DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, DIRECTOR

GEOLOGIC ATLAS

OF THE

UNITED STATES

TALLULA-SPRINGFIELD FOLIO

ILLINOIS

BY

E. W. SHAW AND T. E. SAVAGE

SURVEYED IN COOPERATION WITH
THE GEOLOGICAL SURVEY OF ILLINOIS

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GEOLOGIC ATLAS OF THE UNITED STATES.

The Geological Survey is making a geologic atlas of the United States, which is being issued in parts, called folios. Each folio includes topographic and geologic maps of a certain area, together with descriptive text.

THE TOPOGRAPHIC MAP.

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

Relief.—All elevations are measured from mean sea level. The heights of many points are accurately determined, and those of the most important ones are given on the map in figures. It is desirable, however, to give the elevation of all parts of the area mapped, to delineate the outline or form of all slopes, and to indicate their grade or steepness. This is done by lines each of which is drawn through points of equal elevation above mean sea level, the vertical interval represented by each space between lines being the same throughout each map. These lines are called *contour lines* or, more briefly, *contours*, and the uniform vertical distance between each two contours is called the *contour interval*. Contour lines and elevations are printed in brown. The manner in which contour lines express altitude, form, and grade is shown in figure 1.

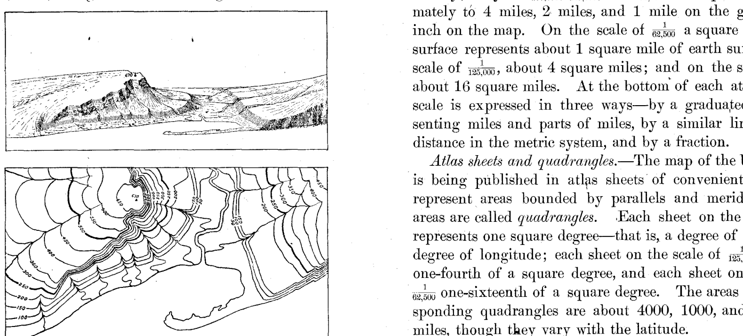

FIGURE 1.—Ideal view and corresponding contour map.

The sketch represents a river valley between two hills. In the foreground is the sea, with a bay that is partly closed by a hooked sand bar. On each side of the valley is a terrace. The terrace on the right merges into a gentle hill slope; that on the left is backed by a steep ascent to a cliff, or scarp, which contrasts with the gradual slope away from its crest. In the map each of these features is indicated, directly beneath its position in the sketch, by contour lines. The map does not include the distant portion of the view. The following notes may help to explain the use of contour lines:

1. A contour line represents a certain height above sea level. In this illustration the contour interval is 50 feet; therefore the contour lines are drawn at 50, 100, 150, and 200 feet, and so on, above mean sea level. Along the contour at 250 feet lie all points of the surface that are 250 feet above the sea—that is, this contour would be the shore line if the sea were to rise 250 feet; along the contour at 200 feet are all points that are 200 feet above the sea; and so on. In the space between any two contours are all points whose elevations are above the lower and below the higher contour. Thus the contour at 150 feet falls just below the edge of the terrace, and that at 200 feet lies above the terrace; therefore all points on the terrace are shown to be more than 150 but less than 200 feet above the sea. The summit of the higher hill is marked 670 (feet above sea level); accordingly the contour at 650 feet surrounds it. In this illustration all the contour lines are numbered, and those for 250 and 500 feet are accentuated by being made heavier. Usually it is not desirable to number all the contour lines. The accentuating and numbering of certain of them—say every fifth one—suffices and the heights of the others may be ascertained by counting up or down from these.

2. Contour lines show or express the forms of slopes. As contours are continuous horizontal lines, they wind smoothly about smooth surfaces, recede into all reentrant angles of ravines, and project in passing around spurs or prominences. These relations of contour curves and angles to forms of the landscape can be seen from the map and sketch.

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

A small contour interval is necessary to express the relief of a flat or gently undulating country; a steep or mountainous country can, as a rule, be adequately represented on the same scale by the use of a larger interval. The smallest interval used on the atlas sheets of the Geological Survey is 5 feet. This is in regions like the Mississippi Delta and the Dismal Swamp. For great mountain masses, like those in Colorado, the interval may be 250 feet and for less rugged country contour intervals of 10, 20, 25, 50, and 100 feet are used.

Drainage.—Watercourses are indicated by blue lines. For a perennial stream the line is unbroken, but for an intermittent stream it is broken or dotted. Where a stream sinks and reappears the probable underground course is shown by a broken blue line. Lakes, marshes, and other bodies of water are represented by appropriate conventional signs in blue.

Culture.—The symbols for the works of man and all lettering are printed in black.

Scales.—The area of the United States (exclusive of Alaska and island possessions) is about 3,027,000 square miles. A map of this area, drawn to the scale of 1 mile to the inch would cover 3,027,000 square inches of paper and measure about 240 by 180 feet. Each square mile of ground surface would be represented by a square inch of map surface, and a linear mile on the ground by a linear inch on the map. The scale may be expressed also by a fraction, of which the numerator is a length on the map and the denominator the corresponding length in nature expressed in the same unit. Thus, as there are 63,360 inches in a mile, the scale "1 mile to the inch" is expressed by the fraction $\frac{1}{63,360}$.

Three scales are used on the atlas sheets of the Geological Survey; they are $\frac{1}{250,000}$, $\frac{1}{125,000}$, and $\frac{1}{62,500}$, corresponding approximately to 4 miles, 2 miles, and 1 mile on the ground to an inch on the map. On the scale of $\frac{1}{62,500}$ a square inch of map surface represents about 1 square mile of earth surface; on the scale of $\frac{1}{125,000}$, about 4 square miles; and on the scale of $\frac{1}{250,000}$, about 16 square miles. At the bottom of each atlas sheet the scale is expressed in three ways—by a graduated line representing miles and parts of miles, by a similar line indicating distance in the metric system, and by a fraction.

Atlas sheets and quadrangles.—The map of the United States is being published in atlas sheets of convenient size, which represent areas bounded by parallels and meridians. These areas are called *quadrangles*. Each sheet on the scale of $\frac{1}{250,000}$ represents one square degree—that is, a degree of latitude by a degree of longitude; each sheet on the scale of $\frac{1}{125,000}$ represents one-fourth of a square degree, and each sheet on the scale of $\frac{1}{62,500}$ one-sixteenth of a square degree. The areas of the corresponding quadrangles are about 4000, 1000, and 250 square miles, though they vary with the latitude.

The atlas sheets, being only parts of one map of the United States, are not limited by political boundary lines, such as those of States, counties, and townships. Many of the maps represent areas lying in two or even three States. To each sheet, and to the quadrangle it represents, is given the name of some well-known town or natural feature within its limits, and at the sides and corners of each sheet are printed the names of adjacent quadrangles, if the maps are published.

THE GEOLOGIC MAPS.

The maps representing the geology show, by colors and conventional signs printed on the topographic base map, the distribution of rock masses on the surface of the land and, by means of structure sections, their underground relations, so far as known and 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*. Where the intrusive rock occupies a fissure with approximately parallel walls it is called a *dike*; where it fills a large and irregular conduit the mass is termed a *stock*. Where molten magma traverses stratified rocks it may be intruded along bedding planes; such masses are called *sills* or *sheets* if comparatively thin, and *laccoliths* if they occupy larger chambers produced by the pressure of the magma. Where inclosed by rock molten material cools slowly, with the result that intrusive rocks are generally of crystalline texture. Where the channels reach the surface the molten material poured out through them is called *lava*, and lavas often 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 as a rule contain, especially in their superficial parts, more or less volcanic glass, produced by rapid chilling. The outer parts of lava flows also are usually porous, owing to the expansion of the gases originally present in the magma. Explosive action, due to these gases, often accompanies volcanic eruptions, causing ejections 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 ejecta deposited in lakes and seas, or of materials deposited in such water bodies by chemical precipitation 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 are then said to be mechanical. Such are gravel, sand, and clay, which are later consolidated into conglomerate, sandstone, and shale. Some of the materials are carried in solution, and deposits of these are called organic if formed with the aid of life, or chemical if formed without the aid of life. The more important rocks of chemical and organic origin are limestone, chert, gypsum, salt, iron ore, peat, lignite, and coal. Any one of the kinds of deposit named may be separately formed, 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 glacial deposits is till, a heterogeneous mixture of bowlders and pebbles with clay or sand.

Sedimentary rocks are usually made up of layers or beds which 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 thereby changed. As a result of upward movement marine sedimentary rocks may become part of the land, and most of our land areas are in fact occupied by rocks 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 the 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. Their upper parts, occupied by the roots of plants, constitute soils and subsoils, the soils being usually distinguished by a notable admixture of organic matter.

Metamorphic rocks.—In the course of time, and by various processes, rocks may become greatly changed in composition and in texture. If the new characteristics are more pronounced than the old such rocks are called *metamorphic*. In the process of metamorphism the constituents of a chemical 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 pressures, to slow movement, and to igneous intrusion have been afterward raised and later exposed by erosion. In such rocks the original structures may have been lost entirely and new ones substituted. A system of planes of division, along which the rock splits most readily, may have been developed. This structure is called *cleavage* and may cross the original bedding planes at any angle. The rocks characterized by it are *slates*. Crystals of mica or other minerals may have grown in the rock in such a way as to produce a laminated or foliated structure known as *schistosity*. The rocks characterized by this structure are *schists*.

As a rule, the oldest rocks are most altered and the younger formations have escaped metamorphism, but to this rule there are many important exceptions, especially in regions of igneous activity and complex structure.

FORMATIONS.

For purposes of geologic mapping 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. Where 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 in some cases the distinction depends almost entirely on the contained fossils. An igneous formation contains one or more bodies of one kind, of similar occurrence, or of like origin. A metamorphic formation may consist of rock of uniform character or of several rocks having common characteristics or origin.

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

AGES OF ROCKS.

Geologic time.—The time during which rocks were made is divided into *periods*. Smaller time divisions are called *epochs*, and still smaller ones *stages*. The age of a rock is expressed by the name of the time interval in which it was formed.

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

Inasmuch as sedimentary deposits accumulate successively the younger rest on those that are 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 superposed by faulting, so that it may be difficult to determine their relative ages from their present positions; under such conditions fossils, if present, may indicate which of two or more formations is the oldest.

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 called fossiliferous. By studying fossils it has been found that the life of each period of the earth's history was to a great extent different from that of other periods. Only the simpler kinds of marine life existed when the oldest fossiliferous rocks were deposited. From time to time more complex kinds developed, and as the simpler ones lived on in modified forms life became more varied. But during each period there lived peculiar forms, which did not exist in earlier times and have not existed since; these are *characteristic types*, and they define the age of any bed of rock in which they are found. Other types passed on from period to period, and thus linked the systems together, forming a chain of life from the time of the oldest fossiliferous rocks to the present. Where two sedimentary formations are remote from each other and it is impossible to observe their relative positions, the characteristic fossil types found in them may determine which was deposited first. Fossil remains in the strata of different areas, provinces, and continents afford the most important means for combining local histories into a general earth history.

It is 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 is deposited 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 known to be of sedimentary or of igneous origin. The patterns of each class are printed in various colors. With the patterns of parallel lines, colors are used to indicate age, a particular color being assigned to each system.

The symbols consist each of two or more letters. If the age of a formation is known the symbol includes the system symbol, which is a capital letter or monogram; otherwise the symbols are composed of small letters.

The names of the systems and of series that have been given distinctive names, in order from youngest to oldest, with the color and symbol assigned to each system, are given in the subjoined table.

Symbols and colors assigned to the rock systems.

	System.	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		TR	Peacock-blue.
Paleozoic	Carboniferous	Permian, Pennsylvanian, Mississippian	C	Blue.
	Devonian		D	Blue-gray.
	Silurian		S	Blue-purple.
	Ordovician		O	Red-purple.
	Cambrian		€	Brick-red.
	Algonkian		A	Brownish red.
	Archean		AR	Gray-brown.

SURFACE FORMS.

Hills, valleys, and all other surface forms have been produced by geologic processes. For example, most valleys are the result of erosion by the streams that flow through them (see fig. 1), and the alluvial plains bordering many streams were built up by the streams; waves cut sea cliffs and, in cooperation with currents, build up sand spits and bars. Topographic 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 first built and afterward partly eroded away. The shaping of a marine or lacustrine plain is usually a double process, hills being worn away (*degraded*) and valleys being filled up (*aggraded*).

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

THE VARIOUS GEOLOGIC SHEETS.

Areal geology map.—The map showing the areas occupied by the various formations is called an *areal geology map*. On the margin is a *legend*, 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 legend, where he will find the name and description of the formation. If it is desired to find any particular formation, its name should be sought in the legend and its color and pattern noted; then the areas on the map corresponding in color and pattern may be traced out. The legend is also a partial statement of the geologic history. In it the names of formations are arranged in columnar form, grouped primarily according to origin—sedimentary, igneous, and crystalline of unknown origin—and within each group they are placed in the order of age, so far as known, 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*. The formations that appear on the areal geology map are usually shown on this map by fainter color patterns and 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 mined or stone quarried. If there are important mining industries or artesian basins in the area special maps to show these additional economic features are included in the folio.

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

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

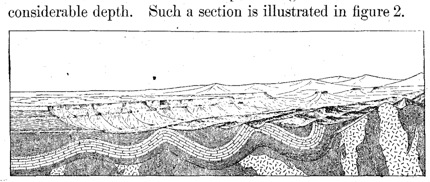

FIGURE 2.—Sketch showing a vertical section at the front and a landscape beyond.

The figure represents a landscape which 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.

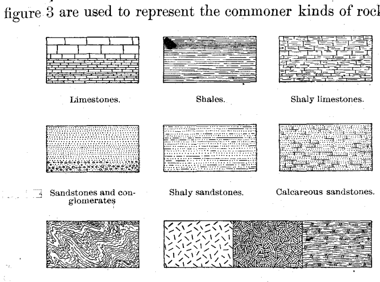

FIGURE 3.—Symbols used in sections to represent different kinds of rocks.

The plateau shown at the left of figure 2 presents toward the lower land an escarpment, or front, which is made up of sandstones, forming the cliffs, and shales, constituting the slopes. The broad belt of lower land is traversed by several ridges, which are seen in the section to correspond to the outcrops of a 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 strata appear at the surface their thickness can be measured and the angles at which they dip below the surface can be observed. Thus their positions underground can be inferred. The direction of the intersection of a bed with a horizontal plane is called the *strike*. The inclination of the bed to the horizontal plane, measured at right angles to the strike, is called the *dip*.

In many regions the strata are bent into troughs and arches, such as are seen in figure 2. The arches are called *anticlines* and the troughs *synclines*. As the sandstones, shales, and limestones were deposited beneath the sea in nearly flat sheets, the fact that they are now bent and folded is proof that forces have from time to time caused the earth's surface to wrinkle along certain zones. In places the strata 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.

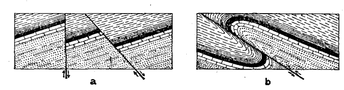

FIGURE 4.—Ideal sections of strata, showing (a) *normal* faults and (b) a *thrust* or *reverse* fault.

At the right of figure 2 the section shows schists that are traversed by igneous rocks. The schists are much contorted and their arrangement underground can not be inferred. Hence that portion of the section delineates what is probably true but is not known by observation or by well-founded inference.

The section also shows three sets of formations, distinguished by their underground relations. The uppermost set, seen at the left, is made up of sandstones and shales, which lie in a horizontal position. These strata were laid down under water but are now high above the sea, forming a plateau, and their change of elevation shows that a portion of the earth's mass has been uplifted. The strata of this set are parallel, a relation which is called *conformable*.

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

The horizontal strata of the plateau rest upon the upturned, eroded edges of the beds of the second set shown at the left of the section. The overlying deposits are, from their position, evidently younger than the underlying deposits, and the bending and eroding of the older beds must have occurred between their deposition and the accumulation of the younger beds. The younger rocks are *unconformable* to the older, and the surface of contact is an *unconformity*.

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

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 as the section in the figure is related to the landscape. The profile of the surface in the section corresponds to the actual slopes of the ground along the section line, and the depth from the surface of any mineral-producing or water-bearing stratum that appears in the section may be measured by using the scale of the map.

Columnar section.—The geologic maps are usually accompanied by a *columnar section*, which contains a concise description of the sedimentary formations that occur in the quadrangle. It presents a summary of the facts relating to the character of the rocks, the thickness of the formations, and the order of accumulation of successive deposits.

The rocks are briefly described, and their characters are indicated in the columnar diagram. The thicknesses of formations are given in figures that state the least and greatest measurements, and the average thickness of each formation is shown in the column, which is drawn to scale. The order of accumulation of the sediments is shown in the columnar arrangement—the oldest being at the bottom, the youngest at the top.

The intervals of time that correspond to events of uplift and degradation and constitute interruptions of deposition are indicated graphically and by the word "unconformity."

GEORGE OTIS SMITH,
Director.

May, 1909.

DESCRIPTION OF THE TALLULA AND SPRINGFIELD QUADRANGLES.[a]

By E. W. Shaw and T. E. Savage.

INTRODUCTION.

POSITION AND GENERAL RELATIONS.

The Tallula and Springfield quadrangles are bounded by meridians 89° 30′ and 90° and by parallels 39° 45′ and 40°, including therefore one-eighth of a square degree of the earth's surface, an area, in that latitude, of 458.44 square miles. They are situated in west-central Illinois (see fig. 1) and comprise a large part of Sangamon County and smaller portions of Morgan, Cass, Menard, and Logan counties. The principal town in the area is Springfield.

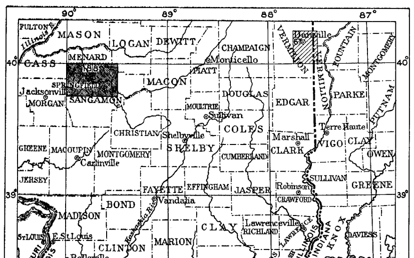

FIGURE 1.—Index map of southern Illinois and portions of adjacent States.
The location of the Tallula and Springfield quadrangles (No. 188) is shown by the darker ruling. Published folios describing other quadrangles, indicated by lighter ruling, are the following: Nos. 67, Danville; 84, Ditney; 105, Patoka; 185, Murphysboro-Herrin.

In their physiographic and geologic relations these quadrangles form a part of a great region of rolling plains that Powell divided into two provinces, to which he gave the names Prairie Plains and Lake Plains. As those names have no genetic significance and as the two regions have had very similar histories, it seems better to look upon the two together, with the exception of a southern extension west of the Ozark province, as constituting a single province. As the surface features of this province are to a large extent the product of glaciation and as there are no other extensive glaciated plains in the United States, this region may be called the Glaciated Plains province.

OUTLINE OF THE GEOLOGY AND GEOGRAPHY OF THE GLACIATED PLAINS PROVINCE.

Definition.—The Glaciated Plains province (see fig. 2) extends from the Appalachian province on the east and southeast to the Great Plains on the west and from the Gulf Coastal Plain and the Ozark province on the south to and beyond the northern boundary of the United States. It is limited by the boundary of the glaciated area of the Central States except at its extreme northwest corner, where, for convenience, the 2000-foot contour may be regarded as its limit, and at its northeast corner, where the Pennsylvania–New York State line forms a convenient boundary. Near the middle of this province is an area of about 10,000 square miles that was not covered by ice and contains no drift. In other respects this driftless region has had a history similar to that of the surrounding territory and it is therefore regarded as a part of the Glaciated Plains.

Relief.—The Glaciated Plains province is in general a broad rolling plain, though it shows considerable diversity in the form of its surface in its different parts. It lies generally from 500 to 1500 feet above sea level but ranges in altitude from 278 feet above sea level in the channel of the Mississippi at Cairo (standard low water) to 2000 feet above sea level at the western border of the province in North Dakota and at a few places in the Upper Peninsula of Michigan.

In some parts of the province the relief is less than 100 feet; in others it is 600 to 800 feet. One of the principal features is the valley of the Mississippi, which is fairly regular in shape. It is flat-bottomed, steep sided, and generally 3 to 6 miles wide and 200 to 400 feet deep. On the other hand, most of the tributaries of the Mississippi flow in valleys that are irregular in width and depth and have indirect courses.

Drainage.—The northern and northeastern parts of the Glaciated Plains lie in the basin of the Great Lakes and the upper St. Lawrence and the remainder in the basin of the Ohio and upper Mississippi. The divide between these drainage basins is irregular and somewhat indefinite and is so low as to be scarcely perceptible.

The province contains several sheets of glacial drift, formed in as many different ice epochs. The narrow irregular belt along the western and southern sides of the province that was not covered by the later ice sheets is well drained, but the area of the later drift includes swampy tracts, many streams having irregular courses, and numerous lakes. The poor drainage of this area is due to its relatively recent occupation by ice, which blocked many drainage lines and on melting left a sheet of débris reaching in places a thickness of several hundred feet and filling many of the old valleys. The reestablished drainage systems are only slowly approaching a normal condition. In the belt that was covered by the earlier glaciers but not by the later ones the streams have had time to become almost readjusted.

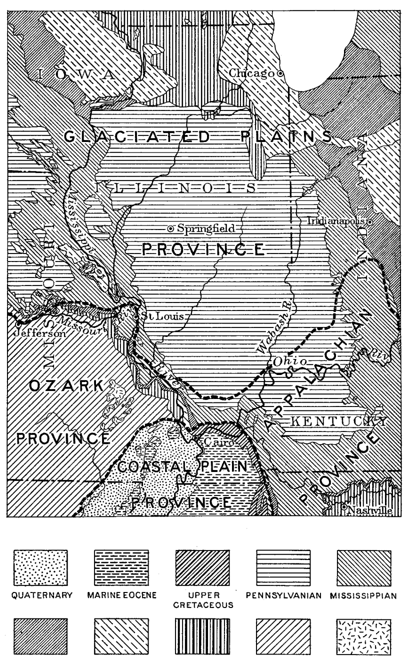

FIGURE 2.—Geologic sketch map of Illinois and surrounding region.
Shows also physiographic provinces of the region. The indefinite boundary between the Ozark and Appalachian provinces coincides approximately with the southeast boundary of Illinois. Map copied from Geologic Map of North America, U. S. Geol. Survey, 1911.

The average discharge of the Mississippi at Quincy, Ill., is estimated to be 72,899 second-feet. The drainage basin above this point covers 135,500 square miles, and the run-off per square mile is thus 0.538 second-foot. Careful measurements indicate that the Mississippi annually carries past Quincy 23,180,000 tons of mineral matter. The surface of the basin above Quincy is thus being lowered at an average rate of about 1 inch in 1100 years.[a]

Stratigraphy.—The rocks underlying the Glaciated Plains include igneous, sedimentary, and metamorphic varieties and range in age from pre-Cambrian to Recent, or from the oldest rocks known to the youngest. However, many epochs are unrepresented by beds of rock and no epoch is represented by formations that underlie the whole province, for there have been many shifts from deposition to erosion, some of which have involved the whole province.

The pre-Cambrian formations are made up of igneous and metamorphic rocks having a complex structure. Upon the deeply eroded and planed surface of these rocks rest all the later strata—the shales, sandstones, limestones, and unconsolidated rocks that outcrop throughout the province except in that part where the pre-Cambrian rocks themselves lie at or near the surface.

Lower and Middle Cambrian time seem to be unrepresented by strata in the Glaciated Plains province, but Upper Cambrian rocks probably underlie all the province except an area in the north, from which they may have been removed by erosion. The Upper Cambrian series is generally over 1000 feet thick and consists principally of sandstone and shale, limestone seeming to have been deposited only to a small extent in this part of the United States.

The Ordovician system consists largely of dolomite and limestone but generally includes a sandstone formation, the St. Peter, a short distance above its base and considerable shale near its top. The Silurian system is made up of dolomite and limestone and minor amounts of shale.

The Devonian system is best developed in the eastern, southern, and western parts of the province and its greatest thickness is generally 700 or 800 feet, but in a few places it is somewhat thicker. It is absent from the northwestern part of the province and is thin in the central part. Throughout much of the province the lower portion of the Devonian is predominantly blue fossiliferous limestone, and the upper portion is black carbonaceous and nonfossiliferous shale.

In the eastern part of the province the Mississippian series consists of clastic rocks, but in the western part it is made up largely of thick limestone with interbedded lenses of shale and sandstone. The Pennsylvanian series is made up largely of shale but includes much sandstone, limestone, and coal. Many of the beds are lenticular, but certain coal beds are continuous over hundreds of square miles.

Cretaceous beds, generally unconsolidated, are found in the western part of the Glaciated Plains province and just south of it, in the Mississippi embayment, but except in Iowa and Minnesota the province probably never contained extensive Cretaceous deposits. The Tertiary strata are likewise of small extent, being represented by scattered bodies of gravel and sand whose exact age has not yet been determined.

The Quaternary system is much more widely developed. It consists of glacial, eolian, lacustrine, and fluviatile deposits, almost wholly unconsolidated, which mantle more than nine-tenths of the province. In certain districts rock outcrops are numerous, but elsewhere, over whole counties and even groups of counties, the consolidated rocks are almost completely concealed and the mantle of unconsolidated material reaches in places a thickness of several hundred feet. Even within the Driftless Area most of the surface is covered with wind-deposited loess and alluvium.

Structure.—The structure of most of the consolidated rocks underlying the Glaciated Plains province is comparatively simple. The strata in most of the province lie nearly flat, their regularity being broken only by small faults and low, broad folds. The principal exceptions are the pre-Cambrian rocks that outcrop in Wisconsin, Minnesota, and northern Michigan, which are in some places so complexly folded, contorted, and faulted that their structure can be worked out only with difficulty. Aside from the complex structure of the pre-Cambrian rocks and local more or less pronounced irregularities, the major structural features are the following:

1. A low, broad arch, known as the Cincinnati anticline, lying in part within the Appalachian Plateau, to the southeast. North of Cincinnati, where it is highest, this arch divides, one branch running toward Lake Erie and the other toward Lake Michigan.
2. A shallow basin practically coextensive with the Lower Peninsula of Michigan.
3. Another basin occupying most of Illinois and southwestern Indiana.
4. A still broader basin extending westward from the Mississippi across Iowa and Missouri into the Great Plains province.
5. A broad arch affecting Wisconsin and Minnesota.

[a] Surveyed in cooperation with Illinois State Geological Survey.

[a] Dole, R. B., and Stabler, Herman, Denudation: U. S. Geol. Survey Water-Supply Paper 234, p. 87, 1909.

Each of the basins contains a great coal field, these coal fields being known as the northern interior, eastern interior, and western interior fields, and the province is bounded on the east by another basin containing the Appalachian coal field. Around each basin the strata crop out in concentric belts, the youngest being found in the middle and the oldest around the outer border. Thus, for example, in central Wisconsin the rocks dip in general toward the lowest parts of the surrounding basins. Beds that lie 1000 feet above sea level in northern Illinois are more than 3000 feet below sea level in the south-central part of that State, and if all the beds found in Illinois were extended to the north the upper ones would be several thousand feet above sea level in central Wisconsin.

TOPOGRAPHY OF THE TALLULA AND SPRINGFIELD QUADRANGLES.

RELIEF.

General features.—The Tallula-Springfield region is of comparatively slight relief and the slopes of most of its elevations and depressions are gentle. Its altitude is low in view of its great distance from the sea. Its highest point, which is 645 feet above sea level, is the summit of German Hill, in the northeastern part of the Springfield quadrangle, and its lowest point, which stands at 485 feet, is in the valley of the Sangamon, at a point where that stream leaves the north side of the Tallula quadrangle. Except the hills or mounds in the northeastern part of the area, which stand 30 to 50 feet above the general level of the upland, the features of relief are due largely to erosion by streams. The surface is that of a drift-formed plain and lies at a general altitude of about 600 feet above sea level. Into this generally level surface the streams have carved valleys, in some places $1\frac{1}{2}$ to 2 miles wide, to a depth of 100 feet below the uplands.

The area contains four distinct varieties of topographic forms—morainic hills, upland prairies, erosion slopes, and flood plains.

Morainic hills.—In the northeastern part of the Springfield quadrangle there are several mounds or hills, which rise abruptly above the surrounding prairie. The highest, German Hill, which lies mostly in the S. $\frac{1}{2}$ sec. 23, T. 18 N., R. 4 W., is half a mile long and a quarter of a mile wide and rises 50 feet above the adjacent upland. It is one of a loop or chain of such hills which lies chiefly outside the area.

Britten Hill, in secs. 28 and 33 of the same township, is of considerably greater extent than German Hill but is a few feet lower. It also is one of a looplike chain of disconnected mounds, which lies about 2 miles south of the belt in which German Hill belongs and which includes a low ridge in sec. 25, northeast of Britten Hill, and others toward the northwest, in secs. 17 and 20 of the same township. These hills form a part of the Buffalo Hart moraine.

Upland prairies.—The upland, comprising more than half of the area of the quadrangles, is flat and differs from the other parts of the area in being unforested. The Tallula quadrangle includes the larger part of the flat upland, which has a general slope from about 640 feet near the west side of the area to 600 feet near the Sangamon and is cut by stream valleys that are gradually being broadened and lengthened and are developing new branches, so that the area of flat upland is slowly being reduced.

The upland of the Springfield quadrangle is the more irregular in outline and the more diverse in topographic form, but it also is generally flat and lies a little more than 600 feet above sea level. East of Athens the altitude is about 615 feet; in the vicinity of Fancy Prairie it is about the same; north of Williamsville it is about 610 feet. Along the northern margin of the quadrangle the bottoms of the poorly defined valleys cut in the upland are scarcely 25 feet lower than the divides. Farther south, near the Sangamon, the valleys are deeper and the side branches are longer, and as a result the interstream areas become progressively narrower and lower toward the south. In the southwestern part of the quadrangle the upland surface is 615 feet above sea level. It maintains an altitude above 600 feet throughout the eastern part of Springfield but slopes gently northeastward to the bluffs along the Sangamon. Narrow interstream prairies lie between Spring Creek and the Sangamon, between Sugar Creek and South Fork, and between South Fork and the Sangamon.

The remarkable levelness of the upland prairies is due in part to the fact that a mantle of glacial drift was so spread over the preglacial surface as to form almost a plain and in part to the fact that in those areas the preglacial surface on which the drift was spread was itself a plain with slight relief.

Erosion slopes.—Sangamon River is bordered by forested bluffs 80 to 100 feet high. In places where the meandering stream has impinged against one side of its valley it has cut into the bluff and exposed a nearly vertical rock cliff of Carboniferous strata, 40 to 50 feet high. In other places the hard rocks are concealed by a mantle of soil and subsoil, but their presence close beneath the surface is indicated by the steep lower slope of the valley sides. Back from the escarpments the slopes are more gentle. Throughout long stretches the river and the smaller streams have cut their valleys in till and loess. (See fig. 11.)

Rock cliffs are more numerous on the southwest side of the river than on the northeast side. They are conspicuous in secs. 5, 6, 26, and 27 of Clear Lake Township, in secs. 3, 4, 6, and 11 of Springfield Township, and on either side of the river near Riverton.

Near the boundary between the quadrangles the Sangamon flows between high banks of drift and is plainly reopening the drift-filled valley of some ancient stream. The smaller streams are cutting rapidly into the unconsolidated material, forming deep V-shaped gullies. This is the most rugged part of the area.

The valleys along the lower courses of the creeks are 70 to 80 feet deep and their slopes are rather steep. Toward their heads they become shallower and their slopes less steep, until, at a distance of 8 to 15 miles from the river, they merge into the upland. Most of the valleys are narrow, but those of Sugar Creek and South Fork are nearly as broad as that of the Sangamon and are bordered by gentle slopes scarcely 60 feet high. The reason these valleys are broader is that they are here being cut into unconsolidated material that fills former stream valleys.

Flood plains.—The flood plain of Sangamon River is for the most part a very even surface standing 12 to 20 feet above low water. Its average width is about a mile. It includes some depressions, usually containing water, which mark old channels of the river, and also some slight elevations, which seem to be the remnants of one or more low terraces.

The tributary streams have flood plains that reach well up to their heads. Most of them are less than a quarter of a mile wide, but a few have a width of nearly half a mile.

DRAINAGE.

Sangamon River, which receives the drainage of the entire area, rises some distance to the northeast, in McLean County. It enters the Springfield quadrangle near its southeast corner, follows a general northwesterly course across the area, and leaves the Tallula quadrangle near the middle of its north side. Its width is about 200 feet and its depth varies from season to season, ranging from 1 to 20 feet in the shallower reaches and from 10 to 30 feet in the deeper places. Its discharge ranges from 200 to 10,000 cubic feet per second, and its drainage area above Riverton is about 2530 square miles. At low water the stream is nearly clear, but at high water it carries much suspended mineral matter. A larger amount of mineral matter is dissolved in the river water, and the surface of the region is being continually lowered by the loss of material thus carried away in suspension or in solution.

In the Tallula quadrangle the principal tributaries of the Sangamon are Clay, Rock, Richland, Prairie, and Spring creeks. They flow through narrow, well-defined flood plains having a slope of 5 to 10 feet per mile. With the exception of Clay Creek these streams have parallel eastward courses and comparatively narrow and straight drainage basins.

In the Springfield quadrangle the largest tributaries of the Sangamon are South Fork, Sugar Creek, and Spring Creek on the south and Wolf, Fancy, and Cantrall creeks on the north. The two principal tributaries, South Fork and Sugar Creek, rise far apart, but in these quadrangles they flow in nearly parallel northeasterly courses only 2 miles from each other to a point within a mile of the Sangamon, where Sugar Creek swings sharply toward South Fork, and they join the river at nearly the same place.

The stream next in importance is Spring Creek, which rises a short distance beyond the southwest corner of the Tallula quadrangle and flows north of east, joining the Sangamon about 2 miles north of Springfield.

In the upland part of the area erosion channels are not so well developed and surface drainage is less perfect. The streams rise in ill-defined depressions in the prairie and throughout their courses are fed by many small springs that issue from the contact between the porous surface loess and the underlying bowlder clay.

CULTURE.

The quadrangles are rather thickly though not densely populated. Springfield, the capital of the State, a city of 51,678 inhabitants in 1910, is in the south-central part of the Springfield quadrangle. The other principal towns of the area are Athens, Riverton, Tallula, Pleasant Plains, Cantrall, and Williamsville, each having several hundred inhabitants. The area outside the towns is well settled, though houses are more numerous near the valleys than on the upland prairies.

Most of the surface is under cultivation, and agriculture and coal mining are the principal industries, the mines, of which there are about 30, employing several thousand men. There is considerable manufacturing, chiefly in Springfield, and the railroads give employment to a large number of people.

The area is well provided with transportation facilities. Several railroads radiate from Springfield, one crosses the northwest corner of the Tallula quadrangle, and interurban electric lines connect Springfield with neighboring towns. Most of the wagon roads follow land-survey lines and hardly any point in the quadrangles is more than half a mile distant from a public road. Few of the roads are macadamized.

DESCRIPTIVE GEOLOGY.

STRATIGRAPHY.

GENERAL CHARACTER OF THE ROCKS.

The consolidated rocks in the Tallula and Springfield quadrangles consist of nearly horizontal indurated strata of Carboniferous age, nearly everywhere overlain by unconsolidated surficial deposits of Quaternary age. They are known from scattered exposures at the surface and from records of borings for coal and water, the deepest boring, which reached a depth of 1500 feet, having penetrated rocks of Devonian age. A generalized section of the rocks below the Springfield coal is given in figure 3.

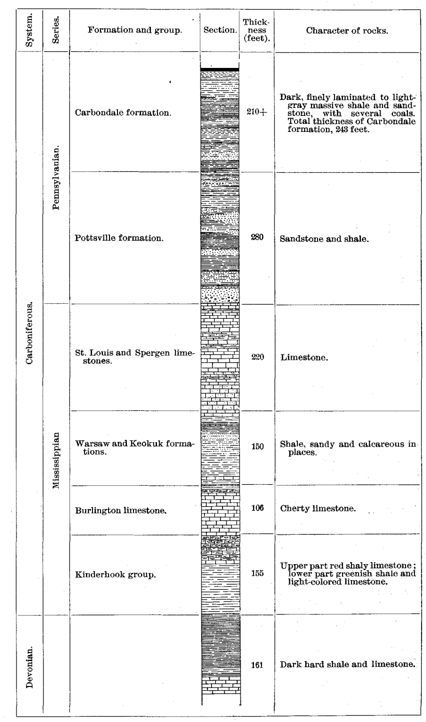

FIGURE 3.—Generalized columnar section of rocks below the Springfield coal encountered in deep wells in the Tallula and Springfield quadrangles.

Upper part compiled from several borings; lower part from boring one-half mile southwest of Springfield.

Scale: 1 inch = 200 feet.

In all probability strata of various ages, from Cambrian to early Devonian, resting on an eroded floor of pre-Cambrian metamorphic rocks such as outcrop about Lake Superior, underlie the Tallula-Springfield region, for such strata are known from outcrops in neighboring regions and from the records of deep borings at numerous places in the State.

The deepest boring in the quadrangles was made in 1903, about one-half mile southwest of Springfield, to a depth of 1500 feet. It passed through the Pennsylvanian and Mississippian strata and penetrated the Devonian to a distance of 161 feet. The record of this drilling, together with the core, was turned over to the State Geological Survey. The log, verified and revised from the core, is given below:

Log of a boring one-half mile southwest of Springfield, in the SE. $\frac{1}{4}$ sec. 5, T. 15 N., R. 5 W.

	Ft.	in.
Quaternary:		
Clay and gravel	34	
McLeansboro formation:		
Coal (No. 8)	1	6
Clay shale	4	
Shale, fine, gray, micaceous, sandy	5	
Sandstone, fine grained, gray	5	6
Shale, sandy, micaceous	15	
Shale, fine, sandy, micaceous, with many dark carbonaceous spots	45	
Shale, dark		3
Shale, bluish, micaceous	17	4
Shale, dark bluish, fossiliferous	2	
Shale, dark blue	3	3
Shale, black, coaly (coal No. 7)		2
Clay shale, light gray	10	5
Shale, gray, with red bands and blotches	6	5
Limestone, gray, argillaceous	1	4
Shale, gray	4	10
Shale, dark	5	

	Ft.	in.
McLeansboro formation—Continued:		
Shale, yellowish, calcareous	4	11
Limestone with *Fusulina*, *Reticularia*, *Seminula*, and *Productus semireticulatus*	6	9
Shale, blue to gray	3	
Carbondale formation:		
Coal, Herrin (No. 6)		6
Shale, bluish gray	4	
Shale, light gray	1	10
Shale, gray, calcareous	3	8
Shale, gray	24	
Limestone, gray, shaly		10
Shale, black, fissile, with *Orbiculoidea* and other fossils	4	6
Shale, black, shelly, pyritiferous		6
Coal, Springfield (No. 5)	6	4
Shale, gray (fire clay)	6	8
Shale, bluish	6	
Shale, black	3	4
Shale, gray	2	8
Shale, grayish blue to yellow	35	2
Coal (No. 4)	2	8
Shale, gray, impure (fire clay)	1	
Shale, black, carbonaceous		8
Shale, dark	20	5
Shale, blue	31	
Shale, black	2	
Coal (No. 3)	1	6
Shale, clay	12	6
Shale, bluish gray	15	
Shale, black	1	4
Coal		3
Shale, blue	2	5
Shale, sandy, micaceous	5	6
Shale, bluish	5	
Shale, gray	2	
Sandstone, shaly, micaceous	11	6
Shale, bluish	1	
Sandstone, coarse grained, micaceous	9	
Shale, dark, micaceous	7	
Clay shale	1	
Shale, brown, with hard bands	5	
Coal } Coal, Murphysboro (No. 2)	1	3
Dark shale } Coal, Murphysboro (No. 2)	3	11
Coal } Coal, Murphysboro (No. 2)		10
Pottsville formation:		
Shale, blue	8	
Shale, dark	10	
Clay shale	2	
Shale, dark gray	12	2
Coal	1	4
Shale, dark gray	6	6
Shale, black	4	
Shale, gray	6	
Shale, black	5	6
Shale, light gray	1	6
Shale, dark, slickensided		6
Shale, light	3	6
Shale, dark	49	
Shale, sandy	15	4
Shale, light blue	1	
Shale, dark blue	1	
Shale, light, clayey	7	
Shale, black	1	
Coal (No. 1?)		10
Shale, black	24	10
Sandstone, coarse, carbonaceous, in places micaceous	13	
Sandstone	1	
Shale, dark	27	
Shale, light	4	
Shale, black	2	4
Shale, conglomeratic, carbonaceous, and gray sandstone	23	2
Shale, dark	6	
Shale, conglomeratic, dark, and sandstone interlaminated	4	10
Sandstone, coarse, brown to gray	36	2
St. Louis and Spergen limestones:		
Limestone	12	6
Shale, hard, light colored	2	
Limestone. light gray, argillaceous, somewhat conglomeratic	11	
Limestone, argillaceous	11	
Limestone, impure, argillaceous	26	
Shale, gray, in places calcareous and somewhat conglomeratic	15	
Limestone, gray	7	
Shale, bluish, variable and somewhat calcareous	10	
Limestone, impure, gray, in places with argillaceous bands	16	
Limestone, gray	20	
Limestone, arenaceous	14	
Limestone, dark, sandy	8	
Shale, impure	2	
Shale, calcareous	9	
Limestone, impure, shaly, and in places sandy	35	
Limestone, white	5	
Limestone, sandy or shaly	12	
Warsaw and Keokuk formations:		
Shale, calcareous	14	
Shale, blue	5	6
Shale, sandy	3	4
Shale, blue	2	2
Shale, dark	4	
Limestone	1	
Shale, gray	12	
Shale, blue	6	
Shale, sandy	3	
Sandstone	1	
Shale, sandy	2	3
Sandstone	3	9
Shale, sandy	14	6
Shale, bluish gray	19	6
Shale, hard, gray	15	
Shale, hard, bluish gray	33	4
Limestone, oolitic	3	8
Shale, blue	6	
Shale, blue, with limestone bands	14	
Burlington limestone:		
Limestone, hard, with chert bands	4	
Limestone, hard, gray	20	
Limestone	9	
Limestone, broken, cherty	15	
Limestone, cherty	7	
Chert	10	6
Limestone, cherty, with *Spirifer grimesi* and other fossils	16	

	Ft.	in.
Burlington limestone—Continued:		
Chert, with some limestone	9	
Limestone, with some chert	16	
Kinderhook group:		
Limestone, reddish, shaly, in places cherty	43	6
Limestone, gray, with chert bands	14	
Shale, greenish	11	
Shale, hard, greenish gray	34	
Shale, bluish gray, upper part with zones of fine-grained oolite	53	
Devonian:		
Shale, black or very dark, with *Sporangites*, *Lingula*, etc., common	133	
Limestone, gray	28	
	1500	

DEVONIAN SYSTEM.

The lower 161 feet of the foregoing section belongs to the Devonian system. The limestone at the base doubtless belongs in the upper part of the Middle Devonian series and is of Hamilton age. Borings in the vicinity of Peoria indicate that this limestone is 85 feet thick at that place.

The overlying dark shale belongs to the Upper Devonian, which here has a thickness of 133 feet. This shale is almost black, uniformly fine grained, and contains numerous lycopod spores known as *Sporangites* and linguloid shells resembling *Barroisella subspatulata* Meek and Worthen.

CARBONIFEROUS SYSTEM.

MISSISSIPPIAN SERIES.

What is known of the character of the Mississippian rocks beneath these quadrangles is shown in the above well section. An interesting fact is the apparent absence of all the strata of the Chester group in the vicinity of Springfield. These beds attain a thickness of several hundred feet in the southern part of the State but are not found in the Mississippi Valley north of the latitude of Springfield.

PENNSYLVANIAN SERIES.

THICKNESS AND CHARACTER.

The rocks of these quadrangles belonging in the Pennsylvanian series have a thickness of about 780 feet. They consist mainly of shale and sandstone but include considerable limestone, clay, and coal. The stratification of the shale and sandstone is irregular and is commonly poorly developed. Shale grades into sandstone and sandstone into shale in short distances both horizontally and vertically.

The most important coal bed in the area, known as the Springfield or No. 5 coal, is reached at an average depth of about 200 feet, and the succession of strata above this coal bed is well known from the logs of mine shafts and test holes.

POTTSVILLE FORMATION.

The Pottsville formation comprises the strata from the base of the Pennsylvanian series to the bottom of the Murphysboro coal (No. 2). It consists largely of sandstone and shale and has a thickness of about 280 feet. These rocks outcrop in the southern and northern parts of Illinois and on the basis of their fossil flora they have been correlated with the Pottsville formation of Pennsylvania. In their lower part they include a thickness of 70 feet of rock which is predominantly sandstone, the lowermost beds, 36 feet thick, being coarse grained and yellowish brown. The overlying beds consist for the most part of thin bands of dark shale interbedded with thicker layers of light-gray sandstone.

Above this sandstone lies about 100 feet of argillaceous material containing lenses of sandstone, which, however, is fine grained and contains much clay. A coal bed about 10 inches thick, which lies about 142 feet above the bottom of the Pennsylvanian, probably corresponds with the coal described as No. 1 by A. H. Worthen, of the Illinois Geological Survey.

In one boring a bed of shale, 16 feet thick, is reported 110 feet below the top of this formation. In another boring, at Riverton, the formation is reported to be sandstone up to a point 45 feet below the base of the Murphysboro coal. This record shows a thin coal bed about 40 feet below the Murphysboro, which is thought to correspond with a thin coal occurring 35 feet below this bed in the Springfield boring. The formation above this coal is argillaceous in both sections.

CARBONDALE FORMATION.

Name and definition.—The Carbondale formation is named from the town of Carbondale, in southern Illinois, near which it is well exposed. It embraces the strata from the base of the Murphysboro coal (No. 2) to the top of the Herrin coal (No. 6) and its average thickness is about 243 feet.

Distribution.—The Carbondale formation is not exposed at the surface anywhere within the quadrangles, but it immediately underlies the surficial materials in a belt about 2 miles wide along the west side of the area and dips to the east beneath the overlying McLeansboro formation. The formation boundary beneath the drift lies west of Pleasant Plains and Tallula.

Lower portion.—The Murphysboro coal is commonly divided into two benches, each ranging from 7 to 24 inches in thickness. They are separated by a few feet of dark shale.

Above the Murphysboro coal there is about 10 to 15 feet of shale or shaly sandstone, upon which lies 25 to 35 feet of micaceous and somewhat argillaceous sandstone interbedded with layers of shale. From the top of this sandstone to the base of the Springfield coal (No. 5) the strata consist of a series of shale beds ranging from gray to blue or black. At some places they appear to be slightly sandy; at others they contain thin beds of coal.

In the Springfield boring a thin coal bed was encountered 56 feet above the base of the formation and a similar coal was found at nearly the same horizon in the drilling at Riverton.

About 30 feet above this bed another coal was found in each hole and still another 140 to 150 feet above the base of the formation.

Springfield coal (No. 5).—The Springfield coal lies about 204 feet above the base of the Carbondale formation, and all the coal now being mined in these quadrangles comes from this valuable bed. It is reached at depths ranging from 80 to 272 feet, and except in a belt along the western side of the area it has been found wherever borings have been put down to the proper horizon. It is generally present and very uniformly developed throughout a large area in the western part of the State, where its thickness ranges from 4 to 8 feet.

One of the conspicuous features of the Springfield coal is the occurrence in it of numerous "horsebacks," as they are called by the miners. These are more or less irregular and branching fissures, filled with clay or shale, extending downward from the overlying beds into or through the coal. They range in width from 2 or 3 inches to 3 or 4 feet, the walls not being very nearly parallel, and are considerably and abruptly wider in the coal than in the overlying roof shale. Figure 4 shows a typical clay seam.

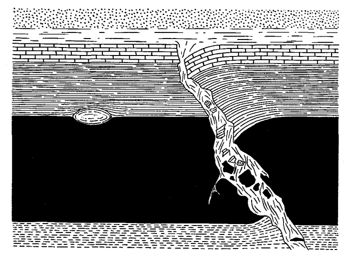

Figure 4.—Clay seam or "horseback" in mine No. 5 of Springfield Coal Mining Co.
Coal is 71 inches thick.

The clay or shale filling the fissures is light gray and generally soft. Rarely it is hard enough to emit sparks when struck with a hammer, but as a rule it soon slakes down into an incoherent mass on exposure to the air. The clay in many fissures contains fragments of black shale derived from the roof of the coal, reaching down 29 inches below the top of the coal. A few fragments of limestone from the cap rock are also found in this clay below the top of the coal bed. In horsebacks that cut through the coal bed pieces of coal have been found as much as 9 inches below the bottom of the bed. No fragments of coal have been found higher than the top of the coal bed.

The fissures show no regularity of spacing or of direction. In some mines they are 40 to 60 feet apart; in others they are separated by 200 to 400 feet or more. They trend in various directions, no one direction predominating, even in the same mine. All are either vertical or steeply inclined, with irregular walls which gradually converge downward within the coal. They have a very slight vertical range. In the Mechanicsburg mine a coal bed, formerly worked, lies about 35 feet above the Springfield coal, which is the coal now mined. Although the Springfield coal is cut by numerous horsebacks, none were encountered in the higher bed.

The walls of the fissures are slickensided but show no traces of weathering. Slickensided planes are also common in the clay filling the fissures. If the fissure is inclined, the uppermost laminæ of the coal adjacent to the fissure on the overhanging side are bent somewhat steeply downward, the distortion fading out laterally within a few feet from the fissure, and in a few places the lowermost laminæ of the coal on the other side of the fissure are bent upward but to a much less degree. If the fissure is vertical, or nearly vertical, the uppermost laminæ of the coal are bent downward on both sides of the fissure, but the more nearly vertical the fissure the less the amount of bending. In no fissure is there a true fault or a relative displacement of the middle part of the coal bed on the opposite sides of the fissure.

The material filling the fissures appears to have been derived chiefly from the gray shale overlying the cap rock of the coal bed and to have been forced downward into the coal through breaks in the cap rock, as is indicated by the downward bending of the edges of the cap rock and of the coal laminæ, by the occurrence of fragments of the cap rock below the top of the coal, and by the continuity of the material of the fissures with that of the bed of gray shale.

The coal appears to have yielded readily in a lateral direction, as shown by the greater width of the fissures in the coal bed than in the overlying and underlying strata. That the coal afforded accommodation to the strains causing the fissures is also indicated by the fact that many of the smaller fissures divide within the coal bed into branches which eventually die out in the coal.

Origin of the clay seams.—The formation of the clay-filled fissures in the Springfield coal was probably determined in part by the character of the overlying strata and in part, possibly, by the character of the underclay, which is dry and does not creep readily. The fissures were formed after the coal bed had been compressed nearly to its present volume, as is shown by the fact that the clay seams are not so deformed as they would be if the coal had been greatly compressed after they were developed. In some places clay from the fissures has penetrated joints in the adjacent coal, indicating that joints had been developed in the coal prior to the formation of the clay seams. Campbell[a] suggests that the carbonization of the coal beyond the lignitic condition depends on the presence of joints and cleavage planes along which gases may escape. If so, the bed should have undergone considerable compression and contraction after the joints were formed before it became bituminous.

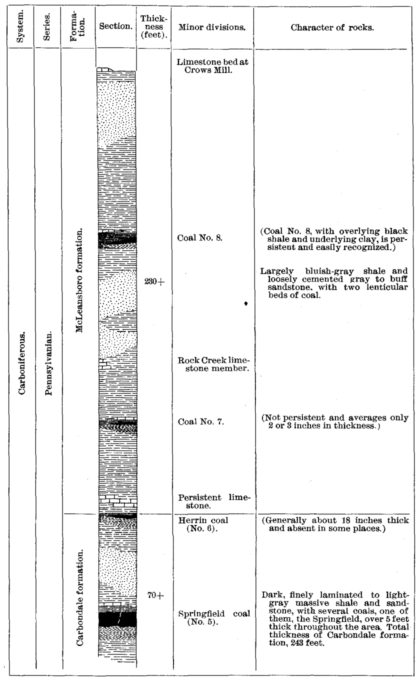

Figure 5.—Generalized columnar section of the rocks known from borings and exposures in the Tallula and Springfield quadrangles.

From borings and shafts for coal and in part from outcrops.
Scale: 1 inch = 50 feet.

It is assumed that as the mass was slowly transformed into coal the contraction in its different parts was somewhat unequal, owing to its lack of homogeneity, and that the contraction continued long after the coal had been greatly consolidated. As long as the material possessed some degree of mobility the unequal shrinkage in the different parts of the bed was equalized by the movement of some of the mass toward points of least resistance. When the consolidation reached a certain stage such adjustment was no longer possible, so that continued unequal shrinkage of the mass produced unequal strains in the roof of the coal under its load of superposed rocks. Where the roof of the coal bed was a somewhat plastic shale the mobility of the particles of the shale permitted an adjustment of the inequalities of strain resulting from the unequal contraction of the coal bed, the adjustment being accomplished by the formation of rock rolls such as are common at the top of the Herrin coal (No. 6) in the Carterville-Zeigler region of southern Illinois. The roof shale in the vicinity of the rolls is cut by slickensided zones for several feet from the center of the roll, indicating a considerable lateral movement in the shale during the adjustment necessitated by the strains. The roof of the Springfield coal, however, is a hard, brittle shale without the mobility requisite for such adjustment. If the limestone cap rock had been very thick it might have withstood, without fracture, the strain due to unequal contraction in the underlying coal, but its average thickness is only 12 or 14 inches. The roof shale and the cap rock were together not strong enough to withstand the unequal strains to which they were subjected and broke under the pressure, at places marked by fissures.

[a] Campbell, M. R., Econ. Geology, vol. 1, No. 1, p. 30, 1905.

Immediately above the cap rock is a bed of rather soft gray shale, the material of which was squeezed downward through the fissures into the coal until the inequalities of pressure were adjusted. The adjustment was limited to a narrow zone below the fractures in the roof shale and cap rock, and its effects are of slight horizontal extent but penetrate to considerable depths.

Upper portion.—The strata overlying the Springfield coal in the Tallula and Springfield quadrangles are better known than the lower rocks, not only by means of numerous outcrops but by means of mine shafts and borings. Their character is shown in the generalized columnar section in figure 5 and in the following detailed sections of mine shafts, which have been selected from many that were furnished by superintendents of the coal companies. Such records give important information concerning the Carbondale strata just above the Springfield coal, which are not exposed in the area, as well as of the McLeansboro formation, which overlies the Carbondale formation.

Section at Berlin Coal Co.'s shaft, in east edge of old Berlin.

[Altitude of surface, 637 feet.]

	Feet.
Clay, yellow	23
Clay, gravelly, "hardpan"	9
Shale (?) red	53
Sandstone, soft	4
Shale	18
Flint rock	5
Shale	40
Sandstone, soft	25
Limestone	8
Shale	3
"Clod"	1
Coal, Springfield (No. 5)	6
	195

Section at Oscar Davis's shaft, one-half mile north of Tallula.

[Altitude of surface, 573 feet.]

	Ft.	in.
Clay, yellow	10	
Clay, blue, with many rocks and bowlders	25	
Sand	14	
Clay, red, tough, with white pieces of soft rock	12	
Clay, hard, with fragments of wood	4	
"Soapstone"	17	
Shale	1	3
Coal	2	4
Clay	4	
Sandstone, very hard	1	4
Clay	1	
Sandstone, soft	5	
Sandstone, medium hard	10	
Clay		6
Sandstone	2	6
Limestone		6
Clay	4	
Sandstone	8	
"Soapstone"	1	
Cap rock		10
Shale	2	
Coal, Springfield (No. 5)	6	
	132	3

Section at Spring Creek Coal Co.'s shaft, near middle of the E. ½ sec. 19, T. 16 N., R. 5 W.

[Altitude of surface, 538 feet.]

	Ft.	in.
Clay	1	
Shale, sandy	4	
Sandstone	2	
Shale, sandy	12	3
"Soapstone"	2	
Shale, blue	5	
Shale, dark	42	
"Soapstone"	8	
Limestone		4
Shale, black	2	3
Coal (No. 7 ?)		2
Clay	5	3
Shale, dark blue	3	
Shale, red	10	
Clay	3	
Limestone, hard	2	
Sandstone	5	
Slate, black	2	
Clay	3	
Limestone	10	
"Soapstone" dark	4	
Coal, Herrin (No. 6)		4
Clay	6	
Sandstone, gray	25	5
"Soapstone"	5	7
Limestone		8
Shale, black	2	10
Coal, Springfield (No. 5)	5	11
	173	

Section at Springfield Colliery Co.'s shaft, in the SW. ¼ sec. 13, T. 16 N., R. 5 W.

[Altitude of surface, 581 feet.]

	Ft.	in.
Surficial materials	23	
Shale, dark	21	6
Shale, black	1	6
Coal (No. 8)	2	
Clay	3	
Shale, blue	3	6
Sandstone	7	
Shale, blue	5	
Limestone		6
Shale, dark	67	
Limestone	1	
Shale, black	1	6
Coal (No. 7)		3
Clay	3	
Shale, blue	11	
Shale, black (soft)	2	3
Clay	4	
Shale, blue	3	
Shale, red	7	
Shale, blue	4	6
Limestone	3	
Shale, light	2	
Limestone	3	6
Shale, blue	1	
Shale, black		4
Coal, Herrin (No. 6)	1	2
Clay	4	
Shale, blue	13	
Limestone		6
Shale, blue	11	
Limestone		9
Shale, light	9	3
Limestone		9
Shale, black	3	8
Coal, Springfield (No. 5)	5	10
	231	3

Section of Williamsville Coal Co.'s shaft at Selbytown, in northeast quarter of Springfield quadrangle.

[Altitude of surface, 590 feet.]

	Ft.	in.
Soil	2	6
Clay, yellow	10	
Sand	11	6
Gumbo	6	6
Clay, blue	5	
Drift	1	3
Clay, blue	1	6
Drift	2	6
Bastard fire clay	5	6
Gumbo	2	6
Gravel	1	
Cement gravel	6	6
"Soapstone"	15	
Iron-stone rock, gray	2	6
Shale		9
Coal (No. 8 ?)	1	6
Clay	4	
"Soapstone"	13	
"Soapstone" and iron stone	14	
Sandstone, soft	12	
"Soapstone" blue	16	
"Soapstone" black	9	
Rock		9
Shale	1	4
Clay	3	
Shale, red	1	8
Rock, blue	1	2
Shale, horizon of coal No. 7	1	8
Clay	3	
Rock, blue		9
Shale, red	8	
Limestone	1	2
Rock, variegated	3	
Limestone	4	
"Soapstone" red	5	6
Shale and clod	4	
Clay, black	4	
"Soapstone" and iron bands	5	
Coal	1	6
Clay		9
Sandstone	3	6
Conglomerate	6	6
Shale	1	
Coal, Herrin (No. 6)		6
"Soapstone" blue	12	6
Sandstone	1	6
Flint rock	1	8
Sandstone, soft	7	
Sandstone	6	
"Soapstone" light-colored	7	
"Soapstone" black	20	
Clod, hard or shale	1	6
Cap rock (limestone)		8
Shale, black	2	6
Coal, Springfield (No. 5)	5	8
	271	9

The above record of the deepest shaft in the area and the upper 215 feet of the log of the deep boring near Springfield show very well the typical sequence of the strata between the Springfield coal and coal No. 8.

Upon the Springfield coal lies a very persistent black, brittle, finely laminated shale, which ranges in thickness from 6 inches to 4 feet, the average measurement being between 2 and 3 feet. The shale contains numerous small lenticular lenses of light-gray material. Irregular gray markings resembling fucoid impressions traverse the beds and appear on the edges of blocks as light-gray laminæ intercalated between darker material.

Round concretions of calcareous marcasitic shale, called pyrite balls or "niggerheads," ranging in diameter from less than an inch to 4 feet or more, are in places numerous along the contact of the shale with the top of the coal. The laminæ of the black shale arch over the concretions and those of the coal are bent beneath them. The continued contraction of the coal bed after the coal and overlying shale had been partly consolidated caused these to move somewhat about the concretions, which therefore have a slickensided appearance, and can be readily detached from their matrix.

In the "niggerhead" zone immediately above the top of the coal there is at some places an interrupted band of dark-colored, calcareopyritic shale or "clod" of much the same composition as the niggerheads. This band is not as a rule continuous throughout large areas. Its thickness is irregular, ranging from 1 to 10 inches, and in places it forms lenslike or nodulelike masses. Both the concretions and the associated pyritic band are rich in fossils, among which the following were collected, the identifications, like all others reported in this folio, having been made by T. E. Savage:

- Lophophyllum profundum Edwards and Haime.
- Orbiculoidea missouriensis Shumard.
- Derbya crassa Meek and Hayden.
- Chonetes mesolobus Norwood and Pratten.
- Productus semireticulatus Martin.
- Marginifera muricata Norwood and Pratten.
- Spirifer cameratus Morton.
- Ambocœlia planiconvexa Shumard.
- Composita argentea Shepard.
- Solenomya radiata Meek and Worthen.
- Clinopistha radiata var. levis Meek and Worthen.
- Cardiomorpha missouriensis Shumard.
- Schizodus rossicus De Verneuil.
- Pernipecten aviculatus Swallow.
- Lima retifera Shumard.
- Pleurotomaria sp.
- Euphemus carbonarius Cox.
- Loxonema cerithiiforme Meek and Worthen.
- Streptacis whitfieldi Meek.
- Sphærodoma medialis Meek and Worthen.
- Orthoceras rushense McChesney.

In some fragments of black shale picked from the "gob" pile shells of *Orbiculoidea missouriensis* Shumard were very abundant, those of *Lingula umbonata* Cox were common, and impressions of *Enteletes hemiplicatus* Hall, *Clinopistha radiata* var. *levis* Meek and Worthen, *Cardinia fragilis* Cox, *Aviculipecten rectilaterarius* Cox, and dermal tubercles of *Petrodus occidentalis* Meek and Worthen were not rare. As is usual in black shale, only those shells are preserved which consist of phosphatic or chitinous material, such as shells of *Orbiculoidea* and *Lingula*. The calcium carbonate of these shells has been entirely dissolved by the action of the chemical compounds produced by the decomposition of the large amount of organic matter in the dark-colored shale. On this account most of the brachiopods and pelecypods are preserved only as impressions, many of which are covered with a film of pyrite.

Above the black shale overlying the Springfield coal there is generally a band of impure limestone known as the "cap rock." In the shaft of the Williamsville Coal Co. this limestone is reported to be 8 inches thick. In a test hole in the SE. ¼ sec. 13, T. 16 N., R. 5 W., it is reported to be 20 inches thick, and in the escape shaft of the Capital Coal Co., at Springfield, its thickness is 24 inches. It is found in all the mines of the area, although it may not be everywhere present in some mines. In some places the lower surface of the limestone is very uneven. Rounded concretionary masses, ranging in diameter from a few inches to 2 or 3 feet, project here and there from its lower surface. In section these masses show intersecting veins filled with calcite, resembling septaria. The limestone in general stands well and provides an excellent roof for the coal mines in this region.

Upon the cap rock lies a bed of light-colored shale, which is locally known as "soapstone," as it is soft and feels greasy. The bed ranges in thickness from 1 foot 6 inches to 9 feet 3 inches. The light-colored clay that fills the fissures in the Springfield coal is thought to have come from this bed.

Above the gray shale are several feet of strata, in some places consisting of sandstone, in others of blue shale with one or two layers of limestone, and in still others of shale and sandstone. In general the shale predominates over the coarser material. The average aggregate thickness of these strata is about 45 feet in the quadrangles and diminishes from north to south.

Herrin coal (No. 6).—In this area the Herrin coal is known only from records of mine shafts and test borings. In the shaft at Mechanicsburg, a few miles east of the area, a bed of coal lying higher than the coal now mined was once worked. This coal contains no clay seams such as are found in the Springfield coal but includes a narrow "blue band" of shaly or bony material about 17 inches above its floor and is probably the Herrin coal. The bed is very irregular in thickness, thinning from about 6 feet at the shaft to 2 inches at a distance of 800 feet.

A few miles south of the area, at Chatham and Auburn, a "blue-band" coal, 5 to 8 feet thick, corresponding in position to the upper bed formerly worked at Mechanicsburg, is extensively mined. In the quadrangles the Herrin coal ranges from 2 inches thick in the shaft of the Barclay Coal Mining Co., in the NE. ¼ sec. 35, T. 17 N., R. 4 W., to 14 inches in the shaft of the Springfield Colliery. It is reported absent at only one point—in a test boring in the SE. ¼ sec. 13, T. 16 N., R. 5 W., where, at this horizon, black shale immediately overlies clay.

In the Mechanicsburg shaft the Herrin coal (No. 6) is reported to be only 27 feet above the Springfield coal (No. 5), but to the north the bed rises considerably and in the shaft of the Madison Coal Co., at Divernon, south of the quadrangles, the "blue-band" coal lies 38 feet above the Springfield coal (No. 5). In the quadrangles the average interval between the two coals is about 50 feet.

McLEANSBORO FORMATION.

Name and definition.—The McLeansboro formation comprises all the Pennsylvanian strata of Illinois above the top of the Herrin coal (No. 6). It is named from McLeansboro, Hamilton County, Ill., where it has been penetrated by a deep boring. It is stratigraphically the highest indurated formation of the area. It has a maximum thickness of about 240 feet and is made up principally of shale but includes considerable sandstone and some limestone, coal, and clay.

Distribution.—The McLeansboro formation lies just beneath the surficial deposits throughout the area except in a strip from 1 to 4 miles wide along the western side of the Tallula quadrangle. It is the only rock formation that outcrops in the area and is exposed in many places in the bluffs along the Sangamon Valley and in the beds and along the banks of many of the smaller streams.

Lower portion.—In the section at the Spring Creek Coal Co.'s shaft, given under the heading "Carbondale formation," 4 feet of dark "soapstone" or shale is reported above the Herrin coal (No. 6). In the shafts of the Springfield Colliery and of the Williamsville Coal Co. several inches of black shale is found above this coal. In none of the records is a dark shale lacking at this horizon. The bed ranges in thickness from 2 inches in the shaft of the Barclay Coal Mining Co. to 4 feet in that of the Spring Creek Coal Co.

Two-thirds of the shaft records obtained in the area show that a bed of impure limestone, 5 to 10 feet thick, immediately overlies the shale capping the Herrin coal. Two of the records show a 1-foot band of shale near the middle of the limestone bed. At a few places there appears to be no limestone, but a bed of "conglomerate" (probably a nodular limestone), 6 feet 6 inches thick, is reported immediately above the roof shale.

Just below the clay underlying coal No. 7 there is generally a bed of red or mottled shale, beneath which lie light and dark shales, with here and there layers of sandstone and limestone.

Some of the records show a second zone of red shale about 15 feet below the upper red shale. In the Mechanicsburg shaft a 5-foot bed of red shale was reported 35 feet above the Herrin coal. In all the records shale greatly predominates over sandstone and limestone in this interval. The average thickness of the beds between the Herrin coal (No. 6) and coal No. 7 is about 50 feet.

In the east-west portion of its course in these quadrangles Sangamon River flows across the general strike of the beds and by erosion of its valley has laid bare a considerable thickness of strata. Owing to the eastward dip of the beds the oldest strata appear in the Tallula quadrangle and successively later rocks are encountered upstream toward the east.

In the south bank of the Sangamon, a short distance west of Rolls Ford, near the middle of the E. ½ sec. 11, Gardner Township (T. 16 N., R. 6 W.), the following section is exposed:

Section of rocks exposed in the south bank of Sangamon River, at Rolls Ford.

	Ft.	in.
Shale, dark gray	1	
Coal (No. 7), clean parting in middle		2
Clay, bluish to greenish gray	4	
Shale	4	
Shale, red and chocolate-colored, mottled in lower part		4–6
Shale, yellowish gray, calcareous, containing *Trepospira sphærulata* and many other fossils	1	6
Shale, light bluish gray, to level of the water	9	6
	20	8

These beds represent the red, blue, and gray shales included in the variegated beds between coals Nos. 6 and 7. From the band of calcareous shale at the top of the red and chocolate-colored shale and from the yellowish-gray shale of the foregoing section the following fossils were collected:

- Lophophyllum profundum Edwards and Haime.
- Derbya crassa Meek and Hayden.
- Chonetes geinitzianus Waagen.
- Productus cora D'Orbigny.
- Productus costatus Sowerby.
- Marginifera splendens Norwood and Pratten ?
- Pugnax utah Marcou.
- Cryptacanthia compacta White and St. John.
- Spirifer cameratus Morton.
- Ambocœlia planiconvexa Shumard.
- Hustedia mormoni Marcou.
- Composita argentea Shepard.
- Clinopistha radiata var. levis Meek and Worthen.
- Nuculopsis ventricosa Hall.
- Yoldia cf. knoxensis McChesney.
- Schizodus sp.
- Aviculipecten occidentalis Shumard.
- Pleurophorus oblongus Meek.
- Astartella concentrica Conrad.
- Astartella vera Hall.
- Pleurotomaria carbonaria Norwood and Pratten.
- Pleurotomaria speciosa Meek and Worthen.
- Phanerotrema grayvillense Norwood and Pratten.
- Worthenia tabulata Conrad.
- Trepospira illinoisensis Worthen.
- Trepospira sphærulata Conrad.
- Bellerophon percarinatus Conrad.
- Euphemus carbonarius Cox.
- Bucanopsis meekana Swallow.
- Patellostium montfortianum Norwood and Pratten.
- Schizostoma catilloides Conrad.
- Meekospira peracuta Meek and Worthen.
- Bulimorpha nitidula Meek and Worthen.
- Soleniscus brevis White.
- Sphærodoma primogenia Conrad.
- Orthoceras rushense McChesney.
- Griffithides ? sp.

In the exposure just described the strata dip upstream, or eastward, about 50 feet to the mile. The altitude of the limestone near the base of the section is about 495 feet. The outcrop is about 2 miles west and 2 miles north of the shaft of the Spring Creek Coal Co. and the beds exposed are considered the equivalents of the six beds above and including the slate in the shaft section, given on page 4.

Clay under coal No. 7 is exposed in the vicinity of Rolls Ford, where it is 4 feet thick. It is soft and greenish gray and ranges in thickness from 6 inches, in a test hole in the SE. ¼ sec. 13, Springfield Township, to 63 inches, in the shaft of the Spring Creek Coal Co. Its average thickness in the shaft records is 38 inches.

Coal No. 7.—Coal No. 7 is not persistent and averages only 2½ inches in thickness. In the shaft of the Barclay Coal Mining Co. 18 inches of mixed coal and rock was reported from this horizon. Elsewhere the horizon is marked by a black shale overlying a bed of clay.

Middle portion.—A very persistent dark shale, which is fine grained and somewhat finely laminated, overlies coal No. 7. Its thickness is remarkably uniform, generally ranging between 18 and 20 inches. Its entire thickness is not exposed at Rolls Ford.

Three of the shaft sections give another clay shale succession only a few feet above coal No. 7. In two of these a thin bed of coal lies between the shale and the fire clay.

All but one of the shaft sections note a thin bed of limestone above the roof shale of coal No. 7, the exceptional record showing a sandstone in this position. The average thickness of this calcareous layer is 26 inches. This limestone is probably present under a thin cover of drift in the banks of Sangamon River not far east of Rolls Ford.

A thick bed of bluish-gray, somewhat sandy shale generally overlies the limestone last described. This shale is exposed in the north bank of the river near the middle of sec. 6, Springfield Township, where its thickness is about 35 feet. In the south bank of the river opposite this place a sandy shale is exposed at a height of 50 feet above the flood plain. In the south bank of the river a short distance east of the wagon bridge in the NW. ¼ sec. 4, Springfield Township, this bed outcrops at a height of 45 feet. It is also well exposed in the south bank of Spring Creek in the NE. ¼ sec. 25 (see fig. 6) and at a number of places in sec. 3, Springfield Township,

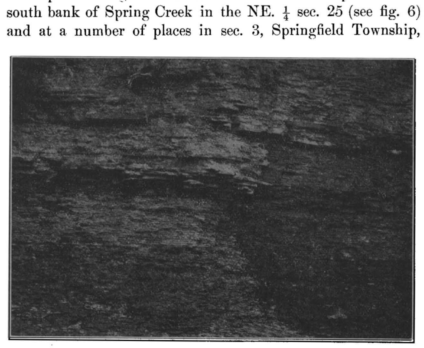

FIGURE 6.—Shale and slaty sandstone above coal No. 7, exposed in south bank of Spring Creek, 4 miles west of Springfield.

where the current of the river is cutting strongly into its west bank. Where unweathered the shale is poorly stratified, bluish gray, and somewhat arenaceous, locally carrying indurated bands of sandstone, which are strongly stained with iron. No fossils were found either in the indurated bands or in the softer shaly portion of the bed.

In the N. ½ sec. 11, Springfield Township, a cliff of gray to yellowish-brown sandstone, 20 to 30 feet high, borders the south bank of the river almost continuously for three-fourths of a mile. The sandstone is rather fine grained and regularly bedded and includes a few less resistant bands of somewhat argillaceous material. The same bed of sandstone is well exposed about a mile farther up the river, at the north end of Carpenter's bridge, in the NW. ¼ sec. 1, Springfield Township. (See fig. 7 and first section on page 6.)

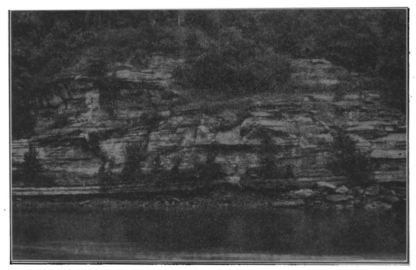

FIGURE 7.—Sandstone beds in McLeansboro formation exposed in north bank of Sangamon River, at Carpenter's bridge, near Peabody. Cross-bedding and local unconformity shown in middle of section.

The general thickness of this sandstone is about 35 feet. In some of the shaft sections the position of this bed is occupied by shale, no sandstone being reported in the interval between coal beds Nos. 7 and 8.

This sandstone outcrops along a tributary to Spring Creek in the SW. ¼ sec. 25, Gardner Township. It appears also in the lower part of the bluff on the east side of Spring Creek, in secs. 15 and 21, Springfield Township. It is also exposed at the south end of the railroad bridge across the river, in the NE. ¼ sec. 1, Springfield Township, to a height of 25 feet above the water. Farther east, in sec. 6, Clear Lake Township, a constantly decreasing thickness of this sandstone appears above the level of the flood plain.

Section of rocks exposed at the north end of Carpenter's bridge, over Sangamon River.

	Ft.	in.
Shale, sandy in thin layers, with a few layers of hard sandstone	6	
Sandstone, strongly cross-bedded	3	
Sandstone, resistant, in layers 1 to 3 feet thick; lentils and somewhat irregular beds occur in upper part	12	
Sandstone, cross-bedded; cross-bedding planes dip east	3	6
Sandstone layers 3 to 20 inches thick; thin partings of shale between the layers	9	
Shale, sandy	2	6
Sandstone, three layers, each about 1 foot thick	3	
Shale to level of water	4	
	43	

The sandstone described in the foregoing section grades upward into a sandy shale which ranges in thickness from 10 to 15 feet. This bed is well exposed in the abandoned shale pit of Masters Bros.' old brick plant, one-half mile northeast of the State fair grounds at Springfield. A section of the layers here exposed is as follows:

Section in the old shale pit of Masters Bros.' brick plant, in the NW. ¼ sec. 14, Springfield Township.

	Ft.	in.
Loess, fine grained, yellow to brown	13	
Drift, pebble bearing		8
Limestone, yellowish, shaly, bearing many fossils (see list of fossils, p. —)	3	6
Shale, black, finely laminated	2	3
Coal (No. 8)	1	6
Shale or clay, gray	4	6
Shale, bluish gray, somewhat sandy, worked to a depth of	12+	
	44	9

The altitude of the top of this exposure is 550 feet. The shale outcrops also below coal No. 8 in the east bank of Spring Creek, where the altitude of its top is about 558 feet. About 1½ miles east of the shale pit, in the shaft of the Springfield Colliery Co., the altitude of the top of this shale is about 530 feet. A bed of sandy shale corresponding to the above is exposed in the south bank of the river, in sec. 6, Clear Lake Township, where its maximum exposed thickness is 12½ feet.

Rock Creek limestone member.—In the NW. ¼ sec. 19, T. 18 N., R. 6 W., layers of hard limestone outcrop at intervals in the bed of Indian Creek for a distance of one-half mile. The rock is light gray and crinoidal or, in places, subcrystalline. It breaks with rough fracture and is commonly more or less brecciated in appearance. The layers are 6 to 18 inches thick and are imperfectly separated along the bedding planes. The total thickness exposed is about 6 feet. Besides fragments of crinoid stems, which were abundant, the following fossils were collected from these layers: *Marginifera splendens?*, *Productus* sp., *Squamularia perplexa*, *Naticopsis* cf. *altonensis*, *Platyceras* sp., and *Strophostylus peoriensis*.

The same limestone is better exposed in the banks of Rock Creek, about 6 miles southwest of the outcrop just described, and from its exposures along Rock Creek Worthen gave it the name Rock Creek limestone. At Huler's quarry, on Rock Creek, the limestone furnished the following fossils:

- Fusulina sp.
- Lophophyllum profundum Edwards and Haime.
- Marginifera cf. muricata Norwood and Pratten.
- Marginifera splendens Norwood and Pratten?
- Rhipidomella pecosi Marcou.
- Pugnax utah Marcou.
- Spirifer cameratus Morton.
- Squamularia perplexa McChesney.
- Hustedia mormoni Marcou.
- Composita argentea Shepard.
- Pleurotomaria sp.
- Naticopsis cf. altonensis McChesney.
- Soleniscus ? angulifer White.
- Trachydomia wheeleri Swallow.
- Strophostylus peoriensis McChesney.

The altitude of the top of this limestone along Indian Creek is about 570 feet. Less than a mile south of the outcrop a bed of hard limestone is reported from a number of water wells at altitudes calculated between 565 and 570 feet. On the farm of J. H. Kincaid, near the northeast corner of sec. 24, T. 18 N., R. 6 W., it was formerly quarried and burned for lime. Stratigraphically it lies some feet below coal No. 8.

In the Springfield quadrangle this limestone was not found except in the immediate vicinity of its outcrops near the northwest corner of the quadrangle. It does not appear in the banks of Sangamon River, where its horizon should be exposed between Springfield and Carpenter's bridge. It is not reported in any of the well records or shaft sections, nor is it exposed in the banks of any of the tributaries of the Sangamon or of their branches outside of the area mentioned above. It seems probable that, throughout the larger part of the quadrangle, this bed was cut out by erosion previous to the deposition of the sandstone exposed at Carpenter's bridge.

Everywhere below the horizon of coal No. 8 there is a bed of greenish-gray clay, which has an average thickness of about 3 feet. The material feels somewhat soapy and is rather plastic where it has been long exposed to weathering.

Coal No. 8.—Coal No. 8 and the beds associated with it, which constitute one of the most easily recognized groups of beds in the area, was probably deposited as a continuous stratum throughout both quadrangles. It lies below drainage level in a belt 2 or 3 miles wide along the east line of the Springfield quadrangle and has been removed by erosion from a strip 3 or 4 miles wide along the west side of that quadrangle and from the entire area of the Tallula quadrangle. It outcrops at numerous places along Sangamon River and its principal branches in much of the middle portion of the Springfield quadrangle.

In the SW. ¼ sec. 13, Woodside Township, the following rocks are exposed in the west bank of Sugar Creek:

Section in the west bank of Sugar Creek, in sec. 13, Woodside Township.

	Ft.	in.
Shale, yellowish blue, without fossils	12	
Limestone, impure, argillaceous, with many fossils	3	2
Shale, black, laminated	1	9
Coal (No. 8) to level of water	1	6
	18	5

The same coal bed outcrops in the south bank of the river in secs. 5 and 6, Clear Lake Township. A section measured near the middle of the E. ½ sec. 6 is given below:

Section in the south bank of Sangamon River, in sec. 6, Clear Lake Township.

	Ft.	in.
Limestone, argillaceous, with fossils	1	6
Shale, black, laminated	4	
Limestone lentil, which feathers out on either side within a distance of 8 feet. Maximum thickness	1	4
Coal (No. 8)	2	6
Clay, gray	2	
Shale, sandy	8	
	19	4

A corresponding succession of beds is exposed near the northeast corner of sec. 31, Williams Township. The following section is exposed in the east bank of Fancy Creek:

Section on Fancy Creek in sec. 31, Williams Township.

	Ft.	in.
Shale, yellowish gray	5	
Limestone, argillaceous, with many fossils	1	6
Shale, black, laminated	2	
Coal (No. 8)	1	6
Clay, gray, becoming sandy below	6	
	16	

On a branch of Cantrall Creek, in the NE. ¼ sec. 9, Fancy Creek Township, a bed of black shale 2 feet thick and an underlying coal seam 8 inches thick are exposed.

The coal on Cantrall Creek is doubtless coal No. 8. Its altitude above sea level here is 560 feet. The same coal bed was penetrated by a well sunk on the same farm. The following log of this well was furnished by the owner, Mr. Powers:

Log of well on farm of C. P. Powers, in sec. 9, Fancy Creek Township.

	Ft.	in.
Soil, black	3	
Clay, yellow	13	
Shale, black	4	
Coal		8
Clay	2	
Shale, bluish gray	4	
	26	8

A 20-inch bed of coal, presumably No. 8, is reported from a well on land of James Dalby, in the SE. ¼ sec. 9, Fancy Creek Township, at an altitude of about 565 feet.

This coal bed is also exposed near the top of the bluff in the east bank of Spring Creek near the middle of the E. ½ sec. 15, Springfield Township, and in several places along the branches of Spring Creek in sec. 32 of the same township.

The thickness of coal No. 8 ranges from 8 inches, in the exposure on Cantrall Creek, to 30 inches, in the outcrops along Sangamon River. Its average thickness for ten measured sections is 18 inches. The coal is bright black and gives a reddish-brown streak. The bed is laminated and much jointed, the strongest set of joints trending N. 40° W.

The altitude of coal No. 8 at a number of places in the area is given in the following table:

Elevation above sea level of coal No. 8.

Location.	Township.	Feet.
SE. ¼ sec. 5	Woodside	550
SW. ¼ sec. 13	Woodside	528
Middle of west side of sec. 5	Clear Lake	522
NE. ¼ sec. 31	Williams	520
Shaft of Williamsville Coal Co.	Williams	514
Shaft of Barclay Coal Mining Co.	Williams	516
NE. ¼ sec. 9	Fancy Creek	562
SE. ¼ sec. 9	Fancy Creek	565
Clay pit, NW. ¼ sec. 14	Springfield	565
SW. ¼ sec. 15	Springfield	563
Shaft of Capital Coal Co.	Springfield	550
SE. ¼ sec. 13	Springfield	526
Shaft of Springfield Colliery Co.	Springfield	535
NW. ¼ sec. 32	Springfield	565

Upper portion.—Coal No. 8 is everywhere overlain by a dark, almost black shale, which is finely laminated, weathering into thin plates. The lower part of this bed contains many pyrite concretions of various sizes.

The thickness of the shale is more irregular than that of the coal bed with which it is associated. It is reported to be only 9 inches thick in the shaft of the Williamsville Coal Co. but is 21 inches in the exposures along Sugar Creek, in Woodside Township, and is 49 inches thick along Sangamon River, in Clear Lake Township. The average thickness of ten measured sections is 28 inches.

The roof shale of coal No. 8 is almost everywhere overlain by two or three layers of yellowish-gray impure calcareous material, resembling shaly limestone. The upper layer, which is the thickest, ranges in thickness from 12 to 16 inches, and the average of seven measured sections of the entire bed is 23 inches. The maximum thickness seen is in the outcrop in sec. 13, Woodside Township, where it is 38 inches. This limestone contains many fossils, among them the following:

Fossils from the limestone overlying the roof shale of coal No. 8.

	Sec. 13, Woodside Township.	Sec. 6, Clear Lake Township.	Sec. 31, Williams Township.	Masters clay pit, Springfield.
Lophophyllum profundum Edwards and Haime	x	x	x	x
Derbya crassa Meek and Hayden	x		x	x
Chonetes variolatus D'Orbigny	x	x	x	x
Productus cora D'Orbigny	x	x	x	x
Productus nebraskensis Owen	x		x	x
Productus pertenuis Meek	x		x	x
Productus semireticulatus Martin	x		x	x
Marginifera splendens Norwood and Pratten ?	x	x	x	x
Spirifer cameratus Morton	x	x	x	x
Spiriferina kentuckyensis Shumard	x		x	x
Ambocœlia planiconvexa Shumard	x	x	x	x
Hustedia mormoni Marcou	x		x	x
Composita argentea Shepard	x	x	x	x
Clinopistha radiata var. levis Meek and Worthen			x	x
Nuculopsis ventricosa Hall	x			
Yoldia sp.			x	x
Aviculipecten cf. occidentalis Shumard		x		
Astartella varica McChesney	x			x
Phanerotrema grayvillense Norwood and Pratten	x	x	x	x
Trepospira illinoisensis Worthen	x	x		x
Trepospira sphærulata Conrad		x		
Bellerophon percarinatus Conrad	x			x
Euphemus carbonarius Cox	x	x	x	x
Bucanopsis meekana Swallow	x			
Patellostium montfortianum Norwood and Pratten	x			x
Schizostoma catilloides Conrad	x			x
Meekospira peracuta Meek and Worthen	x	x	x	x
Bulimorpha nitidula Meek and Worthen	x		x	x
Soleniscus brevis White	x	x	x	x
Sphærodoma primogenia Conrad	x	x	x	x
Orthoceras rushense McChesney		x		x
Griffithides sangamonensis Meek and Worthen	x		x	x

In the NW. ¼ sec. 12, Woodside Township, a bluish-gray shale appears at a number of places along the banks of a small stream tributary to Sugar Creek. The shale is higher in the formation than coal No. 8, which is exposed on Sugar Creek, a short distance farther east. Near the southwest corner of sec. 1, Woodside Township, the Springfield Paving Brick Co.

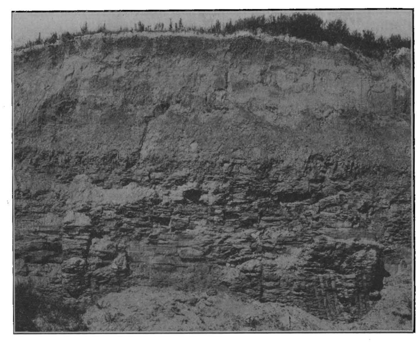

FIGURE 8.—Shale above coal No. 8, overlain by till and loess, exposed in pit of Springfield Paving Brick Co., near Springfield.

has utilized the shale extensively in the manufacture of brick and tile. (See fig. 8.) The section of the pit from which the shale was taken is as follows:

Section of shale pit of Springfield Paving Brick Co.

	Feet.
Loess, fine grained, reddish brown to yellow	12
Drift, containing small pebbles, brown above grading to yellow below	6
Shale, bluish gray; bottom not exposed	44
	62

In many places between this pit and Mildred Park, in the NE. ¼ sec. 10, Springfield Township, there are small outcrops of shale belonging to this bed. Similar exposures are also found in the banks of Sugar Creek at a number of places in sec. 1, Woodside Township, and secs. 29 and 31, Clear Lake Township.

A short distance south of the middle of the east side of sec. 13, Fancy Creek Township, an excavation on the Chicago & Alton Railroad exposes a thickness of 20 feet of gray shale. A similar shale bed outcrops along the streams in secs. 19 and 30, Williams Township. In Fancy Creek and Williams townships this bed is exposed at an altitude of 560 feet, which is 35 feet higher than the top of coal No. 8 in the shaft of the Williamsville Coal Co., located 1½ miles east and northeast of the foregoing exposures. This shale is the equivalent of that seen in the pit of the Springfield Paving Brick Co., and corresponds to that outcropping above coal No. 8 in the banks of Sugar Creek.

In the south bank of Sangamon River, near the middle of the south half of sec. 27, Clear Lake Township, the following beds are exposed:

Section of rocks exposed in bank of Sangamon River, sec. 27, Clear Lake Township.

	Feet.
Sandstone, grayish to yellow, in layers from a few inches to 1½ feet thick; scales of mica abundant	15
Shale, bluish gray, somewhat sandy, to level of water	20+
	35+

The shale constituting the lower part of this section represents the bed of shale last described. The sandstone is rather fine grained and evenly bedded. It contains considerable argillaceous material, which carries conspicuous small flakes of mica. A shale bed corresponding to the one above mentioned is also exposed in the banks of the river in the vicinity of Riverton.

In the cut made by the Illinois Traction Co. through the west bluff of Sangamon River, in the NE. ¼ sec. 17, Clear Lake Township, sandstone having a thickness of 16 feet is laid bare. The rock is micaceous and in places is very irregularly bedded, as shown in figure 7 (p. 5). A short distance west of the main cut the beds shown in the following section are exposed:

Section of rocks exposed in the NE. ¼ sec. 17, Clear Lake Township.

	Ft.	in.
Sandstone, gray to yellow, rather coarse grained and irregularly bedded	25	
Coal (No. 8), weathered	1	3
Shale or clay, grayish to blue	2	
	28	3

At this place the transition from coal to sandstone is very abrupt. The altitude of the coal is a few feet higher than that of coal No. 8 in the banks of the river 2 miles farther north. The black laminated shale and the fossiliferous limestone that overlie this coal bed in other places are absent. The thick body of shale that normally overlies the limestone is also lacking at this place and the sandstone is of coarser grain than any other sandstone seen in the area. The bedding of the sandstone also is more irregular. However, the coal is doubtless No. 8. It is near the position of this bed and no other coal is known within many feet of this horizon. Coal No. 8 and the overlying beds occur in their usual thickness in the shaft of mine No. 1 at Riverton, a mile farther east, and the difference in the beds overlying the coal may signify merely a local unconformity.

The sandstone above coal No. 8 is well exposed on South Fork, where it makes a sharp bend toward the west, near the middle of sec. 4, Rochester Township (T. 15 N., R. 4 W.). At this place the river has cut off the point of a sandstone ridge, leaving the separated portion as a hill, a few square rods in extent, standing in the midst of the flood plain. The north end of the wagon bridge over the river at this place rests on a ledge of this sandstone. In the south face of the hill the rocks are exposed to the water's edge and furnish the following section:

Section of rocks exposed near middle of sec. 4, Rochester Township.

	Feet.
Sandstone, yellowish brown, micaceous, somewhat decayed, in layers 2 to 4 inches thick	14
Sandstone, hard, gray, layers 3 to 18 inches thick, the thicker ones cross-bedded	15
Shale, soft, sandy, bluish gray, grading up into a bluish-gray shaly sandstone at the top, to level of water	12
	41

In the sandstone just above the shale the planes of cross-bedding dip about 30° NE. The micaceous sandstone above described is the latest bed of hard rock exposed in the area. It outcrops in the banks of a small tributary of Sugar Creek, in sec. 14, Woodside Township, at a maximum height of 20 feet. It may be seen also in the banks of Sugar Creek at a few places south of the south border of the quadrangle.

Limestone exposed at Crows Mill.—About 2 miles south of the Springfield quadrangle some impure limestone layers outcrop in the bed and banks of Sugar Creek. One mile still farther south this limestone bed is well exposed in the quarry at Crows Mill, one-half mile south of Cotton Hill station on the Illinois Central Railroad. Below is given a section of the rock exposed in this quarry:

Section exposed in quarry near Crows Mill.

	Ft.	in.
4. Limestone, yellowish brown, coarse grained, compact, in a single layer 2 to 2½ feet thick, containing many shells of *Productus cora*, *P. costatus*, *P. nebraskensis*, *Spirifer cameratus*, and *Composita argentea*	2	6
3. Limestone, light gray to brown, crinoidal, in two or three irregular layers; fossils few	2	8
2. Limestone, very hard, gray, crinoidal	2	
1. Shale, dark, grading to bluish gray in the lower part, with no fossils	6	
	13	2

The following fossils were collected from the limestone layers Nos. 3 and 4 in the section given above:

Lophophyllum profundum Edwards and Haime.	Productus pertenuis Meek.
Derbya crassa Meek and Hayden.	Productus semireticulatus Martin.
Derbya sp.	Marginifera splendens Norwood and Pratten?
Meekella striaticostata Cox.	Spirifer cameratus Morton.
Chonetes variolatus D'Orbigny.	Spiriferina kentuckyensis Shumard.
Chonetes verneuilianus Norwood and Pratten.	Composita argentea Shepard.
Productus cora D'Orbigny.	Aviculipecten sp.
Productus costatus Sowerby.	Allorisma sp.
Productus nebraskensis Owen.	Phillipsia sp.

Masses of *Syringopora multattenuata* were found in the shale at the base of the section.

The limestone exposed in the quarry at Crows Mill lies only a few feet above the sandstone that outcrops in Rochester Township. In the log of the mine shaft of the Madison Coal Co., at Divernon, about 55 feet of shale and sandstone intervene between coal No. 8 and a limestone bed thought to be equivalent to the limestone exposed at Crows Mill. In the shaft section of mine No. 4 of the Illinois Colliery Co., at Virden, there is a distance of 76 feet between coal No. 8 and a 7-foot bed of compact limestone which doubtless corresponds with the limestone at Crows Mill. In the Springfield quadrangle there is 44 feet of shale and about 34 feet of sandstone between coal No. 8 and the limestone exposed at Crows Mill. Numerous large masses of coarse-grained yellowish-brown limestone from the horizon of No. 4 of the Crows Mill section and many blocks of the hard crinoidal layers from No. 2 in this section occur in the drift at several points in the quadrangle. They are common near the middle of the S. ½ sec. 26, T. 16 N., R. 4 W. (See fig. 9.)

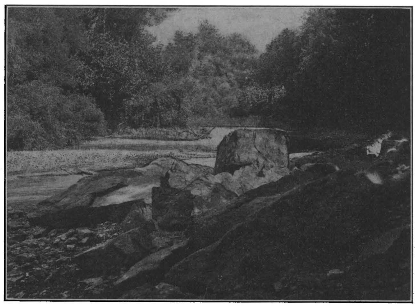

FIGURE 9.—Residual bowlders of limestone bed that outcrops at Crows Mill, which have been washed out of the drift 6 miles east of Springfield.

QUATERNARY SYSTEM.

The surficial deposits of the area, which in some places are more than 170 feet thick, belong to the Quaternary system. They consist of glacial drift or till, interglacial soils, glacial outwash, and loess, all of Pleistocene age, and of dune sand and alluvium, of Recent age.

PLEISTOCENE SERIES.

DIFFERENTIATION OF THE DEPOSITS.

The Pleistocene deposits are believed to represent six of the stages of the Pleistocene epoch in North America. The lower drift, which has been differentiated at a few points in the area, probably belongs to the Kansan stage. It is overlain by a layer of clay and forest soil of probable Yarmouth age. The upper drift, which is present in almost the entire area, is Illinoian and is overlain by the Sangamon soil. The present surface of the quadrangles is underlain almost throughout by a layer of loess (a homogeneous silt or clay), which is thought to be, at least in large part, of Iowan or Peorian age. At several places in the valley of the Sangamon there are terrace deposits composed of glacial outwash of presumed Wisconsin age.

Only the Illinoian drift, the loess, and the terrace deposits are exposed at the surface and shown on the map, the other Pleistocene formations being known only from the wells, mine shafts, and clay pits.

KANSAN (?) DRIFT AND YARMOUTH (?) SOIL.

Several water wells in these quadrangles penetrate two beds of till, separated by a bed of dark clay containing twigs and fragments of wood. The record of one such well follows:

Log of water well in the NW. ¼ sec. 26, T. 16 N., R. 6 W.

	Thickness.	Depth.
	Feet.	*Feet.*
Loess: Clay, yellow, fine grained	15	15
Illinoian drift:		
Clay, blue, pebbly	50	65
Sand	4	69
Clay, blue, pebbly	30	99
Yarmouth (?) soil: Clay, black, with much organic matter, including many fragments of wood	2	101
Kansan (?) drift: Clay, gray, pebbly	7	108

The place was visited soon after the well was drilled and the material from the bed of black clay and from the beds of pebbly clay above and below it was examined. There is little doubt that the black clay represents a forest soil formed during an interglacial stage and that the pebbly clay beneath it is an older bed of till. On a farm about midway between Pleasant Plains and Salisbury and in several wells in the vicinity of Salisbury a soil bed between two beds of bowlder clay is reported to lie 30 to 45 feet below the surface.

In Iowa there are two drift sheets older than the Illinoian. The older (Nebraskan or pre-Kansan) is known at a number of widely separated points. It is almost entirely covered by later deposits and probably does not form a continuous sheet. The Kansan drift, which is intermediate in age between the Nebraskan and the Illinoian, is widespread, covering the larger part of Iowa and northern Missouri. The drift below the Illinoian in the Tallula and Springfield quadrangles is not known sufficiently well for a close comparison with the lower two drift sheets in Iowa, but it is probably Kansan rather than Nebraskan, for the Kansan is known to be so much more widespread.

ILLINOIAN DRIFT.

Occurrence.—Except where removed by recent erosion the Illinoian drift underlies the entire surface of both quadrangles. Its upper surface, upon which the loess lies, is remarkably even, but as it was deposited on the uneven surface of the lower drift its thickness is somewhat irregular. The Illinoian is thickest in a district near the middle of the area. At Bradfordton two well borings penetrate this drift to a depth of 40 feet without passing through it. In a well in the NW. ¼ sec. 26 in the same township (T. 16 N., R. 6 W.) the Illinoian is 84 feet thick. In a well in the NW. ¼ sec. 23, T. 18 N., R. 6 W., a boring was put down 140 feet into this drift without reaching its bottom. In the southeast corner of the Springfield quadrangle, along Rock Creek and elsewhere, the Illinoian is comparatively thin. In many places along the larger streams it was entirely removed before the deposition of the loess or sand, which lies directly on the Carboniferous strata. Exposures showing the entire thickness of the Illinoian are not common along the streams, being obscured by the slumping of the overlying loess and soil.

Character.—In general the Illinoian drift in this region is a bluish-gray till, which weathers to a yellowish gray and which consists of sandy clay containing pebbles and a few bowlders. The clay and sand making up the main body of the till were probably derived for the most part from local beds of shale and sandstone, which were more or less deeply weathered when they were overriden by the glacier.

The coarser constituents of the till are of two sorts, one consisting of pebbles and bowlders of crystalline rock brought from areas far north and northeast of the quadrangles, the other of fragments of chert and masses of limestone transported from regions less remote. Most of the bowlders of crystalline rock are gray or pink granite or greenstone and are generally less than 2 feet in diameter, though a few have a diameter as great as 4 feet. The crystalline pebbles are as a rule well rounded and, like the bowlders, are somewhat decayed. The chert fragments are more or less angular and have doubtless been derived from Paleozoic limestones that outcrop in northern Illinois and southern Wisconsin. Limestone bowlders, many of them larger than the granite bowlders, are numerous in some places. Most of them are of local origin, having been derived from the limestones of the McLeansboro formation.

The Illinoian drift is well exposed in the clay pit of the Dawson Brick & Tile Co., in the SE. ¼ sec. 29, T. 16 N., R. 5 W., where the following section was measured:

Section in clay pit of Dawson Brick & Tile Co.

	Ft.	in.
Loess	12	
Illinoian drift:		
Clay, yellow, somewhat sandy, with many very small pebbles	6	
Sand, coarse	1	6
Clay, blue, sandy, carrying pebbles and bowlders, some as much as 4 feet in diameter	16	
McLeansboro formation: Shale, bluish gray	7	
	42	6

The Illinoian drift that overlies the shale in the clay pit of the Springfield Paving Brick Co. (see p. 6) and in the old pit of the Masters clay plant at Springfield is composed of clay and small pebbles and is yellow throughout. There are no bowlders at those places, and the material seems to have been slightly sorted (or deposited in part) by currents of water.

A section in the old pit of the Masters clay plant is as follows:

Section in pit of Masters clay plant at Springfield.

	Ft.	in.
Clay, yellow, fine grained (loess)	13	
Clay, yellow, with many small pebbles (Illinoian drift)	8	
Limestone, yellowish gray, fossiliferous (McLeansboro formation)	3	6
	24	6

The upper surface of the till at this place is not more oxidized than the lower part. A red iron-stained, highly oxidized zone, which is generally found at the top of the till on hillsides in the southern and western parts of the State, is seldom encountered in the exposures in this district.

The thickness and relations of the Illinoian till at different places in the area are shown in the logs of the following wells:

Log of well near middle of south border of Springfield quadrangle.

	Thickness.	Depth.
	Feet.	*Feet.*
Soil, black for a few feet, grading downward into yellow pebbleless clay	18	18
Hardpan of black bowlder clay (Illinoian drift)	21	39
Sandstone (McLeansboro formation)	1	40

Log of well near middle of south side of sec. 11, T. 17 N., R. 5 W.

	Thickness.	Depth.
	Feet.	*Feet.*
Soil, black	3	3
Loess, yellow, fine grained	10	13
Hardpan, bluish gray (Illinoian drift)	15	28
"Soapstone" (McLeansboro formation)	2	30

Log of well near Washington Park, in the SW. ¼ sec. 32, T. 15 N., R. 6 W.

	Thickness.	Depth.
	Feet.	*Feet.*
Clay, yellow (loess)	12	12
Clay, stiff, with pebbles and bowlders (Illinoian drift)	8	20
Shale, bluish gray (McLeansboro formation)	4	24

Log of well in the NW. ¼ sec. 3, T. 16 N., R. 4 W.

	Thickness.	Depth.
	Ft. in.	*Ft. in.*
Soil, black	3 6	3 6
Illinoian drift (28 feet):		
Clay, with sand and small pebbles	16 6	20
Sand	1 6	21 6
Bowlder clay, compact	6	27 6
Sand	1	28 6
Bowlder clay, blue	3	31 6
McLeansboro formation:		
Shale, bluish gray	1	32 6

Thin layers of sand, such as those noted in the section just given, are very common in the body of the Illinoian drift. The thickest known section of this drift was reported in a well in the NW. ¼ sec. 23, T. 18 N., R. 6 W., the section of which is as follows:

Log of well in the NW. ¼ sec. 23, T. 18 N., R. 6 W.

	Thickness.	Depth.
	Ft. in.	*Ft. in.*
Loess: Clay, yellow	10	10
Illinoian drift (160 feet):		
Clay, gray, pebbly	19	29
Gravel	6	29 6
Bowlder clay, stiff	39	68 6
Gravel, rather fine	1 6	70
Clay, compact blue, with pebbles	100	170

Buffalo Hart moraine.—The Buffalo Hart moraine, named from the town of Buffalo Hart, about 4 miles northeast of Barclay, forms a belt of low hills east of the Springfield quadrangle, extending some distance to the south. It consists of a series of disconnected ridges or mounds, most of which have a core of drift covered with 10 to 15 feet of loess or sand, although some are more like eskers, being composed of sand or gravel with a veneer of loess. It is thought to be a recessional moraine of the Illinoian glacier.

The ridges are disposed in loops which extend nearly north and south. (See fig. 10.) In the largest loop the eastern arm extends from Mount Pulaski southwestward to Buffalo Hart and the western arm stretches northward from Buffalo Hart to Elkhart Mound. Another loop curves broadly from Elkhart Mound southwestward to Britten Hill, whence it can be traced through a number of small mounds for a few miles northwestward to the border of Menard County. A secondary loop, lying within this last, extends southwestward from Elkhart Mound to German Hill, and thence swings in a broad curve toward the northwest. Elkhart Mound, at the junction of the loops, is the largest ridge in this part of the moraine, being a mile in length and rising more than 100 feet above the surrounding prairie. The other ridges range from low, scarcely perceptible swells to mounds 50 or 60 feet high. From Buffalo Hart the moraine continues southward near Buffalo, Mechanicsburg, Mount Auburn, and Grove City.

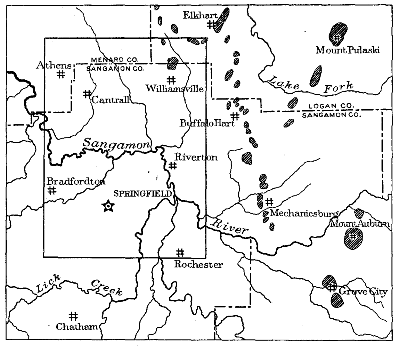

FIGURE 10.—Map of Springfield quadrangle and vicinity, showing the arrangement of the hills of Buffalo Hart moraine in loops.

SANGAMON SOIL.

The interglacial stage following the Illinoian stage is called the Sangamon because of the widespread development of a soil and forest bed and of a more or less deeply weathered zone at that horizon in the northern part of Sangamon County. The Sangamon soil is not well exposed in the Tallula and Springfield quadrangles, but it has been encountered in many wells and probably persists throughout many square miles in the northern part of the area. It seems to have been developed in poorly drained places, where erosion was more or less inactive, at some distance from valleys. As the valleys of Sangamon time were in the same locations as those of to-day, though they were probably much smaller, the soil is not seen along the present slopes where its horizon reaches the surface. It consists of dark malodorous carbonaceous clay containing a large amount of organic matter, including abundant branches of trees and other fragments of wood. It is found at depths of 11 to 20 feet and in many places is directly overlain by the loess though in others it is separated from the loess by a bed of sand.

The following logs of wells in the region will show the relation of the Sangamon soil to the associated beds of surficial materials:

Log of well in the NE. ¼ sec. 36, T. 18 N., R. 6 W.

	Thickness.	Depth.
	Feet.	*Feet.*
Soil, black	3	3
Clay, yellowish, fine grained (loess)	9	12
Soil, black, with pieces of wood (Sangamon)	4	16
Clay, yellow (Illinoian drift)	5	21
Bowlder clay, blue, compact, with some quicksand (Illinoian drift)	10	31

Log of well in the NE. ¼ sec. 12, T. 17 N., R. 4 W.

	Thickness.	Depth.
	Ft. in.	*Ft. in.*
Soil, black	3	3
Clay, yellow, without pebbles (loess)	12	15
Soil, black, with pieces of wood (Sangamon)	3	18
Bowlder clay, blue (Illinoian drift)	10 6	28 6
Sand (Illinoian drift)	1 6	30

Log of well in the SW. ¼ sec. 22, T. 18 N., R. 5 W.

	Thickness.	Depth.
	Ft. in.	*Ft. in.*
Soil, black	3	3
Clay, yellow to gray, pebbleless (loess)	16	19
Clay, black, with pieces of wood (Sangamon soil)	1 6	20 6
Bowlder clay, blue (Illinoian drift)	35	55 6
Sandstone (McLeansboro formation)	22	77 6

LOESS.

Except where removed by the streams the loess, which is 4 to 30 feet thick, overlies the Illinoian drift and the Sangamon soil. (See fig. 11.) As shown in the well sections just given, this material lies in most places just beneath the surface soil.

The loess is composed of friable, uniformly fine grained, and unstratified or very imperfectly stratified dustlike material, containing a small amount of calcium carbonate. Where it has been cut by streams or excavations it is sufficiently coherent to stand for a long time in almost or quite vertical walls. At many places, particularly near present valleys, it contains indiscriminately distributed shells of air-breathing gastropods.

On slopes it is commonly grayish or brownish yellow and contains fossils; on the prairies, at a distance from the streams, the dark surface soil is deeper and the underlying loess is of some shade of gray. The loess on the slopes and that on the prairies are probably not of different origin. The difference between them is probably due in part to different degrees of leaching and of alteration by the action of organic matter.

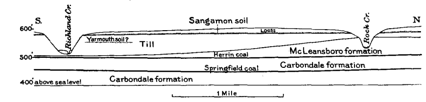

FIGURE 11.—Section near Salisbury.

Shows the stratigraphic relations of the underlying formations and coal beds, the broad flat upland covered with loess, the thick till with Sangamon and Yarmouth (?) soils, a wide valley cut in till, and a narrow valley cut in rock, with characteristic steep slopes.

A bed of fossiliferous loess outcrops on the east side of the wagon road in the NE. ¼ sec. 34, T. 18 N., R. 6 W. Another bed in which fossils are abundant is exposed in the NW. ¼ sec. 12, Springfield Township, and still another, 15 feet thick, is exposed in the NW. ¼ sec. 35, T. 16 N., R. 4 W. Along the Chicago & Alton Railroad, between Peabody and Sherman, banks of loess 14 feet high are exposed continuously for one-fourth mile.

The geographic relation of the main deposit of loess to the border of the area supposed to have been covered by the Iowan ice sheet; its stratigraphic position (above the Illinoian and older drifts and under the Wisconsin drift); and the determination by Shimek that its included fossil shells are those of land mollusks that lived under climatic conditions similar to those prevailing in the region to-day make it probable that conditions were peculiarly favorable for the accumulation of loess during at least the earlier part of the time between the Sangamon and the Wisconsin.[a] A small amount of loess overlies Wisconsin drift at some places in Illinois and Wisconsin, and dust deposits somewhat resembling loess are now being formed, so it is not improbable that part of the original main deposit of loess has been shifted and that other dust has been accumulated since the Peorian stage, but the total amount of such material is comparatively small.

The writers believe that the loess in this region was deposited by the wind. This opinion is based on the facts that the deposit does not tend to level the inequalities of the surface but mantles hills, prairies, and lowlands alike and that it differs from ordinary water-laid clay in showing little evidence of stratification and in containing shells of air-breathing snails, which, though exceedingly fragile, are commonly unbroken.

There is some question whether the thin loess-like material on valley sides is in place or has crept down from the loess above. Figure 12 illustrates the common relation of loess to underlying till on valley sides. Whatever the correct interpretation, the upland areas, where no pebbly or till-like material is to be seen, are so different from the valley sides, where exposures of till are numerous and the loess-like material is commonly pebbly, that the two types have been represented separately on the map.

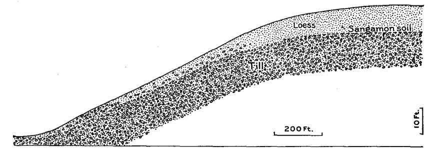

FIGURE 12.—Generalized section of valley side near Pleasant Plains.

Shows common relations of loess and till. There is doubt whether the loess on valley sides below the main body of loess is in place or has crept down from above.

TERRACE DEPOSITS.

Here and there along Sangamon River lie deposits of sand and silt in the form of terrace remnants whose tops are 8 or 10 feet above the flood plain. The material composing these remnants resembles the recent alluvium except that on the whole it is coarser. This resemblance and the fact that the terraces are low and have been extensively eroded makes it difficult in some places to distinguish terrace deposit from alluvium. Apparently, however, the terrace deposit lies beneath the river alluvium in a continuous thick layer, so that it may really be of Wisconsin age. Most of the terraces are much less than a square mile in extent. South of Riverton, in secs. 15 and 22, Clear Lake Township, a terrace about 8 feet above the level of the present flood plain occupies nearly 200 acres. A well put down in this terrace penetrated 18 feet of sand below the surface soil. Smaller remnants of terraces lie in secs. 21 and 27 in the same township. Farther north, in the vicinity of Petersburg, Menard County, they are again conspicuous.

RECENT SERIES.

DUNE SAND.

Conspicuous hills of sand crown the bluffs on one side or the other of the Sangamon throughout much of its course across the Springfield quadrangle. Where the river flows in a general westward direction the dunes are on the south side of the valley; where it flows northwestward they are on the

[a] Calvin, Samuel, The Iowan drift: Jour. Geology, vol. 19, p. 601, 1911.

northeast side. They also occupy a small area on the northeast side of the valley near the northern border of the Tallula quadrangle. The summits of these hills are as a rule perceptibly higher than the upland surface 2 miles or so back from the stream. The sand is not now drifting but is covered with vegetation—commonly forest.

Most of the small sand hills are elongated and somewhat irregularly placed. The sand is commonly yellow to brown and rather fine grained, though the grains are not at all uniform in size. The material composing it is quartz and a variety of partly decomposed minerals, such as commonly make up the loess. In places it has a more or less stratified appearance, due, in part at least, to differences in weathering rather than in the character of the material as deposited. A section showing false bedding is exposed in a cut in the NW. ¼ sec. 12, Springfield Township.

The greater part of the sand is more recent than the main loess deposit, for it overlies the loess in the principal dune region. In the NW. ¼ sec. 12, Springfield Township, several feet of sand overlies a bed of fossiliferous loess. In sec. 22, Clear Lake Township, a small sand dune stands on the terrace deposit. The uppermost 3 or 4 feet of the sand hills, however, contains a larger proportion of clay, probably marking a gradual change from conditions of sand-dune development to those of to-day, when little material is accumulating on the river bluffs.

The position of these sand dunes, on some of the highest points in the area; their relation to the flood plain of the river; their composition, which resembles that of the alluvium and terrace deposit; and the fact that they are on the east side of the valley, where they would be deposited by the prevailing westerly winds, indicate that the sand was gathered largely from exposed portions of the flood plain and terrace in times of drought and was deposited on the obstructing hills, where the velocity of the wind was checked and where a covering of vegetation may have furnished permanent lodgment for the load that was dropped.

ALLUVIUM.

Deposits of alluvium are present along most of the streams, the most extensive being in the valleys of Sangamon River, South Fork of Sangamon River, and Sugar Creek. Less extensive areas of alluvium form bottoms on Spring Creek and on the lower courses of Wolf, Fancy, and Cantrall creeks.

Along Sangamon River the alluvium is about 30 feet thick. Below a few feet of sandy surface clay lies a layer consisting largely of sand and silt, apparently reworked glacial outwash mixed with material derived from the areas of loess and till that border the valley. A well in the flood plain of Spring Creek, in the SE. ¼ sec. 16, Springfield Township, was put down 33 feet without reaching bedrock, and another in the flood plain of Fancy Creek in the NE. ¼ sec. 31, Williams Township, penetrated 60 feet of unconsolidated material, the lower part of which was not alluvium but glacial outwash such as forms the terraces. The deposit is apparently though not very conspicuously stratified, the uppermost beds being even and horizontal and those below being more or less irregular and highly inclined.

STRUCTURE.

In west-central Illinois the layers of rock are nearly horizontal but slope downward to the east at the rate of a few feet to the mile. This slope, however, is not regular but is interrupted by low anticlines, synclines, terraces, and minor irregularities.

REPRESENTATION OF STRUCTURE.

Delineation.—Structure is commonly delineated in one of two ways, by cross sections or by structure contours. Cross sections are best adapted for a region in which the rocks are sharply folded or much faulted, but are of small value for one in which the folds are very low and faults are not extensive, for the structural features in such a region as shown on the sections are almost imperceptible, and structure contours show the structure more clearly.

Structure contours.—To show structure by contours an easily recognizable reference stratum is chosen, whose position can be determined at many points through outcrops or borings. The altitude and dip of its surface are determined at as many points as possible, and points of equal altitude are connected on the map by lines similar to surface contours. In some places the altitude of the reference stratum is observed directly in outcrops, mines, or wells; in other places it is computed from observations made on some other recognizable stratum, for as a rule the strata are approximately parallel and the average interval between any two may be determined. Thus, if a stratum above the reference layer is found, its altitude may be observed and the altitude of the reference stratum determined by subtracting the average distance (or the nearest measured distance) between the two. If the outcrop of a bed below the reference stratum is found the average distance is added, the result being the approximate altitude at which the reference layer would lie if it were present. Where no surficial material occurs intersections of surface contours with structure contours of the same elevation mark outcrops of the reference stratum.

Use of structure contours.—Structure contours are of use not only in the study of broad structural problems and in conveying an abstract knowledge of the structure of the region but are also of practical value in locating and recognizing valuable rock strata and in supplying data as to their "lay." As the strata are approximately parallel it is not difficult to compute the approximate elevation of any bed at any point from the elevation of the reference stratum, by adding or subtracting (according as the bed is above or below the key rock) the average distance between the two. The map may be used in this way for determining the position of coal, limestone, and oil-bearing rocks. Structure contours also show the direction and dip of the beds, a knowledge of which is essential in all mining operations.

Accuracy of structure contours.—The accuracy of structure contours depends (1) on the accuracy of the altitudes obtained directly; (2) on the difference between the actual and the average distances to the key rock; and (3) on the number and distribution of the points whose altitudes have been determined.

In the Tallula and Springfield quadrangles the reference stratum used is the Springfield coal (No. 5), the most extensively worked coal bed in the area. It has very few natural exposures but has been penetrated in many mine shafts and borings in which the altitude of its base was calculated by subtracting its depth below the surface from the altitude of the surface as determined by hand level or barometer. As bench marks are numerous, the hand level and barometer determinations involve only short horizontal distances and hence small possibilities of error.

Variation from the average interval between the key rock and other strata is more likely to lead to error in the structure contours, because the strata are not absolutely parallel. However, the distances between the Springfield coal (No. 5) and other known strata do not generally vary more than 15 feet from the average, and this variation does not seem to increase with the distance of the stratum from the key rock.

On account of the scarcity of outcrops and the fact that artificial excavations are almost the only source of information, the determined altitudes of recognizable strata are not so numerous as might be desired, but they are comparatively evenly distributed, so that the errors arising from this factor are probably not great. The dip of the coal bed in mines also affords information for working out the structure. After allowance for possible errors it is assumed that the structure lines are generally correct within 25 feet, the interval between the structure contours.

STRUCTURE OF THE QUADRANGLES.

As a rule the strata of the Tallula and Springfield quadrangles dip somewhat south of east at the rate of about 10 feet to the mile, but this general dip is modified by low folds and minor irregularities, most of which are too ill-defined to be described separately but which are shown on the maps by contours drawn at intervals of 25 feet on the base of the Springfield coal. These irregularities are the product of irregularities in the surface upon which each layer was deposited and of differential settling and warping since deposition. The prevalent eastward dip is, in part at least, the result of deformation. It carries the base of the Carbondale formation from a position about 200 feet below the surface at the western side of the area to one nearly 600 feet below the surface on the eastern side. This general dip is modified by a syncline just east of Tallula, by an anticline extending southwestward from Springfield, and by many minor irregularities. The syncline east of Tallula is steeper on its west side, as might be expected on account of the prevailing eastward dip. In the mine of the Tallula Coal Co. the dip is so steep that the mine cars on an eastward trip must be "spragged" or otherwise held in check. However, even where steepest, the dip does not exceed 60 feet to the mile. In the northeastern part of the area the predominant dip is eastward and is about 10 feet to the mile. In the southern part the general dip is southeastward but is modified by a syncline and anticline which enter the area near the middle of the southern side. The anticline extends northeastward as far as Springfield, whence it curves to the southeast, passing near the village of Keys. West of Springfield the strata in the flanks of the arch dip 15 feet to the mile, but east of Springfield they become progressively flatter on both sides of the axis, for the anticline plunges southeastward in conformity to the general dip.

In some areas the Springfield coal is almost level throughout several square miles; in others it dips more than 20 feet to the mile. In some places its dip differs from the general slope or is even opposite to it. In most of the mines, however, it has almost no perceptible dip, and throughout a considerable area between Pleasant Plains and Salisbury the coal bed and the other strata seem to lie practically horizontal. In the southeast quarter of the Tallula quadrangle the beds so far as known dip regularly southeastward at the rate of about 15 feet to the mile, but in that district few borings have reached the coal and some of the structural features may have not yet been brought to light. Indeed, throughout a considerable part of this quadrangle no borings have reached recognizable strata, and the structure map therefore lacks many details which can be shown when the coal has been worked more extensively, but the mine shafts and borings already sunk are rather uniformly distributed, so that the major structural features as shown are believed to be approximately correct.

GEOLOGIC HISTORY.

IMPERFECTION OF THE RECORD.

Only a small part of the geologic history of these quadrangles can now be deciphered from rocks exposed at the surface or encountered in borings. The record of many of the principal and some of the minor events of the Carboniferous and Quaternary periods is preserved and is legible, but the record of pre-Carboniferous time lies so far below the surface that only the rocks showing its later part have been reached by drill holes. That of the periods between the Carboniferous and Quaternary has been erased, though there is an indistinct record of the progress of erosion. However, many facts in the history of the quadrangles may be inferred from the results of studies in other areas in the general region, for the processes that operated in the quadrangles affected also an extensive province around them. Much of the history of the smaller area is therefore contained in the more complete record of the larger area.

During the Paleozoic era Illinois was intermittently submerged in an epicontinental sea, the shores of which migrated widely and almost continuously, though the rate at which they shifted varied greatly. Since Paleozoic time the surface of the State has so far as known been continuously above sea level and has been subjected to the wear of streams.

PALEOZOIC ERA.

EARLY PERIODS.

At the opening of Paleozoic time the surface of Illinois had probably been above the sea for a long time and had been eroded until it was nearly flat. Early in the era the region was gradually submerged and sandy deposits were laid down in the encroaching sea. The submergence probably took place in Middle Cambrian time and lasted at least until the close of Cambrian time.

The sediments deposited during Ordovician time consist mainly of calcium carbonate and perhaps magnesium carbonate and also of the more ordinary kinds of mud. Numerous forms of life inhabited the sea and their remains have been preserved in the beds. In Silurian time much of what is now the Mississippi Basin was covered by a clear sea and received extensive calcareous deposits.

The oldest rocks penetrated in the quadrangles are of Devonian age and consist of limestone and shale that were laid down in a sea which was probably not deep and was perhaps in places extremely shallow. The shale contains fossil spores of lycopods, indicating that land was not far away, and shells of linguloid brachiopods such as now inhabit shallow muddy waters.

CARBONIFEROUS PERIOD.

MISSISSIPPIAN EPOCH.

The region was a land surface between the deposition of the Upper Devonian strata and the lowermost Mississippian. During the Mississippian epoch the Mississippi Valley was extensively submerged. In Kinderhook time a considerable quantity of fine sand and clay was carried to the sea by the streams. At the end of the Kinderhook epoch and during the Burlington epoch the sea expanded further and became clearer, so that the deposits which accumulated during the Burlington epoch consist largely of limestone. In the Keokuk and Warsaw epochs conditions varied, both sand and lime being deposited. At the close of the Warsaw epoch the sea withdrew to the southern part of the region. When it next advanced it was bordered by lands so low that they yielded little sediment. The waters were therefore clear and the deposit was pure limestone, which in some places consisted mainly of oolite. The strata formed at this time are now known as the Spergen limestone. During the succeeding St. Louis epoch the sea grew deeper and extended at least to central Iowa. At the close of the St. Louis epoch the water withdrew by a series of oscillations which furnished conditions for the accumulation of oolite beds similar to the Spergen, containing a sandy member in the middle part and forming the Ste. Genevieve limestone. After a considerable interval in which the area was dry land further warping elevated much of the bordering region but permitted the sea again to advance as far north as St. Louis. The thick beds of sandstone, limestone, and shale deposited during this submergence constitute the Cypress sandstone, the Tribune limestone, and the Birdsville formation of the Chester group.

PENNSYLVANIAN EPOCH.

POTTSVILLE EPOCH.

For a long period succeeding the Chester submergence the region was dry land. During this time the surface of part if not all of Illinois, though not high, became much trenched with stream channels and developed considerable relief. This old surface is now exposed at many places in Illinois and has been reached by thousands of borings. It is everywhere more or less uneven. Slight warping preceded the invasion of the Pennsylvanian sea, which transgressed older formations throughout extensive areas in the northern part of the Mississippi Basin. At first sedimentation was restricted to a rather narrow area in the eastern interior coal field of Illinois and western Kentucky. Further warping elevated the surrounding country, so that the area of sedimentation, which was largely above sea, gradually advanced northward and spread eastward and westward. Probably it was connected to the southeast with a similar basin of sedimentation in the Appalachian region. In this gradually enlarging basin were accumulated the sand and mud which now make up the sandstone and shale of the Pottsville formation. The coarseness and great volume of the material shows that the bordering land must have stood several hundred feet higher than the sea. Layers of vegetal material interbedded with the sand indicate the existence of marshes. This material now forms irregular layers and lenses of coal ranging from thin films to beds 2 feet or more in thickness. It is probable that a large part of the sand was deposited not in the sea but on land.

CARBONDALE EPOCH.

During the deposition of the Carbondale sediments the region was at times completely covered by the sea and received deposits of shale, sandstone, and limestone, and at other times the sea was essentially banished for longer or shorter periods, when the surface commonly stayed so low and so level that brackish or fresh-water marshes covered large areas in which were accumulated beds of vegetal matter that were afterward transformed to coal. Part or all of the sand may have been deposited on land, but the limestones and some of the shales formed during that time contain well-preserved remains of marine animals, showing conclusively that the rocks in which they are found were deposited in the sea. One of the best-known layers of this kind lies a few feet above the Springfield coal.

McLEANSBORO EPOCH.

Similar conditions continued throughout McLeansboro time, with the difference that the relative amount of marine sediments was greater, and that of the vegetal accumulations was less. During Pennsylvanian time the region seems to have been generally subsiding, for, although the rocks and their fossils show that each layer must have been deposited very near sea level, the total layers aggregate in thickness many hundreds of feet and when the latest were laid down the earliest must have been far below sea level. On the whole, shoal water or marshes prevailed, but there was much variation in conditions. At many times the region was flooded by the sea; at others it rose slightly above sea level.

POST-CARBONIFEROUS DEFORMATION.

Carboniferous deposition was closed by widespread movements, which resulted in the uplift of the Appalachian Mountains on the east and the Ouachita and Ozark mountains to the west and the further uplift of the La Salle anticline in Illinois. These movements permanently banished the sea from the region.

The attitude of the rocks of the Tallula and Springfield quadrangles was not greatly modified by the widespread deformation near the close of Carboniferous time. The folds produced at that time are so broad and low that they are almost indistinguishable from original irregularities of deposition and no faults have been found, but the general altitude of the surface was probably considerably increased, the district being raised from approximately sea level to a position a few hundred feet above it.

In some parts of southern Illinois and in other places molten rock was forced from places far down in the earth up to levels so near the surface that it has since been laid bare by erosion, but in these quadrangles no evidence of igneous rock has been found and probably no such rock exists within several thousand feet of the surface.

MESOZOIC ERA.

After the elevation and deformation near the close of the Carboniferous, new processes began to act in the region, and areas which before had received rock material almost continuously began to lose it by erosion. Erosion has continued practically without interruption to the present time, though at several epochs it has probably been accelerated by uplifts. There is no reliable evidence of any general subsidence.

Several great uplifts affected the Appalachian Mountains and the Ozarks and between and during these epochs of uplift extensive erosion reduced the surface by many hundreds of feet. Perhaps at each of the epochs of mountain uplift central Illinois suffered some deformation, but presumably it was very slight. In each cycle of uplift and long-continued erosion valleys were carved and the intervening hills were afterward reduced nearly to a plain, and this process may have been repeated several times, for each planed surface—the record of one cycle—was more or less completely destroyed by erosion during the next. Moreover, all possible stages occur in the process of reduction, and the less complete the cycle the more easily is its record destroyed. In central Illinois the uplifts were slight and the rocks are almost uniformly soft, so the records of uplift and erosion are not well preserved. In southern and in northern Illinois the tops of certain hills of resistant rock apparently constitute remnants of two peneplains older than any recorded in the Tallula and Springfield quadrangles; hence another cycle of uplift and erosion seems to have taken place before the oldest surface in the quadrangles was formed.

CENOZOIC ERA.

TERTIARY PERIOD.

Development of relief.—If the third cycle of erosion just referred to took place, it was probably initiated by an uplift, perhaps near the beginning of the Tertiary period. In any event some time before the close of the Tertiary the surface of most of Illinois and of much adjacent territory had been reduced to a nearly level plain, for the surface beneath the Quaternary deposits is very even except where narrow valleys were cut, in late Tertiary or early Quaternary time.

Near the close of the Tertiary period there was apparently a general uplift of the land, which accelerated erosion and caused the streams to deepen their valleys. Well borings show that several such valleys, 60 feet or more in depth and now filled with drift, cross the Tallula and Springfield quadrangles. From the logs of more than 200 wells that reach bedrock the general form of the preglacial surface can be correctly inferred. (See fig. 13.)

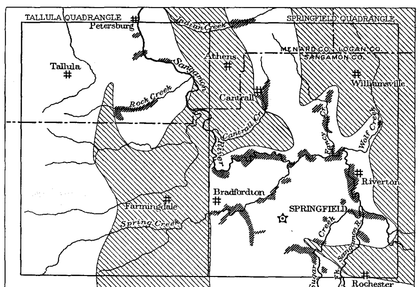

FIGURE 13.—Sketch map of Tallula and Springfield quadrangles showing preglacial topography and the present streams.

Open ruling represents preglacial lowlands now covered with 80 to 125 feet of drift and loess; unshaded areas represent preglacial uplands, on which the drift is only 25 to 80 feet thick; dense ruling indicates areas of extensive rock exposures.

Near the boundary between the quadrangles a broad valley, the bottom of which is more than 100 feet below the present upland surface, extended approximately north and south. For convenience of reference this may be designated the "Athens Valley." Its course is indicated by well records, lack of hard rock exposures, and form of valley sides. One well three-fourths mile south of Bradfordton was put down 106 feet without reaching the base of the drift. The bottom of this well is 18 feet below the level of bedrock a mile to the east. Another well, 3 miles northeast of Athens, penetrated drift to a depth of 170 feet, or 125 feet lower than the surface of the bedrock 2 miles to the east. Near Bradfordton the Athens Valley swings to the southwest and in that direction its width increases from about 2 to 3 or 4 miles. West of Springfield the slope of the valley sides is gentle, but in the vicinity of Richland Creek it is much steeper and the whole valley is constricted where it is cut through the hard layers of Rock Creek limestone. A short distance north of Athens the depression trends slightly west of north, in which direction it has been traced to a point within 2 miles of Petersburg, a branch extending southwestward toward Ashland. A well on the Colby farm 5 miles northeast of Pleasant Plains is reported to have penetrated drift in a branch of this valley to a depth of 140 feet without reaching bedrock.

East of this ancient valley a buried ridge of rock 4 or 5 miles wide, rising more than 100 feet above the valley bottom, extends to a point within 2 miles of the western border of the Springfield quadrangle. Near Cantrall and Andrew it swings southeastward and is cut through by the present valley of Sangamon River. South of the Sangamon it joins a broad upland plain, now 550 to 580 feet above sea level, which probably was originally continuous northeastward as far as Riverton. In the southeastern part of the area the surface sloped eastward and was probably trenched by a stream which flowed in that direction, as the present valleys of Sugar Creek and South Fork are much wider where they cross the old channel near the Baltimore & Ohio Southwestern Railroad.

In the S. $\frac{1}{2}$ sec. 26, Clear Lake Township, the preglacial surface was of medium height, as is shown by the exposure of till and shale in the south bank of Sangamon River. North of this place, in the eastern half of the Springfield quadrangle, the bedrock surface slopes northeastward, and it is probable that the stream that occupied this valley flowed northward.

In the northeast corner of the area a spur of the north-south ridge previously described extended northeastward from Sherman for 3 or 4 miles, with possibly a shorter spur along the lower course of Wolf Creek.

The maximum known relief of the preglacial surface was at least 125 feet, but except in the deepest valleys it did not exceed 60 or 70 feet. The valleys were generally broad, the slopes somewhat gentle, and the divides about as high above the valley bottoms as those of to-day, and in these respects the preglacial surface somewhat resembled the present surface. The valleys had a different arrangement, however, and the courses of the present streams have little relation to the ancient lowlands. Sangamon River crosses the preglacial ridge at almost a right angle, and from the bend near Rolls Ford it takes a diagonal course across the old Athens Valley. Spring Creek crosses the Athens Valley and much of the buried ridge farther east before it joins the Sangamon. Fancy and Wolf creeks flow southward in a direction the reverse of the preglacial slope of the surface. In the vicinity of Keys Sugar Creek and South Fork cross a preglacial valley nearly at right angles.

QUATERNARY PERIOD.

PLEISTOCENE EPOCH.

At the beginning of the Quaternary period the surface of the Tallula and Springfield quadrangles, though in general much like the present surface, differed from it in one important particular. The configuration of the surface at that time was the result solely of erosion, whereas that of the present surface is in part the product of deposition of drift and in part of subsequent erosion of these deposits by the present streams.

Kansan (?) and Yarmouth (?) time.—In the early part of the Pleistocene epoch, probably during Kansan time, an ice sheet developing at the north spread broadly over the northern interior region, including part of Illinois. After a considerable period of glacial occupation the ice melted away, leaving in its place a thick mantle of clay, sand, pebbles, and bowlders that it had brought down with it.

The melting of the glacier was the result of a change of climate and was followed by a long interval during which the climate probably did not greatly differ from that prevailing in the region to-day. During this interglacial time, probably that known as the Yarmouth stage, the surface of the drift was covered with vegetation and the glacial deposits were subjected to considerable erosion.

Illinoian time.—The next event of importance was the invasion of the region by the Illinoian ice sheet, which came from the northeast, centering in Labrador. As it advanced it gathered up much of the material left by the Kansan glacier and mixed it with other débris brought from the north. In some places, however, it did not greatly disturb the older drift, or even the soil which had developed upon it, but buried it just as it was. When the Illinoian glacier melted it left a second mantle of drift, which completely buried the hills and valleys developed in Yarmouth time, leaving the surface more even than before.

Sangamon-Peorian time.—Upon the nearly level drift plain new lines of drainage were developed, and on the more level portions of the surface organic matter from successive generations of plants accumulated to such an extent as to form a carbonaceous soil (the Sangamon soil), which was in places peaty and elsewhere reddish. On slopes in the vicinity of streams, where erosion was active, organic material was not allowed to accumulate.

After these conditions had continued undisturbed for some time and the development of the present valleys was well under way conditions became favorable for the accumulation of extensive deposits of dust. This dust, or loess, was spread over the Sangamon soil and over the leached and eroded Illinoian till where the Sangamon soil was absent. Later dust transportation diminished and became overbalanced by erosive processes, and the carving of valleys continued up to Wisconsin time, when they had reached almost their present form.

Wisconsin time.—The influence of still another glacier was felt in this area. After a long interval ice of the Wisconsin stage invaded northern and eastern Illinois and spread southwestward to a position within 40 miles of the area under discussion. The valley of Sangamon River, which had been developed by that time, was occupied by the ice as far west as a point 8 or 10 miles below Decatur. Water overloaded with glacial débris was discharged westward from the ice, depositing in the valley large quantities of sand and gravel. Such deposition may have continued after the recession of the ice front while new valleys were being established on the newly deposited till. Finally adjustment was again reached and the river once more began to cut down into the material which it had recently deposited and to develop a flood plain at a lower level. In places, as in Clear Lake, Salisbury, Athens, Rock Creek, and Petersburg townships, patches of the old filling, probably deposited during Wisconsin time, remain as terraces.

RECENT EPOCH.

In the Recent epoch there has been, so far as known, no change in the altitude of the district. The principal event has been the removal of part of the material deposited during the Pleistocene epoch. The streams have been widening their valleys and forming flood plains.

The main drainage lines have been developed since the Illinoian ice sheet melted from the region. The only preglacial channel now occupied for any considerable distance is the Athens Valley, which is followed by Sangamon River for a few miles in its northward course near the boundary between the quadrangles. The present streams, in carving new channels in the drift surface, reached the bedrock first where they cross the old divides, and as they continued to deepen their channels they cut into these buried ridges, exposing the rock in their banks. In other places they have not yet reached the bottom of the drift.

In figure 11 (p. 8) are shown the two types of valley and also the broad, flat upland prairie.

MINERAL RESOURCES.

The mineral resources of the Tallula and Springfield quadrangles comprise coal, shale and clay, limestone, sand and gravel, and water. To these may be added the soil, which is the chief source of wealth in the area.

COAL.

The Tallula and Springfield quadrangles lie within the eastern interior coal basin (see fig. 14) and in that part of this basin where the Springfield coal (No. 5) is best developed.

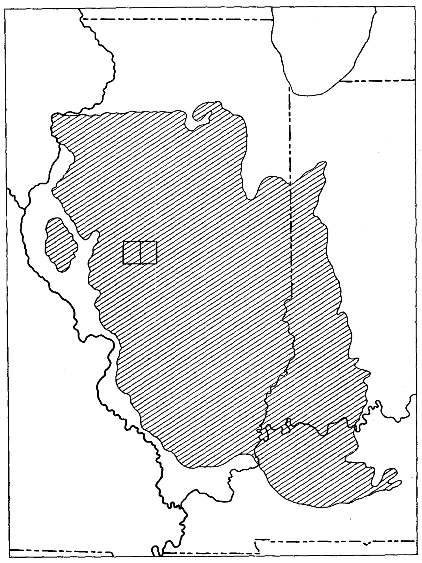

FIGURE 14.—Outline map showing the location of the Tallula and Springfield quadrangles (the small rectangles) in the eastern interior coal basin, represented by the ruled area.

Beds below the Springfield coal.—A fairly persistent coal bed about $2\frac{1}{2}$ feet thick lies about 58 feet below the Springfield coal (No. 5). Another bed, averaging 2 feet in thickness, lies about 60 feet lower and seems persistent. In some districts two other coal beds, aggregating about 3 feet in thickness and separated by a few feet of shale, lie about 190 feet below the bed last mentioned. In the Riverton section still another coal, 32 inches thick, is reported about 250 feet below the Springfield coal, but in the boring at Springfield the corresponding coal is much thinner. A few other thin seams of coal occur here and there below the Springfield coal. At some future time one or more of these lower coal beds may be of importance, but until the Springfield coal becomes practically exhausted the deeper and thinner beds will not be exploited.

Springfield coal (No. 5).—The Springfield coal, formerly known as No. 5, is the only one at present worked in the quadrangles. It is remarkably persistent, being found at every point where borings have been put down to its horizon, and it underlies a very extensive surrounding territory. Its thickness is nearly uniform, ranging in the different mines in the area from 5 to $6\frac{2}{3}$ feet. It lies entirely below drainage, from 150 to 273 feet below the surface, its depth at any place depending on the altitude of the surface and the altitude of the coal at that point.

Herrin coal (No. 6).—The Herrin coal is known only from the records of mine shafts and test borings and seems to be too thin in this area to be profitably worked under present conditions. It was formerly mined at Mechanicsburg, some distance to the east, and it is still mined extensively 20 miles to the south. Where first penetrated by the Mechanicsburg shaft it was about 6 feet thick, but it thinned in a short distance northward and was abandoned when the Springfield coal was discovered below it. In these quadrangles the thickness of the Herrin coal ranges generally from 2 to 14 inches and averages $4\frac{1}{2}$ inches. In two of the shaft sections the coal was not found, but its horizon is marked by black shale underlain by clay. It lies at an average distance of 49 feet above the Springfield coal (No. 5), the interval increasing in general to the north. It thickens abruptly southward. At Chatham, 7 miles south of Springfield, it measures between 5 and 6 feet; near Waverly $3\frac{1}{2}$ feet; and at Divernon nearly 8 feet. It is mined extensively in the southern part of Sangamon County and farther south, in the region of Belleville, DuQuoin, Carterville, and Herrin.

Coal No. 7.—Coal No. 7 is not thick enough to be of economic importance, measuring generally only 2 to 3 inches. In three shafts its horizon is represented only by the clay and black shale that is generally associated with it, the coal itself not being present. It lies 50 feet above the Herrin (No. 6) and about 100 feet above the Springfield coal (No. 5).

Coal No. 8.—The thickness of coal No. 8 ranges from 18 to 31 inches. It lies above drainage level throughout the area, except in a belt about 3 miles wide along the eastern border. It has been eroded from the western half of the area. Before the deeper and thicker Springfield coal was discovered this was the only coal worked in the Springfield region. It was mined for several years by drifts run into the hillsides at points where the bed outcropped above the level of the streams. Traces of such workings may be seen along a branch in the W. ½ sec. 32, T. 16 N., R. 5 W.; in the west bank of Sugar Creek, in sec. 12, T. 15 N., R. 5 W.; and they are numerous along the south bank of Sangamon River, in secs. 5 and 6, T. 16 N., R. 4 W. The greatest measured thickness of this coal bed is at places on Sangamon River, where it is 31 inches. Coal No. 8 lies at an average distance of 77 feet above coal No. 7, and 175 feet above the top of the Springfield coal (No. 5).

A comparison of the thicknesses of the coal beds from No. 5 to No. 8, inclusive, and of the distances separating them in the several mine shafts is given in tabular form below:

Thickness of coal beds and the distance between them in mine shafts.

Name of shaft or owner.	Thickness of coal No. 5.	Distance between coals No. 5 and No. 6.	Thickness of coal No. 6.	Distance between coals No. 6 and No. 7.	Thickness of coal No. 7.	Distance between coals No. 7 and No. 8.	Thickness of coal No. 8.	Total distance from top of coal No. 5 to base of coal No. 8.
	Inches.	*Feet.*	*Inches.*	*Feet.*	*Inches.*	*Feet.*	*Inches.*	*Feet.*
Riverton mine No. 1	72	43½	5	39	2	93	24	175
Barclay Coal Mining Co	73	63	2	48½	(?)	89½	8	201
Williamsville Coal Co	68	60	6	52	0	65½	18	179½
Test hole of Springfield Colliery Co	68	43½	0	62	0	54	(?)	160½
Springfield Colliery Co	70	43	14	45½	3	76¾	24	169
Capital Coal Co. (escape shaft)	72	48½	0	56	0	58	24	164½
Spring Creek Coal Co	72	41½	4	48½	2	79+	(?)	172
Boring one-half mile southwest of Springfield	76	39	6	43	2	97	18	179½
Average	71	48	6	50	2	77	19½	175

No coal beds seem to be present in the interval between coal beds No. 5 and No. 6. Between coal beds No. 6 and No. 7 one and in some places two layers of black shale with underclays are generally reported, and in a few places one of these layers is accompanied by a thin bed of coal. Between coal No. 7 and coal No. 8 a clay-shale succession is less frequently reported, and rarely a thin coal bed.

Mining.—Coal mining has been an important industry in the region since about 1860. Prior to that date coal was mined by drifts on coal No. 8, which was formerly worked at a number of places west, southeast, and northeast of Springfield. This coal is said to be of good quality but was too thin to justify development on a commercial scale. The oldest mine now operating in the area is mine No. 1 of the Springfield Coal Mining Co., at Riverton.

Soon after the discovery of the thicker Springfield coal (No. 5), at easy working depth, several shafts were put down, and the industry rose to the first rank in importance. The output of coal in Sangamon County for 1912 aggregated 5,714,742 short tons, valued at the mines at $6,335,965, which was second in Illinois only to the production of Williamson County for that year. Much the greater part of this amount was taken from mines in the Springfield quadrangle.

Thirty-seven mines are in operation, all but seven of which are commercial producers. The following list of the coal mines of the quadrangles gives the average thickness of the coal, the depth to bottom of the Springfield coal (No. 5), and the altitude of its base in each mine:

Mines in the Tallula and Springfield quadrangles.

Name.	Depth to bottom of coal No. 5.	Thickness of coal No. 5.	Altitude of base of coal No. 5.
SPRINGFIELD QUADRANGLE:	*Feet.*	*Inches.*	*Feet.*
Athens Coal Mining Co	212	75	390
Barclay Coal Mining Co	252	73	311
Capital Coal Co	226	72	372
Chicago & Springfield Coal Co	235	74	330
Cantrall Cooperative Coal Co	212	73	390
Citizens Coal Mining Co (mine A)	212	64	380
Citizens Coal Mining Co. (mine B)	210	69	397
Cora Coal Mining Co	202	72	373
Jefferson Coal Co	246	69	336
Illinois Colliery Co. (mine No. 8)	250	69	332
Illinois Midland Coal Co	204	72	346
Lincoln Park Coal & Brick Co	210	69	360
Number Twelve Coal Co	181	72	379
Sangamon Coal Co. (Starnes coal shaft No. 2)	256	79	336
Spring Creek Coal Co	173	72	365
Springfield Coal Mining Co. (Riverton mine No. 1)	230	69	320
Springfield Coal Mining Co. (Riverton mine No. 2)	238	71	318
Springfield Coal Mining Co. (mine No. 3; Starnes coal shaft No. 1)	245	69	340
Springfield Coal Mining Co. (mine No. 4)	250	70	353
Springfield Coal Mining Co. (mine No. 5)	256	71	351
Springfield Colliery Co	231	73	350
Springfield Cooperative Coal Co	250	69	335
Standard Washed Coal Co. (mine No. 1)	238	69	330
Standard Washed Coal Co. (mine No. 2)	240	69	335
Tuxhorn Coal Mining Co	230	68	345
Wabash Coal Co	206	72	407
West End Coal Co	150	66	380
Williamsville Coal Co	272	68	320
Wilmington & Springfield Coal Co	245		335
Woodside Coal Co	251	78	352
TALLULA QUADRANGLE:			
Tallula Coal Co	185	70	437
Cronister & Davis	86	71	449
Brant & Walker	146	68	449
Citizens Coal Co	108	66	488
W. M. Brown	100	65	427
I. N. Biggs	132	69	458
Golladay	108	65	465

A coal bed a foot thick contains about 1770 tons of coal to the acre. If the average thickness of the Springfield coal (No. 5) is $5\frac{3}{4}$ feet, it would contain 10,177 tons to the acre. In the average mine about 66 per cent of the coal is hoisted, the rest being left in pillars or otherwise lost, so that the amount of coal to the acre available for recovery under the present methods of mining is 6785 tons.

Chemical analyses.—Samples of coal for chemical analysis were collected from the mines listed below. The analyses are given in the second table.

Mines from which samples for analysis were taken.

Name of company.	Mine.	Thickness of coal No. 5.	Depth to bottom of coal No. 5.
		Inches.	*Feet.*
Cantrall Cooperative Coal Co	1	73	212
Citizens Coal Mining Co	A	64	212
Springfield Coal Mining Co	2	71	238
Springfield Coal Mining Co	5	72	256
Springfield Colliery Co	1	70	231
Standard Washed Coal Co	2	69	240
Tuxhorn Coal Mining Co	1	68	230
Wabash Coal Co	Dawson.	62	258
Williamsville Coal Co	1	65	272
Woodside Coal Co	1	67	251

Proximate analyses of coal as received and dry coal.

Laboratory No.[a]	County.	Condition.[b]	Moisture.	Fixed carbon.	Volatile matter.	Ash.	Sulphur.	British thermal units.
2782	Menard	As received	13.69	40.15	36.79	9.37	4.34	10,890
		Dry coal		46.52	42.62	10.86	5.05	12,618
2783	do	As received	14.40	39.58	36.45	9.57	4.15	10,804
		Dry coal		46.23	42.59	11.18	4.85	12,621
540	Sangamon	As received	13.56			9.29	4.13	11,019
		Dry coal				10.78	4.78	12,749
721	do	As received	14.39			11.68	3.95	10,534
		Dry coal				13.64	4.61	12,304
740	do	As received	14.30			10.91	3.52	10,598
		Dry coal				12.75	4.11	12,369
741	do	As received	13.13			10.83	3.72	10,785
		Dry coal				12.47	4.28	12,416
1761	do	As received	14.61	37.76	36.97	10.66	3.88	10,557
		Dry coal		44.22	43.30	12.48	4.55	12,364
1762	do	As received	14.55	38.06	36.41	10.97	3.88	10,493
		Dry coal		44.53	42.62	12.85	4.54	12,281
1766	do	As received	15.42	36.70	35.41	12.47	3.54	10,219
		Dry coal		43.39	41.88	14.73	4.19	12,082
1770	do	As received	14.89	37.15	38.32	9.64	4.08	10,778
		Dry coal		43.66	45.02	11.32	4.79	12,663
1772	do	As received	14.00	38.73	36.23	11.04	3.49	10,628
		Dry coal		45.04	42.13	12.83	4.06	12,358
1773	do	As received	14.44	38.27	37.26	10.03	4.15	10,675
		Dry coal		44.73	43.56	11.71	4.85	12,477
1774	do	As received	14.41	38.49	37.00	10.10	4.35	10,741
		Dry coal		44.98	43.22	11.80	5.09	12,550
1786	do	As received	14.18	37.84	35.39	12.59	4.29	10,396
		Dry coal		44.10	41.23	14.67	5.00	12,115
1790	do	As received	16.41	40.85	33.80	8.94	3.05	10,603
		Dry coal		48.87	40.44	10.69	3.65	12,685
1792	do	As received	15.38	39.51	36.52	8.59	3.38	10,873
		Dry coal		46.70	43.16	10.14	4.00	12,849
1794	do	As received	13.69	38.61	35.39	12.31	3.35	10,472
		Dry coal		44.74	41.00	14.26	3.88	12,133
1704 (U. S.)	do	As received	13.89	40.89	33.96	11.26	3.83	10,636
1705 (U. S.)	do	As received	14.45	40.10	34.79	10.66	3.46	

[a] Numbers of the Illinois Geological Survey except as otherwise stated.
[b] "Dry coal" represents the sample theoretically free of moisture.

The samples analyzed are thought to represent the average coal from the entire bed as it is taken from the mine. They were obtained by first cleaning the face of the coal and then by cutting a narrow channel of uniform width and depth from the top to the bottom of the bed. The coal was caught on canvas, broken fine enough to pass through a sieve of one-half inch mesh, quartered down, and placed in an air-tight mailing can before leaving the mine. A few "sulphur" lenses three-eighths inch or more in thickness were excluded from the samples because such material is generally thrown out of the coal by the miners.

The superior quality of the Springfield coal in this area may be seen from the analyses on page 11, which were made by J. W. Lindgren under the direction of S. W. Parr, of the Illinois Geological Survey.

SHALE AND CLAY.

Shale, loess, and alluvial clay have been used in this region in the manufacture of clay products. Of the shale two beds, the lower underlying coal No. 8 and the upper overlying the limestone above coal No. 8, have been utilized.

Some years ago Masters Bros., of Springfield, operated a brick plant near the State fair grounds, mixing the shale underlying coal No. 8 with the overlying surficial clay in the manufacture of various grades of brick. About 15 feet of the shale and about 8 feet of loess were worked. Coal from bed No. 8 above the shale was used in burning the clay. The product was said to have been of good quality and the plant was successfully operated for several years.

In the western part of Springfield the Dawson Brick & Tile Co. are manufacturing common building brick from a mixture of the surface clay with shale taken from this lower bed, which lies 10 or 12 feet below coal No. 8. A section of the pit of this company was given in the description of the Illinoian drift (p. 7). The bricks are made from a "mix" consisting of about 25 per cent of the shale and 75 per cent of the surface material.

The Springfield Paving Brick Co., which is much the largest maker of clay products in the area, has a pit about a mile southeast of Springfield and manufactures paving brick, sewer pipe, drain tile, and building brick. The raw material used is a mixture of the shale above coal No. 8 with loess.

For a time a plant manufacturing common building and face brick from the loess was operated in Springfield. Also at Tallula, near Athens, and elsewhere common building brick are made from loess. The brick are molded by hand and are burned as the local market demands.

For many years the Lincoln Park Coal & Brick Co. have operated a brickyard in connection with a coal mine. Common brick and face brick are made from loess by the dry-press method.

LIMESTONE.

The only limestones that outcrop in the area are those of the McLeansboro formation. They have been quarried in a small way at several places for making lime and for rough building stone but are scarcely thick enough and their overburden is generally too heavy for extensive operations.

SAND AND GRAVEL.

Sand suitable for plaster and cement is abundant on the hills bordering Sangamon River. Large quantities have been taken from sand ridges near the SW. $\frac{1}{4}$ sec. 1 and in the NE. $\frac{1}{4}$ sec. 11, Springfield Township. Dune ridges in the vicinity of Riverton have also supplied sand for local use. A large amount of sand is annually taken from the bed of Sangamon River near the middle of the east side of sec. 11, T. 16 N., R. 6 W., and from other places along its course.

The supply of gravel in this area is obtained principally from gravel beds along Sangamon River and from the channels of the larger tributary streams. A small amount of the gravel used is a by-product from plants working the surface clays.

SOILS.

Five of the types of soils differentiated in the soil survey of the Illinois Agricultural Experiment Station are found in this area. These are (1) black clay loam, found on the poorly drained prairies; (2) brown silt loam, found on the undulating prairies; (3) yellow silt loam, found in the hilly areas; (4) brown loam, characteristic of the bottom lands or flood plains; and (5) sand soil, crowning the hills in many places along Sangamon River.

These soils, like all others, have been formed by geologic processes and to these processes they owe to a considerable extent their texture, their chemical and physical composition, and their fertility. The character of the soil at any place depends on the character of the rock or rocks from which it was derived and on the conditions and forces that have affected it.

In the Tallula and Springfield quadrangles the black clay loam has been formed from the loess under conditions of poor drainage and temperate humid climate. Which factors were most important in determining its depth and blackness are not known.

The brown silt loam has been developed under similar conditions, except that the surface was somewhat better drained and erosion was a little more active, so that while the soil was being formed its uppermost part was being carried away.

The yellow silt loam is found in places where erosion has been still more effective and where the black soil is apparently being removed by erosion as rapidly as it forms.

The brown loam differs in genesis from the varieties described above in that it receives intermittent accessions of new material. It lies within reach of high water so that a thin film of sediment is deposited more or less uniformly over it at every flood. The resulting soil is therefore loose textured and generally somewhat sandy.

The sand soil is found only on the sand dunes along the river bluffs and is thin, porous, and granular.

WATER RESOURCES.

Shallow wells and springs.—An abundant supply of excellent water for domestic use is to be had at shallow depths throughout the area. Rain and snow water is readily absorbed by the loess and passes downward until it reaches the comparatively impervious bowlder clay below. Here much of it accumulates, though near the borders of the upland a part moves laterally until it reaches the surface on valley sides, where it forms springs. A part also percolates down into the till, commonly reaching and saturating lenses of sand.

Most of the farm wells reach only to the base of the loess, but a few extend into the till. Of 1237 records of wells in the Tallula and Springfield quadrangles and in a surrounding belt half a mile wide, 790 show that the water is derived from a bed above the hardpan or till. These are dug wells and are pretty generally distributed over the quadrangles. Of the total number of records those of 617 wells are so complete that the water-bearing bed can be determined with considerable certainty. Of these wells 339, or about 55 per cent, stop at the hardpan or penetrate it for only a short distance. Some of the records indicate that the water-bearing bed is a layer of sand above the hardpan. That this layer of sand is not continuous is shown by the fact that many wells pass from the pebbleless yellow clay of the loess directly into the pebbly clay of the till. Where the sand bed is more than a few inches thick it yields an abundant supply of water for farm wells. The surface of the top of the till is somewhat undulating. In a general way it corresponds with the present topography of the region, being higher over the uplands and sloping toward the streams, but the slopes are not nearly so steep as those of the present valley sides. Where the streams have cut through the loess into the underlying drift numerous springs issue along the contact of the porous material with the impervious bowlder clay.

About 20 or 30 wells obtain water from the alluvial flood plains of the river and its larger affluents, at depths of 10 to 25 feet. The Springfield city waterworks pumps part of its water from Sangamon River and obtains the rest from filter galleries in the sand and gravel of the flood plain of the river. Much of the water drawn from the filters probably comes from the ground water of the alluvium and not from the river itself.

Wells of medium depth.—Another water-bearing zone consists of lenses of sand in the Illinoian drift. Of the 617 well records that contain definite information regarding the water-bearing bed 92, or about 15 per cent, report the water as coming from sand between two beds of hardpan. A number of the records of wells of this class report that the water "gushed up" when the overlying hardpan was broken through. These wells are not so sensitive to the seasonal fluctuations of the water table as are the shallow wells. In 43 of them a buried soil, the Sangamon, containing numerous wood fragments, was passed through at a depth of about 25 feet. These wells are mostly in the northern half of the area and are especially numerous in the vicinity of Athens and Salisbury. The water from such wells is usually dark, has a bad odor, and is unfit for use. In 134 of the records the wells are reported to obtain water from the hardpan, no definite water-bearing layer being specified. As the till does not permit the ready percolation of water, such wells are weak and many of them are at times dry.

Deep wells.—Of the total number of wells 187 are reported to have reached rock or to have penetrated it to various depths. In 113 of these wells the water was obtained from the base of the till, immediately above the bedrock, and in 22 wells it was reported to come from a layer of sandstone. The water-bearing beds of the hard rocks seem to lie at different altitudes. The head of water in good wells in bedrock is so nearly the same in corresponding topographic areas as to suggest that the water in the sandstone layers may have percolated into the rock from the overlying surficial deposits. The deepest well reported, 2 miles east of Pleasant Plains, penetrated 65 feet of surficial material and 445 feet of rock. Another well, in sec. 22, T. 18 N., R. 5 W., is 280 feet deep, 250 feet of which is in rock. Another, in sec. 2, T. 16 N., R. 4 W., 175 feet deep, passed through 140 feet of rock. Two wells in sec. 1, T. 15 N., R. 5 W., go down 150 feet, one penetrating 120 and the other 140 feet of rock, and several other wells have been sunk to greater depths than 100 feet but were abandoned. In none of the deeper wells is the water-bearing bed known, but in all of them the surface of ground water seemed to be about as near the surface as in neighboring wells that derive water from the surficial materials. In each well some water was found at about 25 feet.

That water-bearing beds in the indurated strata are not continuous throughout the area is shown by borings like that east of Pleasant Plains, just mentioned, which found no water in bedrock, though it went down 510 feet, and that in sec. 32, T. 16 N., R. 5 W., which penetrated 150 feet of rock without finding water. The same fact is indicated by a number of other wells of less depth and by the coal shafts in the quadrangles. There are 37 of these shafts, ranging in depth from 150 to 273 feet, and none of them encountered a strong aquifer nor does water find its way into any of the mines in sufficient quantity to cause serious trouble.

Possibility of deep water supplies.—No very deep borings have been made in the quadrangles, but several flowing wells at Jacksonville, 12 miles west of the area, reach depths of over 3000 feet, and obtain a copious supply of water from the St. Peter sandstone, which lies at a depth of about 2100 feet. Another well, put down at Petersburg, in Menard County, on land of L. E. Hartrick, was carried to a depth of 2011 feet and is also reported to flow.

In general the geologic conditions in the Tallula and Springfield quadrangles do not greatly differ from those at Jacksonville, and artesian water could probably be found at places in these quadrangles at nearly the same depths. Unfortunately, the water from the deep wells mentioned is so highly mineralized that it is unfit for use in boilers and for general use, and there is no reason to expect that water of better quality would be found in a deep well at Springfield.

Wholesomeness of the water supply.—Where reasonable precaution is taken to avoid contamination, the water from the farm wells seems to be generally wholesome. The difficulty of preventing contamination of the water in town wells is much greater. Buried soil and vegetable débris are encountered in a number of wells, and it is possible that this is one source of water pollution.

Analyses of the Springfield city water supply made by Dr. Edward Bartow, director of the State Water Survey, show that it contains solids ranging from 100 to 440 parts per million and chlorine ranging from 1 to 8 parts per million at different times of the year. About one-quarter of the population of the city uses water from shallow wells, most of which go down only to the layer of sand above the till and are therefore exposed to danger of contamination from sewers, cesspools, and other sources of pollution. Dr. Bartow's analyses, some of which are given below, show that the mineral content of these shallow waters varies within wide limits.

Analyses of water from wells in the city of Springfield, in parts per million.

[Edward Bartow, analyst.]

Date of collection.	Total residue.	Chlorine.	Depth of well.
			Feet.
November 20, 1905	1,533	49.	25
October 16, 1905	481	9.5	20
October 16, 1905	452	16.	20
September 5, 1906	1,090	80.	30
October 17, 1906	2,018	107.	----
September 23, 1905	721	32.	30
August 23, 1905	830	40.	25
August 29, 1905	1,562	80.	40
August 1, 1905	1,035	74.	18
June 21, 1902	340	5.1	----
October 29, 1901	1,335	11.	----

Surface water supplies.—The supply of surface water for all ordinary purposes is abundant, but the water contains so much sediment and more important impurities that filtering is necessary to make it fit for domestic use, and as good well water is plentiful stream water has not been much utilized. Only at Springfield is extensive use made of unfiltered river water mixed with filtered ground water.

Water power.—The streams of the area have little fall and hence are not important sources of water power. Little or no such power is now utilized.

November, 1912.

TOPOGRAPHY

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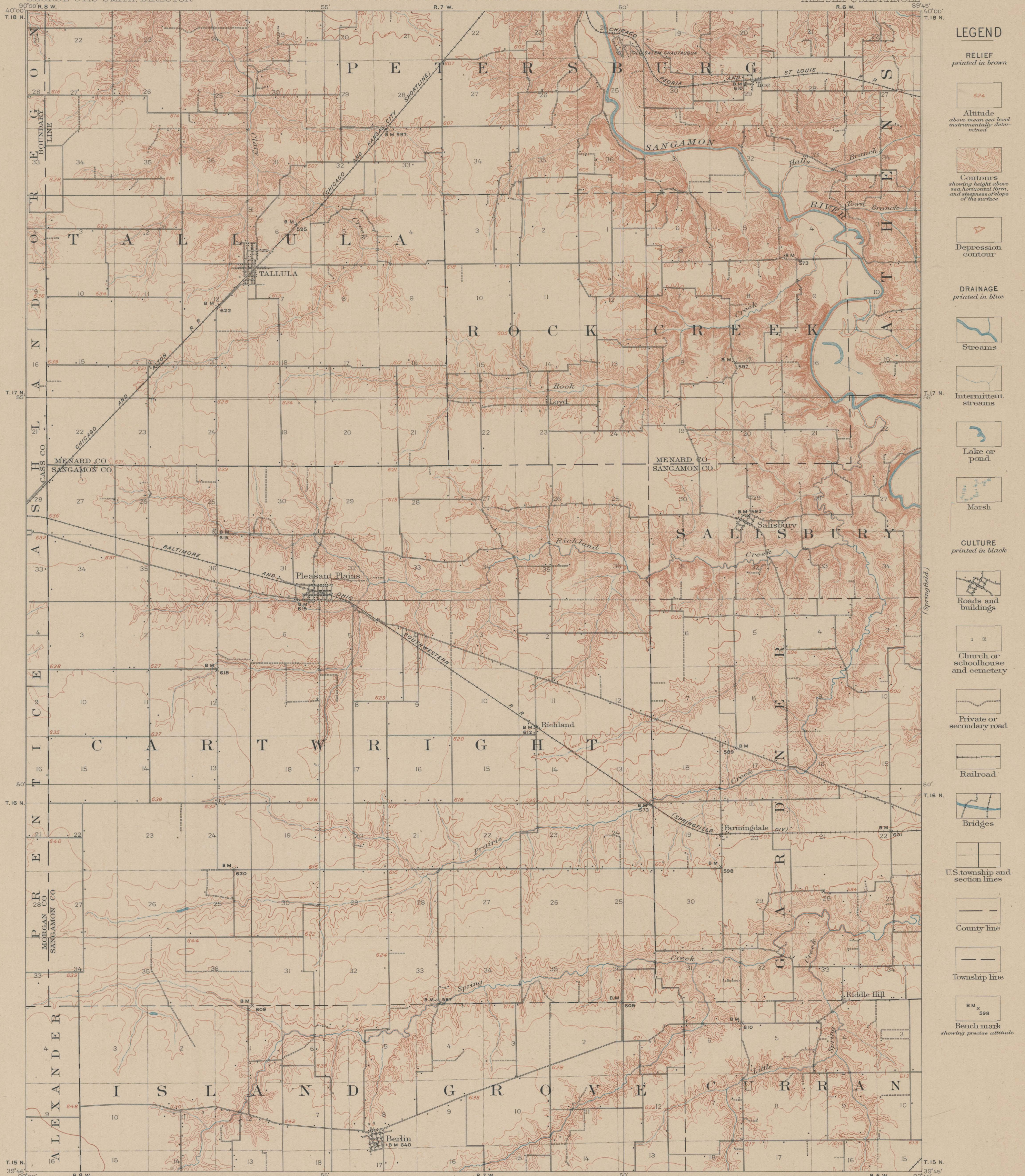

H.M.Wilson and W.H.Herron, Geographers in charge.
Topography by W.J.Lloyd and A.T.Fowler.
Control by E.L.McNair and Geo.T.Hawkins.
Surveyed in 1906-1907.

SURVEYED IN COOPERATION WITH THE STATE OF ILLINOIS.

APPROXIMATE MEAN DECLINATION 1907.

Scale $\frac{1}{62500}$

Contour interval 10 feet.
Datum is mean sea level.

Edition of Feb. 1909, reprinted Apr. 1912.

AREAL GEOLOGY

STATE OF ILLINOIS
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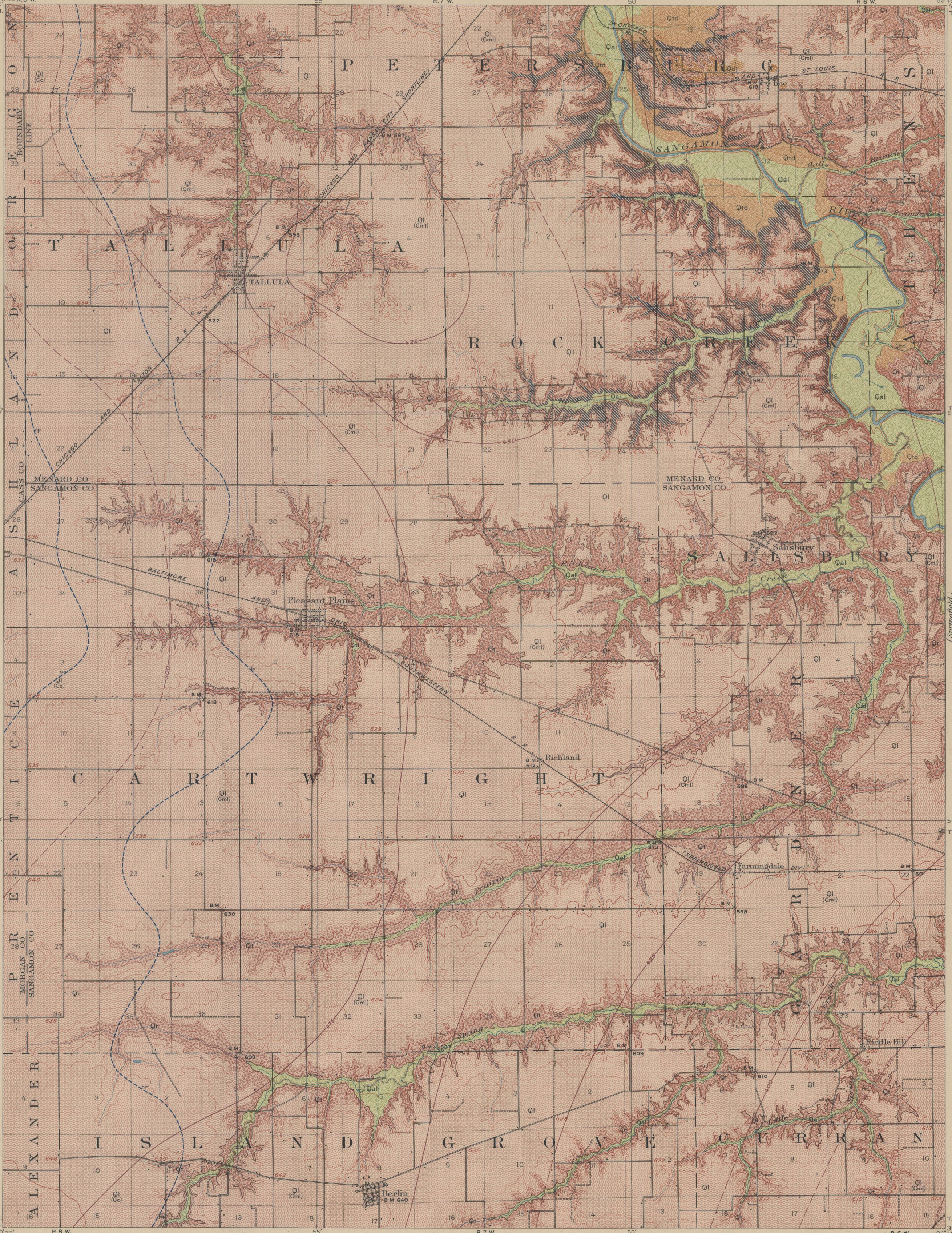

LEGEND

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; generally sandy in Sangamon Valley)

Qd — Dune sand
(wind blown sand, coarse to very fine; local deposit on upland bordering the river, probably derived from the flood plain)

Pleistocene

Qtd — Terrace deposits
(sand and silt with a little gravel, forming terraces along Sangamon River about 30 feet above the flood plain)

Ql — Loess
(buff to gray very fine sand and clay on uplands; thin and discontinuous loess on valley sides mapped with glacial till)

Illinoian stage

Qt — Glacial till
(gravelly and sandy clay, overlain on valley sides by thin loess, most of which has crept down from the uplands, but may be partly in place)

CARBONIFEROUS

Pennsylvanian

Cml — McLeansboro formation
(shale, sandstone, and limestone with several thin coal beds; commonly covered by drift materials, mostly not in place)

(Springfield)

hr sp Cc — Carbondale formation
(shale and sandstone with several beds of limestone and coal; not exposed, but approximate outcrop, beneath the drift, of Springfield (No. 5) and Herrin (No. 6) coals shown on the map)

Note: *The occurrence of McLeansboro formation beneath the drift east of outcrop of Herrin coal and of Carbondale formation west of this outcrop are indicated by the symbols* (Cml) *and* (Cc)

ECONOMIC AND STRUCTURE DATA

hr sp — *Outcrops of coal beds beneath the drift*
(Springfield (No. 5) coal, sp. *and Herrin (No. 6) coal,* hr, *underlie the areas east of their respective outcrops)*

450 — *Structure contours on the base of Springfield (No. 5) coal*
(doubtful position of coal indicated by dashed lines; contour interval, 25 feet; datum, mean sea level)

⚒ *Coal mines (shafts)*

Note: *The most valuable coal is the Springfield (No. 5) in the upper part of the Carbondale formation; other coals occur in the Carbondale and McLeansboro formations; shale for brick and tile and limestone for cement material and building stone occur in the McLeansboro formation; loess and glacial till yield clay for brick and tile; sand dunes, terrace deposits, and alluvium have workable deposits of sand.*

H.M. Wilson and W.H. Herron, Geographers in charge.
Topography by W.J. Lloyd and A.T. Fowler.
Control by E.L. McNair and Geo. T. Hawkins.
Surveyed in 1906-1907.

SURVEYED IN COOPERATION WITH THE STATE OF ILLINOIS.

TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION 1907.

Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 10 feet.
Datum is mean sea level.

Edition of June 1912

Geology by E.W. Shaw.
Surveyed in 1910.

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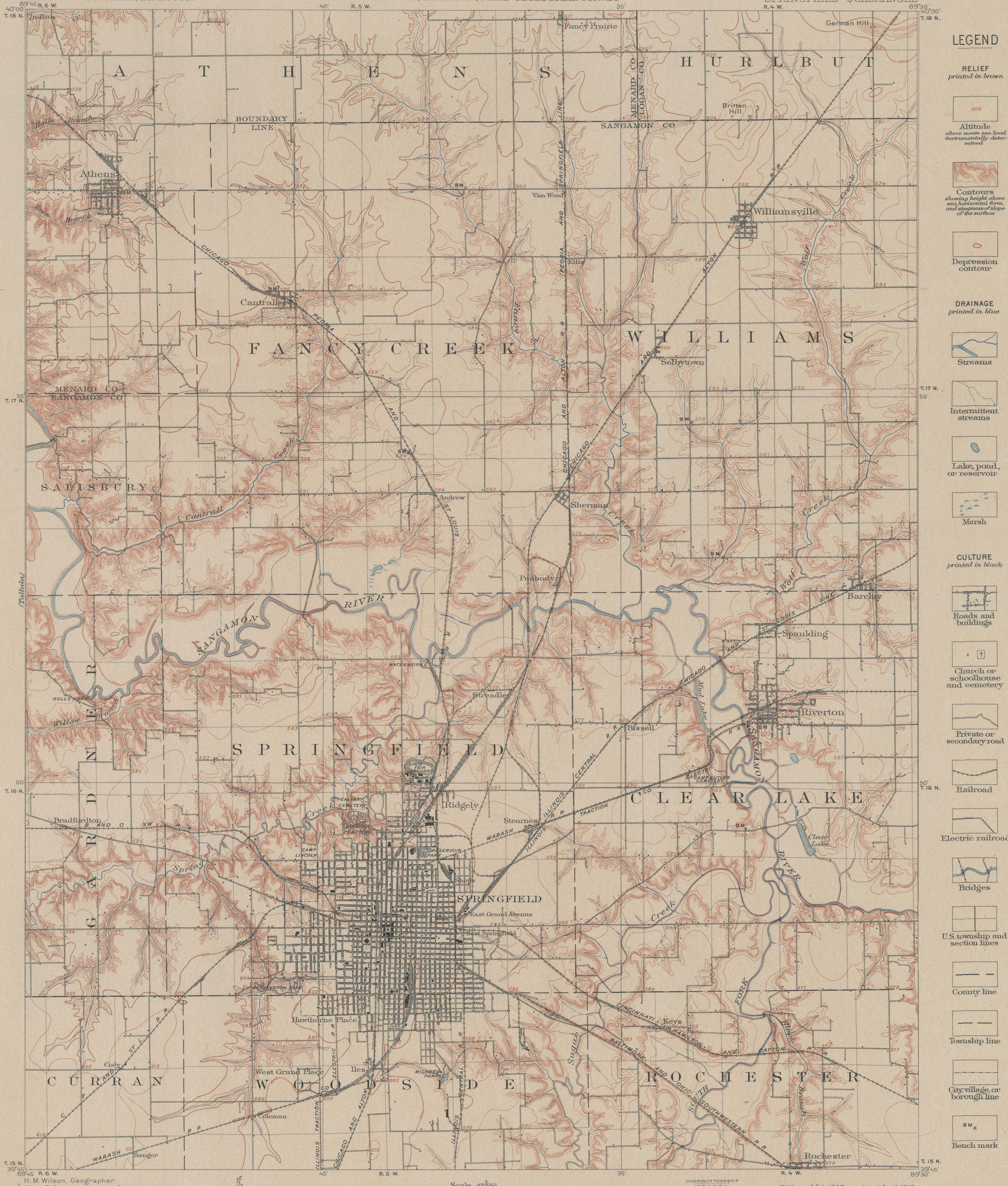
ILLINOIS
SPRINGFIELD QUADRANGLE



H. M. Wilson, Geographer.
Chas. E. Cooke, in charge of section.
Topography by Albert Pike.
Control by Coast and Geodetic Survey,
Geo. T. Hawkins, and E. L. McNair.
Surveyed in 1905.

SURVEYED IN COOPERATION WITH THE STATE OF ILLINOIS.

TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION 1905.

Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 10 feet.

Datum is mean sea level.

DIAGRAM OF TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Edition of Feb. 1907, reprinted April 1912.

AREAL GEOLOGY

U.S. GEOLOGICAL SURVEY
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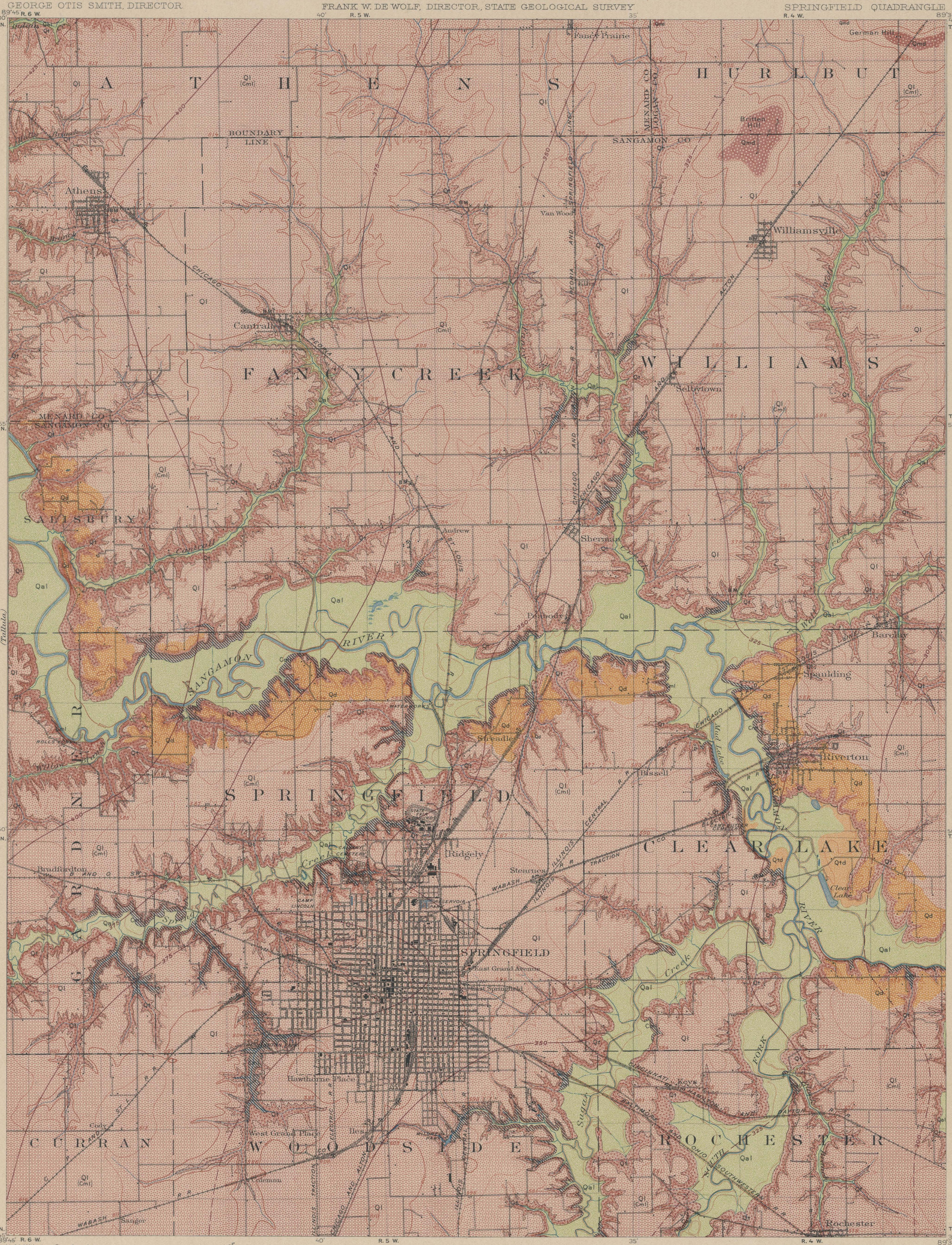

LEGEND

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

QUATERNARY

Recent

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Qtd — Terrace deposits (sand and silt with a little gravel, forming terraces along Sangamon River about 30 feet above the flood plain)

Ql — Loess (buff to gray very fine sand and clay on uplands; thin and discontinuous loess on valley sides mapped with glacial till)

Illinoian stage

Qmd — Morainal drift (ridges and hills composed of sand and gravel and unassorted till)

Qt — Glacial till (gravelly and sandy clay overlain on valley sides by thin loess which is either in place or has crept down from the upland)

CARBONIFEROUS

Pennsylvanian

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

ECONOMIC AND STRUCTURE DATA

350 — Structure contours on the base of Springfield (No.5) coal (doubtful position of coal indicated by dashed lines; contour interval, 25 feet; datum, mean sea level)

⚒ Coal mines (shafts)

Note: The most valuable coal is the Springfield (No.5) in the upper part of Carbondale formation, which underlies the McLeansboro formation throughout the quadrangle; other coals occur in the Carbondale and McLeansboro formations; shale for brick and tile and limestone for cement material and building stone occur in the McLeansboro formation; loess and glacial till yield clay for brick and tile; sand dunes, terrace deposits, and alluvium have workable deposits of sand.

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Surveyed in 1905.

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TRUE NORTH
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Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 10 feet.
Datum is mean sea level.

Edition of June 1912.

DIAGRAM OF TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Geology by T. E. Savage.
Glacial till-Loess boundary by E. W. Shaw.
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