feet above sea level.

The province is glaciated except the Driftless Area, in Wisconsin, Illinois, and Iowa, and the Osage Plain region, which includes parts of Texas, Oklahoma, Kansas, and Missouri. It embraces the greater part of the area for which Shaw formerly used the term Glaciated Plains province.[2] The northern part of the glaciated area has been little dissected, and the relief there is generally not more than 100 feet, but around the margin of the province and along the larger streams the relief is 400 to 600 feet, or even greater.

[1] The Gillespie-Mount Olive district was surveyed under an agreement of cooperation between the United States Geological Survey and the State Geological Survey of Illinois.

[2] Shaw, E. W., U. S. Geol Survey Geol. Atlas, folios 185, p. 1, 1912; and 216, p. 1, 1915.

The valleys of the Mississippi and the Missouri are the major drainage channels of the province. They are flat-bottomed and generally 3 to 6 miles wide and 200 to 400 feet deep, and through them most of the drainage of the part of the province that lies within the United States finds its way to the Gulf of Mexico. The drainage of the northeastern part of the province reaches the Atlantic by way of the St. Lawrence.

In preglacial time the parts of the province since glaciated did not differ greatly in topographic form from the other parts, but the ice that moved down from the north filled many depressions with drift and rounded the irregularities of the surface. The till plain of northern Missouri, southern Iowa, and adjacent parts of Kansas and Nebraska was not covered by the later ice sheets and has consequently undergone much more dissection than those parts of the glaciated region that are covered by drift of later age.

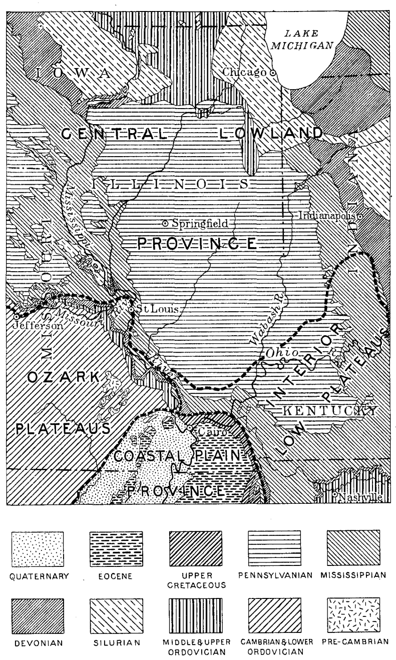


Figure 2.—Geologic sketch map of Illinois and surrounding region

Shows also physiographic provinces of the region. The indefinite boundary between the Ozark and Appalachian provinces coincides approximately with the southeast boundary of Illinois. From geologic map of North America, U. S. Geol. Survey Prof. Paper 71, 1911

The Till Plains section, in which the Gillespie-Mount Olive district lies, includes most of Illinois and large parts of Indiana and Ohio. The southern part of the section is notably dissected, but the northern part still presents to a large degree the surface configuration left after the ice had melted.

GEOLOGIC HISTORY

The events of its early geologic history have had little influence on the physiography of the Central Lowland province, except that the little-disturbed attitude of the beds has permitted geologic agencies to work unimpeded by structure. The Proterozoic era was dominated by metamorphism and igneous intrusion. Although little evidence is available for the elucidation of its history, it was certainly very long, perhaps longer than all subsequent time. Sediments then accumulated in great thickness and were consolidated into rock beds, folded, intruded by molten rock magmas, and ultimately eroded, so that the surface at the beginning of Paleozoic time was rough, though its details are little known, for, except locally, it lies deeply buried under later sedimentary rocks.

The Paleozoic era was predominantly one of sedimentation in this province, which, however, frequently rose above sea level in whole or in part. All the systems of the Paleozoic are represented, though by unequal thicknesses of sediments. The total amounted to 5,000 feet or more, but in some localities erosion removed a part during the era as well as since its end. The province was uplifted at the end of Paleozoic time, and the uplift was accompanied by gentle warping of the beds. More extensive deformation took place in the region east of this province, where the Appalachian Mountains were uplifted, and southwest of it, where the Ouachita Mountains were formed.

During the Mesozoic era erosion and degradation of the land area were the dominant processes in this province. Most of the province stood continuously above sea level, although near the end of the era a considerable area in Minnesota, Iowa, North Dakota, South Dakota, and Nebraska was submerged and sediments were accumulated. The land was elevated several times in the Mesozoic era, and after each elevation erosion reduced it, in whole or in part, nearly to sea level or to the condition of a peneplain. These processes continued through the Cenozoic era. The remnants of at least two of these peneplains are yet distinguishable in the unglaciated parts of this and adjoining provinces. The older peneplain, as preserved in the Driftless Area of southwestern Wisconsin and neighboring parts of Minnesota, Iowa, and Illinois, stands about 1,400 feet above sea level near Tomah, Wis., but descends to about 1,100 feet near Savanna, Ill. Hills in southern and northern Illinois that stand about 1,000 feet above sea level may perhaps be remnants of the same peneplain. Larger areas of this peneplain are preserved near the margin of the province. This peneplain differs in altitude because it has been unequally modified by later movements. This modification is very marked in the Osage Plain region and in the Ozark Highlands.

The second and lower peneplain is 900 to 1,000 feet above sea level in the southern part of the Driftless Area of Wisconsin. In Illinois it is largely concealed by the drift but probably stands at an altitude of about 500 to 600 feet in the southern part of the State. It may be slightly above 600 feet in the Gillespie-Mount Olive district. Before the region had been completely reduced to this plain it was reelevated, and a third period of erosion was in progress when glaciation set in. The ice that moved down over the area from the north (fig. 13) filled the valleys with drift, though it did not greatly increase the average altitude of the region. In the drift-covered areas the amount of dissection of any portion is very largely dependent on the time that has elapsed since its latest glaciation. Thus the Driftless Area has been more fully eroded than the Dissected Till Plain, which was covered by the early ice sheets. This plain is in turn more dissected than the Till Plains, which were covered by the Illinoian and early Wisconsin ice sheets, and much of the northern part of the Central Lowland province, which received a still later deposit of drift, is scarcely dissected at all.

STRUCTURE

The structure of most of the consolidated rocks that underlie the Central Lowland and adjoining provinces is comparatively simple. The beds in most of these provinces lie nearly flat, their regularity being broken by small faults and low, broad, more or less irregular folds. The principal exceptions are the complexly folded and faulted beds of the Proterozoic era that crop out in the Laurentian Upland in Wisconsin, Minnesota, and northern Michigan, the folded beds in the Appalachian Highlands, and the closely folded beds in the Ouachita province of the Interior Highlands. The principal structural features that affect the Paleozoic rocks of the Central Lowland province in the United States are the following:

1. The Cincinnati anticline, a low, broad arch in western Ohio, eastern Indiana, and northern Kentucky.
2. A broad arch in Wisconsin and Minnesota, bringing the Proterozoic and lower Paleozoic rocks to the surface.
3. A shallow basin that is practically coterminous with the Lower Peninsula of Michigan.
4. Another basin that occupies most of Illinois and southwestern Indiana.
5. A still broader basin that extends westward from the Mississippi across Iowa and Missouri and thence southwestward.

These are the most conspicuous structural features, but there are other, less striking deformations of the strata that separate the basins or lie within them.

A broad ill-defined anticline that strikes southwestward into the Ozark region separates the eastern Illinois coal basin from the Western Interior coal basin. An elevated zone also separates the Michigan basin from that of Illinois.

In general the strata rise gently from the basins toward the more prominent adjacent structural arches, but there are several exceptions. One of the best known of these exceptions is the La Salle anticline, which lies within the Illinois trough and divides it into two unequal parts by a gentle northwestward-trending fold parallel to the axis of the basin.

The formation of the domes and basins and other structural features seems to have begun early in the Paleozoic era, if not before, but the greatest movement seems to have occurred near the end of the Carboniferous period, though some of the movements no doubt took place still later, and there is some reason to believe that slight warping has taken place since the retreat of the ice.

The general surface features of the province are due partly to the fact that the strata which underlie it lie nearly flat and are little disturbed and partly to the fact that the province has not recently suffered great elevation. The details are due partly to glaciation and partly to erosion.

GEOGRAPHY

SURFACE FEATURES

The surface of the Gillespie–Mount Olive district is a moderately dissected plain that has an approximate average altitude of 650 feet above sea level, or 250 feet above the flood plain of the neighboring part of Mississippi River. Above this surface in the northeast corner of the Mount Olive quadrangle and near Sorento in the southeast part rise groups of hills. The valleys of the streams have rather steep sides, and the larger creeks have cut to a depth of 80 to 100 feet below the plain. The lowest point is slightly under 500 feet above sea level, where Shoal Creek passes out of the Mount Olive quadrangle in its southeast corner. Macoupin Creek, in the northwestern part of the Gillespie quadrangle, is only a few feet higher.

The topographic forms include an upland plain, morainic or drift hills, valleys, and flood plains.

Upland plain.—The undissected part of the plain constitutes slightly less than half the area of the district. It forms the forked divide between the headwaters of Cahokia Creek and the basins of Macoupin and Shoal creeks, occupying broad areas that stretch northeastward diagonally across the central part of the Gillespie quadrangle and southward along the western margin of the Mount Olive quadrangle.

On the west side of the Gillespie quadrangle the upland has an altitude of about 620 feet above sea level, and it rises toward the southeast at an average rate of less than 4½ feet to the mile, reaching its greatest altitude of 700 feet on the divide between Litchfield and Mount Olive. Southeastward from this divide the upland slopes at an average rate of about 7½ feet to the mile, and in the southeastern part of the Mount Olive quadrangle it has an altitude of less than 600 feet.

The margin of the upland tract is trenched by minor branching valleys of streams which are cutting back into the flat divide and slowly reducing its area. Some of the larger ravines have been cut back several miles into the upland, leaving long level strips in the interstream spaces. The nearly flat divide is slightly diversified by low rounded swells and by shallow depressions which, until they were drained in recent years, were occupied by swampy tracts and ponds.

Morainic or drift hills.—In the eastern part of the Mount Olive quadrangle there is a conspicuous belt or chain of hills, one of which near Butler rises 120 feet above the upland plain and stands at an altitude of over 760 feet above sea level. Other hills northwest of Sorento are 60 to 80 feet high. Near the larger hills there are numerous small mounds 10 to 40 feet in height and of irregular shape and distribution.

In sec. 15, T. 9 N., R. 7 W., in the Gillespie quadrangle, a notable isolated mound, known as Brushy Mound, rises 50 feet above the upland plain. The village of Bunker Hill is built on a much lower mound, and there is another 2 miles northwest of Bunker Hill. In addition to these mounds the flat upland is dotted with small knolls, most of them not more than 20 feet high, which, although little more than swells in the prevailing flat surface, tend to relieve its monotony. The chain of ridges and knolls in the eastern half of the Mount Olive quadrangle is a part of a series of chains of mounds that extends from a point near the south edge of the Wisconsin drift near Pana southwestward through the basin of Kaskaskia River nearly to the Mississippi, as described by Leverett.[3]

Valleys.—As the Gillespie-Mount Olive district lies near the headwaters of three streams none of the valleys are large, and only part of the area is intricately dissected. Where the valleys are cut wholly in drift the streams have fairly wide flood plains, but where they are cut into the underlying hard rock the valleys are narrow. Many of the areas where hard rock is exposed may thus be noted from an inspection of the topographic map. As a rule the valley slopes, even in the drift, are comparatively steep, and the contrast between the topography of the upland plains and that of the valleys is sharp.

At a number of places remnants of river terraces have been preserved where they are underlain by consolidated rocks, such as sandstone or limestone. These remnants do not appear to have any definite systematic relation to one another. An example of an abandoned valley is that occupied by Beaverdam Lake, 1 mile west of Macoupin, in the northwestern part of the Gillespie quadrangle. This valley has been abandoned as the result of stream piracy by a tributary of Macoupin Creek. Hurricane Creek originally found its way into Macoupin Creek through the valley now occupied by Beaverdam Lake, but after it had cut its channel to the resistant sandstones that underlie the drift in this locality its deepening was so retarded that a smaller tributary at the site of its present outlet, which was cutting the softer till and which was assisted, no doubt, by a meander of Macoupin Creek itself, effected an opening at this point and permitted the drainage to escape by a shorter channel. A similar capture is threatened in the SW. ¼ sec. 35, T. 9 N., R. 8 W., where the divide between May Branch and Dry Fork is being approached by a meander of Dry Fork. The abandoned part of the valley of Hurricane Creek crosses a preglacial ridge of hard rock, from the crest of which the drainage of this part of the valley now runs in opposite directions in the old channel. The lake itself is artificial, dams having been constructed at each end so that the lake occupies the gap between the new drainage lines.

Flood plains.—The lower part of the flood plain of Shoal Creek is in some places nearly a mile wide, but the flood plains of West and Middle forks of Shoal Creek and Macoupin Creek are mostly less than a mile wide. The broader parts of the valleys were probably widened by meandering and lateral cutting above points where the down cutting of the streams was retarded by the buried ridges of hard rock. The smaller valleys have flood plains only a few hundred feet wide. Those less than 500 feet wide are not indicated on the geologic map. Valley bottoms more than 300 or 400 feet wide, and some even narrower, are largely under cultivation.

DRAINAGE

The Gillespie-Mount Olive district is well drained, as the surface of the upland plain slopes gently toward the main drainage lines and the ponds and swamps that originally occupied depressions in the upland have been artificially drained. The fine mud accumulated by washing into these basins dries much more slowly than the adjoining surface, and, in spite of the artificial drainage, roads that cross the basins are muddy long after other localities are dry.

The run-off finds its way chiefly into three creeks. Macoupin Creek with its tributaries receives the drainage of the northwestern part of the area and flows in a general westerly course to Illinois River. Shoal Creek with its tributaries receives the drainage of the greater part of the Mount Olive quadrangle and flows southward to Kaskaskia River. The drainage north of Litchfield finds its way by a northerly course to a tributary of Shoal Creek. The run-off from most of the southwest quarter of the area flows directly to the Mississippi through Cahokia Creek and its tributaries and Wood River, which rises in the southwestern part of the Gillespie quadrangle and drains a small area west of Bunker Hill. Shoal Creek, which leaves the area at its lowest altitude about 495 feet above sea level, reaches the Mississippi by the longest channel. It has an average fall of about 4 feet to the mile and flows in a narrow channel cut nearly 20 feet below its flood plain.

Macoupin Creek at the boundary of the Gillespie quadrangle has an altitude of 505 feet and within the quadrangle has a grade comparable to that of Shoal Creek. The grade is materially reduced, however, near the margin of the quadrangle, where the stream has encountered a rock ridge that has retarded the cutting of its valley at this point, above which the flood plain has attained a width which it would not otherwise have had. This interruption has caused some of the tributaries that enter Macoupin Creek above the rock barrier to build alluvial fans, as their own unimpeded erosion permits them to bring down to the main stream greater quantities of alluvium than Macoupin Creek with its checked velocity can transport. This part of Macoupin Creek has cut about 50 feet into hard rock, chiefly sandstone, so that the building of alluvial fans has been going on for a considerable time. Some of the mounds at the margins of the flood plains near the mouths of the valleys are remnants of alluvial fans which were formed earlier in the period of the cutting of hard rock and which were built perhaps on till. Since their formation they have been dissected by the streams that deposited them and also by meanderings of Macoupin Creek.

SETTLEMENTS, INDUSTRIES, AND ACCESSIBILITY

The Gillespie-Mount Olive district is well settled but not thickly populated. The four principal towns are Litchfield, Mount Olive, Staunton, and Gillespie. Litchfield, which is at the junction of three railroads, had a population in 1920 of 6,215. It is dependent chiefly on the adjoining agricultural district, though it has some manufactures. Gillespie (population 4,063) and Staunton (population 6,027) are chiefly coal-mining towns, though the adjoining farming community contributes to their support. Mount Olive (population 3,503) is to a considerable extent an agricultural community, but coal mining contributes to its maintenance.

The Mount Olive quadrangle contains from north to south, the villages of Butler, Hornsby, Walshville, Panama (a coal-mining town), and Sorento. The Gillespie quadrangle contains the villages of Plainview, Dorchester, Bunker Hill, Benld, and Sawyerville, the last two coal-mining towns. The principal mines, which are opened in the southeast corner of the Gillespie quadrangle, are surrounded by small mining communities.

The district is crossed by eight railroads and one electric traction line. The Chicago & Alton, the Cleveland, Cincinnati, Chicago & St. Louis (the main line and the Alton branch), the Wabash, and the Toledo, St. Louis & Western railroads cross the district from northeast to southwest from 5 to 8 miles apart. The Chicago, Burlington & Quincy, the Illinois Central, and the Chicago & Northwestern railroads cross the district from north to south. In addition, the Litchfield & Madison Railway joins Litchfield and Staunton parallel to the Wabash line. The Illinois Traction line, which enters the area at Staunton, has two branches—one running northward through Gillespie to Springfield, the other connecting Staunton with Litchfield and Hillsboro.

Except in the broken country the roads follow section lines.

CLIMATE AND VEGETATION

The average annual rainfall is between 35 and 40 inches, and slightly more than half the amount falls during the spring and summer, though droughts sometimes occur in August.

The plains area was originally to a large extent grass-covered prairie but is now almost entirely under cultivation. The steeper slopes, the sides of ravines, and the morainal areas were originally forested with deciduous trees, but a part has been cleared and is in use as pasture land. Some of the cleared land is being reforested. The bottoms, which were formerly wooded, are now almost entirely under cultivation, and the swampy areas on the divide and in the flood plains are rapidly being drained and converted into farms.

GENERAL GEOLOGY

STRATIGRAPHY

GENERAL CHARACTER OF THE ROCKS

The rocks of the Gillespie-Mount Olive district are of sedimentary origin and consist of nearly horizontal beds of shale, sandstone, limestone, and coal, overlain by unconsolidated surficial deposits which almost entirely conceal them. The rocks below the Carboniferous formations are known only from drill holes and from outcrops in other areas, where they form a thick series that overlies granite and metamorphic rocks, but their thickness and lithologic character differ considerably in different localities, as is indicated by drilling operations.

The columnar section given in Figure 3 shows the character of the rocks beneath the surface in this district, so far as known.

PRE-CARBONIFEROUS ROCKS

The deepest well in the Gillespie-Mount Olive district was drilled on the Mark Flitz farm by the Producers Oil Co. in 1909. It is on the flood plain of Long Branch, at an altitude of 567 feet and is 2,770 feet deep. The log of this well (p. 3) was interpreted by T. E. Savage and R. S. Blatchley,[4] but certain changes in the terminology and in the formational divisions, justified by the study of new logs, have been made. The log is known to be lacking in detail. The well penetrated 85 feet below the St. Peter sandstone into the series of Cambrian and Ordovician rocks, which in Missouri is more than 2,000 feet thick and which overlies the pre-Cambrian complex of granite and metamorphic rock.[5]

Another well, drilled in 1909 by T. A. Rinaker on the Freeman Hall farm to a depth of 2,100 feet, passed through the Mississippian series, but the log (p. 3) does not agree with that of the Flitz well.

In the Hall well the Meramec and Osage groups, the Silurian beds, and the Maquoketa shale are all notably thicker than they are in the Mark Flitz well, whereas the Kinderhook and Devonian (?) shales are thinner. Except the Quaternary deposits, all the recognizable divisions are approximately of the same thickness as those in a well in the city of Jacksonville, Morgan County, 25 miles to the northwest.

[3] Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey Mon. 38, pp. 71–74, 1899.

[4] Blatchley, R. S., Oil and gas in Bond, Macoupin, and Montgomery counties, Ill.: Illinois Geol. Survey Bull. 28, pp. 20–21, 1914.

[5] Correlation by L. A. Mylius in 1923, which places the lower part of the section in the Devonian and Silurian, throws doubt on the interpretation used in this folio.

Log of well on Mark Flitz farm, in sec. 24, T. 8 N., R. 5 W.

[Altitude of curb, 567 feet]

	Thickness	Depth
	Feet	*Feet*
Quaternary system:		
Alluvium and till	60	60
Carboniferous system:		
Pennsylvanian series:		
McLeansboro formation:		
Limestone, Shoal Creek	20	80
Shale	250	330
Limestone	15	345
Shale	40	385
Carbondale formation:		
Place of Herrin coal.		
Shale	145	530
Limestone	6	536
Shale	54	590
Coal (Murphysboro ?)	[a] 7	597
Pottsville formation:		
Shale (probably contains much sandstone)	128	725
Sandstone	15	740
Mississippian series:		
Meramec and Osage groups:		
Limestone	285	1,025
Sandstone	15	1,040
Limestone	125	1,165
Sandstone (?)	105	1,270
Kinderhook group and possible representative of Devonian system:		
Shale	348	1,618
Silurian system:		
Limestone	24	1,642
Ordovician system:		
Maquoketa shale:		
Shale	73	1,715
Limestone	12	1,727
Shale	35	1,762
Kimmswick and Plattin limestones:		
Limestone	48	1,810
Sandstone	35	1,845
Limestone	415	2,260
Shale	195	2,455
Limestone	115	2,570
St. Peter sandstone:		
Sandstone	115	2,685
Shakopee dolomite:		
Limestone	85	2,770

[a] The reported thickness of this coal is questionable.

Log of well on Freeman Hall farm, in sec. 5, T. 9 N., R. 7 W.

[Altitude of curb, 619 feet]

	Thickness	Depth
	Feet	*Feet*
Quaternary system:		
Till	40	40
Carboniferous series:		
Pennsylvanian series:		
McLeansboro formation	210	250
Carbondale and Pottsville formations	320	570
Mississippian series:		
Meramec and Osage groups:		
Limestone, sharp, sandy (?), hard	156	726
Sandstone	5	731
Limestone, hard	24	755
Sandstone	20	775
Limestone "broken"	25	800
Limestone, broken, brown mud	13	813
Sandstone and limestone, broken	20	833
Limestone and sandstone	5	838
Limestone, broken	32	870
Limestone, brown	15	885
Limestone, black, with pyrite	10	895
Sandstone	25	920
Shale	48	968
Limestone, "sandy" (?)	247	1,215
Limestone, red brown	10	1,225
Limestone, gray	25	1,250
Kinderhook group and possible representative of Devonian system:		
Shale, light	50	1,300
Lime, brown	8	1,308
Shale, black, gritty	87	1,395
Silurian system:		
Limestone	160	1,555
Sandstone (?)	45	1,600
Ordovician system:		
Maquoketa shale:		
Shale, white	135 ?	1,735
Kimmswick and Plattin limestones:		
Limestone	179 ?	1,914
Limestone, gray, fine grained	111	2,025
Limestone, yellowish brown, subcrystalline	1	2,026
Limestone, gray, fine grained	74	2,100

CARBONIFEROUS SYSTEM

MISSISSIPPIAN SERIES

The Mark Flitz and Hall wells are the only ones in the district that pass through the Mississippian series. The thick sandstone reported just above the Kinderhook in the Flitz well is not known at any other locality, and this part of the log is believed to be in error. A well drilled by T. A. Rinaker on

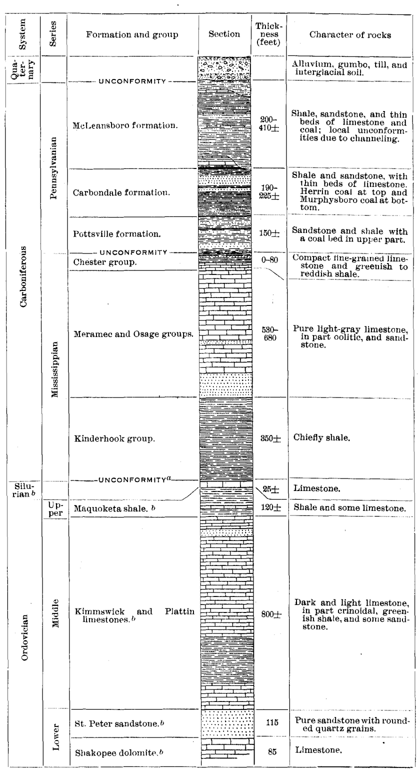
the Smith farm, in sec. 15, T. 7 N., R. 5 W., at an altitude of 621 feet, passed into Mississippian rocks at a depth of 695 feet and penetrated 680 feet of this series.

Log of well on Smith farm, in sec. 15, T. 7 N., R. 5 W.

[Altitude of curb, 621 feet]

	Thickness	Depth
	Feet	*Feet*
Unrecorded	136	136
Pennsylvanian series:		
Shales, sandstones, coal, and limestone	559	695
Mississippian series:		
Chester group:		
"Rock," red	25	720
Sand, gray	35	755
Sandstone	10	765
Sand, gray	5	770
Shale, sandy	5	775
Meramec and Osage groups:		
Limestone, gray	65	840
Hole filled with water	10	850
Limestone	45	895
Limestone, sandy	5	900
Sandstone	25	925
Limestone, gray	50	975
Limestone, brown	25	1,000
Limestone	455	1,455

The "hole" reported in the log was doubtless formed by solution of the limestone during a pre-Pennsylvanian emergence. If this solution occurred during post-Chester time, as seems probable, it implies an elevation above sea level or a depression of the ground-water level of at least 155 feet. If the solution cavity was formed prior to the deposition of the Chester it still indicates a height of the surface of 75 feet above the ground-water level. Indications of solution on the pre-Pennsylvanian surface are common in Missouri, where Pennsylvanian sediments are found in some places in sink-hole openings more than 170 feet deep.



[a] If Devonian is represented it is probably a small part of the overlying shale.
[b] See footnote 5, p. 2.

FIGURE 3.—Generalized columnar section of rocks underlying the Gillespie and Mount Olive quadrangles

Scale 1 inch=400 feet

The Chester group is not represented in any of the wells that penetrate the top of the Mississippian to the north and west of the Flitz well. A few miles to the south and southeast, however, two wells that were drilled by the Patterson & Hedrick Co., as well as the Smith well, contain beds that are believed to represent the Chester group. The Mississippian beds shown in these logs are given in detail, but the Pennsylvanian beds are given only in outline.

Log of well on John Hamby farm, in sec. 20, T. 7 N., R. 4 W.

[Altitude of curb, 516 feet]

	Thickness	Depth
	Feet	*Feet*
Surface deposits	13	13
Pennsylvanian series:		
McLeansboro formation	307	320
Carbondale and Pottsville formations	390	710
Mississippian series:		
Chester group:		
Brown mud	8	718
Red rock	18	736
Sand and shale	29	765
Meramec group:		
St. Louis limestone	139	904

Log of well drilled in 1914 on I. N. Jordan farm, in sec. 24, T. 7 N., R. 5 W.

[Altitude of curb, 550 feet]

	Thickness	Depth
	Feet	*Feet*
Surface deposits	20	20
Pennsylvanian series:		
McLeansboro formation	292	312
Carbondale and Pottsville formations	373	685
Mississippian series:		
Chester group:		
Red rock	5	690
Shale	5	695
Sandstone	5	700
Red rock	10	710
Shale	7	717
Sandstone	33	750
Meramec group:		
St. Louis limestone.		

PENNSYLVANIAN SERIES

The sediments deposited in this district prior to the Pennsylvanian epoch were to a large extent of marine origin. During the Pennsylvanian epoch, however, conditions were reversed, and though marine deposits were formed at times, the sedimentation was largely fluviatile and estuarine. The Pennsylvanian series in this region is divided into three formations—the Pottsville, Carbondale, and McLeansboro—which correspond in age but not in their exact limits to the Pottsville, Allegheny, and Conemaugh formations of the Appalachian region.

POTTSVILLE FORMATION

The Pottsville formation comprises the beds from the base of the Pennsylvanian series to the base of the Murphysboro coal. The beds, which are known in the Gillespie-Mount Olive district only by borings, consist chiefly of alternating sand and sandy shale, apparently of little areal extent. The beds of sand seem to be either small distinct lens-shaped bodies or were laid down in localities where less clay was deposited than elsewhere. Certain beds, however, have local continuity, and certain parts of the formation are more sandy than others.

Only one coal bed is known to occur in the Pottsville of this area, but this bed is most frequently reported as black shale. Most of the holes drilled to the depth of this coal are oil wells, and as other coals known to be present in these localities have been carelessly recorded as black shale or omitted entirely the absence of this coal in all these holes is not conclusively demonstrated. This coal was formerly mined at Litchfield at a depth of about 700 feet. The coal lies 27 feet below the top of the formation and has a maximum thickness of 7 feet; the upper 9 inches is reported as "slaty."

On the Smith farm, in sec. 15, T. 7 N., R. 5 W., 30 feet of black shale, probably the equivalent of this coal, is reported 35 feet below the top of the formation. In the Carlinville and Litchfield oil fields, however, this coal or black shale was locally eroded, and its horizon is in some places marked by sandstone lentils.

By reason of the irregular surface on which it was deposited, the Pottsville formation differs in thickness from place to place. Near Hillsboro it is 125 feet thick, near Litchfield 150 feet, and south of Carlinville 100 feet. In a drilled well 3 miles north of Plainview only 75 feet of Pottsville beds appear to be present, and therefore in this locality a low hill probably marked the pre-Pennsylvanian surface.

CARBONDALE FORMATION

General features.—The base of the Carbondale formation is the base of the Murphysboro coal, and its top is the top of the Herrin or No. 6 coal. The identity of the Murphysboro coal in the Gillespie-Mount Olive district has been determined by stratigraphic evidence supported by faunal observations. White[6] found that the fossil plants of the deep coal bed in the Litchfield mine, mentioned above, place this bed only a short distance below the top of the Pottsville formation. A comparison of logs of wells in Jackson County, to the south, and in La Salle County, to the north, where the Murphysboro coal has been definitely identified, with the logs of wells in this district and at intervening places indicates that

[6] White, David, Paleobotanical work in Illinois in 1908: Illinois Geol. Survey Bull. 14, p. 294, 1909.

the next coal above the coal in the Pottsville is the Murphysboro coal.

The Carbondale consists chiefly of shale, sandy shale, sandstone, a few thin lenticular beds of limestone, and five distinct coal beds with other coal sheets locally interpolated. Like the Pottsville, it is known in this area entirely by records of borings. The formation is much more uniform in character and in thickness than the Pottsville, owing in part to the nearly flat surface on which it was deposited and in part to the more stable condition of the surface during its deposition. The formation contains practically all the workable coal beds of Illinois, and most of the coals were deposited under conditions so uniform that they extend in continuous beds throughout the greater part of the coal fields of the State, though they differ in thickness from place to place. In the Gillespie-Mount Olive district the formation is from 190 to 224 feet thick; the increase in thickness is shown from northwest to southeast. The following list, compiled from the more accurate logs of the Carbondale formation, illustrates this increase.

Increase in thickness of Carbondale formation from northwest to southeast

	Feet
Sec. 18, T. 9 N., R. 7 W.	190
Sec. 29, T. 9 N., R. 5 W.	205
Sec. 3, T. 8 N., R. 5 W.	197
Sec. 22, T. 8 N., R. 5 W.	218
Sec. 15, T. 7 N., R. 5 W.	220
Sec. 11, T. 7 N., R. 5 W.	224

The log of the Litchfield shaft, which is given in the next column, presents a typical section of the Carbondale formation. The section of the McLeansboro, however, is not typical of that formation, and the section of the Pottsville is not complete.

Murphysboro coal.—In this district, as in many other areas, the Murphysboro coal consists of two beds separated by shale and sandy shale of variable thickness. North of Litchfield it has been penetrated at two places. The upper bed at one of these places is reported to be 2 feet 7 inches thick, and the lower, separated from it by 26 feet of shale, is 2 feet thick. At the other place beds 9 and 10 inches thick are separated by 12 feet 4 inches of shale. In the abandoned shaft east of Litchfield two beds, one of them 2 feet 6 inches and the other 2 feet 4 inches thick, are separated by 5 feet 6 inches of clay and shale. In a well drilled by the community of Walshville in sec. 11, T. 7 N., R. 5 W., beds 1 foot 10 inches and 3 feet 10 inches thick, the thicker one lying below, are separated by 11 feet 6 inches of sandy shale. At intermediate localities only one coal has been reported, but the churn-drill records of oil wells, which have furnished the information, are not trustworthy as to details.

Coals between Murphysboro and Springfield coals.—About 75 feet above the base of the Carbondale formation, separated from the Murphysboro coal by sandy shale, lies a group of coal beds that occupies the stratigraphic position of Worthen's No. 3 coal. Many of the logs report a thin limestone layer just above the coal. In some logs a thin layer is also reported just below the lower bench. In several of the logs a third coal bed is noted, and in one log a fourth bed. This group of coal beds and associated limestone or its representatives are reported in logs of wells in Marshall, Livingston, Macon, Scott, Cass, Macoupin, and Montgomery counties. The section of this group of coals given in the log of the Litchfield shaft is typical. The absence of the highest or lowest coal bed would explain the apparent reversal in the order of the limestone frequently reported at this horizon. Limestone is not associated with these beds in the region to the southeast, though it appears to be present to the southwest in Madison and St. Clair counties, where, probably for the reason suggested, limestone appears above the coal. In sec. 5, T. 8 N., R. 5 W., the two highest benches are 2 feet 9 inches and 3 feet 4 inches thick and are separated by 5 feet 9 inches of shale and limestone. The lower and thicker bench, however, is reported to contain "bands of shale."

Another persistent coal bed is present 40 to 60 feet above the one just described. It is 75 to 100 feet below the top of the formation and 105 to 130 feet above the base. Its position in the section is somewhat variable, and its thickness is also more variable than that of the others. It has been mined in the Litchfield shaft, where it was considered to be the Herrin coal on account of a clay parting. The bed is 3 feet 4 inches thick and has a 4-inch parting 8 inches above the base. In sec. 17, T. 8 N., R. 4 W., "coal and smut" 8 feet 6 inches thick is reported at this horizon, and on the Atterbury farm, in sec. 6, T. 7 N., R. 4 W., 6 feet 8 inches of coal overlain by 4 feet 6 inches of limestone is reported. In most of the wells this coal ranges from a few inches to 2 or 3 feet in thickness.

Springfield coal.—The Springfield coal, formerly known as No. 5 in Worthen's classification, lies 30 to 55 feet below the top of the Carbondale formation. In many localities it has a thickness of 2 or 3 feet, but it is usually thinner and is reported as only a few inches thick or entirely absent at some localities in carefully recorded logs. In a diamond-drill hole in sec. 21, T. 7 N., R. 4 W., the coal is reported to be over 8 feet thick, but this thickness is exceptional, and the thick coal probably does not underlie a very large area. This coal is extensively mined a few miles north of the Gillespie-Mount Olive district, at and near Springfield, and also in the southeastern part of the State, where it is the chief coal, but it is too thin to be profitably exploited at the present time in the Gillespie-Mount Olive district.

Log of well at site of Litchfield mine shaft, in sec. 29, T. 9 N., R. 5 W.

[Altitude of curb, 670 feet]

		Thickness		Depth	
		Ft.	*in.*	*Ft.*	*in.*
Surface material		15		15	
Sand		1		16	
Hardpan		29		45	
McLeansboro formation:					
Clay, sandy, blue		18		63	
Limestone			10	63	10
Clay		43	2	107	
Sand, green		13		120	
Gravel		3		123	
Limestone, broken		12		135	
Shale, sandy		2		137	
Shale, black		1		138	
Shale, sandy		45		183	
Limestone, dirty		1		184	
Shale, black		1	7	185	7
Limestone, dirty		1	5	187	
Coal, slaty			4	187	4
Shale, gray		6	8	194	
Limestone, with shale bands		5		199	
Shale, sandy		24		223	
Limestone		5		228	
Sandstone		11		239	
Shale, sandy		28	6	267	6
Shale, sandy		22	6	290	
Sandstone		28		318	
Shale		64		382	
Limestone		5		387	
Shale, sandy		13		400	
Limestone		3		403	
Shale		53	5	456	5
Carbondale formation:					
Coal	Herrin coal	1	1	457	6
Shale	Herrin coal	1	1	458	7
Coal	Herrin coal	1	5	460	
Fire clay		1		461	
Shale, blue		2		463	
Conglomerate		3		466	
Shale, hard gray		16		482	
Shale, black		1	6	483	6
Coal, Springfield coal		1	1	484	7
Fire clay		2	5	487	
Sandstone		46	2	533	2
Coal		2	4	535	6
Shale			4	535	10
Coal			8	536	6
Shale		2	6	539	
Sandstone, shaly partings		17		556	
Shale, dark sandy		34		590	
Shale, black		1	11	591	11
Coal		1	10	593	9
Shale		2	3	596	
Limestone		3		599	
Shale, soft		1	2	600	2
Coal, slaty			10	601	
Coal		2	7	603	7
Shale		1	5	605	
Limestone		1		606	
Shale, dark		2	6	608	6
Coal			9	609	3
Shale, soft		4	3	613	6
Fire clay		9	6	623	
Shale, sandy		16		639	
Sandstone		5		644	
Shale, black		4	2	648	2
Coal	Murphysboro coal		9	648	11
Shale	Murphysboro coal	12	4	661	3
Coal	Murphysboro coal		10	662	1
Pottsville formation:					
Shale, sandy		14	11	677	
Sandstone, shaly		10		687	
Shale, sandy, dark		14		701	
Limestone, broken		2		703	
Coal		4	10	707	10
Fire clay, hard		6	2	714	
Shale, dark		3		717	
Sandstone, shale parting		14		731	
Limestone, shale parting		3		734	
Shale, dark sandy bands		9		743	
Sandstone, hard		2		745	
Shale, sandy		22		767	
Sandstone		26		793	
Shale, blue		10		803	
Sandstone		8		811	

Herrin coal.—The Herrin coal, also known in this part of the State as the No. 6 coal, according to Worthen's enumeration, is the thickest and most valuable coal in the area and is the only one now mined. It lies nearer the surface than the other coals and may be mined under more favorable conditions. A thin band of clay, which lies from 8 to 20 inches above its base, is present in this coal everywhere throughout the southern part of Illinois, and on this account it is sometimes referred to as the "blue band" coal. The coal bed has a rather even thickness of 6 to 8 feet over the western two-thirds of this district, though in the southwest corner there are many rolls, and its thickness may decrease from 7 to 4 feet within the length of a mine room.

In most places this coal is overlain by hard, tough black shale a few inches to 8 feet thick, though in some places it is much thicker. Above the black shale in most places in this area lies a thick limestone, which is generally interstratified with shale. In a strip 5 or 6 miles wide, extending 2 or 3 miles on both sides of a line passing through Litchfield and Walshville, the No. 6 coal is entirely absent or is too thin to work. Farther east, particularly near Hillsboro, the coal, though generally present, is entirely absent from distinctly channel-shaped areas, being cut off sharply along a curved line in the mine workings by a steeply sloping surface which has been attributed to faulting. Drilling in one place, however, demonstrated very clearly that the coal there is not displaced but is entirely absent in an area about three-fourths of a mile wide, beyond which the coal is again present in undisturbed continuity at the same horizon.

The roof limestone is absent in Honey Point Township and the northern and eastern parts of Cahokia Township and is irregular in thickness in areas bordering the zone in which the coal itself is thin or absent. Limestone is generally though not everywhere absent from the horizon in this border zone.

The absence of the limestone and the thinning of the coal are probably due to the same cause. A short time after the deposition of the coal and limestone the land was slightly elevated and subjected to erosion, and broad, shallow basins were ultimately cut in the new land surface. In localities farthest from the streams only the limestone was eroded. Close to the streams the coal and limestone were both affected, and in some localities, particularly near the channels, the coal and some of the underlying shale were cut away. The flat valleys afterward became filled with sand and silt, in some places containing streaks of coaly material, and here and there limy beds were laid down. Continued accessions to the beds at and above the original position of the limestone succeeded in apparent local conformity.

The fire clay below the coal is rarely seen in the mines. It is variously reported in the drill logs. In most places it is only 1 to 3 feet thick, but in some places it is reported to be 6 to 15 feet thick.

Clastic beds.—The sandstones of the Carbondale formation, like those of the Pottsville, are irregular and discontinuous. The Vergennes sandstone, which is a conspicuous member toward the base of the formation to the southeast, in the Murphysboro-Herrin district, is not represented in the Gillespie-Mount Olive district. Between the base of the formation and the group of coals at the horizon of Worthen No. 3 coal the beds in most places do not contain sandstone, though in one or two logs sandstone beds 5 to 8 feet thick are reported and locally sandy shale is present.

The beds that lie between the coal group just mentioned and the Springfield coal show the greatest diversity and irregularity of sedimentation. In the northwestern part of the Gillespie quadrangle the strata of this part of the section are predominantly shaly, whereas in the vicinity of Litchfield sandstone beds predominate, but it is impossible to correlate the sandstones from one drill hole to another.

Between the Springfield coal and the Herrin coal the beds are thin and are composed of different materials. In many of the logs limestone is reported a short distance below the Herrin coal. In some places several thin beds of limestone are associated with limy shale, and in other places no limestone at all is reported. Sandstone is rare in this interval.

McLEANSBORO FORMATION

The McLeansboro formation in Illinois, like the Conemaugh formation of the Appalachian region, to which it corresponds in age, is practically barren of workable coal beds and consists very largely of shale and sandy shale. It contains also some beds of sandstone, thin coals, and several beds of limestone.

The McLeansboro formation includes in this region all the Pennsylvanian strata above the Herrin coal. It is named from the town of McLeansboro, the county seat of Hamilton County, Ill., near which it has a thickness, as shown in borings, of nearly 1,000 feet. Its greatest known thickness in the Gillespie-Mount Olive district is in the Litchfield mine shaft, where 411 feet of beds were passed through before the Herrin coal was reached. The formation underlies the surficial materials of the district and crops out where these have been removed by erosion. Because of erosion and the general eastward dip of the beds, the formation in this district becomes thinner westward, and less than 200 feet of combined McLeansboro and surficial deposits overlies the Herrin coal on the western margin of the Gillespie quadrangle.

Limestone members.—The most conspicuous members of the McLeansboro formation are the limestones. The most persistent of these beds is the one which lies above the Herrin coal and is almost coextensive with that coal. In most places it is 20 to 30 feet thick and is separated from the coal by a few inches to 8 feet of black "slate" (shale). In many places, however, the deposition of limestone at this horizon was interrupted by the deposition of shale, so that limestone alternates with shale and forms a heterogeneous though distinct group of beds. This limestone is characterized by a small fossil, of the shape and size of a grain of wheat, which is known as *Girtyina ventricosa*, but which has also been known by several other names, chiefly perhaps by the name *Fusulina secalica*. By reason of its wide deposition and its characteristic fossil this limestone is useful in identifying the Herrin coal. However, as mentioned in explaining the local absence of the Herrin coal, it is rather generally absent in a large part of the Mount Olive quadrangle.

Two other limestone beds, the Carlinville and Shoal Creek members, in the middle and upper parts of the formation respectively, are particularly conspicuous, and indeed they are the only outcropping members of the formation that can be readily identified. The Carlinville limestone, the lower of these beds, is named from its exposures near Carlinville, just north of the Gillespie quadrangle. It lies from 200 to 225 feet above the base of the formation, but toward the eastern margin of the district the bed becomes thin and irregular and is apparently absent. At its outcrops the bed has a thickness of 6 to 7 feet. It is tough, gray, and dense and is much more homogeneous than the Shoal Creek limestone, which lies at a higher altitude. The Carlinville is also less argillaceous and may be distinguished from the Shoal Creek member by its smoother grain and its method of weathering. The Carlinville breaks into regular smooth-sided blocky chips, whereas weathered outcrops of the Shoal Creek member are littered with ragged flattish chips and plates. To the south, toward the Belleville-Breese district, as well as the east, the Carlinville member becomes thin and irregular and can not be identified positively in the logs. Possibly, however, it underlies a very small area.

The following fossils, determined by G. H. Girty, were collected from the outcrop of the Carlinville limestone in an exposure on Big Branch southwest of Benld, in the SW. ¼ sec. 12, T. 7 N., R. 7 W.:

Axophyllum rude?	Deltopecten occidentalis?
Craterophyllum verticillatum?	Acanthopecten carboniferus.
Fistulipora nodulifera?	Myalina sp.
Chonetes verneuilianus?	Parallelodon sp.
Marginifera sp.	Schizodus sp.
Squamularia perplexa.	Euphemus carbonarius?
Composita subtilita.	Naticopsis altonensis?

The "top" limestone mentioned by Udden and Shaw[7] may be the equivalent of the Carlinville limestone, but it seems more probable that this limestone, which is 100 to 130 feet above the Herrin coal in the Belleville-Breese area, is the equivalent of a limestone member reported in some logs, especially in the western part of the area, at an interval of 150 to 175 feet above the Herrin coal, though there is nothing save the stratigraphic position to justify the correlation. This limestone crops out in the railroad cut east of Plainview, and Worthen regarded it as the Carlinville member, which it closely resembles. Logs of wells near by, however, clearly indicate that it is beneath that bed and only 150 feet above the Herrin coal.

At the bridge over Spanish Needle Creek, in the W. ½ sec. 21, T. 9 N., R. 7 W., the following section was measured:

Section of Carlinville limestone and associated beds on Spanish Needle Creek

	Ft.	in.
Carlinville limestone:		
Limestone, massive, smooth, fine textured, in three benches, 56 inches, 5 inches, and 11 inches thick, respectively	6	
Limestone, highly fossiliferous		2
Limestone, shaly, fossiliferous		5
Shale, dark drab, with carbonaceous layer 6 inches from top; abundant leaf prints	2	6
Water level.		
	9	1

The dark fossiliferous shale commonly underlies the Carlinville in this part of the district, and the carbonaceous layer in some places becomes a thin band of coal. Fossil plants have been found in the clay beneath the Carlinville limestone at this place and in the SE. ¼ sec. 33, T. 9 N., R. 8 W.

Above the Carlinville member and 30 to 50 feet below the Shoal Creek member occurs a thinner bed of limestone which is exposed at a number of localities in the headwaters of Cahokia Creek south and west of Gillespie. This limestone is composed to a large extent of fragmental shells and is colored reddish brown by iron minerals. Its thickness in most places is only 2 or 3 feet, and it does not appear to form a continuous bed, for it is not reported in many reliable well logs. It crops out in the bed of Big Branch, in the SE. ¼ sec. 1, T. 7 N., R. 7 W., where the following fossils, identified by G. H. Girty, were found:

Craterophyllum verticillatum.	Dielasma bovidens?
Septopora biserialis?	Spirifer cameratus.
Derbya broadheadi?	Squamularia perplexa.
Productus pertenuis.	Composita subtilita.
Marginifera wabashensis.	Hustedia mormoni.
Pugnax osagensis.	

[7] Udden, J. A., and Shaw, E. W., U. S. Geol. Survey Geol. Atlas, Belleville-Breese folio (No. 195), p. 6, 1915.

The Shoal Creek limestone lies about 75 feet above the Carlinville and from 275 to 325 feet above the base of the formation. South of the Gillespie-Mount Olive district, however, at Breese, this interval increases to 350 feet. The limestone is conspicuously exposed near shaft No. 3 of the Superior Coal Co., in sec. 36, T. 8 N., R. 7 W.; also in sec. 25, T. 8 N., R. 6 W., on Shoal Creek east of Litchfield, on Lake Fork and Shoal Creek near Sorento, and elsewhere. It has a thickness of 12 to 25 feet, but it consists of a series of layers of more or less argillaceous limestone and is not a homogeneous member like the Carlinville. In certain localities parts of the bed become limy shale. Near Litchfield it appears to be split into two parts, the lower separated from the upper by 15 to 30 feet of shale, but the lower limestone may represent a locally developed lentil. The face in weathered exposures presents a ragged appearance, which is due to the fine conchoidal jointing of the beds and to the tendency of the bed to split along the bedding planes.

The following partial section of the Shoal Creek shows the character of the bed at one locality:

Section of Shoal Creek limestone in NE. ¼ sec. 2, T. 8 N., R. 5 W.

	Ft.	in.
Clay shale, laminated, with small "ironstone" concretions	4	
Shoal Creek limestone:		
Limestone, hard, crystalline	1	3
Limestone, very argillaceous; weathers into clods	2	
Limestone, argillaceous; weathers to limy clay	1	6
Limestone, dense, white, with dull "stony" surface	1	6
Limestone; shattered irregular slabs; slightly argillaceous	5	
Bed of creek.		
	15	3

The Shoal Creek limestone is generally underlain by 1 to 3 feet of black to gray "slate," beneath which is a coal streak a few inches thick and fire clay. At the quarry east of Litchfield, in the SW. ¼ sec. 2, T. 8 N., R. 5 W., 3 to 6 inches of coal occurs 1 foot beneath the limestone, and the underlying fire clay is said to be 7 feet thick.

On Shoal Creek in sec. 20, T. 7 N., R. 4 W., on the road to Panama, the following section of the Shoal Creek limestone and associated beds was measured:

Section of Shoal Creek limestone and associated beds in sec. 20, T. 7 N., R. 4 W.

	Ft.	in.
Shoal Creek limestone	6	
Clay, dark bluish		6
Shale, black	2	
Shale, dark blue	4	
Slate, black, coaly		3
Coal, dirty		3
Coal and mother coal		2
Coal, clean	1	3
Fire clay.		

The coal exposed in this section is said to be 2 feet thick beneath beds of the Shoal Creek limestone 15 feet thick at the ford on Lake Fork 2 miles north of Sorento, in the NW. ¼ sec. 29, T. 7 N., R. 4 W. It was mined about 40 years ago, but the outcrop is no longer visible. The coal is said to have been of excellent quality and to have been in demand for use by blacksmiths.

The following fossils, determined by G. H. Girty, were collected at this exposure:

Lophophyllum profundum.	Pugnax osagensis.
Batostomella sp.	Dielasma bovidens.
Polypora sp.	Spirifer cameratus.
Rhombopora lepidodendroides?	Squamularia perplexa.
Chonetes verneuilianus.	Composita subtilita.
Productus pertenuis.	Hustedia mormoni.
Productus nebraskensis.	Acanthopecten carboniferus.
Productus insinuatus?	Naticopsis altonensis?
Marginifera splendens.	Fish tooth.
Marginifera wabashensis.	

The following fossils, not found at the locality mentioned above, were found at other outcrops of the Shoal Creek member:

Tegulifera armata.	Campophyllum torquium.
Spiriferina kentuckyensis.	Stenopora carbonaria.
Cladochonus? prosseri.	Cyclotrypa barberi?
Cladochonus? anna?	Phillipsia sp.
Fusulina?	Fistulipora.
Septopora biserialis.	Productus cora.
Craterophyllum?	

One of the most distinctive beds recognizable in the drill records of the district is a bed of red or variegated clay. It is usually reported from 40 to 60 feet above the base of the formation. Though it is not recorded at all localities it is widely distributed throughout the central part of the State, being present at least as far north as Springfield and 20 miles or more south of the Gillespie-Mount Olive district.

Four thin coal beds are generally present at approximately 40, 75, 150, and 260 feet above the base of the formation. In a few places thin lentils of coal occur at other horizons. None of these coal beds are more than a few inches thick, except in T. 7 N., R. 4 W., where the third bed approaches workable thickness at several points. A carefully kept log of a drill hole in sec. 32 records a thickness of 7 feet of coal 134 feet above the base of the formation. In sec. 35 reports show 3 feet of coal underlain by 20 feet of fire clay 158 feet above the base of the formation. In sec. 22 this bed is reported to be 147 feet above the Herrin coal and to be 3 feet thick, with a 6-inch parting of fire clay near the middle. In sec. 5 reports give 4 feet of "coal and fire clay" 158 feet above the base of the formation. Most of the other logs, however, report less than 18 inches of coal.

Clastic beds.—The beds for 50 to 75 feet above the Herrin coal are extremely variable, and, except the basal limestone member, most of them are thin. Thin beds of limestone are common, thin lenses of coal are locally present, and black shale and sandstone are interbedded with shale and sandy shale. Beds of sandstone have been recorded in well logs at all horizons of the McLeansboro, though most common from 100 to 200 feet above the base of the formation, but they are of local extent.

The following log gives a representative section of the McLeansboro formation:

Log of well in southwestern part of T. 8 N., R. 5 W.

	Thickness		Depth	
	Ft.	*in.*	*Ft.*	*in.*
Quaternary system:				
Clay, yellow	4		4	
Sand	6		10	
Clay, yellow	25		35	
Sand	7		42	
Clay, blue	33		75	
Sand and gravel	8		83	
Carboniferous system (Pennsylvanian series):				
McLeansboro formation:				
Shale, limy	13		96	
Limestone, Shoal Creek	16		112	
Shale, dark	37		149	
Coal		3	149	3
Shale, clayey		9	150	
Shale, black	3		153	
Coal		3	153	3
Shale, clay	5	9	159	
Shale, limy	2		161	
Limestone	4		165	
Shale, sandy	10		175	
Shale, dark	15		190	
Limestone, Carlinville	6		196	
Shale, sandy	23		219	
Shale, gray	20		239	
Coal		6	239	6
Shale	2	6	242	
Shale, limy	9		251	
Shale, sandy	32		283	
Shale, gray	48		331	
Shale, dark blue	11	9	342	9
Coal		3	343	
Shale, clay	6		349	
Shale, dark	5		354	
Shale, clay	2		356	
Shale, red	8		364	
Shale, limy	2		366	
Limestone	6		372	
Shale, clay	4		376	
Shale, blue	1		377	
Coal	1	6	378	6
Shale, gray	9	6	388	
Limestone, lower part shaly	16		404	
Shale, dark	4		408	
Carbondale formation:				
Coal, No. 6 (Herrin)	8	9	416	9
Shale, clay	3	3	420	

Intraformational unconformities.—The unconformity a short distance above the Herrin coal is widespread and may be the equivalent of that which locally cuts out the same coal bed in the western Kentucky coal district.

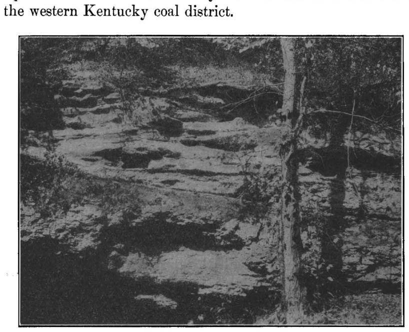


FIGURE 4.—Sandstone beds in McLeansboro formation resting unconformably on Shoal Creek limestone member of the formation, NW. ¼ sec. 25, T. 9 N., R. 5 W.

Another conspicuous unconformity was developed at some time after the deposition of the Shoal Creek limestone. This unconformity is well shown in the outcrops on Shoal Creek northeast of Litchfield, in secs. 23, 24, 25, 26, and 36, T. 9 N., R. 5 W. Here the Shoal Creek limestone may be seen in a series of exposures above the bridge in sec. 25 and on the road to the east. A few hundred feet farther south, however, where the creek impinges on a bluff, more than 80 feet of sandstone and sandy shale are exposed at the horizon of the limestone. This sandstone has no counterpart in adjacent exposures below the limestone, but in the ravine east of the bridge massive sandstone that has a basal limestone conglomerate rests unconformably on the Shoal Creek. (See fig. 4.) This sandstone is exposed in a few places southward along the creek to sec. 36, where the Shoal Creek limestone overlain by shale again appears. The relations of the unconformable beds are indicated in Figure 5. A study of the section shows that

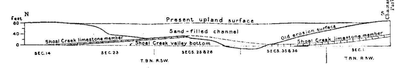


FIGURE 5.—Diagrammatic cross section along course of Shoal Creek projected on north-south plane, showing unconformity within the McLeansboro formation that cuts out the Shoal Creek limestone member

the unconformity is sharp and that the erosion formed a considerable valley. The depth can scarcely have been less than 100 feet, and the width of the channel not much more than 1½ miles. The geologic record indicates a period of temporary and unusual elevation of the land surface, which may have amounted to several hundred feet for the region as a whole. The fact that the filled channel occurs at the crest of an anticline naturally raises the question whether the limestone exposures north and south of the filled channel represent the same bed, but borings in the vicinity satisfactorily demonstrate their identity.

QUATERNARY SYSTEM

CHARACTER AND THICKNESS OF DEPOSITS

The surficial deposits of the Gillespie-Mount Olive district, which are 20 to 235 feet thick, belong to the Quaternary system. They consist almost entirely of unassorted drift or till, of Pleistocene age, and alluvium, of Recent age. All the material has been derived from consolidated rocks, in part through the grinding and plucking action of glaciers and in small part by wear effected by streams. These surficial materials have been transported partly by ice and partly by water, and perhaps to a minor degree the wind has been an agent in moving them.

The greatest thickness of Quaternary deposits known within the district is 235 feet, recorded in a hole drilled on Brushy Mound, in sec. 15, T. 9 N., R. 7 W. This thickness is exceptional, however, for the hole was drilled on a drift mound and descends into a preglacial valley. At mine No. 7 of the Consolidated Coal Co., in sec. 21, T. 7 N., R. 6 W., 193 feet of glacial till was penetrated.

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Preglacial saprolite.—Weathered shale or residuary clay overlain by glacial till, which is exposed in the cut on the Illinois Traction line just east of the bridge over Shoal Creek in sec. 12, T. 8 N., R. 5 W., is believed to represent preglacial rock decay. It is only natural to suppose that in areas protected from the scouring action of the advancing ice the old weathered preglacial rocks have been preserved at many points to form what has been termed saprolite and residuary clay. As a rule the bedrock in southern Illinois was not so deeply scored as in many other areas.

Pre-Illinoian (Kansan?) till.—At a number of localities in the central part of the district a till distinctly older than the Illinoian, which forms the surface, is exposed in the ravines. It is overlain at several places by interglacial soil or alluvium, which separates it from the Illinoian drift above. At most of the localities at which it is distinctly determinable only a few feet of more or less weathered till is present, and so far as known it is probably in few places more than 30 feet thick. In sec. 35, T. 9 N., R. 5 W., east of Litchfield, a partial exposure of what is believed to be the lower till occurs in the ravine a short distance below the outcrop of interglacial soil. At this place it has a distinctly more greenish cast than the usual bluish-gray color of the Illinoian till, and as it is composed of a larger proportion of clay it is tough and hard. The lower till appears also at several localities to contain a greater quantity of fragments of coal than the Illinoian, which may be due perhaps to the fact that at the time of the advance of the Illinoian ice sheet the Pennsylvanian rocks were more or less generally covered by remnants of the earlier till deposit, whereas the pre-Illinoian ice sheet advanced over a surface on which the outcropping coal beds were protected only by the thinner residuum.

Only two Pleistocene till sheets older than the Illinoian are known in North America, and one or both of these may extend into Illinois. The pre-Kansan touches the State along the Mississippi. In the absence of definite evidence the pre-Illinoian drift of this district is provisionally referred to the drift sheet next older than the Illinoian—that is, the Kansan. The percentage of pebbles of different kinds of rock in the glacial débris is given in the table on page 7.

Interglacial soil (probably Yarmouth).—The interglacial soil, which separates the older till from the Illinoian, is reported in many records of wells in the area and was observed in several outcrops. This soil is thought to correspond to the buried soil found by Leverett near Yarmouth, Iowa.[8]

In addition, several detailed records show yellow clay and sandy clay underlying blue till at considerable depths below the surface, and these clays probably represent interglacial weathering. Many records also show beds of sand and gravel of considerable thickness, and although no doubt many of those beds represent lenticular masses in the drift it is probable, in view of the established presence of an interglacial soil, that at least some of them represent pre-Illinoian alluvial deposits, such as have been observed in the outcrops.

The most striking exposure of interglacial soil lies 1 mile north of Staunton, in a ravine in the SW. ¼ sec. 20, T. 7 N., R. 6 W., where the following section was measured:

Glacial and interglacial deposits north of Staunton

	Ft.	in.
Illinoian glacial till:		
Buff to bluish-gray sandy clay, mostly covered in wooded slope; lower part, exposed in bank of gully, very hard, dense, partly cemented, calcareous, with rusty zones 1 to 2 inches wide bordering joint cracks and around small tubes	40	
Yarmouth (?) interglacial deposits:		
Sand or sandy clay, very fine, clean, grayish-white, limy, compact, tough but breaking with conchoidal fracture; weathered face shows lamination; contains vertical plant and tree stems, the largest of them 3 inches in diameter	2	
Clay, bluish, tough, with small stems		2
Sand, like above but yellowish		0–6
Sandy loam, black and carbonaceous, grading downward into coarse unsorted sand; contains small spiral shells and at top many large and small pieces of wood and roots in place; sandy portion at base brownish, with less wood (probably rotted)		6–12
Sand, reddish brown, unsorted but irregularly stratified, grading downward into weathered till	2–3	
Kansan (?) glacial till:		
Weathered deposit; bits of coal and black shale conspicuous	1	
Till, estimated thickness, only upper part exposed	30	

The fine sand just below the Illinoian till is gray to bluish white. Most of the stems and branches have completely rotted away, leaving only small holes in the centers of cylindrical crusts of yellow-stained hardened sand, although in some places cores of rotten or even firm wood remain.

At one place where the scour of the stream has exposed the surface of the black loam the trunk of a small tree 2 inches in diameter remains in place as it grew in the old soil. The roots radiate and show for a distance of 3 feet from the trunk. (See fig. 6.) The roots are no longer round but are flattened,

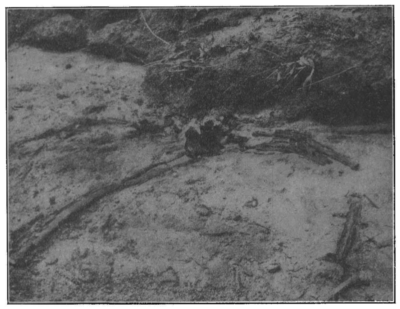


FIGURE 6.—Tree stump rooted as it grew in Yarmouth (?) interglacial soil, overlain in near-by exposures by Yarmouth (?) sand and clay and Illinoian till.

owing to the weight of the superincumbent material, and this is true of all the fragments that are buried in a horizontal position.

In another ravine, a quarter of a mile distant, the black soil is very sandy and contains very little wood but an abundance of shells, which in connection with the coarse sand and lack of woody fiber suggest lake or stream deposits at this point.

The following shells were collected and determined by William H. Dall, who reports that these as well as other specimens collected are all living species of a distinctly cool temperate climate, such as might be found in the same region to-day:

Pupilla muscorum Linné.	Planorbis sp. fragment.
Bifidaria corticaria Say.	Limnaea stagnalis Linné.
Vallonia costata Müller.	Planorbis parvus Say.
Zonitoides arboreus Say.	Unio sp., fragment.
Succinea avara Say.	

Another exposure in the same locality shows the contact of the soil with the underlying till, which suffered rather peculiar weathering (fig. 7), the joints in the till having become cemented by iron that was deposited along the cracks, a phenomenon sometimes observed in present-day exposures of jointed Illinoian till in deep well-drained cut banks.

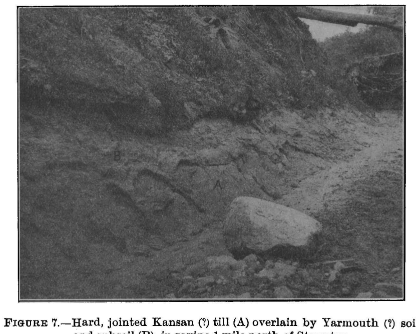


FIGURE 7.—Hard, jointed Kansan (?) till (A) overlain by Yarmouth (?) soil and subsoil (B), in ravine 1 mile north of Staunton

The ferruginous subsoil material extends down into joint cracks in the underlying till

A similar exposure of the soil occurs in a ravine northeast of Litchfield, in the NW. ¼ sec. 35, T. 9 N., R. 5 W., where the following section was measured:

Glacial and interglacial deposits northeast of Litchfield

	Ft.	in.
Illinoian glacial till:		
Mostly covered in wooded slope; lower part, exposed north of bridge, very dense partly cemented gray till, with rusty zones around tubelets and bordering joint cracks.		
Yarmouth (?) interglacial deposits:		
Sand, fine, bluish-gray, limy; stained yellow and hardened where it surrounds openings left by rotted stems; lamination extremely irregular, contorted	4	
Loam, bluish gray, carbonaceous, with small shells; base irregular, top smooth; a few fine roots		2–14
Sand, irregularly laminated, weathered brown; upper part contains shells, which are rare in lower part	2	
Kansan (?) glacial till:		
Weathered deposit; very dense and calcareous; rusty zones around small tubes and bordering joint cracks.		

The following fossils, determined by Mr. Dall, were found at this locality, those given in the left column in the soil, and those given in the right column in the sandy subsoil:

Pupilla muscotum Linné.	Bifidaria contracta Say.
Vallonia costata Müller.	Succinea avara Say.
Succinea avara Say.	Limnaea parva Lea.

The fine gray to bluish-white sand that overlies the soil at these localities is believed to have been deposited in ponded areas formed in front of the advancing Illinoian ice sheet. It served to bury and preserve, at least in part, the tangle of dead wood, and to protect the old soil from the scouring action of the ice, which, however, must have been slight in these localities.

A similar exposure of interglacial soil was observed in a cut bank on Timber Creek, in the SW. ¼ SE. ¼ sec. 15, T. 8 N., R. 6 W. At the bridge just west of this locality 2 feet 6 inches of yellowish to orange-colored oxidized sand and waterworn gravel is exposed between two layers of till. No soil occurs at this point.

Another exposure of the soil was seen in a drain in the SW. ¼ NW. ¼ sec. 32, T. 9 N., R. 4 W. The following section was measured:

Glacial and interglacial deposits 4 miles east of Litchfield

	Ft.	in.
Illinoian glacial deposits:		
Till, oxidized, yellow-brown	5	
Till, fresh	15	
Till, carbonaceous	1	
Yarmouth (?) interglacial deposits:		
Soil line, calcareous; one twig observed		1
Sand, fine, with pebbles; calcareous		3–5
Kansan (?) glacial till, fine sandy and pebbly, calcareous	4	
Shoal Creek limestone.		

In a cut bank at the bend of Brush Creek, in the SW. ¼ SE. ¼ sec. 29, T. 9 N., R. 4 W., half a mile from the exposure just described, a channel cut in the lower till is filled with

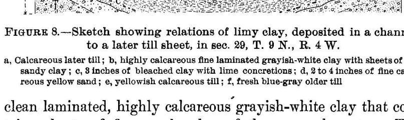


FIGURE 8.—Sketch showing relations of limy clay, deposited in a channel, to a later till sheet, in sec. 29, T. 9 N., R. 4 W.

a, Calcareous later till; b, highly calcareous fine laminated grayish-white clay with sheets of fine sandy clay; c, 3 inches of bleached clay with lime concretions; d, 2 to 4 inches of fine calcareous yellow sand; e, yellowish calcareous till; f, fresh blue-gray older till

clean laminated, highly calcareous grayish-white clay that contains sheets of fine sandy clay of the same character. The whole deposit is overlain by a few feet of calcareous till, the

[8] Leverett, Frank, The weathered zone (Yarmouth) between the Illinoian and Kansan till sheets: Jour. Geology, vol. 6, pp. 238-243, 1898; Iowa Acad. Sci. Proc., vol. 5, pp. 81-86, 1898; abstract in Am. Geologist, vol. 21, p. 254, 1898.

upper part of which is leached and reddened by exposure. The relations of the clay to the overlying and underlying till are shown in Figure 8. This clay is believed to represent a clayey phase of the compact grayish-white sand that was deposited in advance of the ice sheet, as observed above the interglacial soil in the exposures at Staunton and Litchfield. As this sediment here, however, was deposited in a channel or choked drain at some distance from the ice front, the sandy character is subordinate. Another outcrop of similar clay was observed in the SW. $\frac{1}{4}$ NW. $\frac{1}{4}$ sec. 25, T. 7 N., R. 5 W., but here the relations to the till are not clear.

The following table gives the available information from well records concerning buried wood, soil, and other deposits, some of which seem clearly to be of interglacial origin. Several of the occurrences of wood can not be certainly correlated with a definite horizon. These pieces may have been derived from either interglacial or preglacial soils and incorporated in the drift.

Buried wood and interglacial soil and other deposits found in wells in the Gillespie-Mount Olive district

Location	Elevation of top of well	Depth to soil	Thickness	Thickness of till below soil	Remarks
	Feet	*Feet*	*Feet*	*Feet*	
SE. $\frac{1}{4}$ sec. 12, T. 8 N., R. 7 W.	670	20	5±	(?)	Black mixed clay at 20 feet. Sticks and branches at 25 feet.
NW. $\frac{1}{4}$ sec. 6, T. 8 N., R. 6 W.	662	35	------	(?)	Pieces of "grape-vine" 3 to 4 inches in diameter.
E. $\frac{1}{2}$ sec. 21, T. 9 N., R. 6 W.	660	16	------	(?)	Log of wood found in water well.
Center of sec. 33, T. 9 N., R. 6 W.	670	40	------	(?)	Well dug 40 years ago. Log of wood reported.
Center of sec. 14, T. 7 N., R. 8 W.	650	80	2	0	Wood in old soil above Pennsylvanian shale in shaft.
SE. $\frac{1}{4}$ sec. 21, T. 7 N., R. 6 W.	645	100	30	63	30 feet of clay reported between till sheets. Possibly interglacial material.
SW. $\frac{1}{4}$ sec. 29, T. 8 N., R. 5 W.	654	35	30+	21	30 feet of sand and rotten wood above 10 feet of sand and gravel and 11 feet of clay and gravel.
SW. $\frac{1}{4}$ sec. 24, T. 8 N., R. 4 W.	614	107	23	16	Sandy loam and gravel.
SW. $\frac{1}{4}$ sec. 8, T. 9 N., R. 4 W.	660	33	(?)	(?)	Wood found in water well.
NW. $\frac{1}{4}$ sec. 7, T. 9 N., R. 5 W.	660	40	(?)	(?)	Wood found in water well.
Sec. 4, T. 8 N., R. 5 W.	680	50	(?)	(?)	Log of wood in drilled water well. Same depth as gas-bearing bed in drift half a mile west.

In the northwest corner of sec. 16, T. 8 N., R. 4 W., the following section, showing interglacial alluvial deposits, was observed:

Glacial and interglacial deposits southwest of Hillsboro

	Feet
Illinoian glacial till:	
Red, oxidized, very sandy and pebbly, with subordinate clay, coarser at top	40
Yarmouth (?) interglacial deposits:	
Sand, black, gravelly	4
Sand and gravel, stratified, yellow to dark brown, like river gravel	8
Sand, fine, limy, fossiliferous	1+
Talus	9
Kansan (?) glacial till	6+

The following fossils, identified by William H. Dall, were collected from the interglacial sand and gravel:

Fragment of Unio.
Sphaerium sulcatum Law.
Pisidium variabile Prime.
Planorbis parvus Say.
Planorbis bicarinatus Say.
Limnaea desidiosa Say var. decampi Streng.
Valvata tricarinata Say.
Amnicola cincinnatiensis Anthony.

Illinoian till.—Except in a comparatively small area from which it has been eroded, the Illinoian till underlies the entire Gillespie-Mount Olive district. Its upper surface, on which the gumbo rests, is for the most part smooth and level, the principal irregularities being the drift ridges. Its average thickness is indeterminable for the reason that the thickness of the earlier till is unknown except at a few localities. At not many of these places, however, has it been found to exceed 30 feet in thickness. The average thickness of combined till and interglacial material, as reported in drill records in three representative townships, is 81 feet. On the preglacial divide it is 35 to 40 feet thick, and in the preglacial valleys it is 150 to 193 feet thick, or even thicker beneath some of the morainal mounds, the greater part no doubt being of Illinoian age.

In general the Illinoian drift in this region is a dark bluish-gray till, which is weathered yellowish gray in the upper part. Where it contains a subordinate amount of clay, as in the morainal area between Butler and Hillsboro, it is weathered reddish brown. In general it consists of sandy clay that contains subangular pebbles and a few boulders. Some of these are of considerable size, the largest boulders being 2 to 3 feet in longest diameter. In the SW. $\frac{1}{4}$ sec. 16, T. 8 N., R. 5 W., a large granite boulder, only partly exposed, protrudes above the gumbo of the upland. The exposed part measures $1\frac{1}{2}$ by $3\frac{1}{2}$ feet and stands about 2 feet above the level plain.

The till, though it consists chiefly of a mass of unsorted and unstratified material, is not homogeneous but contains within its mass lenticular bodies and interrupted sheets of well-sorted, in places laminated coarse and fine sand and even gravel, representing perhaps local deposition of materials by water beneath the ice. Lenticular sheets of fine, porous sand are common 15 to 30 feet beneath the surface and furnish the chief water-bearing beds in the upland plain.

The coarser constituents of the till are of great variety and come not only from the territory immediately north of the district or within it but also from Canada. A considerable percentage of the pebbles are of Canadian origin and a somewhat larger proportion are of shale and sandstone, chiefly from the Pennsylvanian rocks. Natural exposures of the upper part of the till contain few or no pebbles of limestone, most of these having been dissolved by percolating water. A large part of the pebbles lower down in the Illinoian till as also in the Kansan (?) till are of limestone or dolomite. The following table gives the percentages by number of pebbles of different kinds contained in the Illinoian till and in the older till sheet. The determinations were made by collecting pebbles from the glacial tills and sorting them according to their lithologic composition.

Percentages of different kinds of pebbles in Illinoian and Kansan (?) till in the Gillespie-Mount Olive district

Location	Limestone	Chert	Local pebbles, sandstone, shale, and coal	Quartzite	Light-colored igneous rock	Dark igneous rock	Schist	Quartzite
Illinoian till								
Near interglacial soil in NE. $\frac{1}{4}$ sec. 35, T. 9 N., R. 5 W.	57	20	13	3	3	2	----	2
At bridge above gravel band in SW. $\frac{1}{4}$ sec. 15, T. 8 N., R. 6 W	48	37	4	2	------	6	2	6
On Timber Creek in sec. 15, T. 8 N., R. 6 W	52	27	9	2	3	5	----	2
Above interglacial soil in SW. $\frac{1}{4}$ sec. 20, T. 7 N., R. 6 W	60	5	18	5	10	2	----	----
Above interglacial stump in SW. $\frac{1}{4}$ sec. 20, T. 7 N., R. 6 W.	26	26	23	2	7	10	1	5
Kansan (?) till								
Below channel clay in SE. $\frac{1}{4}$ sec. 29, T. 9 N., R. 4 W.	49	29	6	----	6	10	----	----
Below interglacial stump in SW. $\frac{1}{4}$ sec. 20, T. 7 N., R. 6 W.	54	13	17	1	7	3	----	5
Below stratified sand in SW. $\frac{1}{4}$ sec. 20, T. 7 N., R. 6 W.	44	15	21	10	5	3	----	2
Below interglacial soil in SW. $\frac{1}{4}$ sec. 20, T. 7 N., R. 6 W.	48	24	20	----	8	----	----	----
Below interglacial soil in NW. $\frac{1}{4}$ sec. 35, T. 9 N., R. 5 W.	82	8	2	2	------	----	2	4
500 feet down drain from interglacial soil in NW. $\frac{1}{4}$ sec. 35, T. 9 N., R. 5 W	52	17	20	1	1	5	----	4

Drift ridges.—The drift of the ridges is more sandy and coarser than that underlying the plain and contains beds of assorted material more generally. Owing no doubt to greater porosity and to the relief of these areas the drift here has been considerably more oxidized than the till beneath the upland plain. Thus the coarse till that overlies the interglacial beds in the northwest corner of sec. 16, T. 8 N., R. 4 W., is deeply oxidized, and in the cut on the Illinois Traction line at the Brush Branch school, on the north line of sec. 8, T. 8 N., R. 4 W., 27 feet of leached and highly oxidized gravelly till is exposed beneath $8\frac{1}{2}$ feet of normal yellowish-gray, sparsely pebbly clay or gumbo. The oxidized till is underlain by 20 feet of calcareous blue-gray till. Reddish-brown oxidized till has been noted at a few other localities, but it is thin and rather rarely seen except in the morainal area in the eastern part of the Mount Olive quadrangle.

The log of a well drilled near the crest of Brushy Mound, in sec. 15, T. 9 N., R. 7 W., shows the following section of drift:

Log of well on Brushy Mound

	Feet
Soil and clay	40
Blue gumbo	45
Sand and gravel	21
White mud and sand	89
Quicksand and gravel	10
Sandy "slate" (?)	18
Quicksand	12
Black shale.	
	235

A well on the north slope of a drift ridge in sec. 10, T. 9 N., R. 4 W., penetrated the following materials:

Log of well north of Butler

	Ft.	in.
Soft red clay, sandy and "sticky"	16	
Gravel		8
Quicksand with water	18	
Hardpan.		

A well dug on the east slope near the crest of Robbs Mound, in sec. 35, T. 7 N., R. 5 W., also encountered sorted materials, the following beds being reported:

Log of well on Robbs Mound

	Feet
Clay	6
Gravel	2
Sand, coarse, becoming finer below	14
Quicksand with water	2
	24

Upland gumbo.—Upon the Illinoian till on the uneroded upland lies a deposit of structureless yellow-gray clay 5 or 6 feet in depth, which has been considered as loess by Leverett[9] but which differs so strikingly from the typical loess of the river bluffs that it will here be called upland gumbo. On the glacial mounds it is thinner, and it may be entirely eroded from the higher hills.

The typical loess has not been found by the writer within the Gillespie-Mount Olive district. This material occurs along the major streams of the surrounding region, where it has a thickness of 15 to 20 feet or more, but it becomes thinner as the distance from the streams increases and changes to a somewhat more compact deposit. Some authors, notably Leverett, believe that it grades into what is here termed gumbo. The upland gumbo occurs characteristically on the undissected plains area throughout the southern part of the State, and its thickness shows little variation, being generally 4 to 6 feet. The typical loess is porous, and vertical faces stand well for a long time. It has little plasticity when wet and is crumbly when dry. The upland gumbo is more impervious, washes badly in excavations, and, as its name implies, is highly plastic when wet and is stiff and hard when dry. It is commonly well leached and does not effervesce with acid, though in some places it is calcareous and here and there it contains lime concretions. The typical loess of this general region, as determined by Leverett,[10] is in most places leached from top to bottom, though in a few places it retains shells of air-breathing snails. One of the most striking differences between these deposits, however, is the presence in the upland gumbo of scattered small pebbles and chips and rarely coarse pebbles and even boulders—constituents which are entirely absent from the unmodified typical loess.

The contact between the underlying till and the upland gumbo in this district does not form a sharp line but lies within a transition zone about 1 foot thick. Below this transition zone the till contains many pebbles, but they become notably fewer toward the top of the zone. In the lower part of the gumbo scattered pebbles are generally present, but as the distance above the till increases these become fewer and smaller. At the top of the gumbo the pebbles average less than a quarter of an inch in diameter, although coarse pebbles or even small boulders are sometimes found. Generally the pebbles are few, so that a close search is sometimes necessary to obtain even a small collection. The writer, however, has always found them wherever he has searched.

The origin of this clay, or upland gumbo, that carries few pebbles is not well understood, and it is still being studied. The characteristics above described have given rise to several theories which can not be fully discussed in this place. As already stated, Leverett regards this dense, sparsely pebbly clay as one phase of the loess. He informs the writer that he has seen at many places in this general region evidence of an erosion unconformity between the Illinoian till and this gumbo. This unconformity he regards as representing the interval marked elsewhere by the Sangamon soil. He thinks the most probable explanation of the presence of the included pebbles is that they were carried up from the underlying drift by crawfish or other animals.

The writer has found no evidence of erosional unconformity or of the formation of soil separating the upland gumbo from the Illinoian till in the Gillespie-Mount Olive district. The transition appears to him to be one of gradation, so that he regards both materials as glacial till of Illinoian age and as intimately associated in their deposition. He regards as unsatisfactory the theory that the presence of pebbles so generally in the gumbo is due to the work of crawfish or other burrowing animals. If the pebbles are original constituents of this deposit, as the writer believes they are because of their universal presence and the size of some of them, the gumbo can not be a deposit of wind-blown dust, which the typical loess is believed to be.

An explanation has been proposed for the origin of similar deposits in Iowa,[11] and this is regarded by some as possibly applicable to the upland gumbo of the Gillespie-Mount Olive district. According to this explanation the upland gumbo is essentially the result of the thorough chemical weathering of the upper part of the till, but subordinately the wind, frost, burrowing of animals, and slope wash have played a part in its formation. The part of the till which has been changed to gumbo may possibly have differed somewhat from the normal till that lies below the gumbo.

This explanation also seems to the writer to be not wholly satisfactory. There can be no doubt, however, that extensive alteration of the material has taken place. Most of the calcium carbonate has been removed, so that as a rule the material down to and including the upper part of the underlying till no longer effervesces when moistened with cold hydrochloric acid,

[9] Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey Mon. 38, p. 158, 1899.

[10] Personal communication.

[11] Kay, G. F., Some features of the Kansan drift in southern Iowa [abstract]: Geol. Soc. America Bull., vol. 27, pp. 115-117, 1916; Gumbotil, a new term in Pleistocene geology: Science, new ser., vol. 44, pp. 637-638, 1916. Kay, G. F., and Pearce, J. N., The origin of Gumbotil: Jour. Geology, vol. 28, pp. 89-125, 1920.

although in some places calcareous concretions are observed, and at one place a pitted limestone pebble was found. The feldspathic grains as well as the iron minerals have been decomposed, and the iron and manganese have been reprecipitated in small "buckshot" concretions, which comprise most of the grains over 0.05 millimeter in diameter. This alteration is thought by the writer to have taken place at the same time as that which occurred in the Sangamon weathered zone of Leverett.

The assumption, however, that coarse material has been lost through disintegration and solution of the particles to the degree indicated by the difference in texture between the upland gumbo and the underlying till seems to the writer to be unwarranted. The discrepancy between the size and number of quartz and chert pebbles in the till and in the upland gumbo is not satisfactorily explained either by solution or by disintegration. Coarse pebbles in the till are common, and many of them are of considerable size, and an amount of solution necessary to dissolve this material must have been competent to attack both the coarse and fine sand as well. Except for the ferruginous concretions, the proportion of materials exceeding 0.05 millimeter in diameter in every sample of the upland gumbo examined is less than 10 per cent, whereas in the till these constituents range from 20 per cent to more than 50 per cent. The sand grains of the gumbo that were examined do not show any etching or other visible evidence of solution. They are as bright and as generally angular as similar grains in the till. The surfaces of the roundish pebbles of quartz are smooth and in some specimens polished, whereas the chert pebbles are as a rule fresh and sharp-edged. Possibly 90 per cent of the sand (medium, coarse, and fine) in the specimens of till examined is composed of quartz grains, so that the lack of coarse material in the gumbo is not due simply to decomposition of feldspathic material and ferruginous silicates.

As the till contains from 20 to 53 per cent of material coarser than 0.05 millimeter in diameter, most of which is quartz, and as the upland gumbo has generally less than 5 per cent of material of these sizes, it follows that according to this hypothesis a remarkable amount of solution of the coarse grains must have taken place without etching or corroding the remaining material, an assumption that is altogether unreasonable.

A series of analyses of river loess, designed to show the variations in physical character and depth, were obtained by E. W. Shaw.[12] The samples at 1 foot and 10 feet showed the maximum of disintegration from any single size to the next finer to be less than 60 per cent, whereas the disintegration and solution required for the disappearance of the coarse quartz grains from the till demands that at least 90 per cent of the quartz constituents, ranging from 0.05 to 2 millimeters in diameter and constituting from 20 to 50 per cent of the material, be reduced to less than 0.05 millimeter in diameter and that this shall have taken place almost uniformly to a depth of 6 feet. It is unlikely that conditions of weathering have been much more severe in the areas occupied by upland gumbo than in those occupied by the river loess.

The results of further studies of deposits like the upland gumbo of this district are awaited with interest. Those which have thus far come to the writer's attention, taken in connection with his own studies, seem to him not to support very strongly the hypothesis above set forth.

A somewhat different explanation seems to the writer to be in some respects more satisfactory. This explanation he presents without detailed discussion. In brief, he regards the upland gumbo as essentially englacial drift, or material carried along in the basal part of the ice and let down on the surface of the ground moraine when the ice melted and the glacial margin retreated across the district. The conditions of such a method of transportation and of the prolonged rubbing between the basal ice and the overriden till, perhaps frozen, seem to the writer likely on the whole to produce a material of considerably finer texture than the till of the ground moraine. The clay would be more dense and the pebbles fewer and smaller. With this material would be commingled whatever fine dust might have been blown onto the front slope of the glacier. The total amount of englacial material carried by the continental ice sheet and of dust blown onto its surface was probably not large, so that the resulting gumbo averaged only a few feet in thickness. As it was let down on the fresh, unweathered, and uneroded surface of the ground moraine without assortment or stratification by water there would be apparent gradation and not a sharp line of contact between the till and the upland gumbo. A certain amount of subsequent disintegration and solution of pebbles as the result of weathering would further contribute to the character of the material as found.

This interpretation differs from the one immediately preceding, as understood by the writer, principally in ascribing a larger part of the difference between the upland gumbo and the underlying till to original differences in texture and composition and a smaller part to modification by subsequent weathering.

[12] Shaw, E. W., and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Murphysboro-Herrin folio (No. 185), p. 9, 1912.

Sangamon soil.—The soil and associated deposits that were formed on the Illinoian till after the melting of the ice sheet and before the main deposition of loess in the surrounding region are known as the Sangamon soil and weathered zone. The presence of a soil and weathered zone was noted more than 50 years ago in Sangamon County, Ill., by Worthen, and this zone was later named Sangamon by Leverett.[13]

If, as the writer believes, the upland gumbo is the upper part of the Illinoian till, the modification of the deposit by weathering began in the Sangamon stage of deglaciation. In some other areas the sparsely pebbly clay, or a deposit similar to it in character and position, is overlain by the typical loess. Here, however, it has not been protected by such a covering, so that modification by weathering and the development of the soil has continued to the present day. It is therefore discussed under the following heading.

RECENT SERIES

Surface soil and subsoil.—The greater part of the upland plain is so flat that inequalities can scarcely be detected with the eye, and on this originally ill-drained broad, flat surface, processes of weathering and the accumulated refuse of dead roots and dying vegetation formed a dark soil cover.

Throughout the greater part of the undissected area this dark humus-enriched soil forms a layer from 1 to 2 feet thick on the surface of the upland plain. It is not present on the more prominent morainal mounds but continues thinly over the low swells that form the only unevenness in the surface of the western part of the area. In color it is dark to mouse-gray, but in earlier times, before the run-off had developed good drainage, it was probably much darker in color and more like that in the flatter ill-drained areas of to-day. Probably also it was once much deeper, as indicated by root marks in the subsoil and by portions that have been preserved from oxidation in the unaerated subsoil of swampy tracts.

Root marks are distinguishable in excavations in the flat plain down to a depth of 6 feet or more, and in swampy places carbonaceous material is found even in the upper part of the till itself. The upland plain, except in small areas, is not known to have supported within historic times a vegetation that could make such deep roots, and it appears at least possible that the climatic vicissitudes through which the region has passed since the disappearance of the Illinoian ice cap are recorded indistinctly by the amount of humus in different parts of the subsoil.

Dissected old pond deposits.—Many of the small swampy areas on the upland plain were occupied by ponds until they were drained by farmers within the last 30 years, and the fine material that was washed and blown into them from the surrounding land has continued to accumulate to the present time. Beneath the black surface soil in these areas in all the localities observed there is a yellowish to grayish white zone of oxidation, which contains conspicuous root marks but very little organic matter. This zone is underlain by a basal zone of grayish-black to black carbonaceous clay that rests on the till, which itself is in places impregnated with organic matter. The lower dark zone was at first thought by the writer to represent an early soil, which had become buried beneath subsequent alluvial accumulations, and this conclusion seemed to be substantiated by bands of white and blackish material, which appeared to represent lamination in the upper part of the zone. (See fig. 9.) The lamination of the soil, however, is excep-

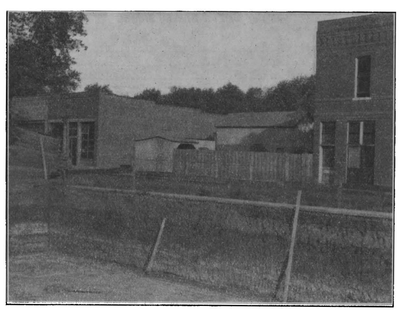


FIGURE 9.—Illinoian till (lower lighter beds) overlain by carbonaceous swamp clay (dark band) with lighter-colored oxidized clay at top, in excavation at Gillespie, Ill.

tional, and no trace of lamination is visible in the filling above the dark zone. A microscopic examination shows also that no lamination of grains is present in the banded material itself, but that the pseudolamination is due to microscopic carbonaceous grains that are apparently residual from the leaching of the clay in streaks. The dark streaks as a rule fade out into

[13] Worthen, A. H., Geology of Sangamon County: Illinois Geol. Survey, vol. 5, pp. 306-319, 1873. Leverett, Frank, The weathered zone (Sangamon) between the Iowan loess and Illinoian till sheet: Jour. Geology, vol. 6, pp. 171-181, 1898; Iowa Acad. Sci. Proc., vol. 5, pp. 71-80, 1898; abstract in Am. Geologist, vol. 21, pp. 254-255, 1898.

the white without the orderly arrangement to be expected from lamination or occur in irregular patches and shadowy spots. In addition to these features the deep carbonaceous band and the material extending nearly to the surface also contain scattered small pebbles in every way similar to those in the upland gumbo. Perhaps such grains may have been transported to the swampy areas from the flattish inclosing slopes of gumbo, but as such material is not now being transported to swampy tracts and as probably the slopes were originally exceedingly gentle and clothed with vegetation, it is difficult to see how pebbles a quarter of an inch in diameter could have been transported to the central part of such a basin. Comparison with material known to have been moved by crawfish leads the writer to think that these pebbles have not been so transported. Moreover, except for the presence of the microscopic carbonaceous material, the mechanical analyses do not show that the material in the lower parts of these tracts differs essentially from that in the surrounding areas of upland gumbo. The stiff plastic clay, however, from the surface of these areas does not contain pebbles but does contain a notably higher proportion of the finest material, amounting to an increase of 80 per cent in the material finer than 0.005 millimeter in diameter. In view of these observations the writer concludes that the lower dark carbonaceous zone is residual from the bleaching of a layer that was originally much thicker, and that by its depth and position in a poorly drained area it has been preserved from the aeration and oxidation which destroyed to a large degree the microscopic vegetal material in the upper part.

It also seems safe to conclude that as the subsoil of the ponded areas is not known to differ from the upland gumbo, except in its content of microscopic organic matter, and as both the subsoil and the gumbo overlie the typical till in the same manner with a similar transition zone, they are one and the same deposit.

The surface material in the swampy tracts is, however, different from that below, as has been mentioned. It is best developed in the ponded areas northwest of Litchfield and at Barnett, 1 mile north of the Mount Olive quadrangle, where it is very black, is exceptionally plastic when wet, dries very slowly, and becomes exceptionally hard. It has a relatively higher percentage of fine material and no pebbles and almost no coarse grains more than 0.05 millimeter in diameter. It rests on the upland gumbo, but no line of separation can be drawn between them. At Gillespie the gumbo clay is not so strikingly developed, possibly because of the development of surface drainage, which may have removed such an accumulation, or because it was less favorably situated to receive such wash than to accumulate a heavy humus. Most of the wells within the city limits are reported to expose a carbonaceous band from 5 to 7 feet below the surface, but not all show it so strikingly as the excavation for the Farmer's Cooperative Store (fig. 9), where the following section was measured. The members grade into one another, and no sharp line of separation exists between them.

Section in excavation for Farmers' Cooperative Store, Gillespie.

	Ft.	in.
Black soil; contains fine roots	2	
Clay, blackish gray to yellowish; contains impressions of fine roots	1	
Clay, yellowish to blackish yellow; contains impressions of fine roots	2	
Carbonaceous clay, upper part banded in layers of black and gray; sandy at base with some pebbles; contains impressions of fine roots		8-12
Till, with some pebbles; upper 6 inches stained with iron	3	

The black surface soil no doubt owes its color to the roots of comparatively recent vegetation; the middle part, which is perforated with fine threadlike root openings, is believed by the writer to have lost or perhaps is still losing its carbonaceous content through drainage, aeration, and oxidation; the basal dark band still retains the humus of an ancient vegetation, possibly the Sangamon soil. The area is now well drained, and the humus, except in so far as it is renewed at the surface, will eventually become bleached throughout, leaving only the tiny root holes as evidence of its former presence. Bleached material of this character has been observed in clay pits north of the area, at Auburn and at Morrisonville, Ill., where the lower carbonaceous band is almost entirely oxidized and can be recognized at the base only in spots. Sections like that at Gillespie were observed in a cistern north of the morainal mound at Bunker Hill and in a road cut in the east side of sec. 17, T. 8 N., R. 4 W. Similar conditions are suggested by auger borings in sec. 36, T. 8 N., R. 8 W., and in sec. 24, T. 9 N., R. 5 W., and elsewhere.

Most of the ponded areas shown on the map are indicated by stiff dark clays at the surface or are swampy areas recently drained. The large areas in sec. 30, T. 8 N., R. 7 W., and sec. 26, T. 9 N., R. 4 W., are suggested by the topography. The second area has been to a considerable extent eroded, but suggestive exposures occur on its margin. The ponded area in secs. 3, 4, 9, and 10, T. 9 N., R. 4 W., was evidently at one time a lake basin. Its present surface has a range in altitude of only 2 or 3 feet, and it is completely encircled by hills except on the north, where the drainage escapes through a gap only about 300 feet wide. The topography suggests that during the time when drainage to the north was blocked by the ice the run-off for a time found escape southward through the early channel of Brush Creek.

Alluvium.—The alluvial deposits that underlie the flood plains of the streams consist of silt and sand and some gravel. The alluvium in most places extends beneath the flood plain to depths greater than the depth of the stream channel, but the depth of the alluvium is nowhere positively ascertainable, as the logs of drilled wells, which are the only ones available, do not generally make sufficient distinction between the alluvium and the till. However, in sec. 8, T. 9 N., R. 7 W., in the flood plain of Macoupin Creek, the alluvium seems to be about 70 feet thick. In the smaller tributary of Spanish Needle Creek, in sec. 17, T. 9 N., R. 7 W., the alluvium, which is reported as topsoil, quicksand, and gravel, appears to be 55 feet thick. The depth of alluvium in Shoal Creek is less clearly indicated, but where the stream runs in soft shale or in till the depth is probably about the same.

The alluvium on Shoal Creek is much more sandy than that on Macoupin and Cahokia creeks, no doubt because these streams drain a morainal area in which the beds are composed of coarser material than the till beneath the plains in which these streams run, though the sandstone, which is extensively exposed in the basin of West Fork of Shoal Creek, has also contributed sandy material.

The flood plain of Shoal Creek stands about 15 feet above the water level during the dry season, and that of Macoupin Creek is approximately at the same altitude. The flood plain of Cahokia Creek near Staunton is 10 to 12 feet above the level of the stream.

Effects of weathering.—On the upland that borders the valleys, erosion has removed a foot or two of darker soil cover, and good drainage has prevented the retention of the humus, so that the upland area is bordered throughout by a margin of dusty-white topsoil from one-fourth to one-half mile wide. Both the gray and the white soils contain tiny concretionary pellets, composed mainly of iron carbonates with a large proportion of manganese. These pellets are more abundant and more conspicuous in the white soil than in the dark soil, and the white bleached soil, which is comparatively poor, has come to be known as buckshot soil.

Another phase of weathering is exhibited in the "scalds," as the farmers term roughly elliptical areas in the fields in which the soil is gray-white and comparatively barren. These local areas are thought to be underlain by porous till, which has given them a more or less perfect subterranean drainage, thus preventing the accumulation of humus and effectively removing calcium carbonate and other soluble constituents from the subsoil.

Probably the formation of "hardpan," a crusted layer at or near the surface of the sandy till, is due to similar conditions. In such places the till has received infiltrations of calcium carbonate and silica, which have cemented the ordinarily close-grained material into a dense conglomerate-like mass in which excavation is difficult and drainage poor.

STRUCTURE

In the Gillespie-Mount Olive district the layers of hard rock have not been markedly deformed. Although the beds have an average easterly dip of about 9 feet to the mile, the slope is irregular, and the strata are warped into irregular low domes and shallow basins without any very definite order of arrangement.

REPRESENTATION OF STRUCTURE

Methods employed.—Structure is commonly represented in two ways—by cross sections and by contour lines. Cross sections furnish the best means for representing structure in a region where the rocks are sharply folded and faulted, but in a region where the folds are low and where there are few if any faults they are of small value, for the structural features in such a region as shown in cross sections are almost imperceptible. In a region like that in which lies the Gillespie-Mount Olive district contour lines indicate the structure more clearly, and therefore structure contours have been drawn on the areal-geology maps in this folio.

Delineation of structure by contours.—For delineating structure by means of contours an easily recognizable reference stratum, one whose position can be determined at many points by means of outcrops or borings, is chosen. The altitude and dip of its surface are determined at as many places as possible, and points of equal altitude are connected by lines on the map, just as topographic contour lines are drawn. At some places the altitude of the reference stratum is observed directly in outcrops, mines, or wells; at other places it is calculated from observations on some other recognizable stratum, for generally the layers of stratified rock are approximately parallel, and the average interval between any two layers may be determined. Thus, if a stratum above the reference layer is found at any point its altitude above sea level at that point may be determined and the altitude of the reference stratum or key rock at that point may be calculated by subtracting from the altitude of the stratum found the average interval (or the nearest measured interval) between the two. If the outcrop of a bed below the reference stratum is found the average interval beween the two is added to the altitude of the outcropping bed thus giving the approximate altitude at which the reference layer would lie if it were present.

Use of structure contours.—The structure map is useful not only in studying broad structural problems and in conveying an abstract knowledge of the structure of the region, but it is also of practical value because it aids in locating and recognizing valuable beds and gives information concerning their "lay." As the beds are approximately parallel and the average spacing of valuable beds is known, it is not difficult to calculate from the altitude of the reference stratum the approximate position of any bed at any point by adding or subtracting, according as the bed is above or below the key rock, the average interval between the two as indicated on the map. The map may be used in this way for locating beds that contain coal, limestone, or oil.

The structure map also shows the direction and amount of dip of the beds, a knowledge of which is highly useful in all mining operations.

Accuracy of structure contours.—The accuracy of the structure contours depends upon three factors—the accuracy of the altitudes obtained directly; the difference between the actual and the assumed vertical distance to the key rock, as calculated; and the number and distribution of the points whose altitudes have been determined.

In the Gillespie-Mount Olive district the reference stratum used is the Herrin coal. It does not crop out at the surface in the area, but it has been penetrated in many mine shafts and borings. The altitude of the surface at these places has been determined by hand level and barometer readings, and as bench marks are numerous the possibilities of error by these methods are small.

The second factor is more likely to lead to error, because the strata are not absolutely parallel, so that strictly the map shows only the warped surface of the coal. The variations in the interval between the beds, however, are not large, and contour lines drawn on any other bed would differ from those shown only in a minor degree. Where outcrops of other beds have been used for calculating the position of the Herrin coal the average of the intervals between the bed used and the Herrin coal, as shown in adjacent borings, has been taken as the amount to be added or subtracted.

Information from artificial excavations and borings or from outcropping beds is fairly abundant for most of the district. In the greater part of T. 9 N., Rs. 4, 5, and 6 W., however, and in some other areas the available information is rather scanty.

The Herrin coal is absent from many localities in the central part of the Mount Olive quadrangle, and in such places it has been necessary to determine the horizon of the coal by comparing the records of the wells at these places with those of wells near by in which the coal is present.

It should be borne in mind that the contours show only the larger and more prominent features of the structure. The workings of the coal mines show many fluctuations that the scattered drill holes fail to reveal. These fluctuations, shown on the floor of coal mines, in some places amount to 10 or 20 feet or even more and bear no apparent relation to the general structure. As there is no way of determining whether a boring has penetrated an anticlinal or synclinal phase of this subordinate warping, a certain amount of deviation from accuracy is thus inevitably introduced into the delineation of structure by the contour lines.

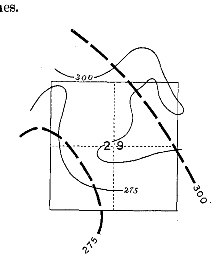


FIGURE 10.—Structure contours on base of coal in mine workings, sec. 29, T. 8 N., R. 6 W.

Light lines are accurate detailed structure contours. Broken heavy lines are generalized structure contours as shown conventionally on areal-geology map

The character of this subordinate warping is shown in Figure 10. The sketch, which is taken from a map of the mine workings prepared by the Superior Coal Co., shows the structure at the base of the coal in sec. 29, T. 8 N., R. 6 W. The contour lines in this sketch differ from those shown on the contour map not only because they represent a horizon about 6 feet lower but because they show the details of the lines. If perfect contour lines could be drawn for a large area, they would follow intricate meanders similar to those shown in Figure 10, but each lying within a strip half a mile to a mile wide, in the general direction of the corresponding contour line shown on the structure map. The true contours shown by light lines in Figure 10 would be represented on the structure map by lines like the heavy broken lines in the sketch. This sketch shows the futility of any effort to represent the structure of the district in any greater detail by the use of a smaller contour interval than that employed.

STRUCTURE OF THE GILLESPIE-MOUNT OLIVE DISTRICT

Within the Gillespie-Mount Olive district or near its boundaries the altitude of the Herrin coal has been determined in 185 borings and mine shafts. In addition, the altitude of the coal has also been estimated from 82 outcrops of other beds which have been identified with sufficient accuracy to make them available for this purpose. The contour lines on the structure map are based on these determinations, and they show the altitude of the coal in feet above sea level at 25-foot intervals.

The Herrin coal rises irregularly from an altitude of 150 feet above sea level at the eastern margin of the Mount Olive quadrangle to over 425 feet at the western margin of the Gillespie quadrangle, the relief of the surface of the coal being thus more than 275 feet. In parts of the district the beds lie practically flat, as in the area southeast of Mount Olive, where the average dip is about 4 feet to the mile toward the east. Steep dips occur north of Staunton, where for a distance of about a mile the beds dip eastward from 25 to 40 feet to the mile, and near Panama, where about the flanks of a ridgelike structural feature the dip is over 50 feet in less than half a mile.

The chief structural features include a trough, here called the Shoal Creek syncline, which extends from a point northeast of Panama nearly to Litchfield and follows the valley of Shoal Creek; a structural flat 6 to 8 miles wide, which extends from Walshville Township northwestward into Honey Point Township; and a gently sloping surface, which rises from this flat toward the west and is greatly modified by subordinate warpings. A less distinct feature that strongly suggests a gentle anticline crosses these larger features diagonally, extending from sec. 4, T. 9 N., R. 4 W., southwestward toward Litchfield and Mount Olive. Two sharp anticlinal ridges project into the west side of the Shoal Creek syncline, the larger one extending from a point north of Sorento to a point south of Panama, and around the flanks of this anticlinal ridge are the steep slopes already mentioned. A structural basin north of Litchfield is shown by borings at the Litchfield mine and probably extends farther north. The horizon of the Herrin (No. 6) coal is here depressed nearly 50 feet below its general position. This basin probably extends northward, possibly in continuation of the interrupted Shoal Creek syncline, which is cut off by the diagonally trending anticline just mentioned.

Domes occur in the Carlinville oil field, in sec. 8, T. 9 N., R. 7 W.; in the Spanish Needle Creek gas field, in secs. 21 and 28, T. 9 N., R. 7 W.; in the Litchfield oil field, in sec. 3, T. 8 N., R. 5 W.; and in the Staunton gas field, 3 miles northwest of Staunton, in T. 7 N., R. 7 W. In an ill-defined area northwest of Butler the strata are probably higher than in the surrounding territory. Another small area $3\frac{1}{2}$ miles north of Plainview may also be underlain by warped strata.

Faulting.—No faults of structural significance are known to occur in the Gillespie-Mount Olive district. Faults have been reported near Litchfield and also at Hillsboro, on the eastern margin of the Mount Olive quadrangle, but on investigation they have proved to be erosional unconformities.

In the mine workings 1 mile north of the shaft of the Shoal Creek Mining Co. at Panama, two small nearly vertical faults, which strike N. 10° E. and N. 20° E., have permitted the upward movement of a block about 100 feet in diameter. The movement along each of these faults is about 5 feet, and as the movement of the block is upward the faults must be thrust faults. The strike of the faults does not bear any obvious relation to the deformation indicated by the structure contours.

GEOLOGIC HISTORY

GENERAL FEATURES

Only a small part of the geologic history of the Gillespie-Mount Olive district is decipherable from the rocks exposed at the surface or penetrated in borings in the district, but the broad general facts have been determined by studies of the region as a whole.

The surface of the region since the beginning of the record has been subjected to continual oscillatory movements, but until the later part of the Paleozoic era it was never far above or far below sea level. The repeated changes with respect to the level of the sea are well indicated in the Pennsylvanian deposits of this area, in which terrestrial deposits and marine deposits succeed each other in rapid alternation. The net result of such movements during long periods of time was sometimes positive, so that the land remained long above sea level, and sometimes negative, so that the surface was long submerged. The record of fluctuations during periods of continuous emergence or continuous submergence is not everywhere directly recorded in the rocks, because during emergence erosion is usually dominant and during long-continued submergence deposition is uninterrupted, though the fluctuations are recorded in the alternations of sediments near the shore. Changes in the strand line and the shifting of submerged basins, however, were frequent throughout the Paleozoic era, and changes in the character of the deposits of the different epochs indicate that the surrounding lands were subject to as many and as frequent vicissitudes as the seas in position, form, and relation to the shore.

PALEOZOIC ERA

PRE-PENNSYLVANIAN TIME

At the beginning of the Paleozoic era the surface of the area now comprised in the Middle Western States had been for a long time above the sea. The rocks, which consisted of granite and other crystalline rocks and of metamorphosed sedimentary formations, had been maturely folded and long eroded. Hills many hundred feet high existed in some places, and some of these continued as islands for a long time, though in the Gillespie-Mount Olive district they were all, so far as known, completely buried in early Ordovician time.

The earliest Paleozoic deposits were probably laid down in Middle Cambrian time. They consisted at first of sand, which smoothed but did not fill the inequalities of the dissected land surface. These deposits of sand were followed in Middle and Upper Cambrian and early Ordovician time by shallow-water deposits of dolomitic limestone, in part argillaceous, in some places over 2,000 feet thick. The basin subsided gradually by oscillatory movements throughout the deposition of these beds. Then the land was raised above sea level, the emergence being pronounced but not great, and later the surface was again depressed below sea level, and the St. Peter sandstone was deposited over a widespread area. During the Ordovician period in this area submergence and elevation alternated. The degree of erosion varied during exposure, and the material deposited during submergence was predominantly limestone. The Ordovician deposits are in part dolomitic and argillaceous, and those laid down in the later part of the period include some shale and sandstone. The surface was above the sea during the greater part of the Silurian period, but a thin deposit of limestone was accumulated during a short submergence, though it was in part removed during a subsequent reelevation.

During the Devonian period southern Illinois was twice invaded by the sea, but only the second invasion reached as far north as the Gillespie-Mount Olive district. Deposits of carbonaceous clay laid down in this period afterward became black shale, and these deposits so closely resemble the earliest Mississippian sediments, which immediately overlie them, that it is doubtful how much of the thick shale reported in well logs is of Devonian age.

The beginning of the Mississippian epoch was marked by an extensive submergence, during which the Kinderhook shales were deposited. During the later part of the Kinderhook epoch and during Osage time the shore line was receding and the water was becoming clearer, so that the deposits above the Kinderhook consist largely of limestone. At the end of the Osage epoch the sea withdrew from the region, but it returned during Meramec time, when it encroached northward, reaching its maximum expansion during the time when the St. Louis limestone was deposited. After the St. Louis epoch the sea withdrew, and offshore deposits of sand and shale and more or less impure limestone were laid down in a heterogeneous series known as the Chester group. These deposits covered a considerably greater area than that in which they are now found, as is suggested in Figure 11.

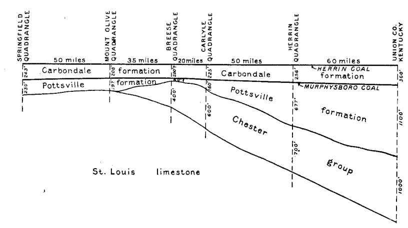


FIGURE 11.—Sketch showing attitude of strata at time of deposition of Herrin coal

Based on generalized sections for the quadrangles indicated. Note deformation and erosion of Mississippian rocks

At the end of the Mississippian epoch there was widespread elevation accompanied by deformation, during which the surface attained an altitude above the sea higher than at any time since the beginning of the Paleozoic era. The surface was much worn and trenched by stream valleys, and the Chester beds were eroded from the northern and western parts of the Gillespie-Mount Olive district, and probably from a considerable area farther north.

The amount of deformation of the beds and their subsequent erosion is suggested in Figure 11, which illustrates the attitude of the formations at the time of deposition of the Herrin coal. Even if a considerable part of the warping took place during the deposition of the Pottsville formation, it is obvious that the post-Mississippian deformation must have been several hundred feet and that the amount of erosion by the beginning of Pottsville time was considerably greater than has usually been supposed. It is probable, however, that only a part of the depth of the Pennsylvanian basin is due to down-warping during the Pottsville epoch, so that the relief of the surface of the region at the beginning of Pennsylvanian time may have been 600 or 700 feet, and it is not impossible that a thickness of several hundred feet of sediments may have been eroded from the northern and more elevated parts of the region before its resubmergence, in early Pottsville time. There may have been in western Illinois, therefore, during early Pennsylvanian time an elevated area comparable in some respects to the Ozark dome.

PENNSYLVANIAN EPOCH

Warping and subsidence were followed by the earliest Pennsylvanian deposition, but although the sediments that accumulated in previous epochs were predominantly marine, those that accumulated in Pennsylvanian time were largely terrestrial.

The warping of the surface which depressed the Eastern Interior basin at this time was simultaneously effective in raising more remote regions if they had not already been elevated at the end of the Mississippian epoch. The material eroded from those areas and transported by the rivers of the time furnished a flood of detritus that was more than sufficient to keep pace with the downward movement of the basin and to maintain a great land area nearly at the level of the sea.

Pottsville time.—Early in the Pennsylvanian epoch sedimentation was confined to a rather narrow area in southern Illinois and western Kentucky, but later it spread slowly northward and westward in Illinois and eastward in Indiana. Sand, which in places contains coarse quartz pebbles that are conspicuous, was the predominating material that accumulated at this time, though sandy mud was also deposited, and locally marl beds were formed. At times marshes were formed in places on the broad, flat coastal plain, and in them enough vegetal material accumulated to form thin layers of peat. At first some of the clastic sediments may have come from the Chester beds that were still exposed in adjacent areas, but, as much of the sand in the Pottsville beds is coarser and more micaceous than any in the Chester beds and in far greater volume than could have been derived from such a source, the greater part must have come from more remote areas.

Carbondale time.—During the Carbondale epoch conditions similar to those in the Pottsville continued. The basin continued to subside and was alternately just above and just below the sea, but the marginal areas, near which lies the Gillespie-Mount Olive district, subsided more slowly than the central part of the basin in eastern and southwestern Illinois, a condition which probably existed in both the preceding and following epochs.

The relations of the beds at the best-known stratigraphic horizons at the time of the deposition of the Herrin coal are illustrated in Figure 11. The swamp in which this coal was laid down must have had an essentially level surface, because the coal bed is almost coextensive with the Illinois coal basin and because its lower part throughout the basin contains a thin clay parting which everywhere has practically the same thickness. If the surface had contained irregularities the fine silt must have accumulated to a greater degree at some points than at others, but this did not occur. The Herrin coal therefore furnishes a very satisfactory key horizon. Unfortunately the areas in which the thicknesses of the formations are best known do not lie in the line of the general dip, which is approximately eastward. The areas that have been studied have a rough alinement to the southeast, and thus the structure indicated in the section is given a modified and distorted attitude. One of the most striking features shown is the divergence of the coal beds to the east. The divergence of only 100 feet in 200 miles would not in itself be so remarkable if it were not so even and regular, and furthermore it occurs not only between the Herrin and Murphysboro coals but also between these coals and the intermediate Springfield coal. The inference is therefore clear that the central part of the basin, in which the intervals between the beds are greatest, was subsiding at a slightly greater rate than the part near the western margin.

In general, conditions of sedimentation were much more uniform in the Carbondale epoch than in the Pottsville epoch and the sediments were finer. The Carbondale beds contain a larger proportion of shale and sandy shale, and in the main the sandstones are finer grained than those deposited earlier. Several times during the epoch great swamps covered the area, and the vegetal material that accumulated in them in the form of peat became transformed into coal by consolidation and compression beneath succeeding sediments.

Almost at the beginning of the Carbondale epoch a great peat swamp covered the basin, though parts of the region appear to have stood above the swamp. The irregular subsidence of parts of the surface and the incursion of muddy water locally interrupted the accumulation of vegetation, which, however, was soon resumed, so that in the Gillespie-Mount Olive district, as well as in some other localities, the peat bed was divided into two parts. This peat bed, which ultimately was transformed into the Murphysboro coal, was covered by clay and sandy muds. Later the region was again occupied by a swamp. At this time the western part of the basin seems to have been below sea level but to have been protected temporarily from the prevailing muddy water, for limy deposits accumulated, and for a time the fluctuation in elevation permitted the accumulation of alternating beds of peat and marl. These deposits were soon covered by sandy silt, the deposition of which continued, except during a temporary interruption, during which another somewhat discontinuous peat swamp covered the region, until the peat swamp was developed in which the Springfield coal was deposited. The Springfield swamp was widespread and seems to have been practically coextensive with the basin, but though thick peat accumulated elsewhere a comparatively small amount of vegetal matter was accumulated in the Gillespie-Mount Olive district. Between the time of the Springfield peat swamp and that in which the Herrin coal was laid down marl was frequently deposited, a fact which indicates that at times parts of the region were submerged beneath the sea and more or less effectively protected from muddy water.

The swamp that covered the region at the end of the Carbondale epoch was as widespread as that in which the Springfield coal was formed. In the Gillespie-Mount Olive district the vegetal accumulations were the thickest and gave rise to the most valuable coal of that district. During the early part of the existence of this swamp the area was inundated by muddy water and a thin sheet of mud was deposited, but at the end of the Carbondale epoch, as at the beginning, the area was again occupied by a great swamp.

In the central part of the basin, where the total subsidence was greater, swamps prevailed more frequently, and many thin peat beds, some of them of considerable extent, were formed, in addition to those of the Gillespie-Mount Olive district.

McLeansboro time.— Conditions similar to those of the Carbondale epoch continued through the McLeansboro epoch, with the difference that the proportion of limy accumulations was greater, that of vegetal matter less, and sandy beds, at least in the Gillespie-Mount Olive district were less frequently deposited. In general, conditions seem to have been less quiet; and although there were many swamps of greater or less extent, they existed only a short time. At least twice in the recorded history of this epoch the land was notably elevated above the shore line and erosion was active.

At the beginning of the McLeansboro epoch the great peat swamp that covered the basin was submerged, and limy deposits accumulated over the area. The lands that contributed the clastic material had doubtless been worn down, so that the submergence of much of the surface at this time probably affected to a marked degree the region that furnished the sediments, for though some clay was interstratified with the limy silt it was subordinate in amount and the sea must have been clear, at least intermittently. In the gradual emergence which followed a thin coal was deposited, and on the flat shore some terrestrial deposits were no doubt laid down. As the land continued to rise above the sea, drainage developed in the lowland and erosion and dissection of the area began. The relief may have reached as much as 40 feet, for not only the deposits of marl but also the peat of the Herrin coal were worn away from considerable areas. As the land subsided after this exposure, sedimentation was resumed and the inequalities cut in the recent land mass were filled and leveled. Irregular and local swampy areas appeared, and a short time later an unusual deposit of red and variegated mud was laid down. Whether this deposit represents the elevation and weathering of the surface itself under peculiar climatic conditions not previously existing, or whether it represents the entrance into the basin of silt from a weathered land surface whose drainage was not previously tributary to the basin, is uncertain. The evidence favors the former explanation. The deposit was thin, and the occurrence is unique in the Pennsylvanian of this district.

After the accumulation of more than 350 feet of sediment, including some persistent beds of limestone during the formation of which the area must have been far from the shore or protected from mud-laden water by barriers, the surface was again elevated, and narrow valleys 100 feet or more in depth were scoured in the new land. The surface was later brought nearly to sea level, the channels became filled with sand, and ultimately the land was resubmerged. No younger Paleozoic deposits than those that fill these old valleys are now present in this district, but before the end of the Pennsylvanian epoch at least 800 feet of similar deposits were laid down in southern Illinois and western Kentucky. Possibly these deposits, and perhaps many more, were laid down throughout the basin and have since been eroded.

POST-CARBONIFEROUS DEFORMATION

Carboniferous deposition was closed by widespread elevation and deformation of the land, by which the sea that had intermittently occupied the region for so long a time permanently withdrew. The most prominent earth movements which took place at this time in eastern and central North America were the folding and elevation of the Appalachian Mountains, the folding and elevation of the Ouachita Mountains, the elevation of the Ozark region, the accentuation of the La Salle anticline and the accompanying synclines, and the faulting and gentle folding and intrusion of the Shawneetown faulted belt. These disturbances were different in character, in intensity, and in orientation. Thus the Appalachian movement was intense and folded the rocks along a northeastward-trending axis, whereas the intensely folded region of the Ouachita Mountains was deformed along an eastward-trending axis; the Ozark region was not notably folded but was elevated in a broad, low arch; the Shawneetown uplift is an eastward-trending zone in which the beds are complexly faulted and folded; and the La Salle anticline and the parallel synclines are very gentle but distinct folds that trend slightly west of north.

These conflicting movements have all been assigned to the final stages of the Paleozoic era. They were, however, slow deformations, and most of them had been begun early in Paleozoic time and doubtless continued to affect the surface even in Mesozoic time. The maximum deformation caused by some of these disturbances possibly lagged behind that caused by others, and the Shawneetown movements, with the intrusion of basic dikes, may possibly have reached their climax some time later, perhaps in the Cretaceous period, when notable reelevation of the land took place. No means for determining positively the relative age of the most intense activity of these movements has, however, been discovered.

The Gillespie-Mount Olive district is on the west side of the broad downwarp west of the La Salle anticline, the dips of which are so gentle that they can with difficulty be distinguished from the irregularities of original deposition.

MESOZOIC ERA

Erosion became the controlling influence in the development of the region after the elevation and deformation that ended Paleozoic deposition, and areas that had previously received rock material began to lose it. Erosion has continued practically without interruption, except during the glacial stages, to the present time, though not always at the same rate, for it has been accelerated several times by uplifts. There is no reliable evidence of any general subsidence, though the surface of the region was several times brought low by erosion.

Several great uplifts affected the Appalachian Mountains, the Ozark region, and the intervening area during the Mesozoic era, and the extensive erosion that followed each reelevation reduced the surface many hundreds of feet. The record of only two of these uplifts is preserved in Illinois. The earlier of the two is represented by the high hills southwest of Shawneetown, in the southern part of the State, and the relatively high unglaciated areas in the northwest corner of the State. These areas correspond in altitude to other similar remnants in the adjoining States and are believed to represent an early peneplain, during the formation of which the surface was for the most part worn down to a nearly level plain that stood only a short distance above sea level. The region was subsequently reelevated, perhaps in Cenozoic time, and all but the few remnants of the early peneplain were eroded to a level, probably not at any point far above the sea. This surface, which is represented by the high divide beneath the glacial drift, is the oldest surface in the Gillespie-Mount Olive district.

CENOZOIC ERA

TERTIARY PERIOD

A third cycle of erosion began perhaps in the Tertiary period and is still in progress. Its beginning was marked by an uplift which raised the smooth surface just described several hundred feet above sea level, and before the end of the Tertiary period the surface had acquired a relief greater than that of to-day and was apparently more maturely dissected. The surface of the district at the end of the Tertiary period, as nearly as it can be reconstructed from the records of drill holes and rock outcrops, is represented in Figure 12. The maximum relief was about 230 feet, whereas that of the present time, leaving out of account the morainal ridges, is less than 200 feet. East of Staunton the lowest point of the old surface is probably less than 400 feet above sea level, whereas that of the surface of to-day is about 500 feet. The old ridge has an average altitude of slightly more than 600 feet above sea level, whereas the average altitude of the modern ridge with its superimposed glacial till is 650 feet. The valleys appear to be much smoother and more open than those of to-day, but this difference, though in part perhaps the result of glaciation, is in part only apparent, being the inevitable result of the lack of detailed information and the necessity of using a greater contour interval on the map.

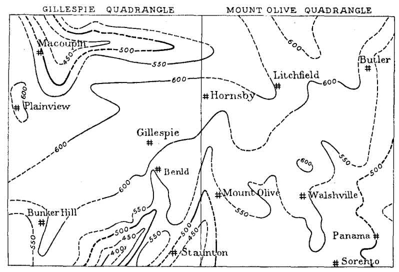


FIGURE 12.—Restored preglacial land surface in the Gillespie and Mount Olive quadrangles represented by contours

Based on position of bedrock surface in well borings. Contours show altitude above present sea level. Contour interval 50 feet

The main drainage lines at the end of the Tertiary period were remarkably similar in position to those of to-day, as might be supposed from the fact that the average thickness of the drift is less than the relief of the older surface. Certain changes, however, have taken place. Macoupin Creek no longer flows from the Gillespie-Mount Olive district in a northwesterly direction but has cut a new channel toward the west. The early channel of Shoal Creek probably was east of its present channel and outside the district. The drainage basins of to-day, however, conform closely to those of the Tertiary period, and these seem to have been controlled to some extent by outcrops of hard rocks, the Shoal Creek limestone being at or near the Tertiary surface in the greater part of the Mount Olive quadrangle. In the Gillespie quadrangle the drainage is in the opposite direction to the dip of the rocks, and the relation of the drainage to the hard beds is not so obvious.

QUATERNARY PERIOD

When the destruction of the peneplain in the Gillespie-Mount Olive district had reached the stage represented in Figure 12, a climatic change resulted in the development of great ice sheets, which gradually spread over the northern part of North America and invaded the United States. (See fig. 13.)

FIGURE 13.—Map of North America showing the area covered by the ice sheet of the Pleistocene epoch at its maximum extension

Shows the approximate southern limit of glaciation, the four main centers of ice accumulation, and the driftless area within the border of the glaciated region

This change interrupted the work of stream erosion, which had been in progress since the last reelevation of the surface. This glaciation and a later one completely buried the pre-Quaternary surface beneath a thick layer of unsorted clastic material known as drift. The first of the great glaciers, which reached Iowa and Nebraska in pre-Kansan time, may not have invaded this part of Illinois.

KANSAN (?) STAGE OF GLACIATION

At the second or Kansan stage of glaciation the ice from the center in Labrador probably spread over most of Illinois, and to this stage is provisionally referred the older till that is found beneath the Illinoian drift at so many localities in the Gillespie-Mount Olive district. This district was probably not far from the southern limit of the ice sheet, and the glacial débris may not have covered the area very deeply, though the action of the ice was probably effective to some extent in smoothing the sharper irregularities and wearing down the more prominent features. After occupying the region for a considerable time, the ice gradually melted away, leaving in its place a mantle of clay, sand, pebbles, and boulders, some of which it had brought from the region far to the north.

YARMOUTH (?) INTERGLACIAL STAGE

The change of climate that resulted in the melting of the ice was followed by a long interval during which ordinary agencies of erosion were again dominant and the climate was not dissimilar to that in the same region to-day. Streams excavated new valleys or began to clear out old ones. Beds of sand and waterworn gravel accumulated in the drainage bottoms, ponds and swampy areas in which lived snails and unios developed in some places, and elsewhere a dark to black soil was formed, in which trees and other plants grew in more or less abundance.

ILLINOIAN STAGE OF GLACIATION

The mild climate that followed the early glaciation eventually gave place to a more rigorous climate, and another ice sheet, which originated in Labrador, came from the northeast and spread over most of Illinois. As it advanced it gathered up much of the material left by the earlier ice sheet, and in scouring along the valleys it gathered also considerable material from exposed portions of the preglacial surface. In the Gillespie-Mount Olive district, however, its scouring action was not very pronounced, even though the basal rocks are soft shale, and in many places the Yarmouth soil was buried and little or not at all disturbed.

This glacier reached the most southerly point attained by any of the Pleistocene ice sheets, extending southward in Illinois at least as far as the northern edge of Johnson County. As a result of this invasion by the ice the surface of the greater part of Illinois was buried beneath a mantle of gravelly and sandy clay which contains material derived from most of the rocks traversed by the ice sheet. The surface of the deposit laid down at this time was a nearly flat or gently undulating plain dotted with small depressions and morainal mounds. Its configuration in the Gillespie-Mount Olive district, as reconstructed from the undissected remnants of the plain that now comprises the divides, is shown in Figure 14. As the surface in this figure is delineated by 20-foot contours, only the larger depressions in the area are shown.

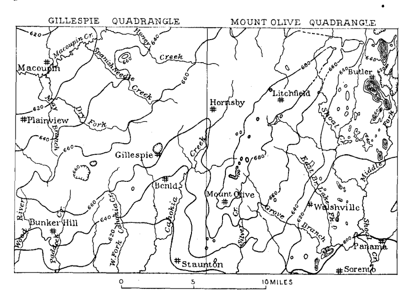


FIGURE 14.—Restored surface of the land at end of period of glaciation in the Gillespie and Mount Olive quadrangles shown by contours

Reconstructed from undissected upland areas. Contours show altitude above present sea level. Contour interval 20 feet

The conditions which led to the formation of the morainal mounds in the belt extending from north to south in the eastern part of the Mount Olive quadrangle are not certainly known. The group of ridges in this belt is only a part of a long chain of similar mounds in the valley of the Kaskaskia, extending from the border of the later or Wisconsin drift near Pana southwestward to Mississippi River. As the ridges lie in the basin of Kaskaskia River, and as this basin was probably a broad valley at the end of Illinoian time, so that it may have been effective in controlling the movements of the ice near the margin of the ice sheet while the glacial front was retreating, there is a possibility that the ridges constitute the terminal moraine of a minor lobe. The original height of the ridge in this area above the basin of the Kaskaskia is not known, but its height above the postglacial valley of Shoal Creek, as shown in Figure 14, is over 80 feet. This difference in altitude must have had some effect on the movement of the ice and the débris carried by it in the final stages of glaciation. However, the distribution of the ridges relative to the axis of the Kaskaskia basin does not lend entirely satisfactory support to this hypothesis, so that the question must remain open until more extensive studies have been made.

SANGAMON STAGE OF DEGLACIATION TO RECENT TIME

When the climate again became warmer and the ice front began to retreat, the run-off, seeking the lower places on the till surface, began to develop the valleys as they are to-day. The courses of the present streams, with one exception, are the direct result of the configuration of the surface of the drift as left by the ice (fig. 14). The exception is the West Fork of Shoal Creek, which cuts directly across the main divide of the area. From a casual inspection of the map it would seem that the valley now occupied by Brush Creek in the basin west of the high glacial mounds should have furnished the outlet for drainage from the north. Certain conditions, however, may have closed this outlet. For example, the glacial front may have stood for a time at the morainal area in the northeastern part of the Mount Olive quadrangle after the ice had disappeared from most of the district. Such a barrier would have been effectual in diverting the run-off from the north to the position of the West Fork of Shoal Creek. This channel, while carrying the drainage from the west side of the ice lobe and that from the region to the north, must have been cut deep enough to retain the drainage after the disappearance of the ice barrier. Otherwise the drainage must have found an exit southward through the low gap west of the Ware Grove Mound, for this opening in the hills is at least 40 feet lower than the crest of the till ridge across which the West Fork of Shoal Creek established its course.

On the disappearance of the ice the surface was again given over to vegetation, and the remains of successive generations of plants formed a deep carbonaceous soil on the ill-drained upland surface. During the succeeding stages of glaciation the conditions seem to have continued favorable to the growth of vegetation. None of the post-Illinoian ice advances are known to have reached the Gillespie-Mount Olive district. The extent of the Labradorean ice at the Iowan stage is unknown. The Wisconsin ice sheets did not reach as far south as this district. Each of these ice sheets, however, must have exerted a chilling effect on the climate of this area and have tended to prevent complete decomposition of vegetation. In the ponded tracts the accumulation of carbonaceous material, combined with the fine mud washed into the basins from surrounding low-lying areas, increased to thicknesses commensurate with the depth of the depressions. With variations of climate, perhaps accompanying subsequent interglacial stages, much of the carbonaceous material that had accumulated in the soil became oxidized. In the broad, flat areas, the soil of which at one time must have been almost as dark as that of the swampy areas, there appears to have been a subsequent bleaching due to the action of humic acids in the water that percolated downward as the ground-water table became lower in consequence of dissection of the smooth plain by the streams. To this bleaching is probably due the ash-gray color of the so-called "white clay" soil.

A time of slack water resulted in the accumulation of considerable thicknesses of alluvium into which the streams are now cutting.

ECONOMIC GEOLOGY

The mineral resources of the Gillespie-Mount Olive district are coal, oil and gas, clay, stone, sand and gravel, soil, and water.

COAL

General features.—The district lies in the southwestern part of the Eastern Interior coal basin. (See fig. 15.) Coal occurs in all the formations of the Pennsylvanian series, but only those in the Carbondale formation are of great value. The Herrin coal at the top of the formation is the most valuable of these and the only one now worked. The quantity of coal produced in Macoupin and Montgomery counties in 1924 was 8,342,178 short tons, most of which came from mines within the Gillespie-Mount Olive district.

None of the coals below the Herrin coal are sufficiently valuable to make exploitation profitable at present. None of them are as thick as the Herrin coal, and so far prospecting has shown none that have so good a roof or are so easily accessible. In several wells drilled for oil by churn drills considerable thicknesses of coal have been reported, but the details of the logs of such borings are doubtful.

Coal in the Pottsville formation.—Only one bed of coal occurs in the Pottsville formation in the Gillespie-Mount Olive district. This coal was formerly mined in the Litchfield shaft, but though locally of good quality it was found to be so irregular in character that it was abandoned. It is reported to become much thinner within a short distance to the north and east, and in those directions it was followed until its thickness decreased to 18 inches. Toward the northeast the roof is bad and the coal dirty. Toward the south and west the bed is 6 feet thick, but bone replaces the coal at a locality 2,000 feet west of the shaft. In the shaft the coal, as reported, is overlain by 22 feet of dark sandy shale and underlain by 6 feet of fire clay, but these beds appear to vary from place to place.

The following analyses were made from samples collected by the Illinois Geological Survey while the mine was being operated. Unfortunately the analyses were made before the adoption of standard methods of determining air-drying loss, so that only the results of analysis stated on the moisture-free basis are reliable. These analyses are given only because no others are available.

Analyses of coal in Litchfield shaft

[W. F. Wheeler, analyst. Analyses made for the Illinois Geological Survey]

Laboratory No.	Air-drying loss [a]	Form of analysis [b]	Proximate				Ultimate					Heating value	
			Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	British thermal units
83	4.90	A	12.41	32.35	34.19	21.05	3.55	3.76	50.75	0.75	7.73	5,070	9,126
		B	7.90	34.02	35.95	22.13	3.73	3.95	53.37	.79	8.13	5,331	9,596
84	4.14	A	13.61	35.65	43.85	6.89	2.53	4.28	62.97	.94	8.78	6,192	11,146
		B	9.88	37.19	45.74	7.19	2.64	4.47	65.68	.98	9.16	6,459	11,627
1842	8.31	B	5.78	41.45	44.76	8.01	4.12	------	------	------	------	------	12,695
		C	------	43.98	47.52	8.50	4.37	------	------	------	------	------	13,473
1864	11.12	A	12.84	37.04	40.90	9.22	3.74	------	------	------	------	------	11,107
		B	1.93	41.68	46.01	10.38	4.22	------	------	------	------	------	12,497

[a] Air-drying loss questionable.
[b] A, Sample as received; B, air-dried sample; C, moisture-free sample.

83. Illinois Collieries Co., Litchfield, second west main entry, northeast side. Face sample.

84. Illinois Collieries Co., Litchfield, room 7, eleventh south main entry. Face sample.

1842. Litchfield Coal Co., formerly Illinois Collieries Co., Litchfield, room 7, third east off straight north. Face sample, 68 inches.

1864. Litchfield Coal Co., formerly Illinois Collieries Co., room 11, eighth entry west of shaft, north face. Face sample, 69 inches.

The following section was measured by the Illinois Geological Survey:

Section of coal bed in the Pottsville formation in the Litchfield shaft

	Ft.	in.
Shale, gray.		
Sand and shale		3
Coal		6
Mother coal and "sulphur"		$\frac{1}{2}$
Coal	1	5$\frac{1}{2}$
"Sulphur"		1$\frac{1}{2}$
Coal	2	4$\frac{1}{2}$
"Sulphur"		$\frac{1}{8}$
Coal	1	3$\frac{1}{4}$
Fire clay.		
	6	$\frac{3}{8}$

The coal has a maximum thickness of over 7 feet, but development showed that the coal is exceptionally thick near the shaft and that the ash there is exceptionally low. The bed is variable in other localities, and in the logs of most of the drill holes that reach this horizon it is reported as black shale. In some places it appears to have been eroded a short time after it was deposited. For these reasons the bed does not give much promise of future value in this locality, though it is possible that in adjoining areas, and perhaps in the Gillespie-Mount Olive district, portions sufficiently persistent to warrant mining may be proved by the drill.

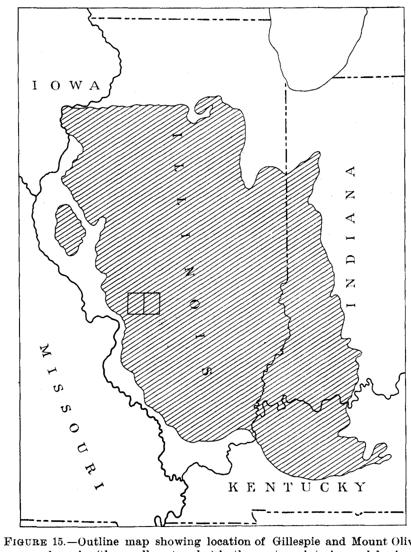


FIGURE 15.—Outline map showing location of Gillespie and Mount Olive quadrangles (the small rectangles) in the eastern interior coal basin of Illinois, Indiana, and Kentucky (ruled area)

Coal in McLeansboro formation.—Only one coal in the McLeansboro formation approaches workable thickness. This coal is about 150 feet above the Herrin coal. Its maximum thickness, which is reported to be 7 feet, is very exceptional, and its average thickness in T. 7 N., R. 4 W., where it is thickest, is less than 2 feet. The known details concerning the thickness of this coal are given on page 5. Near Sorento a coal that occurs rather generally below the Shoal Creek limestone was once mined for local use, but its thickness does not exceed 2 feet, as described on page 5.

Carbondale coals below the Herrin (No. 6) coal. — The Murphysboro coal, at the base of the Carbondale formation, is split into two beds at all the localities within the area where detailed information of its occurrence is available. Its greatest recorded thickness is at Walshville, where the lower bench was reported in the log of a well put down by the community to be 3 feet 10 inches thick. Elsewhere the benches range from a few inches to 2 feet 6 inches in thickness.

The next coal, or rather group of coals, above the Murphysboro is that which lies at the horizon of the limestone already mentioned. In sec. 5, T. 8 N., R. 5 W., there are two beds, 2 feet 9 inches and 3 feet 4 inches thick, separated by 8 feet 10 inches of shale and limestone. The thicker bed, however, which is the lower one, is reported to contain bands of shale. The Walshville town well is said to pass through beds 2 feet 10 inches and 2 feet 7 inches thick, separated by 6 feet 6 inches of black and blue shale and limestone, and the well at the Hillsboro shaft, just east of the Mount Olive quadrangle, is reported to pass through 3 feet 6 inches of coal with bands of fire clay at this horizon. In the shaft east of Litchfield 4 feet of coal is said to have been mined in the early seventies, but the shaft has long been abandoned. In the future this coal may possibly be found valuable, at least locally. No analyses of it are available.

The second coal above the Murphysboro and the next below the Springfield coal was mined for a time in the Litchfield shaft, where the following section was reported:

Section of the "upper coal," Litchfield shaft

	Inches
Sandstone.	
Bone, coal, and slate	10–14
Coal	24
Fire clay	10
Coal	8–10

The bed is variable in thickness and perhaps in character. At many places it is too thin ever to be mined, but as it has been reported to be over 6 feet thick at several places in the southwest quarter of the Mount Olive quadrangle the drill may demonstrate sufficiently extensive areas of good coal at this horizon to render possible the mining of this bed at some future time.

The Springfield coal, which is so valuable both north and south of the Gillespie-Mount Olive district, is too thin to be mined within this district. A thickness of 3 feet at some places is reported, but the average thickness does not exceed 2 feet. At one place, in sec. 21, T. 7 N., R. 4 W., the bed is reported to be 8 feet 3 inches thick.

Herrin coal or No. 6 coal.—The Herrin coal underlies the greater part of the district, but it is absent or thin in a belt 5 to 6 miles wide that crosses the central part of the Mount Olive quadrangle, from which it was eroded a short time after it was deposited. It is also absent from smaller areas and strips representing valleys that were tributary to the main valley. One of these areas lies near Hillsboro, and perhaps another lies near the Carlinville dome. Future prospecting will demonstrate similar conditions in other areas that border the zone of maximum erosion.

The coal which it is considered profitable to mine is at present confined to areas in which the roof is sufficiently strong. In a considerable area bordering that in which the coal was eroded the overlying limestone above it has been partly or entirely removed, and as the sediments that subsequently replaced the eroded materials have formed in most places more or less incoherent shale, mining is more difficult and expensive and consequently less attractive under present economic conditions than in the areas where the roof is good. This condition prevails rather generally in Honey Point Township and to some extent east and northeast of Mount Olive. Where the limestone lies only a short distance above the coal it forms an excellent roof. In the entries the black roof shale, which is the usual immediate cover of the coal, is taken down, and the limestone stands indefinitely without timbering. The character and thickness of the roof shale are variable, however, and the thickness may range from a thin film to more than 6 feet in the same mine. In places the roof shale includes or is replaced by lenticular bodies of lighter-gray claylike shale which contains a remarkably high percentage of finely divided pyrite. The pyrite is inconspicuous, owing to the clayey content of the material, but its finely divided state offers a large surface for oxidation, and decomposition takes place so rapidly when the material is in contact with the moist air of the mines that spontaneous combustion occurs. Parts of some of the mines have had to be sealed for months to extinguish fires that have started in this way, but fortunately the condition is local and has not seriously affected mining.

The black shale roof stands fairly well in the rooms, but falls sometimes occur, especially where there are "slips." In the eastern part of the Mount Olive quadrangle, near Hillsboro, the gray calcareous shale which locally underlies the limestone forms a very poor roof, and at Panama the thicker parts of the black shale are so insecure that the top bench of the coal is not mined but is left to reinforce the roof.

The base of the limestone is studded with mammillary protuberances several feet in diameter, which project into the coal where the roof slate is thin. In some places they penetrate within 2 or 3 feet of the floor. These projecting masses show slickensides where they are squeezed into the coal and slate, and they represent original nests or pockets in the upper surface of the bed on which the limestone accumulated. The holes may have been produced by the action of swirling currents during a rush of water into the area.

The floor is composed of impure fire clay, usually not more than 2 or 3 feet thick, though at Panama it averages about 15 feet. When wet or long exposed it has a tendency to "heave," but as the mines are quite dry at most places this does not give much trouble.

As a rule very little gas is present, and, as the mines are practically dry, water and gas do not create difficulties in mining operations. The coal lies at no great depth, being nowhere within the district more than 500 feet below the surface. In the Gillespie quadrangle it is in most places at a depth of less than 300 feet. Faulting is rare, and the few faults known have a throw of only a few feet. At Panama several faults have been found, but the effect on mining is not much more serious than the presence of pronounced rolls. These conditions, together with the general regularity of the bed throughout the district, combine to make the mining of this coal particularly attractive.

The incoherent character of the beds of the McLeansboro formation causes the beds between the coal and the surface to subside where the coal has been extensively mined without adequate pillars. The beds in most places subside by shearing around the edges of the undermined area, the pillars probably being crushed. The change of level at the surface is in places 2 or 3 feet.

The sections presented in Figure 16, which are designed to show the physical conditions of the coal, are perhaps not entirely representative of the mines in which they were measured, but they indicate the variations encountered and are therefore representative of the No. 6 coal within the area. In the middle part of the bed there are generally a number of lenticular sheets of pyrite from one-eighth to one-fourth inch thick and some clay partings and sheets of mineral charcoal, which are not shown in the sections. Such impurities also occur in the upper and lower parts, but they are less common there.

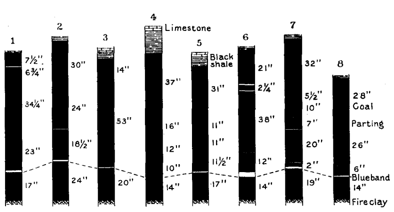


FIGURE 16.—Detailed sections of the No. 6 (Herrin) coal in the Gillespie and Mount Olive quadrangles

1, Superior Coal Co., mines Nos. 1 and 2; 2, Superior Coal Co., mine No. 3; 3, Consolidated Coal Co., mine No. 15; 4, Consolidated Coal Co., mine No. 7; 5, Madison Coal Co., mine No. 5; 6, Shoal Creek Coal Co., mine No. 1; 7, Hillsboro Coal Co., Hillsboro mine; 8, Baucer mine. Thin lenticular sheets of pyrite in the middle bench are not shown in the sections

The thickness of the coal ranges from 4 feet in some parts of the workings near Bunker Hill to 9 feet 8 inches in a drill hole southeast of Mount Olive. The average thickness is about 7 feet, and in a given district the thickness is in general fairly uniform, the fluctuations rarely exceeding 1 foot above or below the average.

The cleat is very well developed locally but differs in direction and in development in different parts of the field. At Gillespie it is so perfectly developed that according to reports a transit may be oriented within a few degrees on the cleat alone. It is not, however, well developed at Staunton. Near Mount Olive the cleat is N. 9° W., but at Hillsboro it is N. 45° E.

The coal is sometimes called the bench coal, a name suggested by the fact that certain layers of the bed have regularly different characteristics. The top coal is hard and usually free from impurities, and its luster is brighter than that of the next lower bench, from which it is in some places separated by a parting of pyrite. As a rule it is not over 2 feet in thickness. The middle bench is somewhat dull in luster and contains layers of pyrite, clay, and bone, which, however, are thin and irregular in position. The blue band already mentioned is generally about 1 inch thick, but at one place a thickness of more than 3 inches has been observed. It consists of fine shale or clay and in some places contains thin streaks of pyrite. Generally it is from 14 to 20 inches above the base of the bed. The lower bench is brighter and harder and usually cleaner than the middle bench, though in some places it has a few inches of bone at its contact with the underlying fire clay.

The railroads are the largest consumers of the coal of this district, taking nearly half the quantity produced. The remainder is used for making steam and heating, and nearly as much goes to Chicago as to St. Louis. The coal is not so good as the average coals of the Appalachian field, but it ranks well with other coals of the Eastern Interior and Western Interior basins. Its heating value is lower than that of the coal of the southern part of the State but slightly higher than that of the Springfield coal in Sangamon County. It has nearly the same heating value as the coals of the La Salle and Danville districts, although it is higher in sulphur and ash. In these constituents it is also higher than that of other districts of the State, possibly because of its position near the margin of the coal basin.

The chemical character of the Herrin coal is shown by the accompanying analyses, which were made in the laboratories of the University of Illinois under the direction of Prof. S. W. Parr.

Analyses of face samples of Herrin (No. 6) coal from Gillespie-Mount Olive district

[Made under direction of S. W. Parr for Illinois Geological Survey]

Mine	Laboratory No.	Form of analysis [a]	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	Heating value (British thermal units)
Superior Coal Co., mine No. 3, Gillespie.	5087	A	13.77	38.69	36.74	10.80	4.37	10,493
		B	7.75	41.89	39.31	11.55	4.68	11,226
		C	--------	44.86	42.62	12.52	5.07	12,169
Do	5086	A	14.29	39.09	37.21	9.41	4.18	10,635
		B	8.82	41.81	39.80	10.07	4.42	11,376
		C	--------	45.60	43.42	10.98	4.82	12,408
Do	5088	A	14.73	38.33	37.24	9.70	4.50	10,522
		B	7.79	41.45	40.28	10.48	4.87	11,379
		C	--------	44.95	43.69	11.36	5.28	12,339
Consolidated Coal Co., mine No. 15, Mount Olive.	5113	A	13.27	38.58	38.15	10.00	4.39	10,790
		B	5.62	41.99	41.51	10.88	5.32	11,748
		C	--------	44.48	43.99	11.53	5.64	12,442
Do	5112	A	12.11	40.32	39.14	8.43	4.39	11,170
		B	5.55	43.33	42.06	9.06	4.72	12,001
		C	--------	45.88	44.52	9.60	5.00	12,705
Do	5114	A	13.27	38.85	38.91	9.01	4.39	10,985
		B	6.13	42.03	42.09	9.75	4.75	11,829
		C	--------	44.77	44.84	10.39	5.06	12,601
Shoal Creek Coal Co., mine No. 1, Panama.	5107	A	13.70	37.25	37.93	11.12	4.39	10,444
		B	5.97	40.59	41.32	12.12	4.78	11,379
		C	--------	43.17	43.94	12.89	5.08	12,102
Do	5106	A	13.83	36.95	39.22	10.00	3.72	10,728
		B	6.11	40.26	42.73	10.90	4.06	11,692
		C	--------	42.88	45.51	11.61	4.32	12,453
Do	5105	A	14.15	36.96	38.19	10.70	3.43	10,547
		B	5.46	40.70	42.05	11.79	3.78	11,614
		C	--------	43.05	44.48	12.47	4.00	12,285
Peabody Coal Co., Taylor Spring mine, Mount Olive.	5516	A	14.00	36.88	40.02	9.10	3.84	10,761
		B	8.49	39.24	42.59	9.68	4.09	11,450
		C	--------	42.88	46.54	10.58	4.47	12,511

[a] A, Sample as received; B, air-dried sample; C, moisture-free sample (theoretical recalculation of the analysis).

The coal in the Belleville-Breese district, which is entirely similar to the coal of the Gillespie-Mount Olive district, was found to be essentially noncoking, and attempts to produce a good blast-furnace coke were not successful. It is probable, therefore, that the coals of the Gillespie-Mount Olive district are also noncoking. Like the Belleville coal it is probably well adapted to use for briquetting.

OIL AND GAS

The Gillespie-Mount Olive district has produced only small quantities of oil and gas. In all, four productive areas are known. The oldest of these areas, the Litchfield oil pool, was discovered in 1879, and by 1902, when it was abandoned, it had produced about 22,000 barrels of oil. The gas that accompanied the oil in rather large quantities was used in the homes in Litchfield for several years, but the field had ceased to produce gas in 1889. The Carlinville field was discovered in 1909, and during the first year it yielded gas which was utilized in Carlinville. In 1911, however, a small oil pool was discovered in the same locality at a slightly greater depth, and by the end of 1914 it had yielded 16,540 barrels. Production in the field is declining, and as the productive area is small it seems probable that the field will soon be exhausted.

On Spanish Needle Creek two gas wells were drilled in 1915 in an area that had been previously recommended by the United States Geological Survey and the Illinois Geological Survey in a cooperative report.[14] The open-flow production has not been measured, but the production of one of these wells is reported at 3,000,000 cubic feet. In the same year a more extensive area containing gas was discovered northwest of Staunton under similar circumstances, at a depth of 450 to 500 feet. In this area in 1916 several wells had produced 2,000,000 to 15,000,000 cubic feet and were then estimated to be capable of producing over 60,000,000 cubic feet.

The oil in the Litchfield area is said to have been almost black, and to have a specific gravity of 22° Baumé. That of the Carlinville pool is dark brown and has a specific gravity of 28.6° Baumé.

The gas is of good quality, is almost odorless, and burns with a hot blue flame. The initial pressure at Carlinville was 135 pounds, but in less than three years the pressure had fallen to 35 pounds.

The oil and gas come from lenticular bodies of sandstone in the upper part of the Pottsville formation, at a depth of 500 to 550 feet in the Carlinville area and of about 700 feet at Litchfield. The most productive sandstone lens cuts out the Pottsville dirty coal in both oil fields, and the sandstones are thought to be contemporaneous, although they are not continuous.

[14] Blatchley, R. S., Oil and gas in Bond, Macoupin, and Montgomery counties, Ill.: Illinois Geol. Survey Bull. 28, pl. 2, 1914.

The accumulation of oil in the Carlinville field seems to be dependent on the accidental presence of a favorably conditioned sandstone lens beneath a structural deformation. The oil and gas are accumulated eccentrically beneath the dome because the tilted sandstone lentil in which they occur wedges out near the crest and does not underlie the whole area. The uplift is only 15 or 20 feet, and the accidental combination of a lenticular sand body and a dome has localized the oil. The Litchfield area furnishes an example of anticlinal accumulation of oil and gas, as does also the gas pool on Spanish Needle Creek. In the area northwest of Staunton the presence of a body of sand on the dome appears to be necessary to localize the accumulation, for a number of points beneath the dome have been proved nonproductive.

Structural conditions seem to favor the accumulation of oil beneath the other domes in the district, but it is not known whether favorable sandstone lenses are present in those areas. The fact that a slight deformation proved effective in localizing the Litchfield pool at the edge of the tilted sand lens suggests that similar conditions may occur in other parts of the field where such slight folding may have escaped detection.

CLAY AND SHALE

The subsoil of the area, which is from 4 to 5 feet thick and rests on the glacial till, yields suitable material for the manufacture of common brick and tile. The brick, however, is not of very good appearance, and the presence in it of the small pebbles carried in the soil is an objectionable feature, although for certain uses the product is not unsatisfactory. The clay that underlies the Carlinville limestone is utilized near the northern margin of the Gillespie quadrangle in the manufacture of tile of good grade, and this bed of clay, which is exposed at a number of places in the northeastern part of this quadrangle, is elsewhere probably of similar grade and character, though not so accessible.

A number of samples of clay and shale were collected from the McLeansboro formation and tested by the ceramics department of the Illinois State University, but only one of these samples, which is reported as being of excellent quality, was found to be suitable for making brick. This clay came from an exposure in the bed of Big Branch of Cahokia Creek, in the NE. ¼ sec. 12, T. 7 N., R. 7 W., about 1 mile southwest of Sawyerville. It is less than half a mile from the Illinois Traction line and the same distance from the branch of the Chicago & Northwestern Railway. The shale is exposed in a cut bank of the creek and occurs beneath a moderate cover. The entire thickness of the bed is not exposed, but it exceeds 10 feet, and a large quantity of clay is accessible in the vicinity. In burning it has an excellent color range of fine deep red and a good range of vitrification and would therefore be suitable for making vitrified brick.

Samples of the underclay beneath the Herrin coal at Bunker Hill and at Panama were tested but were found unsatisfactory. The sample from Panama was gray and reported to be fairly hard and fairly plastic. It had a high drying shrinkage, scummed badly in burning, and became overburned at cone 02. It is not suitable for commercial use.

The sample from Bunker Hill was a soft gray clay that contained considerable iron and calcium in the form of concretions of iron carbonate and calcium carbonate (Fe_2CO_3 and $CaCO_3$). The burned samples were badly scummed and contained granular particles of the lime-iron concretions. It is not of much value. Four other samples were tested from other localities but were found to be unsatisfactory. Two samples of clay shale came from horizons above the Carlinville limestone near the head of Paddock Creek at Bunker Hill; one sample was obtained a short distance above the Shoal Creek limestone on the farm of Thomas Compton, 1 mile north of Sorento; and one was obtained beneath the Shoal Creek limestone at the ford in the road that connects Sorento and Panama. All four samples were found to be undesirable for commercial use, although the clay exposed in Paddock Creek in the northwest corner of sec. 24, T. 7 N., R. 8 W., is reported to be suitable for common brick and some for face brick, but there is some scumming, and the rapid vitrification makes burning dangerous. Possibly other clays in the area may be more desirable, but most of them are highly micaceous and contain much fine sand.

BUILDING STONE

There is no building stone of any value in the district except for local use. The Carlinville and Shoal Creek limestones have been used locally for foundation stone, for which suitable blocks 8 to 12 inches thick can be procured. Although these limestones are suitable for crushed stone in concrete the stone shipped into the district from places on Mississippi River has superseded the local stone because the thick cover over the outcrops along the valley sides generally makes the quarrying of the local stone unprofitable. A notable exception, however, is the quarry on the Illinois Traction line between Litchfield and Shoal Creek in the SE. ¼ sec. 2, T. 8 N., R. 5 W. Here the Shoal Creek limestone forms a bench with but little cover in a wide meander of a small creek, and it was extensively quarried and crushed for use as ballast in the construction of this line. No other outcrops of limestone were observed so well situated for transportation and quarrying. Small areas of outcropping limestone that could be utilized locally for road metal occur a short distance east and north of Sorento, near mine No. 3 of the Superior Coal Co., near Gillespie, and at the head of Dry Fork northwest of Gillespie, and elsewhere. The accessible stone is somewhat argillaceous and of variable grade, and it is doubtful if small quarries can be established at these exposures that could compete with the plants on Mississippi River.

SAND AND GRAVEL

Sand and gravel occur in most of the valleys and are used locally, but in cities and towns it is more convenient to purchase that brought in by rail than to utilize the local material, if it must be hauled some distance by wagon. The small concretions of limonite from the size of birdshot to buckshot, that occur in the upland soil are concentrated by the action of streams in the sand bars and in places aggregate over 5 per cent of the sand. These pellets form an objectionable constituent for use in concrete, and the limit of such impurities usually provided in specifications for road construction eliminates some deposits of sand that otherwise might be used.

SOILS

The soil of the Gillespie-Mount Olive district has been for the most part derived from the till and its cover of gumbo, though where the underlying Pennsylvanian rocks are exposed they have contributed to some extent to the alluvial soil of the valleys.

The soil on the flat upland surface is light drab, brown, or dark grayish black, the humus which it contains giving it the dark color. It is friable and has appreciably less organic matter at a depth of 20 to 30 inches, grading at this depth into yellowish silty subsoil that is less porous than the top soil but not very compact. Its relatively porous texture enables the soil to withstand droughts better than the closer-textured soil in the southern part of the State. It contains the principal plant foods in sufficient quantity to make extensive or frequent fertilization unnecessary.

In the postglacial ponds the fine material washed from the surrounding slightly higher areas formed a soil of different type. This soil is rich in organic matter, black, sticky, and plastic. In some places it is sometimes difficult to provide adequate drainage, but the soil contains abundant plant food and is more productive than the other upland soils which have been longer under cultivation and which are not so well supplied with nitrogen and phosphorus.

The steeper morainal mounds are covered with yellowish silty soils which are generally deficient in nitrogen and phosphorus and unless carefully tilled are subject to serious loss from washing. For this reason they are better adapted to pasture and are so utilized in large measure, though in some places they are farmed. The soils of the valley slopes are similar in character but more sandy, being derived largely from the till. As the valley slopes are steeper than the morainal mounds, they are even less adapted to cultivation except near the heads of drains, where the soil is of mixed character, much of it consisting of material washed from the upland plain. The soil of the bottom lands is variable and consists of material derived from the upland plain, the till sheet, and the outcropping Pennsylvanian rocks. As Shoal Creek drains a morainal area where the soil is composed of coarser material its alluvium is notably more sandy than that in the other valleys. Although variable in character, the soil of the bottom lands generally contains about the same quantity of the principal plant foods as the best upland soil. The bottoms, however, are subject to overflow at times of high water and in some places are deficient in calcium and are more or less acid.

WATER RESOURCES

The water supply of the Gillespie-Mount Olive district comes largely from shallow wells in the drift. Although water from this source is used extensively in the towns of Litchfield, Mount Olive, and Staunton, the municipal supplies are procured from reservoirs provided by damming the upper parts of adjacent valleys. These reservoirs afford a moderately satisfactory but not always adequate water supply, for the drainage basins are small.

Wells ending in rock formations.—Little water is obtained from deep wells. The only beds that yield much water are sandstones in the Pottsville formation at or near the horizon of the oil and gas, and this water is highly mineralized and very salty and is therefore unfit for use. The Carbondale and McLeansboro formations do not yield water except in a few places. This absence of water is no doubt due to the fact that the sandstones are lenticular and are cut off from the circulation of ground water by the till and the inclosing shales, which are themselves too impervious either to serve as storage reservoirs or to convey water to these porous sandstones. A well drilled on the east side of Gillespie, however, penetrated a water-bearing stratum of sandstone 7 feet thick at a depth of 113 feet, or 237 feet above the Herrin coal. The water is reported to rise to a level within 24 feet of the surface. The beds at this horizon, however, have been penetrated at a number of places within a radius of a few miles and at none of these places has water been found. The supply in this well is probably not large, though the well is reported never to have been pumped dry. A considerable quantity of water is also reported at Bunker Hill from a fissure penetrated by the drill in the lower part of the McLeansboro formation.

Wells ending in glacial drift.—The most abundant supply of water, so far as the rural population is concerned, is obtained from shallow wells that end in the glacial drift. In most parts of the upland plain water can be obtained at depths of 15 to 25 feet. As the water occurs, however, in comparatively thin lenticular sandy sheets, there are many exceptions. Near the edge of the plains area, where the streams have cut back into the upland, the sandy bodies appear to be so thoroughly drained, especially near the heads of ravines, that the conditions are unfavorable to the development of water in the drift. Water is in some places encountered in the drift at depths of more than 40 feet, but the prospects of getting water below 25 or 30 feet decrease somewhat in proportion to the depth.

Many wells fail in the dry season, a condition which, according to reports, did not exist prior to the extensive ditching of the upland plain and the drainage of the swampy areas and ponds. The thin lenticular sand beds in the till are no doubt of small extent and are not generally interconnecting. The subsoil is comparatively impervious, and the little water contained in the sand is probably being drawn upon in many wells faster than the water percolates through the subsoil. The improved drainage of the area that has been obtained by the ditches is probably the chief cause of the decreased supply of water, for no doubt much water is thus conducted to the valleys which might pass through the subsoil and replenish the water in the sand lenses if it were allowed to stand on the surface.

As most of the wells are shallow, there is considerable danger of contamination by surface drainage.

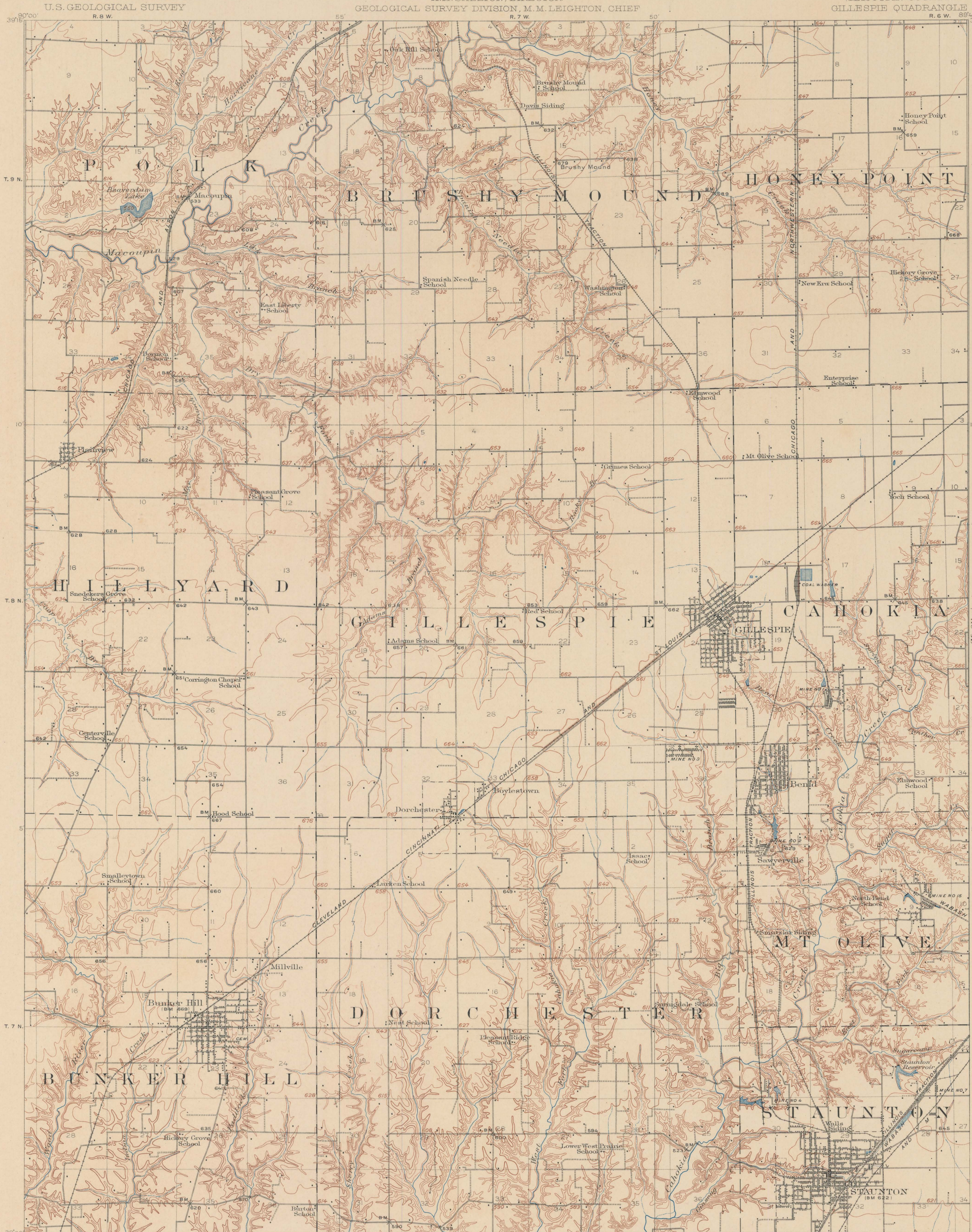
July, 1924.

TOPOGRAPHY

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION
A. M. SHELTON, DIRECTOR
GEOLOGICAL SURVEY DIVISION, M. M. LEIGHTON, CHIEF

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

ILLINOIS
(MACOUPIN COUNTY)
GILLESPIE QUADRANGLE



EXPLANATION

RELIEF
printed in brown

Altitude *above mean sea level instrumentally determined*

Contours *showing height above sea, horizontal form, and steepness of slope of the surface*

Depression contour

DRAINAGE
printed in blue

Streams

Intermittent streams

Lake or pond

Lake or reservoir and dam

CULTURE
printed in black

Roads and buildings

Church and cemetery

Schoolhouse

Private or poor road

Railroad

Electric railroad

Bridge

U.S. section lines

State township line

City, village, or borough line

Triangulation or primary traverse monument

Bench mark giving precise altitude

Temporary bench mark

R. B. Marshall, Chief Geographer.
W. H. Herron, Geographer in charge.
Topography by Frank Tweedy, C. W. Goodlove, L. L. Lee, and R. M. Herrington.
Control by J. H. Wilson and R. G. Clinite.
Surveyed in 1912.

SURVEYED IN COOPERATION WITH THE STATE OF ILLINOIS.

Scale $\frac{1}{62500}$

Contour interval 20 feet.
Datum is mean sea level.

APPROXIMATE MEAN DECLINATION 1924.

Edition of Jan. 1926.

AREAL GEOLOGY

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DEPARTMENT OF REGISTRATION AND EDUCATION
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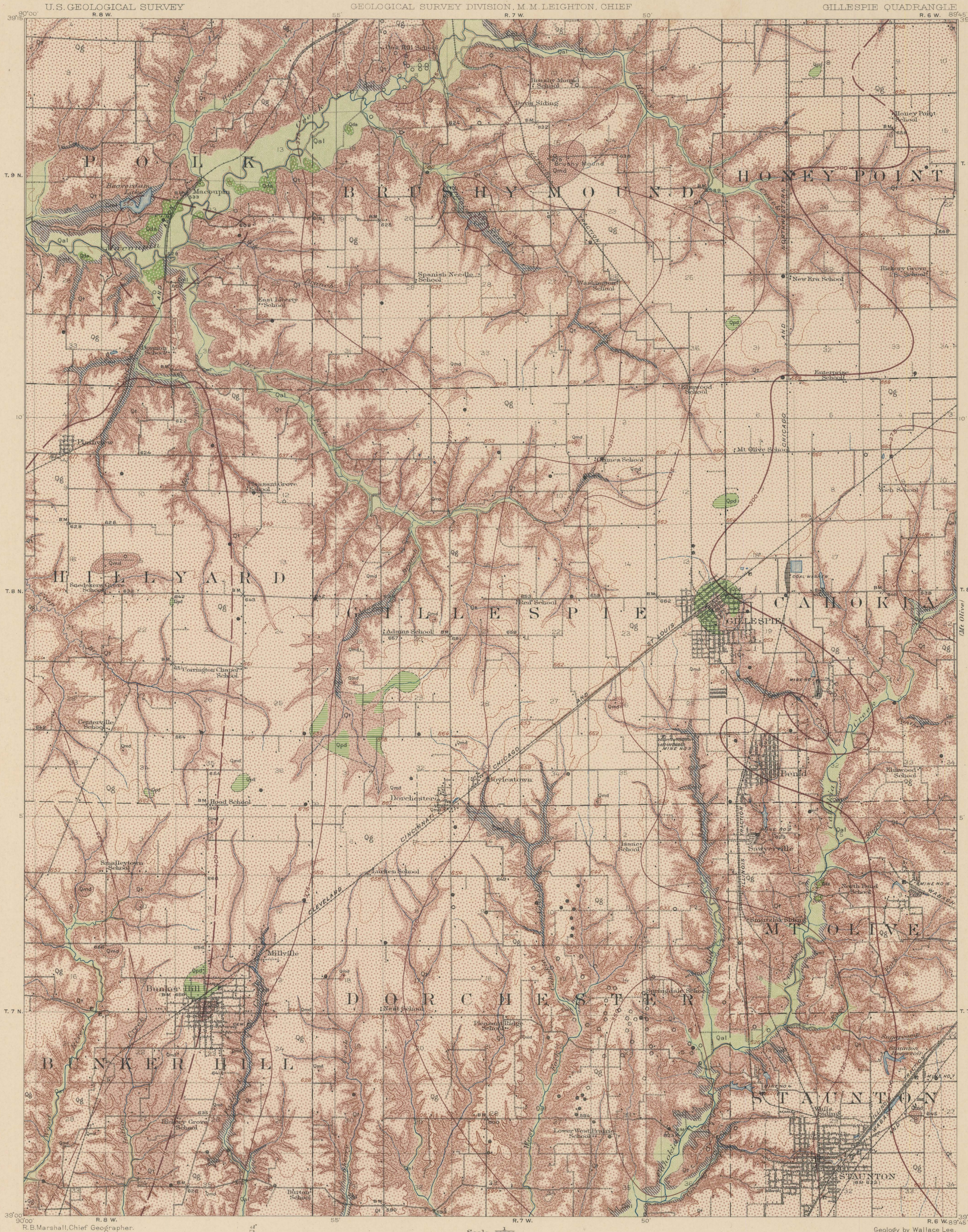

EXPLANATION

SEDIMENTARY ROCKS

(Areas of subaqueous deposits are shown by patterns of parallel lines; subaerial deposits by patterns of dots and circles)

QUATERNARY

Recent

- Qal — Alluvium *(in flood plains of present streams; silt, sand, and some gravel; more sandy where streams drain morainal areas)*
- Qda — Dissected older alluvium *(sand and gravel on low terraces)*
- Qpd — Remnants of old pond deposits *(grayish-black carbonaceous clay grading up into grayish-white in oxidized zone; former approximate outline of deposits shown by dashed lines)*

Pleistocene — Illinoian stage

- Qg — Upland gumbo *(structureless yellowish-gray clay)*
- Qmd — Morainal drift *(mounds of gravelly and coarse sandy clay with some lenses of clean sand and gravel)*
- Qt — Glacial till *(dark bluish-gray gravelly and sandy clay)*

UNCONFORMITY

CARBONIFEROUS

Pennsylvanian

- Cml — McLeansboro formation *(chiefly shale and sandy shale with some sandstone, thin beds of coal, and several limestone beds; underlies all Quaternary deposits in the quadrangle)*

ECONOMIC AND STRUCTURE DATA

- Structure contours on top of Herrin (No. 6) coal *(doubtful position of coal indicated by dashed lines; contour interval 25 feet; datum mean sea level)*
- Coal-mine shaft
- Coal test boring
- Well drilled for oil or gas

Note: *The most valuable coal, Herrin (No. 6), at the top of the Carbondale formation, underlies the McLeansboro formation throughout the quadrangle except in certain restricted areas where it was locally eroded soon after the deposition of the coal; other coals occur in the Carbondale and McLeansboro formations; shale for brick and tile and limestone for cement materials and building stone occur in the McLeansboro formation; gumbo and glacial till yield clay for brick and tile; alluvium and morainal drift locally carry sand and gravel; oil and gas in small quantities have been obtained in limited areas.*

R. B. Marshall, Chief Geographer.
W. H. Herron, Geographer in charge.
Topography by Frank Tweedy, C. W. Goodlove, L. L. Lee, and R. M. Herrington.
Control by J. H. Wilson and R. G. Clinite.
Surveyed in 1912.

SURVEYED IN COOPERATION WITH THE STATE OF ILLINOIS.

APPROXIMATE MEAN DECLINATION 1924.

Scale $\frac{1}{62500}$

Contour interval 20 feet.
Datum is mean sea level.
Edition of Jan. 1926.

Geology by Wallace Lee.
Surveyed in 1914.

SURVEYED IN COOPERATION WITH THE STATE OF ILLINOIS.

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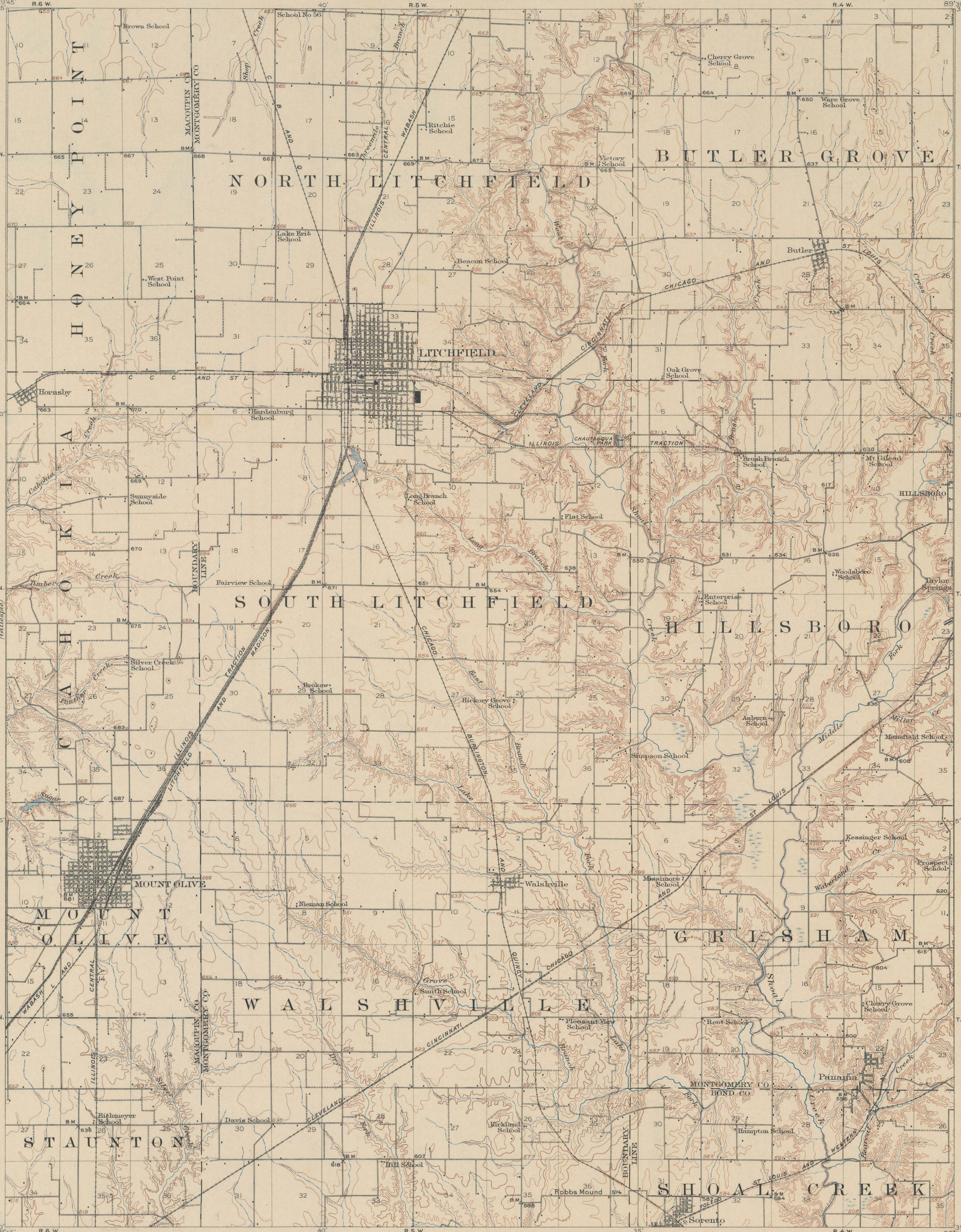
ILLINOIS
MOUNT OLIVE QUADRANGLE



EXPLANATION

RELIEF
printed in brown

Altitude
above mean sea level instrumentally determined

Contours
showing height above sea, horizontal form, and steepness of slope of the surface

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Surveyed in 1913.

SURVEYED IN COOPERATION WITH THE STATE OF ILLINOIS.

Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 20 feet.
Datum is mean sea level.

TRUE NORTH
MAGNETIC NORTH
5°
APPROXIMATE MEAN DECLINATION 1911.

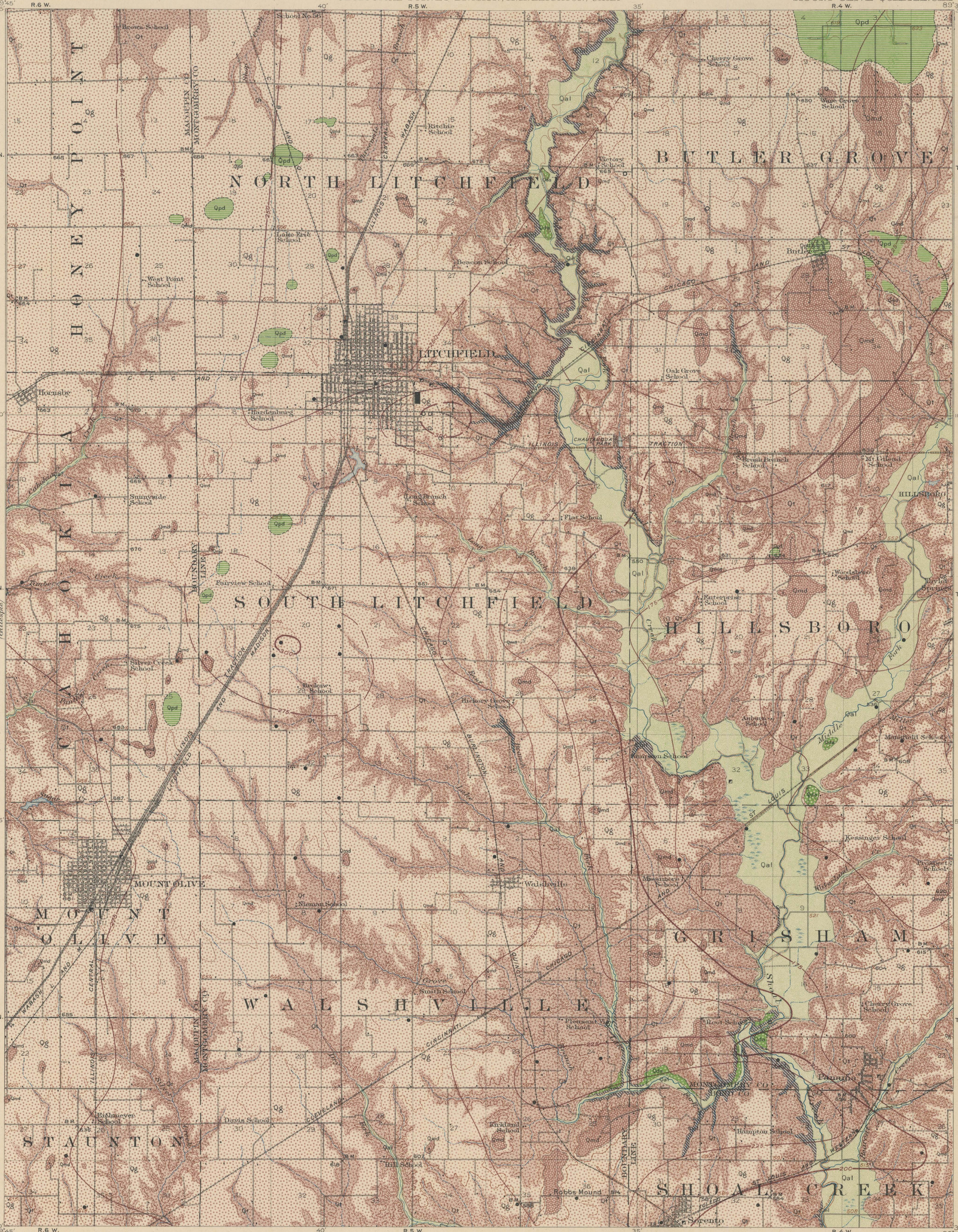
Edition of Jan. 1926

AREAL GEOLOGY

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION
A. M. SHELTON, DIRECTOR
GEOLOGICAL SURVEY DIVISION, M. M. LEIGHTON, CHIEF

DEPARTMENT OF THE INTERIOR
U. S. GEOLOGICAL SURVEY

ILLINOIS
MOUNT OLIVE QUADRANGLE



R. B. Marshall, Chief Geographer.
W. H. Herron, Geographer in charge.
Topography by W. L. Miller and L. L. Lee.
Control by J. H. Wilson, R. G. Clinite, and S. R. Archer.
Surveyed in 1913.

SURVEYED IN COOPERATION WITH THE STATE OF ILLINOIS.

TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1924.

Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 20 feet.
Datum is mean sea level.
Edition of Jan. 1926.

Geology by Wallace Lee.
Surveyed in 1914.

SURVEYED IN COOPERATION WITH THE STATE OF ILLINOIS.

EXPLANATION

SEDIMENTARY ROCKS

(Areas of subaqueous deposits are shown by patterns of parallel lines; subaerial deposits by patterns of dots and circles)

QUATERNARY

Recent

Qal — **Alluvium** *(in flood plains of present streams; silt, sand, and some gravel; more sandy where streams drain morainal areas)*

Qda — **Dissected older alluvium** *(sand and gravel on low terraces)*

Qpd — **Remnants of old pond deposits** *(grayish-black carbonaceous clay grading up into grayish-white in oxidized zone; former approximate outline of deposits shown by dashed lines)*

Pleistocene — Illinoian stage

Qg — **Upland gumbo** *(structureless yellowish-gray clay)*

Qmd — **Morainal drift** *(mounds of gravelly and coarse sandy clay with some lenses of clean sand and gravel)*

Qt — **Glacial till** *(dark bluish-gray gravelly and sandy clay)*

UNCONFORMITY

CARBONIFEROUS

Pennsylvanian

Cml — **McLeansboro formation** *(chiefly shale and sandy shale with some sandstone, thin beds of coal, and several limestone beds; underlies all Quaternary deposits in the quadrangle)*

ECONOMIC AND STRUCTURE DATA

200 — *Structure contours on top of Herrin (No. 6) coal* *(doubtful position of coal indicated by dashed lines; contour interval 25 feet; datum mean sea level)*

- *Coal-mine shaft*
- *Coal test boring*
- *Well drilled for oil or gas*

Note: *The most valuable coal, Herrin (No. 6), at the top of the Carbondale formation, underlies the McLeansboro formation throughout the quadrangle except in certain restricted areas where it was locally eroded soon after the deposition of the coal; other coals occur in the Carbondale and McLeansboro formations; shale for brick and tile and limestone for cement materials and building stone occur in the McLeansboro formation; gumbo and glacial till yield clay for brick and tile; alluvium and morainal drift locally carry sand and gravel; oil and gas in small quantities have been obtained in limited areas.*

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