ILLINOIS
STATE GEOLOGICAL SURVEY

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION

DIVISION OF THE
STATE GEOLOGICAL SURVEY
M. M. LEIGHTON, *Chief*

BULLETIN NO. 57

GEOLOGY AND MINERAL RESOURCES OF THE ALEXIS QUADRANGLE

BY

HAROLD R. WANLESS

PRINTED BY AUTHORITY OF THE STATE OF ILLINOIS

URBANA, ILLINOIS
1929

STATE OF ILLINOIS

DEPARTMENT OF REGISTRATION AND EDUCATION

M. F. WALSH, *Director*

BOARD OF

NATURAL RESOURCES AND CONSERVATION

STATE GEOLOGICAL SURVEY DIVISION

M. M. LEIGHTON, *Chief*

JEFFERSONS PRINTING & STATIONERY CO.
SPRINGFIELD, ILLINOIS
1929

Letter of Transmittal

State Geological Survey Division, August 29, 1929.

M. F. Walsh, Director, and Members of the Board of Natural Resources and Conservation,

Gentlemen: I have the honor of transmitting herewith a report on the *Geology and Mineral Resources of the Alexis Quadrangle,* by Dr. Harold R. Wanless, which is to be printed as Bulletin No. 57 of our series. This report is based upon detailed field studies which were undertaken to ascertain the mineral resources of the area in coal, clay and shale, limestone, sandstone, sand and gravel, molding sand, oil and gas, underground water supplies, and other possible resources, and to secure stratigraphic and structural information important to an understanding of the geology of this portion of the State.

The various mineral resources, of which coal, clay and shale, and underground water supplies were found to be the most important, are herein discussed as to their occurrence, character, relative importance, present development, and possibilities of future development. In addition to the needed detail that is incorporated in this report, there are in the files of the Geological Survey certain other data and collections of materials available to those interested in special economic and scientific problems.

Editorial preparation of the author's manuscript and maps, from the standpoint of geologic science, has been made by Dr. George E. Ekblaw, Geologic Editor.

Very respectfully,

Morris M. Leighton, *Chief.*

Contents

Chapter III—*continued* PAGE

Illustrations

Tables

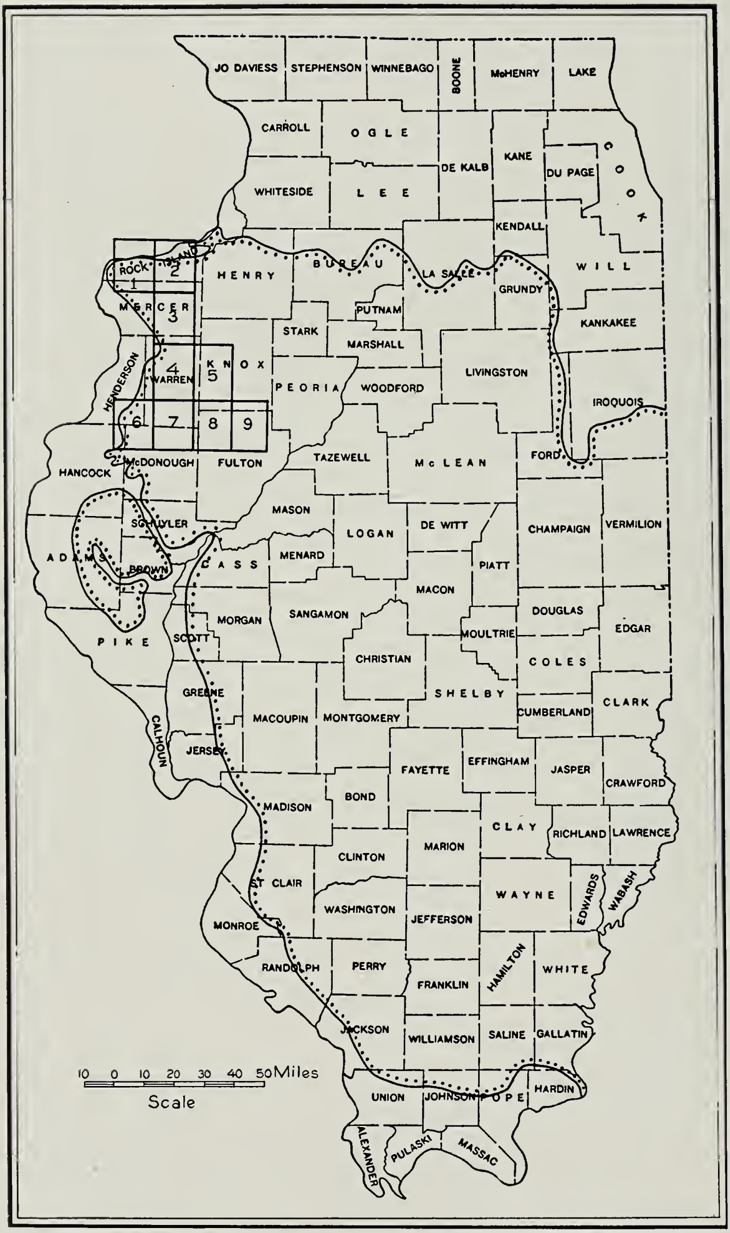

Fig. 1. Index map of Illinois showing the location of the Alexis quadrangle (No. 3) with reference to the Illinois coal field (outlined by stippled boundary) and to other nearby quadrangles which have been surveyed geologically: (1) Edgington; (2) Milan; (4) Monmouth; (5) Galesburg; (6) La Harpe; (7) Good Hope; (8) Avon; (9) Canton.

GEOLOGY AND MINERAL RESOURCES OF THE ALEXIS QUADRANGLE

By Harold R. Wanless

CHAPTER I

Location and Extent

The Alexis quadrangle is located in the northwestern part of Illinois, about fifteen miles south of Rock Island. Approximately the north three-fourths of the quadrangle is in Mercer County, and the south quarter is in Warren County. (See fig. 1.) It is bounded on the east and west respectively by the meridians of 90° 30′ and 90° 45′ W. and on the south and north respectively by the parallels of 41° 00′ and 41° 15′ N. It is about 17 miles long and 13 miles wide, and its total area is about 225 square miles.

Purpose of the Report

This report is published in order to place geological information regarding all of the mineral resources of the area in the hands of those who are interested in either or both the economic or educational possibilities of the area.

Coal underlies extensive portions of the Alexis quadrangle; some clay and shale is being utilized for brick and tile, and other deposits present are suitable for ceramic uses; ground-water supplies for both domestic and industrial uses are being continually sought; and the productive soils constitute a mineral resource of fundamental importance. The geological history of the area also is of more than usual interest to teachers, students, and residents.

Acknowledgments

Mr. R. E. Grim and Mr. A. W. Waldo served as field assistants during the summers of 1925 and 1926, respectively, when the field studies in the Alexis quadrangle were made.

The author is indebted to various members of the Illinois State Geological Survey for contributory suggestions and for criticism of the manuscript, especially to Dr. M. M. Leighton, Chief, in regard to the Pleistocene deposits, to Dr. G. H. Cady and to Dr. H. E. Culver, formerly of the Survey, in regard to the Pennsylvanian formations, and to Mr. L. E. Workman in regard to the older formations, and to Dr. G. E. Ekblaw for geologic editing of the entire report. Dr. R. S. Poor and Mr. L. E. Workman supplied information based on their respective studies in the Galesburg and Monmouth quadrangles, both adjacent to the Alexis quadrangle.

Incidental assistance has been rendered by many others. Dr. A. C. Noé, of the University of Chicago, collected plant fossils from this area and identified all the Pennsylvanian plants listed in this report. The late Professor Stuart Weller, of the University of Chicago, and Dr. J. M. Weller, of the Illinois State Geological Survey, checked the identifications of Pennsylvanian invertebrate fossils. Mr. F. C. Baker, Curator of the Natural History Museum, University of Illinois, identified the Pleistocene fossils. Mr. J. H. Markley, Jr., assisted by Mr. A. Prucha, ran precise levels on about 130 stations, which data were used in the preparation of the structure maps of the area. (Figs. 38, 39, 40, 41.) Members of the Department of Geology of the University of Illinois offered many helpful suggestions.

The cordial cooperation and hospitality of the residents of the region, especially those engaged in well drilling, in coal mining, and in the shale industries, is gratefully acknowledged.

Fundamental Geologic Processes[1]

INTRODUCTORY STATEMENT

A mere description of the rocks of a region and a discussion of their economic uses does not constitute a geological report. Geology, in a broad sense, is the history of the earth—the record and the interpretation of the changes it has incurred. The earth is not a finished product; under our observation agencies are everywhere changing its surface at the present time, though the rate of such changes is very slow compared with the rate of progress of human events. These agencies have been operative throughout the past, and some of their results have been nothing short of revolutionary. Once or repeatedly areas now land were below the sea for long ages; regions now of gentle relief were the sites of lofty mountains; some districts where now there is fertile farming land were the scenes of volcanic eruptions, and others were buried beneath thousands of feet of glacial ice; areas now frigid supported palms, fig trees, magnolias, and other subtropical plants.

Many of the events of earth history are recorded in the rocks, that is, the rocks are the products of past conditions. The present environment represents the cumulative result of the past environments. Consequently an appreciation of the geology of any region as it is today involves an adequate comprehension of the geological history of that region. By studying the rock formations and interpreting their features as nearly as possible in accordance with current phenomena, geologists have worked out a considerable portion of the past history of the earth. They have subdivided geologic time

[1] This section has been adapted from the report on the Geology and Mineral Resources of the Kings Quadrangle, by J. H. Bretz, State Geological Survey Bull. 43, pp. 211-217, 1923.

into significant intervals, each of which is characterized by a suite of conditions that is reflected in the rocks that represent the interval. The major subdivisions are eras and periods (Table 1, p. 30). The transition from one to the other of these major subdivisions was marked by some momentous change that had world-wide effects. Some but not all of these great changes are recorded within the area of the Alexis quadrangle.

Running water, ground-water, wind, and man constitute the agencies that are now actively engaged in creating geological changes in the Alexis quadrangle. Their results are gradational and tend to bring the surface of the whole area and adjacent areas to an accordant level. Degradation, or wearing away, is everywhere occurring on the slopes and uplands, and aggradation, or building up, is in progress to some extent on the lower tracts.

WORK OF RUNNING WATER

The average annual rainfall in this region is 34 inches, of which more than a third, perhaps a half, flows down the slopes and converges in the definite water courses. Most of the smaller streams are intermittent and exist only during and immediately after rains and the melting of snow. Others are permanent and persist with a greater or lesser flow throughout the year. These streams, whether intermittent or permanent, are generally more or less muddy, and when in flood they carry sand in suspension and roll pebbles along their bottoms. Such action, continued through centuries, inevitably lowers the surface of the region by removing loose material and abrading more substantial deposits.

Measurements of the rate of flow of many Illinois rivers indicate that the run-off per square mile of their drainage basins averages nearly 700,000 tons of water per year. If in its course to the permanent streams this run-off descended a slope averaging 50 feet to the mile, it would produce an average of nearly four and one-half horsepower operating on every square mile of surface. After the water is concentrated in streams, its work is even more pronounced and conspicuous. The adequacy of running water to wear down the land through long intervals of time is thus apparent.

WORK OF GROUND-WATER

The portion of the precipitation that sinks into the ground constitutes ground-water. All but the uppermost portion of soils and porous rocks is continually saturated. The upper limit of the saturated rock and soil is called the water-table. In general it is nearer the surface in valleys than on hills. The bottoms of many valleys are below the water-table, in which instances springs and seeps may issue at or below the water-table along the lower parts of the valley-slopes and the streams that occupy the valleys will be permanent.

Depressions whose bottoms are below the water-table will be occupied by lakes or swamps. Wells must be dug or drilled below the water-table in order to assure a permanent source of water. Most quarries, mines, and other excavations that extend below the water-table fill with water unless pumps are constantly operated to remove it.

Ground-water rarely produces mechanical effects like those which result from surficial run-off, because generally it only seeps slowly through pores and cracks in the rocks. But it effects other changes by other means, chief of which is solution. The ground-water which issues as springs or seeps or is obtained from wells frequently carries in solution great quantities of mineral matter which it has obtained from the rocks through which it has passed. It is this dissolved material which makes water "hard". When precipitated it constitutes the mineral deposits around springs and forms the scale in teakettles, steam-boilers, and water-pipes. Calcium carbonate, the dominant constituent of limestone, is the chief substance dissolved by the ground-water.

Ground-water also reacts on the rocks by means of three chemical processes—hydration, oxidation, and carbonation—all of which tend to disintegrate the solid rocks and reduce them to soil. The three processes are chemical combinations of water, oxygen, and carbon dioxide, respectively, with some minerals or their constituent elements. The oxygen and carbon dioxide are absorbed from the air by the falling rain. Oxidation is best revealed by the rusting of iron-bearing minerals in rocks and their eventual development as reddish-stained soils. Carbonation first produces calcium carbonate, which is dissolved by the ground-water.

WORK OF STAGNANT WATER

Plant debris may be preserved from decay only when it accumulates in expanses of standing water, such as lakes and marshes, where the material gradually becomes peat or muck. Such deposits are now being formed in undrained depressions in the recently glaciated areas of northeastern Illinois, northern Michigan, Wisconsin, Minnesota, and southern Canada. Swamp deposits of peat and muck that were developed in ancient geologic epochs were buried beneath other sediments, and subsequent compression has changed them into beds of coal, such as those which form the principal source of mineral wealth of the Alexis area.

The organic acids that result from the decay of plant material leach and deoxidize the underlying soil of its more soluble and more highly oxidized minerals, so that a white or light gray clay is formed. Such clays are found underlying most coal beds. They are called fire-clays, because most of them, when burned, form brick which is especially resistant to high temperatures (fire-brick).

WORK OF WIND

Wind, which is simply air in motion, produces only mechanical changes. When it is bearing loose material it acts like a sand-blast and wears away exposed surfaces of indurated rock. It removes loose material from one place (erosion or degradation) and deposits it in another (aggradation). The material borne by the wind under ordinary conditions must of necessity be composed of small particles—dust and sand—but under unusual conditions fine gravel and even larger fragments may be moved. Soil may be blown away from areas in which the moisture or vegetation is insufficient to hold it. Sand will accumulate in the lee of any obstacles and there form sand

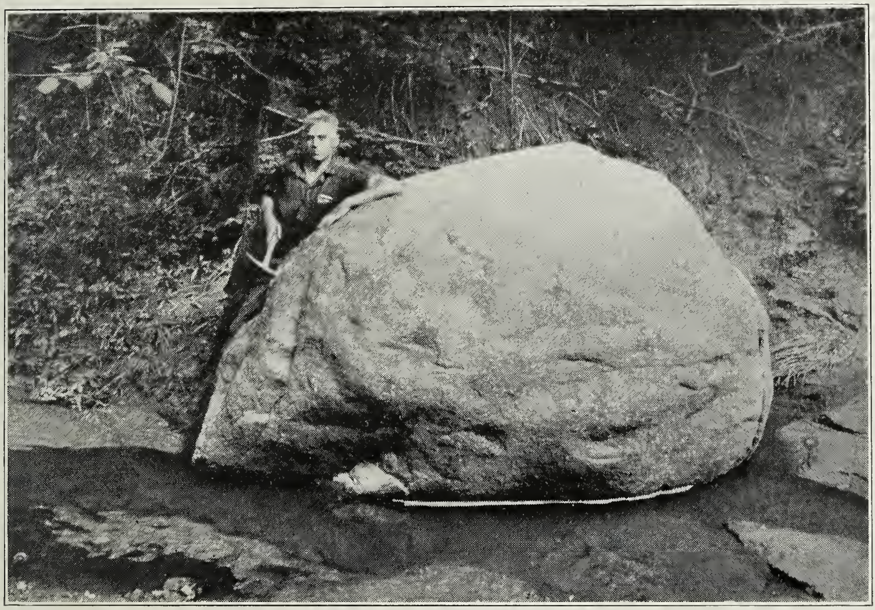

Fig. 2. An eight-foot boulder of pink granite from the Kansan glacial drift, in the bed of a creek in sec. 18, T. 12 N., R. 2 W. (Spring Grove Twp.).

dunes. The finer constituents may be carried as suspended dust for miles and may be deposited as a widespread mantle of loess.

The geological changes above outlined are known to have occurred in this region intermittently in the past, as well as in the present. Other gradational changes, of which three will be outlined in the following topics, alternated with them.

GLACIATION

In the Alexis quadrangle most of the non-indurated rock, commonly called the subsoil, is non-stratified stony clay. It contains boulders and pebbles of rocks utterly unlike the subjacent bedrock. Granites (fig. 2) and fine-grained lavas which have solidified from a former molten state; gneisses whose twisted and gnarled structures tell of tremendous pressures and movements in the throes of mountain-making; red quartz porphyry (an igneous rock consisting of a red, microcrystalline ground-mass in which are set crystals of glassy quartz and pink-to-red feldspar) whose parent ledges are probably north of lakes Superior and Huron; an immense amount of limestone; and a great variety of other types of rock foreign to the region are represented in the surficial gravel of road cuts and stream beds.

These rocks have been introduced by an agency which carried and deposited particles of all sizes, from huge boulders to the finest clay, in intimate association. Further, it has dragged them under great pressure, because they are beveled, planed, polished, and scratched and the surface of the bedrock has been smoothed, grooved, and marred with long, parallel scratches that show the direction in which the debris was moved. Neither wind or water can do this. There is but one gradational agent which does these things, and that is glacial ice. The stony clay which it deposits is known as till, or sometimes as drift.

MARINE SEDIMENTATION

The indurated rock, or bedrock, of the region is stratified and consists of sandstones, shales, and limestones. Records of wells and other borings reveal that these rocks extend to a depth of more than 3,000 feet at least. Originally these formations were unconsolidated sands, muds, and calcareous ooze deposited in layers or strata at the bottoms of shallow seas that opened into oceans which then surrounded the continent of North America. When the sands were deposited the shores of the ancient seas were not far inland from this region. The currents created by waves and tides were strong enough to carry the sand grains along the bottom for some distance from the land from which the material was derived. When the calcareous ooze was deposited the shores were perhaps farther inland from this region and the water was probably a little deeper and surely much clearer and less disturbed by waves and currents. The ooze consisted largely of the shells and other hard parts of marine animals living in the seas, with which organic debris only mud fine enough to be carried in suspension far from the land was mingled.

Subsequent to the deposition of these marine sediments the originally incoherent materials have become indurated, partly by compression but largely by cementation. The cement consists of mineral matter which was introduced in solution in ground-water and was precipitated between the grains of the unconsolidated material.

The consolidated formations can rarely be traced continuously between two places where they may be exposed. The identification or correlation of scattered outcrops must be based on certain features or criteria, which are unique to the formation, and which are widely distributed in it.

One reliable criterion for correlation is fossils, which are the impressions or petrifactions of plant or animal organisms that lived in the region while the sediments were being deposited. The existence of fossils has been known for many centuries, but the fact that each of the different formations in one region contains different assemblages of such forms and that any one formation contains the same assemblage wherever it may occur was first recognized in England about 125 years ago. This fact is now established as one of the most important of geological principles. After careful study of the embedded fossil forms, sedimentary formations may be correlated across great gaps, perhaps some hundreds of miles wide, in which no outcrops of these formations occur.

DIASTROPHISM

The stratified bedrock, with its entombed marine fossils, is undisputable evidence that several times in the past the Alexis quadrangle was inundated by embayments of the oceans. The region now stands several hundred feet above sea-level. These two facts indicate that since the last strata were deposited the region has been raised, the sea-level has been lowered, or both movements have taken place, to create a differential approaching, if not attaining, a thousand feet. Movements in the body of the earth, manifested by warpings of its exterior, explain such changes in altitude. Downwarp of the ocean basins would draw off the waters; upwarp of the continent, or a part of it, would convert areas covered by shallow water into land. Such movements constitute diastrophism.

Should the region as it now exists be again submerged beneath the sea, mud, sand, or calcareous materials would again be deposited, and these would rest on the present irregular surface. The contact between the new deposit and that already deposited would be as irregular as the present topography. (Pl. II.) Such contacts are termed unconformities. If marine strata occur both above and below an unconformity, the following succession of events is recorded: (1) the presence of the sea over the region and marine deposition; (2) the withdrawal of the sea and the action of degradational agents; and (3) the return of the sea and the renewal of marine deposition.

WEATHERING

The sum total of all unobtrusive processes by which solid rock is reduced to an unconsolidated condition is known as weathering. In addition to the processes and agencies already mentioned, the following are worthy of note: (1) differential expansion and contraction of solid rock from daily changes in temperature; (2) expansional force of the freezing of water in pores and crevices; (3) wedge work of plant roots growing in cracks in the rock; and (4) the burrowing of animals. It is obvious that any rock, however firmly indurated, must slowly disintegrate as a result of the attack of these varied agents during the passage of years. Thus a mantle of unconsolidated material—physically and chemically unlike the underlying parent rock—is formed on all outcrops of indurated rock, save those too steep to retain it. This loose material is appropriately termed mantle-rock. Its upper portion, with which is mingled the carbonaceous matter of decayed plant tissues, forms the soil.

CHAPTER II

Physiography

RELIEF AND DRAINAGE

The Alexis quadrangle lies entirely within the Interior Glaciated Plains Province.[1] Topographically the area is a dissected upland plain. The undissected remnants which rise gradually from elevations of about 700 feet in the southwest portion to about 800 feet in the northeast portion show that the original surface of the plain was gently rolling. The total relief in the quadrangle is approximately 220 feet, measured between the lowest points of the main streams where they leave the west side of the quadrangle and the highest points on the uplands in the northeast part of the quadrangle.

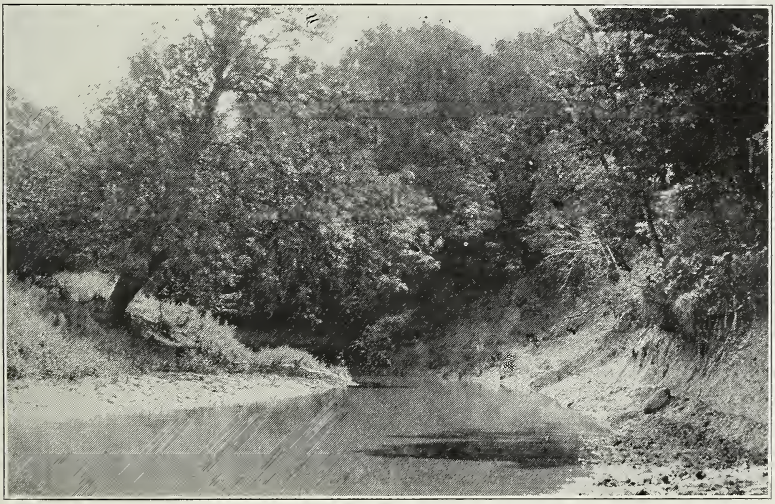

Fig. 3. Pope Creek in sec. 3, T. 13 N., R. 3 W. (Ohio Grove Twp.), showing the steep, wooded south slope and the gentle, more open north slope.

The present relief is a distinct but considerably modified reflection of the bedrock surface, despite a mantle of glacial drift. In the southern portion of the quadrangle, where the uplands are lower, the drift overlies shale (Kinderhook); in the northern portion, where the uplands are higher, it overlies more resistant strata (Pennsylvanian). Most of the principal valleys follow pre-glacial valleys.

[1] Fenneman, N. M., Physiographic divisions of the United States: Annals of the Association of American Geographers, vol. 6, pp. 19-98, 1916.

The quadrangle is drained by five main streams which have rudely parallel courses and flow westward toward Mississippi River. (See Pl. I.)

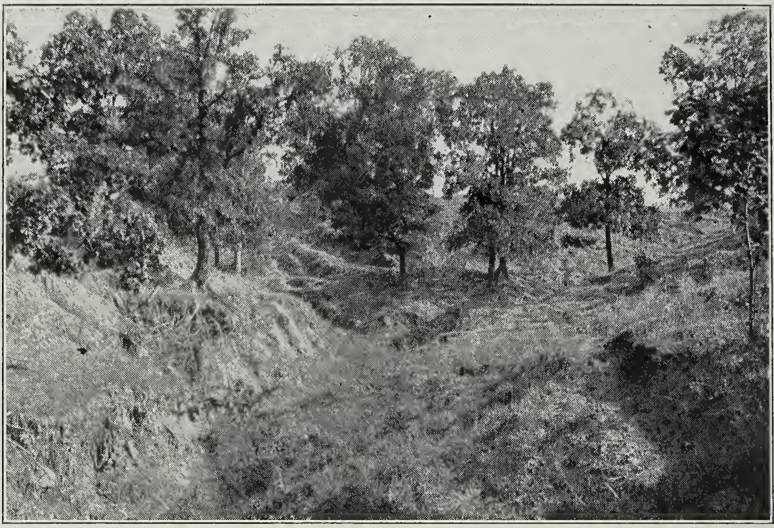

Fig. 4. Early stage in the development of gullies on deforested slopes in glacial drift. This condition is typical of small ravines in the area

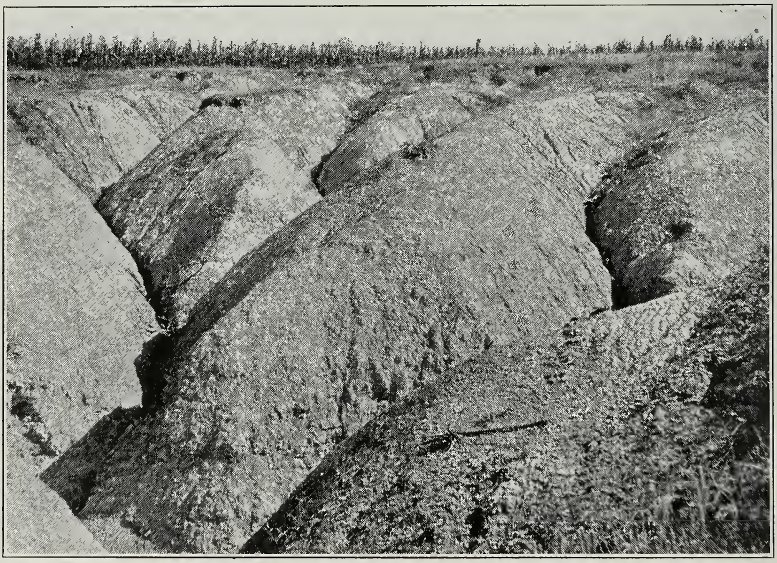

Fig. 5. "Bad-land" topography developed in Pennsylvanian shale on the north slopes of a large creek valley in sec. 7, T. 14 N., R. 2 W. (Greene Twp.).

Their principal tributaries have similar westward courses, and many of them turn almost at right-angles to join the main streams. Numerous smaller tributaries flow north or south into the larger west-flowing streams. There is a marked dominance of tributaries on the north side of all valleys, with regard both to number and development.

The slopes of the larger valleys are sufficiently gentle that many of them may be cultivated, and even in some of the longer tributary ravines the slopes are gentle enough to permit cultivation. Most of the valleys have an asymmetric cross-section, with the south wall usually steeper (fig. 3).

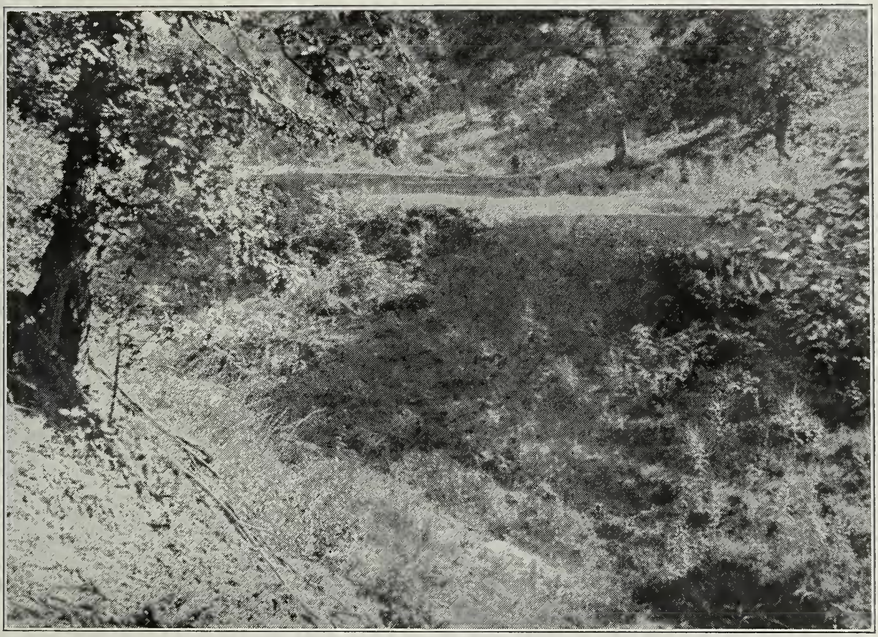

Fig. 6. A terrace remnant of a former alluvial plain in a tributary valley. The small creek in the forground has entrenched itself in the former valley-flat since deforestation along the headwaters. Sec. 5, T. 13 N., R. 1 W. (North Henderson Twp.).

The north slopes of most of the valleys have less vegetation than the south slopes and consequently are more affected by recent gullying. The steeper slopes are generally forested or grassed and are thereby protected from gullying. Locally, however, "bad-land" topography has developed in glacial drift (fig. 4) and Pennsylvanian shale (fig. 5).

The valleys of the main streams vary from an eighth of a mile to nearly a mile in width. Most of the valleys have a reasonably consistent width across the quadrangle, but the valleys of North Henderson and Pope creeks are greatly constricted in the central part of the quadrangle, where their steep walls consist of bedrock beneath a thin veneer of glacial drift.

Small valley-flats, composed of alluvial sand and silt, extend far up toward the headwaters of even the smaller tributaries. Terrace remnants of valley-flats at higher levels occur in many of the tributary valleys (fig. 6).

The valley-flats are subject to flood during periods of heavy rainfall. Following a series of exceptionally heavy rains in August, 1924, the water of Edwards River stood seven feet above a road on the valley-flat in sec. 35, T. 15 N., R. 2 W. (Preemption Twp.). Rains in early June, 1926, transformed parts of the valley-flats of Henderson, Middle Henderson, Pope, and other creeks into great lake-like stretches of nearly stagnant water which existed for nearly a week, seriously damaging crops and making many roads impassable.

Geography

DISTRIBUTION OF POPULATION

About half of the estimated population of the Alexis quadrangle resides in the rural districts, and consequently urban settlements are few and scattered. Aledo, the county seat of Mercer County, is the largest town in the quadrangle and has a population of 2200. Alexis, with a population of 800, is second in size. Other villages, in order of size, are Viola, Little York, Shale City, Burgess, and Gilchrist. The rural population is well distributed and averages four or five families per square mile. The topographic map shows 939 rural houses. The population consists largely of native born Americans.

INDUSTRIES

Agriculture constitutes the most important industry in the quadrangle, which lies within the corn belt. Corn, with the associated rotational crops of oats, clover, and timothy hay, is grown on the uplands, along gentle slopes, and in the valley-flats. (Fig. 7.) The steeper slopes are occupied by woodlots or pasture. Hog and cattle raising are concomitant industries of commercial importance.

At present coal is mined in a number of non-shipping mines which supply part of the coal used locally in both towns and rural districts. Former mining operations on a commercial scale account for the development of the villages of Wanlock, Gilchrist, and Old Gilchrist. Another mineral industry of commercial importance is the manufacture of sewer pipes, drain tiles, wall coping, and flue linings. A large brick plant, operated by the Hydraulic Press Brick Company, is located at Shale City, and another large plant operated by the Northwestern Clay Manufacturing Company, is located at Griffin in sec. 4, T. 14 N., R. 1 W. (Rivoli Twp.) about a quarter of a mile east of the quadrangle boundary. The larger towns of the area have no manufacturing industries.

TRANSPORTATION

Railroad transportation in the quadrangle is furnished chiefly by branch lines of Chicago, Burlington and Quincy Railroad. (Pl. I.) One branch of this system serves Viola, Gilchrist, and Aledo; another passes through Alexis. Rock Island Southern Railway crosses the quadrangle from north to south and has a branch line from Gilchrist to Aledo, but in 1926 it operated only for freight service. The Minneapolis and St. Louis Railroad crosses the southwestern corner of the quadrangle and passes through Little York.

A concrete road (State Highway No. 3) follows the western margin of the quadrangle. Most of the country roads are graded and are frequently dragged; some of the earth roads which are traveled most frequently are oiled. The hilly sections of the quadrangle have poorer roads, but all are passable except during rainy seasons.

Fig. 7. A field of corn growing in the alluvial plain along Pope Creek in sec. 32, T. 14 N., R. 1 W. (Rivoli Twp.). Note the gentle valley-wall in the distance and the steeper wall in the right foreground.

CHAPTER III—DESCRIPTIVE GEOLOGY

Introduction

Strata representing all but the Permian system of the Paleozoic group and deposits representing the Pleistocene and Recent systems of the Cenozoic group (Table 1) are penetrated by deep wells, shallow wells, and other borings (Appendix C, and Pls. V and VI) or are exposed at the surface. The oldest rocks known in the quadrangle belong to the Mt. Simon formation of the Cambrian system and are penetrated only by the Aledo city well. The character of rocks below that horizon can be only surmised. Wherever they are exposed, pre-Cambrian sedimentary rocks are intensely metamorphosed, sharply folded, and intruded by igneous rocks, and presumably they have the same character in Illinois. The oldest rocks exposed at the surface belong to the Kinderhook series of the Mississippian system.

Cambrian System

introduction

The name Cambrian is derived from Cambria, the Roman name for northern Wales, where typical exposures of rocks of this system were first studied.[1]

Rocks of the Cambrian system outcrop at only one place in Illinois,[2] but they are penetrated by many deep wells, especially in the northern part of the State. The Aledo well in this quadrangle penetrates 1439 feet of the Cambrian system. All of the Cambrian rocks that are known to occur in Illinois belong to the Croixan (Upper Cambrian) series.

croixan series

The name Croixan is derived from St. Croix, the name of a river that forms part of the boundary between the states of Minnesota and Wisconsin. In 1874 N. H. Winchell[3] proposed the name St. Croix because the series was best exposed along that river, but subsequently the name has been simplified.

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[1] Sedgwick, Rev. A., Edinburgh New Philos. Jour., vol. 19, p. 390, August 14, 1835 (abstract).

Sedgwick, Rev. A., and Murchison, R. I., On the Silurian and Cambrian systems, exhibiting the order in which the older sedimentary strata succeed each other in England and Wales: Notices and abstracts of Communication, pp. 59-61, appendix to British Assoc. Adv. Sci. Rept. 5th meeting, 1836 (Read August, 1835).

[2] Bevan, A. C., Fault block of Cambrian strata in northern Illinois: Abstract, Bull. Geol. Soc. America, vol. 40, No. 1, p. 88, 1929.

[3] Winchell, N. H., Sketch of the geology of Minnesota: Geol. and Nat. Hist. Survey of Minnesota, First Annual Rept. for 1872, p. 70, 1873.

The Croixan series consists of sandstones, shales, and dolomites, any of which may possess some of the others' characteristics, and all of which may be glauconitic. It is divided into several formations, namely, in ascending succession, Mt. Simon, Eau Claire, Dresbach, Franconia, Mazomanie, Trempealeau, Jordan, Mendota, and Madison.

The name Mt. Simon was first applied to the basal sandstone of the Croixan series in 1914.[4] The formation is essentially a fine-grained sandstone tinted red or brown. The Aledo well ends after penetrating 657 feet of the formation, which is believed to be not far from the total thickness. The name Eau Claire, which is the name of a town in Wisconsin near which the formation is well exposed, was first used also in 1914.[5] The formation is principally shale with some beds of sandstone, limestone, and dolomite. It is only 142 feet thick in the Aledo well, but at Moline, Rock Island County, it is 250 feet thick. Dresbach is the name of a town in Winona County, Minnesota, near which the formation was quarried.[6] The formation is a brownish-gray, yellow, or white, slightly dolomitic sandstone, of which 150 feet was penetrated in the Aledo well. Franconia is also the name of a town in Minnesota, in the vicinity of which the formation was first distinguished.[7] The name Mazomanie was introduced[8] to designate a formation in eastern Wisconsin but in western Illinois it is not distinguishable from the Franconia formation. The Mazomanie-Franconia formation consists principally of dolomitic, sandy shale and pink, fine-grained, dolomitic sandstone with a minor amount of sandy dolomite. Glauconite is generally abundant in most of the formation and gives a strong greenish cast to the rocks. The Aledo well penetrates 215 feet of this formation. The name Trempealeau is derived from Trempealeau Bluff, along Mississippi River.[9] The Trempealeau formation consists of a thick dolomite member (St. Lawrence) and thinner shale and sandstone members (Lodi, Norwalk, et cetera). The Aledo well penetrates 195 feet assigned to the formation; at Moline and Monmouth, respectively, the formation is 285 and 260 feet thick. Jordan is the name of the town in Minnesota, near which exposures of the formation were early recognized.[10] It is a light gray sandstone with dolomitic cement. Its thickness varies from 10 to 121 feet in the region of the Alexis quadrangle; 90 feet of the formation was penetrated in the Aledo well. The Mendota and Madison formations, for which the names were respectively derived from a lake

[4] Walcott, C. D., Cambrian geology and paleontology: Smithsonian Misc. Coll., vol. 57, p. 354, 1914.

[5] Idem.

[6] Winchell, N. H., Geology of Minnesota: Geol. and Nat. Hist. Survey of Minnesota, Final Rept., vol. 2, preface, p. 22, 1888.

[7] Berkey, C. P., Geology of the St. Croix Dalles: Am. Geol., vol. 20, p. 373, 1897.

[8] Ulrich, E. O., Major causes of land and sea oscillations: Wash. Acad. Sci. Jour., vol. 10, pp. 74-76, 1920; Ann. Rept. Smiths. Inst., pp. 333-335, 1922.

[9] Ulrich, E. O., Notes on new names in table formations and on physical evidence of breaks between Paleozoic systems in Wisconsin: Wis. Acad. Sci. Trans., vol. 21, pp. 72-90, 1924.

[10] Winchell, N. H., Geology of the Minnesota Valley: Geol. and Nat. Hist. Survey of Minnesota, Second Ann. Rept. for the year 1873, p. 149, 1874.

Group		System	Sub-syste
		Recent	
Cenozoic	Quaternary Sub-group	Pleistocene	
	Tertiary Sub-group	*Pliocene †Miocene †Oligocene *Eocene	
Mesozoic		*Cretaceous †Comanchean †J[illegible]	

near the city and the city of Madison, Wisconsin, are not found in the region of the Alexis quadrangle.

The Croixan series presumably overlies pre-Cambrian rocks (granite or metamorphosed sedimentary rocks) on a peneplain surface that slopes southward as revealed by surface exposures and by well records in central and southern Wisconsin. An unconformity intervenes, as the Lower and Middle Cambrian series are missing. Another unconformity intervenes between the top of the Croixan series and the overlying strata, as the upper two formations of the Croixan series are missing.

The Cambrian rocks of the upper Mississippi Valley were formerly grouped as the "Potsdam" formation and correlated with the Upper Cambrian rocks of Potsdam, New York. When the Mississippi valley rocks were found not to be identical with those of New York, the name "St. Croix" was substituted. The succession of Cambrian formations in Illinois, known only in deep wells, is correlated as far as possible with the Cambrian formations which outcrop in Wisconsin and Minnesota.[11]

Ordovician System

INTRODUCTION

The name Ordovician refers to the Ordovices, an ancient tribe of people who, at the time of the Roman Empire, lived in Wales where the rocks of the system are typically exposed.[12]

The Ordovician rocks of northern Illinois and adjacent states are divided into three subsystems: Lower Ordovician, which is represented by the Prairie du Chien series; Middle Ordovician, represented by the Mohawkian series, which contains the St. Peter, Glenwood, Platteville, Decorah, and Galena formations; and Upper Ordovician, which is represented by the Maquoketa formation. The Ordovician system is represented in the Alexis quadrangle by sedimentary rocks totaling nearly 1000 feet in thickness and interrupted by three erosional unconformities.

PRAIRIE DU CHIEN SERIES

The name Prairie du Chien was introduced[13] to replace the old name "Lower Magnesian" that had been originally used to designate the strata that lie between the Croixan series and the St. Peter sandstone. The name

[11] Thwaites, F. T., The Paleozoic rocks found in deep wells in Wisconsin and Northern Illinois: Jour. Geol. vol. 31, pp. 529-555, 1923.
Thwaites, F. T., Stratigraphy and structural geology of northern Illinois, with special reference to underground water supplies: Illinois State Geol. Survey Rept. Inv. No. 13, pp. 24-36, 1927.

[12] Lapworth, C., On the tripartite classification of the lower Paleozoic rocks: Geol. Mag., London, new ser. vol. 6, pp. 12-14. 1879.

[13] Bain, H. F., Zinc and lead deposits of the upper Mississippi Valley: U. S. Geol. Survey Bull. 294, p. 18, 1906 (cites Lancaster-Mineral Point folio).
Grant, U. S., and Burchard, E. F., U. S. Geol. Survey Geol. Atlas Lancaster-Mineral Point folio (No. 145), page 3, 1907.

is derived from the town of Prairie du Chien, Wisconsin, because near that town typical exposures of the series occur along the bluffs of the Mississippi River valley.

The series presumably underlies all of Illinois, as many deep wells encounter it, but it crops out only along Illinois River east of La Salle and in a few other northern Illinois localities. In the Alexis quadrangle, it is penetrated only by the Aledo well.

The Prairie du Chien series is 435 feet thick at Aledo, but in the vicinity of Rock Island to the north, it is recorded as varying from 229 to 425 feet thick, and at Monmouth, south of Alexis, it is 525 feet thick.

The Prairie du Chien series is usually subdivided into three formations—Oneota, New Richmond, and Shakopee.[14] The Oneota formation consists of gray or buff sandy dolomite and is 205 feet thick at Aledo. The name is derived from a river (now called Upper Iowa), in Iowa along whose valley the formation is well developed.[15] The New Richmond formation consists of white or reddish dolomitic sandstone and is 105 feet thick at Aledo. The name is derived from a town in Wisconsin in the vicinity of which the formation is typically developed.[16] The Shakopee formation is also a gray or buff dolomite with some sand and considerable shale. The name is derived from the town of Shakopee, in Scott County, Minnesota, where it was quarried for lime.[17] The Aledo well penetrates 125 feet of the formation, but the thickness varies greatly, and at some localities in Illinois and adjacent states the formation is entirely missing.

The relation between the Prairie du Chien series and the underlying Croixan series can not be determined in the Alexis quadrangle, as the succession is shown in only one drill record, but the fact that the Mendota and Madison formations of the Croixan series are missing indicates that the two series are separated by an erosional unconformity. An erosional unconformity also probably separates the Prairie du Chien series from the overlying St. Peter sandstone, as such a relationship is exposed at some localities in Illinois[18] and at many places in Wisconsin[19] and is supported by the correlation of records of numerous wells in both states. This unconformity represents an erosional interval during which relief of several hundred feet was

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[14] Bain, H. F., Zinc and lead deposits of northwestern Illinois: U. S. Geol. Survey Bull. 246, p. 18, 1905.

[15] McGee, W. J., Pleistocene history of northeastern Iowa: U. S. Geol. Survey Eleventh Ann. Rept., pt. 1, p. 333, 1891.

[16] Wooster, L. C., Geology of the lower St. Croix district: Geology of Wisconsin, vol. 4, p. 106, 1882.

[17] Winchell, N. H., Geol. and Nat. Hist. Survey of Minnesota Second Ann. Rept. for 1873, p. 138, 1874.

[18] Knappen, R. S., Geology and mineral resources of the Dixon quadrangle: Illinois State Geol. Survey Bull. 49, p. 47, 1926.

Cady, G. H., Geology and mineral resources of the Hennepin and LaSalle quadrangles: Illinois State Geol. Survey Bull. 37, p. 36, 1919.

Sauer, C. O., Geography of the Upper Illinois valley and history of development: Illinois State Geol. Survey Bull. 27, pp. 38-39, 1916.

[19] Thwaites, F. T., Stratigraphy and geologic structure of northern Illinois with special reference to underground water supplies: Illinois State Geol. Survey Rept. Inv. No. 13, p. 22, 1927.

locally developed,[20] and at some places the Prairie du Chien series was completely removed.[21]

The Prairie du Chien series is usually correlated with the Beekmantown (Lower Ordovician) of New York. It can not be stated definitely that the sandstone formation designated as New Richmond at Aledo is the true equivalent of the New Richmond formation at the type locality, as lenticular sandstones have been found at various horizons in the series.

MOHAWKIAN SERIES

ST. PETER FORMATION

The St. Peter formation was originally named by D. D. Owen[22] because he saw good exposures of it along St. Peters (now Minnesota) River, near St. Paul, Minnesota. It has been penetrated by many deep wells in Illinois and probably underlies all of the State, but it crops out in limited areas only.[23] Typical exposures occur along Illinois River between La Salle and Ottawa and along Rock River in Lee and Ogle counties in the vicinity of Dixon and Oregon. It underlies all of the Alexis quadrangle, and it has been penetrated in several wells in and near the quadrangle.

The typical St. Peter sandstone in this area is commonly light gray and less commonly pink or yellow in color, medium- to fine-grained, and more or less dolomitic. It is composed of well-rounded grains, almost all of which are quartz, whose surfaces are frosted and pitted (fig. 8). Many of the grains have been enlarged by secondary growth or accretion of silica deposited from ground-water. The sandstone is slightly cemented with magnesium carbonate and is highly porous. Greenish shale or red marl occurs in the basal part of the formation at many places, and sandy dolomite occurs in the formation at some localities.

The total thickness of the formation in and near the Alexis quadrangle ranges from 40 to 290 feet.

The St. Peter sandstone rests unconformably on the underlying Shakopee dolomite. Most of the fragments that comprise the conglomerate that occurs in the basal St. Peter beds at some localities consist of residual chert derived by weathering and erosion of the Shakopee formation.

The sandstone is correlated with the St. Peter formation in Minnesota chiefly because they have the same stratigraphic position, but they are identical with respect to their lithologic characteristics, the slight cementation, and the secondary enlargment of the quartz grains.

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[20] Fisher, D. J., Geology and mineral resources of the Joliet quadrangle: Illinois State Geol. Survey Bull. 51, p. 20 and Pl. III, 1925.

[21] Thwaites, F. T., op. cit., p. 23.

[22] Owen, D. D., Preliminary report of the Geological Survey of Wisconsin and Iowa: U. S. Gen. Land. Office Rept. 1847 (U. S. 30th Cong. 1st Sess. S. Ex. Doc. 2) pp. 160-173, 1847.

[23] Lamar, J. E., Geology and economic resources of the St. Peter sandstone of Illinois: Illinois State Geol. Survey Bull. 53, pp. 14-18, Pl. I, 1928.

On the basis of its fossil content the St. Peter sandstone of Minnesota is correlated with the upper Chazy (Ordovician) series which is exposed at Chazy, near Lake Champlain, New York.

Fig. 8. Photomicrograph of St. Peter sand. The grains marked A and B show respectively a pitted grain and a grain which fitted into a pit. Magnified about 20 diameters. (Photograph by courtesy of U. S. Silica Company.)

GLENWOOD FORMATION

This formation was recognized as a more or less distinct lithologic unit in northwestern Illinois, Wisconsin, Iowa, and Minnesota for some time before the name Glenwood was applied to it because it is typically exposed in Glenwood Township, Winneshiek County, Iowa.[24]

In its type locality the formation is a shale 15 feet thick, of which the lower 8-10 feet are sandy. Elsewhere the formation consists of sandstone, limestone, dolomite, and shale, in almost every conceivable mixture and alternation.[25] The sandstone in the formation differs from the St. Peter sand-

[24] Calvin, Samuel, Geology of Winneshiek County: Iowa Geol. Survey, vol. 16, pp. 60-61 and 74-75, 1906.

[25] Norton, W. H., et al, Underground water resources of Iowa: Iowa Geol. Survey, vol. 21, pp. 29 et seq., 1912.

Bevan, A. C., The Glenwood beds as a horizon marker at the base of the Platteville formation: Illinois State Geol. Survey Rept. Inv. No. 9, 1926.

Athy, L. F., Geology and mineral resources of the Herscher quadrangle: Illinois State Geol. Survey Bull. 55, p. 25, 1928.

stone in that it consists mainly of fine, angular grains among which are scattered large rounded grains (fig. 9). A greenish color is typical of the Glenwood beds.

The thickness of the formation also varies greatly, ranging from 10 to 60 feet where it is present at all. In well No. 6 (Appendix C), 141 feet is assigned to this formation, but this thickness may include part of the St. Peter formation.

The precise limits of this formation can not be satisfactorily differentiated in the records of all wells, because its dolomitic and calcareous phases closely resemble the overlying typical Platteville formation and its sandy phases equally closely resemble the underlying St. Peter formation. A minor erosional unconformity occurs between the Glenwood and St. Peter formations at some localities,[26] but in most places the Glenwood beds appear as transitional beds between the St. Peter and Platteville formations.

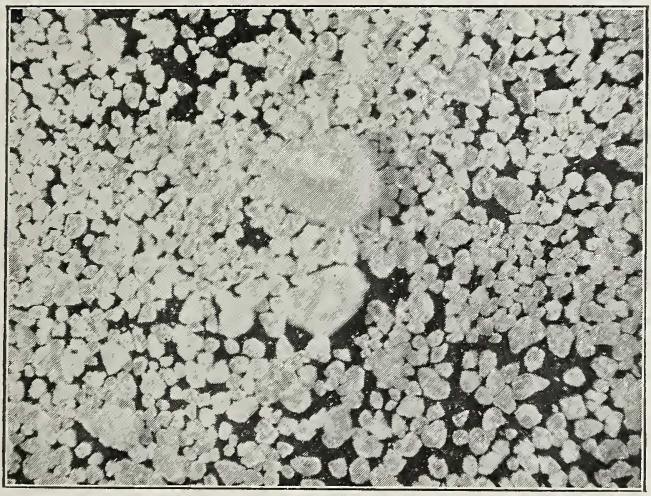

Fig. 9. Photomicrograph of Glenwood sandstone (magnified about 16 diameters).

Owing to its arenaceous content, the formation has been allied with the St. Peter formation by some geologists,[27] but most geologists[28] prefer to

[26] Bevan, A. C., op. cit., pp. 11-12.
[27] Calvin, Samuel, op. cit.
[28] Bevan, A. C., op. cit.
Bain, H. F., Zinc and lead deposits of northwestern Illinois: U. S. Geol. Survey Bull. 246, p. 19, 1905.
Grant, U. S., and Burchard, E. F., U. S. Geol. Survey Geol. Atlas, Lancaster-Mineral Point folio (No. 145), p. 4, 1907.
Thwaites, F. T., The Paleozoic rocks found in deep wells in Wisconsin and northern Illinois: Jour. Geol., vol. 35, p. 540, 1923.
———————, Stratigraphy and geologic structure of northern Illinois, with special reference to underground water supplies: Illinois State Geol Survey Rept Inv. No. 13, p. 17, 1927.

classify it as basal Platteville. The slight unconformity between the Glenwood and St. Peter formations, the variable transition between the Glenwood and Platteville formations, and the occurrence of Platteville fossils in the Glenwood shale[29] support this view. The formation has been further considered[30] to be the equivalent of the Joachim formation of Missouri and southern Illinois.

PLATTEVILLE FORMATION

The name Platteville was adopted for this formation because its full thickness is typically exposed along Little Platte River west of Platteville, Wisconsin.[31] At the time that the name Platteville was adopted, the formation included both a basal sandy shale member and an upper green shale member that were later respectively designated as the Glenwood and the Decorah formations. Consequently the name Platteville was restricted to apply only to a series of thin beds of brownish-gray dolomitic limestone commonly separated by thin shale partings. The formation occurs over all of northern Illinois and adjacent parts of Iowa, Wisconsin, and Minnesota. In most places it is 90-100 feet thick but in some localities it becomes as much as 125 feet thick and in others it is only 50 feet thick. A thin shale member noted 50-60 feet above the base of the formation in the Aledo and Monmouth wells may be the Decorah shale, in which case the Platteville formation is limited to that thickness; or it may be only a shale horizon within the formation.

The Platteville formation is not sharply differentiated from either the underlying Glenwood formation or the overlying Decorah formation. It has been correlated with the Upper Stones River series in Tennessee and the Chazy-Lowville series in New York. Formerly it was correlated with the Trenton formation in New York, but later it was discovered that the Platteville formation was not the exact equivalent of the Trenton horizon.[32]

DECORAH FORMATION

This formation, like the Glenwood formation, was included in the Platteville formation until it was specifically designated by the name Decorah because it is well exposed in and near the city of Decorah, Iowa.[33]

The formation persists over all of northern Illinois and in Wisconsin, Iowa, and Minnesota, where it has been regularly recognized as the "Green shale". In its type locality it consists of calcareous shale with limestone bands and is there 25-30 feet thick. Elsewhere it is more shaly or more

[29] Sardeson, F. W., U. S. Geol. Survey Geol. Atlas, Minneapolis-St. Paul folio (No. 201), p. 6, 1916.
[30] Knappen, R. S., Geology and mineral resources of the Dixon quadrangle: Illinois State Geol. Survey Bull. 49, p. 53, 1926.
[31] Bain, H. F., op. cit., p. 19.
[32] Bain, H. F., op. cit., pp. 18-19.
[33] Calvin, Samuel, op. cit., pp. 60-61 and 84-85.

calcareous, and its thickness varies greatly. In the Alexis quadrangle 5 or 10 feet of shale noted in some well records may mark the Decorah horizon, in which case it is probable that some of the superjacent shaly dolomite is also in the Decorah formation.

The Decorah formation is correlated with the Lowell Park limestone in the Dixon, Illinois, area[34] and with the Black River formation in New York.

GALENA FORMATION

The formation derives its name from the fact that in it is found most of the lead-bearing mineral galena that once made the upper Mississippi valley a mineral district important for its production of lead and zinc.[35]

Like the Glenwood, Platteville, and Decorah formations, the Galena formation occurs everywhere in northern Illinois and in adjacent parts of Iowa, Wisconsin, and Minnesota. It is a relatively massive, gray cherty, coarsely crystalline magnesian or dolomitic limestone, which weathers to a yellow color and a sandlike texture.

The thicknesses of the Galena formation in three drill records in the Alexis quadrangle are 232, 240, and 253 feet, but if the shale horizon, already discussed, is not the Decorah formation, these thicknesses may be reduced. In other well records in the region, the thickness of rock strata assigned to the Galena formation ranges from 180 to 259 feet. The total thickness of the Galena and Platteville formations combined ranges from 280 to 334 feet.

In northern Illinois an erosional unconformity of small relief has been reported at the base of the Galena formation, but the drill records in this quadrangle do not show any evidence of such unconformity.

CINCINNATIAN SERIES

MAQUOKETA FORMATION

The Maquoketa formation is named from exposures along the Little Maquoketa River in Iowa.[36] It underlies most of northern Illinois and is recorded in several drill records in the Alexis quadrangle and adjacent territory.

The Maquoketa formation consists of gray or brown calcareous shales interbedded with thin limestones. A limestone or dolomitic limestone from 15 to 30 feet thick persists near the middle of the formation. The beds above this limestone are principally shale, with thin beds of limestone, whereas the beds below it vary from calcareous or dolomitic shale, red, brown, or gray in color, to drab-colored, shaly dolomite.

In the Alexis quadrangle and vicinity the Maquoketa formation ranges from 160 to 265 feet in thickness, but in most records the thickness ranges

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[34] Knappen, R. S., op. cit., p. 60.

[35] Foster, J. W., and Whitney, J. D., Geology of the Lake Superior Land District, Part 2: 32d Cong. spec. sess., S. Ex. Doc. 4, p. 146, 1851.

[36] White, C. A., Geology of Iowa, vol. 1, p. 181, 1870.

from 195 to 215 feet. The formation becomes thinner from north to south across the region. It is believed to rest unconformably on the Galena formation.

The Maquoketa formation in the Alexis quadrangle is correlated with the Maquoketa beds of Iowa because they have identical stratigraphic position and lithologic character. The upper part of the Maquoketa formation of Iowa and northwestern Illinois is correlated with the lower Richmond (Fernvale and Waynesville) of Indiana and Ohio on the basis of fossil evidence.[37] Although three zones within the Maquoketa formation can be recognized in the records of wells in the Alexis quadrangle, they are probably not widely distributed through the State.

Silurian System

INTRODUCTION

The name Silurian, which is applied to a system of rocks that occurs below the "Old Red Sandstone" (Devonian), is derived from Silures, the Roman name for a Celtic tribe who formerly inhabited a region that now includes parts of both England and Wales, where the system is typically exposed.[38] At first the system was divided into the Lower and Upper Silurian subsystems, but the lower division was subsequently recognized as a distinct system and named Ordovician.

The Silurian rocks in Illinois are divided into two series, the Alexandrian and the Niagaran, and a third series, the Cayugan, may be represented. Only the Niagaran series is known to occur in the Alexis quadrangle. The Alexandrian series may also occur but cannot be differentiated in well records.

NIAGARAN SERIES

The name Niagaran was adopted to designate this series because Niagara Falls, which is produced by the passage of Niagara River over a precipitous ledge of the limestone rocks of the series, exhibits the greatest natural development of the series in New York state.[39] Rocks of Niagaran age outcrop extensively in northeastern, northwestern, and southwestern Illinois and in adjacent parts of Wisconsin, Iowa, and Missouri. They underlie most of the State, being absent only where they have been eroded after diastrophic elevation exposed them at the surface. They are present under all of the Alexis quadrangle and surrounding area.

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[37] Savage, T. E., Richmond Rocks of Iowa and Illinois: Amer. Jour. Sci., 5th ser., vol. 8, pp. 411-427, 1924.

[38] Murchison, R. I., On the Silurian system of rocks: London and Edinburgh Philos. Mag. and Jour. Sci., 3d ser., vol. 7, pp. 46-52, July, 1835.

[39] Hall, James, Report of the Survey of the fourth geological district: Natural History of New York, part 4, Geology of New York, vol. 4, p. 80, 1843.

The rocks of this series in the upper Mississippi Valley are assigned to the Lockport subseries and have been subdivided into the Joliet, Waukesha, Racine, and Port Byron formations.[40] But these formations cannot be satisfactorily differentiated in well records, so all the Silurian rocks in the Alexis quadrangle and vicinity are treated as a single combined Niagaran unit. They consist of massive, gray, fine-grained, crystalline dolomite and dolomitic limestone, in which there is more or less chert and some pyrite.

According to well records in the Alexis quadrangle, the Niagaran rocks vary in thickness from 125 to 200 feet, but in the vicinity of Rock Island, north of the Alexis quadrangle, they range in thickness from 276 to 375 feet, and at Monmouth, south of the Alexis quadrangle, their thickness is only 40 to 58 feet. It is thus apparent that the Niagaran series in this region thins rapidly from north to south.

The Niagaran rocks rest unconformably on the Maquoketa formation, but the relatively uniform thickness of the Maquoketa formation suggests that there are only slight irregularities on its upper surface. They are in turn overlain unconformably by the Devonian system, and the great range in their local thickness represents the relief that exists on the upper surface of the Niagaran series.

The Niagaran rocks in this quadrangle are correlated with other Niagaran rocks of Illinois on the basis of identical stratigraphic position and similar lithologic characteristics.

Devonian System

INTRODUCTION

The name Devonian was proposed for this group of rocks because they are typically exposed in Devonshire, England.[41] The term was substituted for a much older name, "Old Red Sandstone", because rocks other than sandstone were discovered to be its equivalent in many localities.

Except in localities where they have been removed by erosion, Devonian rocks are presumed to underlie all of that portion of Illinois that lies south of Green River (Rock Island to La Salle) and southwest of a line drawn southeast from La Salle through Danville. They crop out in limited areas only along the outer border of this region—Hardin County and Alexander, Union, and Jackson counties in southern Illinois; Jersey and Calhoun counties in southwestern Illinois; and Rock Island and Henry counties in northwestern Illinois.

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[40] Savage, T. E., Silurian rocks of Illinois: Bull. Geol. Soc. America, vol. 37, pp. 513-534, 1926.

[41] Sedgwick, Rev. A., and Murchison, R. I., Geol. Soc. London Proc., vol. 3, No. 63, pp. 121-123, abstract, 1839.

——————, On the physical structure of Devonshire, and on the subdivisions and geological relations of the older stratified deposits, etc: Geol. Soc. London Trans., 2d ser., vol. 5, pt. 3, pp. 701-702, 1840. (Read April 24, 1839.)

The Devonian system has been subdivided into Lower, Middle, and Upper Devonian subsystems. The Devonian rocks of northwestern Illinois, which are well exposed along both banks of Mississippi and Rock Rivers in the vicinity of Rock Island, Illinois, belong to the Upper Devonian subsystem[42] and are divided into two formations, the Wapsipinicon and the Cedar Valley.[43]

SENECAN SERIES

WAPSIPINICON AND CEDAR VALLEY FORMATIONS

The Wapsipinicon formation was so named because exposures of the whole formation occur along Wapsipinicon River in Iowa,[44] and the Cedar Valley formation is so designated because it was first studied along Cedar River, also in Iowa.[45] As it is impossible to distinguish these formations in well records, they are described together in this report.

Both formations consist principally of massive and thin beds of limestone, some of which are shaly and some of which are dolomitic; some of the beds are coarsely crystalline. Thin beds of shale are also reported, and chert is locally abundant. The combined thickness of the formations ranges from 100 to 200 feet.

A horizon of porous limestone 20 to 25 feet thick, reported as a "blue sand" in all wells which have been drilled to it, is the source-bed of water for numerous wells in the quadrangle (Appendix C, wells 32-84). This horizon may be the basal portion of the Devonian strata; it may be the upper weathered portion of the Niagaran series; it may be a combination of the two; or it may be only an irregular horizon or a series of porous lenses in both Devonian and Silurian strata, in which case it possesses no stratigraphic import.

The marked thinning of the Niagaran series from north to south across the area from Rock Island to Monmouth indicates that an erosional unconformity intervenes between the Silurian and Devonian systems. If the porous zone be the base of the Devonian strata, its varied elevations indicate that the unconformity had considerable relief.

The Devonian strata in the Alexis quadrangle are correlated with the Devonian strata exposed about 30 miles north of the quadrangle.[46] They are also correlated with the Tully formation of New York, the lowest forma-

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[42] Savage, T. E., Devonian formations of Illinois: Am. Jour. Sci., 4th ser., vol. 49, pp. 181-182, 1920.

[43] Savage, T. E., and Udden, J. A., The geology and mineral resources of the Edgington and Milan quadranges: Illinois State Geol. Survey Bull. 38C, pp. 24-28, 1921; Bull. 38, pp. 136-140, 1922.

[44] Norton, W. H., Notes on the lower strata of the Devonian series in Iowa: Iowa Acad. Sci. Proc. 1893, vol. 1, pt. 4, pp. 22-24, 1894.

[45] Owen, D. O., Report of a geological survey of Wisconsin, Iowa, and Minnesota and incidentally of a portion of Nebraska Territory, 1852.

[46] Savage, T. E., and Udden, J. A., Geology and mineral resources of the Edgington and Milan quadrangles: Illinois State Geol. Survey, Bull. 38C, pp. 24-28, 1921; Bull. 38, pp. 136-141, 1922.

tion of the Upper Devonian subsystem.[47] The fauna of these limestones indicates that the Devonian seas in this area were connected with the Arctic and Pacific oceans, probably by way of the McKenzie River and the northern Great Plains.

Mississippian System

INTRODUCTION

The term Mississippian was proposed and is used by most North American geologists as a geographical designation for this system of rocks because they are so largely developed in the basin of Mississippi River.[48] The name Carboniferous, which means "coal-bearing", has been long used[49] and is retained as a system term by some American and by European geologists, who refer to rocks equivalent to the Mississippian system as "Lower Carboniferous".

The Mississippian system, like the Devonian system, is distributed over that portion of Illinois that lies south and southwest of a line drawn east from Rock Island to La Salle and thence southeast to Danville. It is divided into two subsystems; the Lower Mississippian, which includes the Kinderhook, Osage, and Meramec series; and the Upper Mississippian, which consists of the Chester series. The Upper Mississippian subsystem and the Meramec series of the Lower Mississippian subsystem are not represented in the Alexis quadrangle.

KINDERHOOK SERIES

The name Kinderhook was proposed to include the beds lying between the "Black Slate" and the Burlington limestone[50] because the series as such was first examined at Kinderhook, Illinois.[51]

The series underlies all of the Alexis quadrangle except a small area in the west central portion from which it has been removed by erosion. In southwestern Illinois it has been divided into five formations—the Grassy Creek shale, the Saverton shale, the Louisiana limestone, the Hannibal formation, and the Chouteau limestone[52]—but farther north the Louisiana and Chouteau limestones disappear and the Grassy Creek and Saverton shales become a single unit designated the Sweetland Creek shale.[53] The Sweetland Creek and the Hannibal formations only are present in the Alexis quadrangle.

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[47] Idem.

[48] Winchell, A., On the geological age and equivalents of the Marshall group: American Philos. Soc. Proc. vol. 11, No. 81, p. 79, 1869; No. 83, pp. 245 and 385, 1870.

[49] Conybeare. W. D., and Phillips, W., Outlines of the geology of England and Wales, pp. vii, 278, and 320-364, 1822.

[50] Meek, F. B., and Worthen, A. H., Note (p. 288) to "Remarks on the age of the Goniatite limestone at Rockford, Indiana, and its relations to the "Black Slate" of the western states, and to some of the succeeding rocks above the latter" (pp. 167-177): Am. Jour. Sci. and Arts, 2d ser., vol. 12, 1861.

[51] Meek, F. B., and Worthen, A. H., Geol. Survey of Illinois, vol. 1, Geology, p. 111, 1866.

[52] Moore, R. C., Early Mississippian formations in Missouri: Missouri Bureau of Geol. and Mines, 2d ser., vol. 21, pp. 33-76, 1928.

[53] Idem, p. 36.

SWEETLAND CREEK FORMATION

The Sweetland Creek formation is so named because its relations are best exhibited along Sweetland Creek in Muscatine County, Iowa.[54] It underlies all except the southwest part and other local areas of the Alexis quadrangle, from which it has been eroded. The formation constitutes the lower part of a thick shale series that lies between the Devonian limestones and the Burlington (Lower Mississippian) limestone. It is brownish-gray or gray in color, and in many layers the tiny spore-cases of a fern-like plant named *Sporangites huronense,* occur in great abundance.

The precise thickness of the Sweetland Creek formation can not be determined everywhere in the quadrangle, because in well records the formation can not be differentiated from the overlying Hannibal shale and higher Pennsylvanian shales unless samples of cuttings have been preserved and are available for study. Well records (Appendix C) reveal that the formation is absent in the west central part of the quadrangle and that 130 feet of it intervenes between Devonian limestone and Pennsylvanian strata at Aledo. At Monmouth, six miles south of the quadrangle, the lower 190 feet of a 280-foot shale horizon between Devonian and Mississippian limestones is assigned to the Sweetland Creek formation on the basis of a study of samples of well cuttings. If this be assumed the normal full thickness of the formation in the general area, a similar thickness probably occurs at some places in the Alexis quadrangle, as for instance in the SE. corner NE. ¼ NE. ¼ sec. 29, T. 12 N., R. 2 W. (Spring Grove Twp.), where the driller's record of a farm well reveals 210 feet of shale at the same horizon.

In this area the Sweetland Creek shale apparently rests conformably on the underlying Cedar Valley limestone but in Iowa an unconformity intervenes between them, and farther south in Illinois and in Missouri the Sweetland Creek formation or its equivalent, the Grassy Creek formation, overlaps strata ranging downward from Devonian to Middle Ordovician in age.[55] The change from limestone (Cedar Valley) to shale (Sweetland Creek) in the Alexis area reflects the unconformable relations elsewhere. So far as known, the Sweetland Creek formation conforms with the overlying Hannibal formation where both formations occur. This condition exists only in the south part of the Alexis quadrangle; in other parts of the quadrangle and in areas adjacent to such parts the Sweetland Creek formation is overlain unconformably by Pennsylvanian strata or Pleistocene deposits. The variation in thickness of the Sweetland Creek formation and its unconformable relations with Pennsylvanian and Pleistocene formations are consequences of both post-Mississippian, pre-Pennsylvanian and post-Pennsylvanian, pre-Pleistocene erosion.

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[54] Udden, J. A., Geology of Muscatine County: Iowa Geol. Survey Ann. Rept. 1898, vol. 9, p. 291, 1899.

————, The Sweetland Creek beds: Jour. Geol., vol. 7, p. 67, 1899.

[55] Moore, R. C., Op. cit., p. 34.

The Sweetland Creek formation in the Alexis quadrangle is directly correlated with the type Sweetland Creek formation in Iowa, on the basis of identical stratigraphic position and similar lithologic character. It has been also considered the equivalent of the Grassy Creek shale in northeastern Missouri; the Mountain Glen shale in Union County, Illinois; the Chattanooga shale in Kentucky and Tennessee; and the "Chattanooga" shale in southwestern Illinois, southern Missouri, and Arkansas. Formerly all of these local developments of a supposedly equivalent formation were considered to be of Late Devonian age, but more recently many geologists have presented evidence[56] that they are actually Early Mississippian in age.

HANNIBAL FORMATION

The name Hannibal was applied to this formation because typical outcrops of it occur near Hannibal, Missouri.[57] The formation occurs in practically the same portion of the State in which the Devonian system and Sweetland Creek formation occur. It underlies only the south part of the Alexis quadrangle and outcrops at a few localities in T. 12 N., R. 3 W. (Sumner Twp.), and T. 12 N., R. 2 W. (Spring Grove Twp.). It is the oldest formation exposed in the quadrangle.

In its type locality the Hannibal formation consists of sandstone ("Vermicular") and shale, and elsewhere in Iowa, Missouri, and Illinois it includes a magnesian limestone member,[58] but as seen in exposures and in samples of well cuttings and as reported in well records in the Alexis quadrangle it is a light gray or greenish-gray, soft, non-fossiliferous clay-shale without hard bands. Its color and the absence of *Sporangites* distinguish it from the underlying Sweetland Creek shale. One of the best exposures of the Hannibal shale in the Alexis quadrangle is in a road-cut on the south side of Henderson Creek, at the SW. corner sec. 2, T. 12 N., R. 3 W. (Sumner Twp.), where about 8 feet of the shale is exposed.

The normal full thickness of the Hannibal shale in this region is slightly more than 100 feet, as revealed by well records. At Monmouth, six miles south of the Alexis quadrangle, the upper 90 feet of the 280-foot shale series between Devonian and Burlington (Mississippian) limestones is assigned to the Hannibal formation, but as a consequence of both post-Missis-

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[56] Moore, R. C., op. cit., including numerous citations to other authors.
Mylius, L. A., Oil and gas development and possibilities in east-central Illinois: Illinois State Geol. Survey Bull. 54, pp. 53-57, 59-65, 1927.
Swartz, Joel H., The age of the Chattanooga shale of Tennessee: Am. Jour. Sci., 5th ser., vol. 7, pp. 24-30, January 1924.
——————, The age of the Big Stone Gap shale of southwestern Virginia: Am. Jour. Sci., 5th ser., vol. 12, pp. 512-531, December 1926.
——————, Chattanooga shale in eastern Tennessee and Virginia (abstract): Bull. Geol. Soc. America, vol. 39, No. 1, p. 201, March 1928.
——————, Devono-Mississippian boundary in Virginia and Tennessee (abstract): Bull. Geol, Soc. America, vol. 40, No. 1, p. 93, 1929.

[57] Keyes, C. R., The principal Mississippian section: Bull. Geol. Soc. America, vol. 3, pp. 283-300, 1892.

[58] Moore, R. C., op. cit., pp. 20-24, 33, 50-60.

sippian, pre-Pennsylvanian and post-Pennsylvanian, pre-Pleistocene erosion the formation thins rapidly to the north and has been removed from all but the south part of the Alexis quadrangle. Only the upper 20 feet of a 210-foot shale series between Devonian limestone and Pennsylvanian sandstone, reported in a farm well in the SE. corner NE. ¼ NE. ¼ sec. 29, T. 12 N., R. 2 W. (Spring Grove Twp.) (Appendix C, well No 26), may be assigned to the Hannibal formation, because: (1) the normal thickness of the Sweetland Creek formation is assumed to be approximately 190 feet, as at Monmouth; (2) there is in this area no unconformity between the Sweetland Creek and Hannibal formations which would suggest a thinning of the Sweetland Creek formation; and (3) the occurrence of Pennsylvanian sandstone overlying Hannibal shale is evidence that post-Mississippian, pre-Pennsylvanian erosion removed all of the Mississippian strata younger than the Hannibal formation and doutbless cut partly into the Hannibal shale itself at this locality.

The Hannibal formation apparently conforms with the Sweetland Creek formation, but the lighter, greenish-gray color and the absence of *Sporangites* in the Hannibal shale suffice to distinguish it from the dark colored, *Sporangites*-bearing Sweetland Creek shale. A disconformity intervenes between the Hannibal formation and the overlying Burlington limestone, but as a consequence of the post-Mississippian, pre-Pennsylvanian and the post-Pennsylvanian, pre-Pleistocene erosions, the Hannibal formation in most of the area in which it underlies the Alexis quadrangle lies unconformably beneath Pennsylvanian and Pleistocene strata. The upper limit of the Hannibal formation is exposed in only two places in the Alexis quadrangle:

Geologic section 1.—Small gully near middle of north line of sec. 30, T. 12 N., R. 2 W. (Spring Grove Twp.)

	Thickness *Feet*
Mississippian system	
Burlington formation	
3. Chert, crinoidal	1
2. Limestone, purple or buff	2
Hannibal formation	
1. Shale, blue-gray, soft	4½

Geologic section 2.—Small gully in the SE. ¼ SE. ¼ sec 22, T. 12 N., R. 2 W. (Spring Grove Twp.)

	Thickness *Feet*
Pennsylvanian system	
Pottsville formation	
2. Sandstone, coarse-grained and thick bedded, and conglomerate containing fragments of Burlington limestone and chert	3+
Mississippian system	
Hannibal formation	
1. Shale, blue-gray, soft	1+

The Hannibal shale in the Alexis quadrangle is correlated with the Hannibal formation of western Illinois on the basis of similar lithologic characteristics and similar stratigraphic position.

OSAGE SERIES

The name Osage was proposed to designate one of three major paleontological subdivisions of the Mississippian system,[59] and presumably refers to Osage River in southwestern Missouri, which cuts through the series.[60] The series includes four formations—Fern Glen, Burlington, Keokuk, and Warsaw. Neither the typical Fern Glen formation nor its better-developed limestone equivalent in western Illinois, which has been recently designated the Sedalia formation,[61] have been recognized in the Alexis quadrangle, although the purple color of the limestone member in geologic section No. 1 is characteristic of the Fern Glen formation. The Keokuk and Warsaw formations are absent in the quadrangle. Apparently they were removed by pre-Pennsylvanian erosion.

BURLINGTON FORMATION

The Burlington formation was so named because excellent exposures of it occur at Burlington, Iowa.[62] The formation as typically developed underlies all of western Illinois south of Mercer County. It underlies only a very small area along the south edge of Alexis quadrangle, as it crops out only along the banks and in tributary gullies of a small stream along the north side of the NE. ¼ sec. 30, T. 12 N., R. 2 W. (Spring Grove Twp.), and is recorded in only a single well which is located nearby in the SE. corner of sec. 19, same township. This occurrence is believed to mark the northern limit of the present distribution of the Burlington formation. The presence of fragments of Burlington limestone and chert in the basal Pennsylvanian conglomerate suggests that the Burlington formation originally extended over all of the quadrangle but was removed by pre-Pennsylvanian erosion.

The Burlington formation is a gray, coarsely crystalline, very fossiliferous limestone. Fragments of crinoids constitute such a large proportion of the calcareous material composing the limestone that it has been long recognized as the "Crinoidal" or "Encrinital" limestone. It contains much chert in concretions and discontinuous bands, and most of the Burlington material exposed at the one outcrop in the Alexis quadrangle is chert, in which there are many traces of fossils. The internal casts of shells have been removed by solution, and the surfaces of the resulting hollow external molds are lined with fine crystals of calcite.

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[59] Williams. H. S., Correlation papers—Devonian and Carboniferous: U. S. Geol. Survey Bull. 80, p. 169, 1891.

[60] Keyes, C. R., Geological formations of Iowa: Iowa Geol. Survey, vol. 1, pp. 59-60, 1892.

[61] Moore, R. C., op. cit.

[62] Hall, James, Observations upon the Carboniferous limestones of the Mississippi Valley: Am. Jour. Sci., 2d ser., vol. 23, p. 190, 1857.

The single outcrop of the formation in the quadrangle exposes only 3 feet of limestone and chert, but before it was truncated by pre-Pennsylvanian erosion the formation was probably 150 to 200 feet thick.

The Burlington limestone appears to overlie the Hannibal shale conformably. It is also conformable with the overlying Keokuk formation wherever both formations occur. But in the Monmouth quadrangle to the south the Burlington formation is overlain by Pennsylvanian strata with a marked erosional unconformity between them. The Burlington limestone in the Alexis quadrangle is the basal part of the formation.

The formation is correlated with the typical Burlington limestone on the basis of its identical stratigraphic position and lithologic character. It is also doubtless equivalent to a portion of the beds which occur in southern Illinois and adjacent states and which have been designated by various local names but are correlated with the whole Osage series.

Pennsylvanian System

INTRODUCTION

The term Pennsylvanian was proposed as a synonym for the terms "Upper Carboniferous" and "Coal Measures,"[63] because excellent exposures of the coal-bearing rocks were first thoroughly studied in the State of Pennsylvania. Like the term Mississippian, it has been recognized only as a series term by the United States Geological Survey and it has not been generally adopted in Europe.

Rocks of the Pennsylvanian system underlie all except the north part, west border, and south end of Illinois and occupy what is familiarly known as the "Illinois Coal Basin" (fig. 1). They underlie all of the Alexis quadrangle except T. 12 N., R. 3 W. (Sumner Twp.) and parts of T. 13 N., R. 3 W. (Ohio Grove Twp.), T. 12 N., R. 2 W. (Spring Grove Twp.), and T. 13 N., R. 2 W. (Suez Twp.), where they were removed by preglacial erosion. Basal Pennsylvanian shales cannot be distinguished from the Hannibal and Sweetland Creek shales in records of borings unless samples of the well cuttings are available for study.

Pennsylvanian strata in the Alexis quadrangle rest unconformably on the Burlington limestone, Hannibal shale, Sweetland Creek shale, and perhaps the Cedar Valley limestone (Pl. II). The base of the Pennsylvanian is exposed in only one outcrop. (Geologic section 2, p. 44.) Wherever Pennsylvanian strata occur in the Alexis quadrangle, they are overlain unconformably by glacial drift of Pleistocene age.

The sub-Pennsylvanian surface in the Alexis quadrangle is markedly irregular. (Pl. II.) Some pre-Pennsylvanian river channels approximately

[63] Williams, H. S., The geology of Washington County: Arkansas Geol. Survey Ann. Rept. for 1888, vol. 4, p. xiii, 1891.

100 feet deep are known to exist, and the shale-filled depressions on the Devonian limestone surface (fig. 39) may be also pre-Pennsylvanian channels, although the shale can not be positively identified as Pennsylvanian. A pre-Pennsylvanian highland, reflecting the superior resistance of the Burlington limestone, existed just south of the quadrangle and a spur of it projected northward into the southwest portion of the quadrangle. A general lowland excavated in the weaker Sweetland Creek and Hannibal shales occupied most of the quadrangle. When the Pennsylvanian sea transgressed the area, it submerged the channels and lowlands first and covered them for some time before the highlands were submerged. Basal Pennsylvanian sediments at all localities in the quadrangle therefore are necessarily not of the same age.

The Pennsylvanian system consists of shales, sandstones, underclays, coals, limestones, and conglomerates, listed in order of abundance. Its maximum known thickness in the Alexis quadrangle is about 250 feet, as determined by borings in sec. 8, T. 14 N., R. 2 W. (Greene Twp.), but its average thickness is much less.

SUBDIVISIONS

The Pennsylvanian system in Illinois is divided into three formations—Pottsville, Carbondale, and McLeansboro—which, according to paleobotanical evidence,[63a] are approximately equivalent respectively to the Pottsville, Allegheny, and Conemaugh formations in the Appalachian province. The paleobotanical data reveal that all Pennsylvanian strata between and including coals No. 2 (Murphysboro) and No. 6 (Herrin) and possibly No. 7 (Danville) in Illinois belong in the Allegheny formation,[63a] but thus far they do not reveal the precise horizons at which the upper and lower boundaries of the formation may be drawn, except that the lower (Pottsville-Allegheny) limit occurs somewhere between the base of the Murphysboro (No. 2) coal and the "fireclay" series that is commercially exploited at various places in the State.[63b] Consequently the local names Carbondale and McLeansboro were adopted in place of Allegheny and Conemaugh, and for convenience the boundaries between the formations were arbitrarily drawn respectively at the base of the underclay beneath the Murphysboro (No. 2) coal at first[63c] and later at the base of the coal itself[63d] and at the top of the Herrin (No. 6) or Danville (No. 7) coal.[63c, 63d] Further paleobotanical, paleontological,

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63a White, David, Report of the field work in the coal districts of the State: Illinois State Geol. Survey Bull. No. 4 (Year-Book for 1906), pp. 201-203, 1907.
White, David, Report on field work done in 1907: Illinois State Geol. Survey Bull. No. 8 (Year-Book for 1907), pp. 268-272, 1908.
White, David, Paleobotanical work in Illinois in 1908: Illinois State Geol. Survey Bull. No. 14 (Year-Book for 1908), pp. 293-295, 1910.

63b White, David, Paleobotanical work in Illinois in 1908: Illinois State Geol. Survey Bull. No. 14 (Year-Book for 1908), p. 294.

63c Shaw, E. W., and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Murphysboro-Herrin folio (No. 185), p. 6, 1912.
Udden, J. A., and Shaw, E. W., U. S. Geol. Survey Geol. Atlas, Belleville-Breese folio (No. 195), p. 4, 1915.
Hinds, Henry, U. S. Geol. Survey Geol. Atlas, Colchester-Macomb folio (No. 208), p. 5, 1919.
Shaw, E. W., U. S. Geol. Survey Geol. Atas, New Athens-Okawville folio (No. 213), p. 4, 1921, and Carlyle-Centralia folio (No. 216), p. 4, 1923.

and stratigraphic investigations now in progress may provide data by which the formation boundaries may be accurately determined.

The Pennsylvanian rocks in the Alexis quadrangle belong to the Pottsville and Carbondale formations and are so designated on the geologic map (Pl. I). They are separated at the base of a coal bed that is correlated with the Colchester coal in western Illinois, which in turn has been considered to be the equivalent of the Murphysboro (No. 2) coal.

During the geological survey of the Alexis quadrangle, a natural grouping of the Pennsylvanian strata was noted, due to the fact that the same succession of beds is repeated several times, each sequence being demarcated at least locally by unconformities both below and above (Pl. II). In this report the Pennsylvanian system is discussed in accordance with this grouping, but the definition of the standard classification is preserved. A succession of sequences in the Peoria quadrangle had been noted earlier[63e] and additional investigations carried on by the author and other men over a considerable portion of western Illinois since the Alexis area was studied show not only that the typical sequences occur commonly but also that the various members within the sequences, even very thin ones, are remarkably persistent. The possible importance of repeated sequences in the interpretation of Pennsylvanian stratigraphy is indicated by the fact that they can be recognized in other states, where it has also been shown that individual members of such sequences are traceable over wide areas. For instance, in Nebraska and adjacent states about 150 individual strata, some of them only a few inches thick, have been distinguished and recognized as continuous over extensive areas.[63f] A similar situation exists in Ohio.[63g] The sequences are interpreted as each representing the record of sedimentation within a cycle of time, part of which is occupied by uplift and erosion.[63h]

In this report the term suite is used to designate each of the natural sequences. Numbers are herein applied to the suites, but after more extended studies have revealed the most typical outcrops of each suite it will probably prove desirable to supplant the numbers with names derived from

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[63d] Shaw, E. W., and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Springfield-Tallula folio (No. 188), p. 3, 1913.

Lee, Wallace, U. S. Geol. Survey Geol. Atlas, Gillespie-Mt. Olive folio (No. 220), p. 3. 1926.

Lines, Edwin F., Stratigraphy of Illinois with reference to Portland-cement material: Chap. IV; Portand-cement resources of Illinois: Illinois Geol. Survey Bull. No. 17, pp. 73-74, 1912.

All later publications of the Illinois State Geol. Survey.

[63e] Udden, J. A., Geology and mineral resources of the Peoria quadrangle, Illinois: U. S. Geol. Survey Bull. No. 506, pp. 47-50, 1912.

[63f] Condra, G. E., The stratigraphy of the Pennsylvanian system in Nebraska: Nebraska Geol. Survey, Vol. I, second series, 1927.

Condra, G. E., Dunbar, C. O., and Moore, R. C., Persistence of thin beds in the Pennsylvanian of the northern midcontinent region (abstract): Preliminary list of titles and abstracts of papers to be offered at the 42nd annual meeting of the Geol. Soc. America, 1929.

[63g] Consult various bulletins published recently by the Ohio State Geological Survey.

[63h] Udden, J. A., Op. cit.

Weller, J. Marvin, Cyclical sedimentation of the Pennsylvanian period and its significance: Jour. of Geol. vol. 38, No. 2, February-March, 1930.

Moore, Raymond C., Sedimentation cycles in the Pennsylvanian of the northern midcontinent region (abstract): Preliminary list of titles and abstracts of papers to be offered at the 42nd annual meeting of the Geol. Soc. America, 1929.

the localities at which such outcrops occur. Suites II and IV in the following table are typical and comprise, from bottom to top, a sandstone or sandy shale, an underclay, a coal, a black laminated shale, a limestone, and a gray shale. The sandstone, sandy shale, underclay, and coal are believed to have been formed under continental conditions; the black laminated shale, limestone, and gray shale are marine deposits.

The author has found that in western Illinois suites II and IV are widespread; that suites I and III are composite; and that there are additional suites not represented in the Alexis quadrangle. Therefore the enumeration in this report represents the status of these investigations and the views of the author at the time that the geological survey of the Alexis quadrangle was completed.

Generalized geologic section of Pennsylvanian strata in the Alexis quadrangle

	Thickness *Feet*
Carbondale formation	
Suite V.	
d. Clay or shale	5
c. Coal	½
b. Underclay	5
a. Pleasantview sandstone	0–50+
Suite IV.	
h. Gray shale	0–1
g. Dark limestone, concretionary	½±
f. Gray shale with septarian calcareous concretions	5–10
e. Black laminated shale, concretionary	1
d. Soft gray shale (Francis Creek shale)	0–9
c. Colchester (No. 2) coal	1–2½
Pottsville formation	
b. Underclay, sandy	4–5
a. Sandstone or shale, concretionary locally	2–8
Suite III.	
c. Gilchrist shale	20–100
b. Undifferentiated sandstonc, shale, underclay, and coal	10–20
a. Sandstone, with chert in base locally	0–25
Suite II.	
g. Gray shale	1–4
f. Shaly limestone	1–20
e. Hard blue limestone, locally nodular in upper part	1–3
d. Black laminated shale or soft clay, concretionary	0–4
c. Rock Island (No. 1) coal, with local parting	0–5
b. Sandy underclay	0–4
a. "Stigmarian" sandstone	2–7
Suite I.	
a. Undifferentiated sandstones, shales, and underclays, with thin beds of limestone and coal	50–80+

POTTSVILLE FORMATION

The name Pottsville was first applied to the basal conglomeratic series of the Pennsylvanian strata.[64] The name presumably was derived from the town of Pottsville, Pennsylvania. In Illinois it is used as a formation name for the lower part of the Pennsylvanian system, which consists principally of sandstones, shales, conglomerates, and underclays, and in which coal beds are few and of minor commercial value.

Most of the Pennsylvanian rocks exposed in the Alexis quadrangle belong to the Pottsville formation. The best exposures of the Pottsville strata occur along the tributaries of Edwards River and Pope Creek in T. 14 N., R. 2 W. (Greene Twp.) and T. 14 N., R. 3 W. (Mercer Twp.) and near

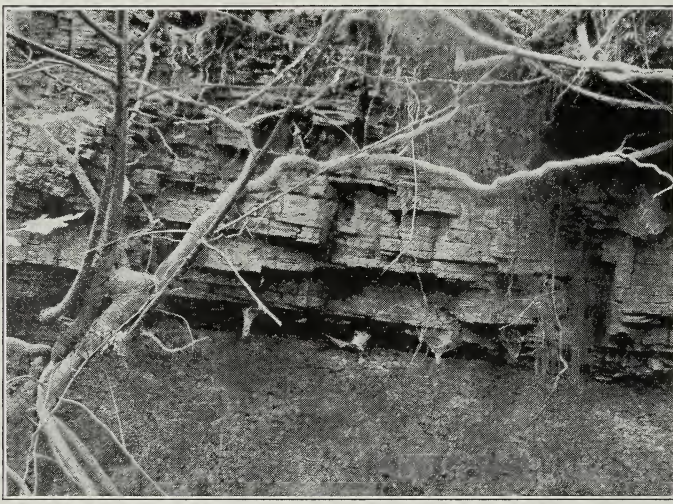


Fig. 10. Workable bed of coal in Suite I of the Pottsville formation, exposed in a gully near Pope Creek, SE. ¼ SW. ¼ sec. 33, T. 14 N., R. 2 W. (Greene Twp.). The coal bed is 27 inches thick.

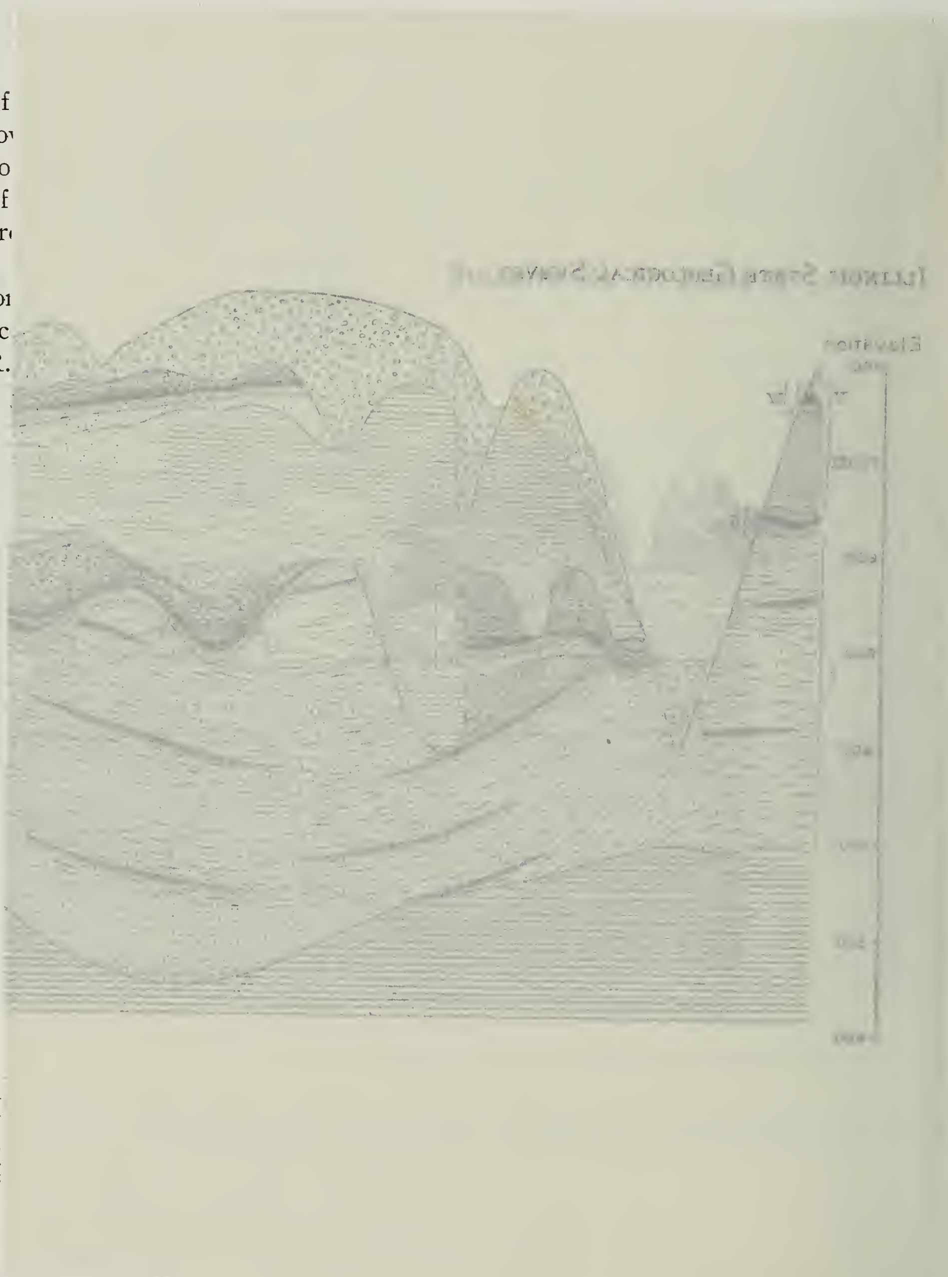
Henderson Creek in T. 12 N., R. 2 W. (Spring Grove Twp.) (Pl. I). The maximum known thickness of the Pottsville formation in the quadrangle is 220 feet, as determined from borings in the SW. ¼ NW. ¼ sec. 8, T. 14 N., R. 2 W. (Greene Twp.).

The Pottsville formation is subdivided into three suites and part of a fourth as follows: I—Strata below the "Stigmarian" sandstone; II—Strata between the base of the "Stigmarian" sandstone and a marked unconformity

[64] Platt, W. G., and Platt, F., Report on progress in the Cambria and Somerset district of the bituminous coal fields of Western Pennsylvania; Part I, Cambria: Second Geol. Survey of Pennsylvania, Report of Progress H H, p. xxvi, 1877.

above the Rock Island (No. 1) coal; III. Strata between the unconformity

The coal is also well exposed about a mile and a half farther east:



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[64] Platt, W. G., and Platt, F., Report on progress in the Cambria and Somerset district of the bituminous coal fields of Western Pennsylvania; Part I, Cambria: Second Geol. Survey of Pennsylvania, Report of Progress H H, p. xxvi, 1877.

above the Rock Island (No 1) coal; III—Strata between the unconformity above the Rock Island (No. 1) coal and the top of the Gilchrist shale; IV—Strata above the top of the Gilchrist shale.

SUITE I—STRATA BELOW THE "STIGMARIAN" SANDSTONE

These strata, which constitute the lower part of the Pottsville formation, are exposed at numerous places along Edwards River and the lower portions of its tributaries in T. 14 N., R. 3 W. (Mercer Twp.), and T. 14 N., R. 2 W. (Greene Twp.); along Pope Creek in secs. 32 and 33, T. 14 N., R. 2 W. (Greene Twp.); and along Henderson Creek in sec. 14, T. 12 N., R. 2 W. (Spring Grove Twp.).

The strata consist of sandstones, shales, underclays, and thin beds of coal and limestone. (Geologic sections Nos. 3, 4, 5, 6, 8, 11, and 12.) The characteristics of the lower portion of Suite I in the Alexis quadrangle are not well known, as it is not exposed in this area.

A coal bed 2 to 2½ feet thick, which is known from drill records to be 9 to 15 feet below the Rock Island (No. 1) coal in the vicinity of a mine in the SW. ¼ sec. 32, T. 14 N., R. 2 W. (Greene Twp.), is locally persistent along the south bank of Pope Creek in secs. 32 and 33, T. 14 N., R. 2 W. (Greene Twp.) (fig. 10).

Geologic section 3.—Composite of two outcrops along Pope Creek; NW. ¼ SW. ¼ sec. 32, T. 14 N., R. 2 W. (Greene Twp.)

	Thickness *Feet*	*Inches*
Pleistocene system		
9. Loess and glacial drift	(not measured)	
Pennsylvanian system		
Pottsville formation		
Suite II.		
8. Sandstone, hard, cherty ("Stigmarian"?)	2	
Suite I.		
7. Clay, underclay, white	4	
6. Covered	6	
5. Limestone, blue, hard, evenly bedded, sparingly fossiliferous		8
4. Coal, fairly hard	2	6
3. Underclay, sandy, gray; lower part blue-gray	5	6
2. Clay, sandy, gray	4	
1. Shale, blue-gray, containing ironstone concretions	9	

The coal is also well exposed about a mile and a half farther east:

Geologic section 4.—Outcrop on the south side of Pope Creek and in an adjacent gully about 200 yards southeast of the middle of sec. 33, T. 14 N., R. 2 W. (Greene Twp.)

	Thickness Feet	Inches
Recent and Pleistocene systems		
20. Soil and glacial drift	(not measured)	
Pennsylvanian system		
Pottsville formation		
Suite III.		
19. Sandstone, gray to olive-gray, micaceous, medium to massively bedded; contains traces of fossil roots, possibly *Stigmaria*, and some carbonaceous matter; becomes shaly and finely laminated at base	5	10
18. Coal		1½
17. Clay, sandy, purplish-gray		4
16. Clay, sandy, gray, blocky fracture, rusty; contains impressions of fossil roots	2	
15. Clay, gray to yellowish-gray, blocky fracture; becomes laminated at base	2	6
Suite II.		
14. Shale, blue, thinly bedded; contains oval, flattened concretions of gray limestone	4	2
13. Coal (Rock Island No. 1)		5
12. Clay, sandy, dark gray, somewhat laminated, micaceous		5
11. Clay, sandy, gray; contains impressions of fossil roots and lenticular streaks of carbonized material, probably roots; locally grades into sandstone 8 to 10 inches thick, containing *Stigmaria;* lower part laminated and basal 6 inches very rusty and apparently calcareous	6	
Suite I.		
10. Shale, dark blue-gray, soft, somewhat flaky; contains "ironstone" concretions and lenses of dark gray sandstone; weathers to clay	6	6
9. Limestone, blue-gray, coarsely grained, fossiliferous, pyritic		10
8. Shale, abundantly carbonaceous, black to brownish-gray, soft		2
7. Coal	1	8
6. Underclay, very sandy, dark blue-gray, blocky; derived from sandstone	1	3
5. Underclay, sandy, light gray, blocky fracture, derived from and grades down into sandstone; thickness varies according to amount of alteration of sandstone	2	6
4. Sandstone, light gray, blocky, contains *Stigmaria*	2	
3. Sandstone, yellow-gray, hard, laminated; contains *Stigmaria* and some carbonaceous matter; some recrystallization of grains	2	
2. Coal, dull, blocky, similar to cannel coal		6
1. Clay, light gray		10

Other thin coal beds are present locally in Suite I in the northwest part of the quadrangle, especially in secs. 9 and 10, T. 14 N., R. 3 W. (Mercer Twp.).

STRATIGRAPHIC RELATIONS

The unconformity between the Pennsylvanian and older systems marks the base of Suite I (Pl. II). An apparent angular and erosional unconformity occurs between Suites I and II, as the sandstones, shales, underclays, coal beds, and limestone layers which compose Suite I are frequently inclined where the overlying strata of Suite II are horizontal, as described below.

Geologic section 5.—Outcrop in gully about 200 feet south of the center of sec. 3, T. 14 N., R. 2 W. (Greene Twp.)

	Thickness *Feet*	*Inches*
Pleistocene system		
18. Glacial drift	(not measured)	
Pennsylvanian system		
Pottsville formation		
Suite III.		
17. Clay, gray, dense	2	
16. Sandstone, light-colored, hard, thin-bedded	2	
Suite II.		
15. Covered	2	
14. Limestone, shaly, blue-gray ("Blue rock")	2	
13. Limestone, dark blue, hard, containing *Fusulinella* sp	1	6
12. "Clod"		2
11. Coal (Rock Island No. 1)	2	8
10. Underclay	1	6
Suite I.		
9. Sandstone, massive	1	6
8. Sandstone, thin-bedded	3	6
7. Sandstone, shaly, fine-grained	1	
6. Sandstone, thin-bedded	8	6
5. Shale, gray	2	
4. Calcareous nodules, elliptical in shape		3
3. Shale, light gray		11
2. Coal "blossom"		1½
1. Shale, sandy, dark gray	1	

The strata numbered 10 to 17 are essentially horizontal, and those numbered 1 to 9 dip 8° to the south (fig. 11).

Geologic section 6.—Outcrop in bank back of a barn 300 feet southeast of the middle of the west line of sec. 5, T. 14 N., R. 2 W. (Greene Twp.)

	Thickness	
	Feet	*Inches*
Recent and Pleistocene systems		
8. Soil and clay	(not measured)	
Pennsylvanian system		
Pottsville formation		
Suite I.		
7. Shale, soft, blue-gray	3	
6. Coal		7
5. Shale, light gray	1	11
4. Shale, black, containing oval calcareous concretions		5
3. Underclay, light gray, containing calcareous concretions	3	
2. Sandstone		2–0
1. Shale, gray-black, including band of 2-inch concretions	2	6

Fig. 11. Inclined sandstone beds of Suite I exposed in a small gully southwest of the center of sec. 3, T. 14 N., R. 2 W. (Greene Twp.). The sheet-like fragments of light colored rock on the left bank are derived from the limestone cap-rock of the Rock Island (No. 1) coal.

All of the Pottsville strata dip approximately 4° southwest, but the "Stigmarian" sandstone which outcrops about 600 feet to the southeast is essentially horizontal. The same unconformable relations are also exposed

(1) for some distance along the west bank of a large creek tributary to Edwards River, near the east edge of the NE. ¼ sec. 11, T. 14 N., R. 3 W. (Mercer Twp.), where the "Stigmarian" sandstone lies horizontal upon tilted beds of sandstone, shale, underclay, and coal belonging to Suite I; and (2) on the north side of Henderson Creek, 250 yards west of the middle of the east line of sec. 14, T. 12 N., R. 2 W. (Spring Grove Twp.), where the Rock Island (No. 1) coal lies horizontal upon 12 feet of sandstone containing a 2-inch coal bed and dipping approximately 12° west.

PALEONTOLOGY AND CORRELATION

The blue limestone (geologic sections 3, member 5 and 4, member 9) is the only bed in Suite I that is known to contain marine invertebrate fossils (Appendix A). Plant impressions are found in some of the shale and sandstone beds. A specimen of *Lepidodendron veltheimianum* Sternberg, a *Lepidodendron* of distinctly Pottsville type, was collected from a massive sandstone exposed in a road-cut along State Highway Route No. 3 south of Edwards River, in sec. 9, T. 14 N., R. 3 W. (Mercer Twp.).

The age of Suite I may be Middle or Late Pottsville. More complete fossil collections are needed before the age can be definitely determined. Suite I appears at the same horizon and is the equivalent of a series of Pottsville strata in Fulton County which have been designated "Spoon River,"[65] because they are well exposed along the river with that name.

SUITE II.—STRATA BETWEEN THE BASE OF THE "STIGMARIAN" SANDSTONE AND THE UNCONFORMITY ABOVE THE ROCK ISLAND (NO. 1) COAL

The strata comprising this suite represent approximately the middle portion of the Pottsville formation in the Alexis quadrangle and constitute a definite succession of beds that can be recognized in widely separated exposures, in contrast to Suite I. The complete succession of beds is (a) "Stigmarian" sandstone, (b) sandy underclay, (c) Rock Island (No. 1) coal, (d) laminated shale, (e) blue limestone, (f) shaly limestone, and (g) shale (Pls. II and III).

LITHOLOGIC CHARACTERISTICS

The following geologic section describes the most complete exposure of the suite in the Alexis quadrangle (see also geologic sections 4, 5, 8, 10, 11, 12, 13, 14, and 16).

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[65] Savage, T. E., Significant breaks and overlaps in the Pennsylvanian rocks in Illinois: Am. Jour. Sci., vol. 14, p. 308, 1927.

Geologic section 7.—Outcrop in gully in the SE. ¼ SE. ¼ sec. 14, T. 12 N., R. 2 W. (Spring Grove Twp.)

	Thickness Feet	Thickness Inches
Pleistocene system		
14. Clay .... (approximately)	5	
Pennsylvanian system		
Pottsville formation		
Suite III.		
13. Sandstone, shaly, thinly bedded, black to yellowish........	7	6
12. Underclay (mostly covered)............................	6	6
11. Shale, carbonaceous, black (horizon of thin coal bed)......		10
10. Sandstone, hard, containing *Stigmaria*..................		4
9. Sandstone, thinly bedded, soft..........................	3	4
8. Chert		0–8
Suite II.		
7. Shale, light gray, hard, silicified........................	1	5
6. Shale, calcareous, dark gray, rather hard................	1	
5. Limestone ("Blue rock"), shaly, blue-gray, slabby, splitting in broad thin plates, highly fossiliferous................	3	6
4. Limestone, hard, nodular, with wavy lines of bedding; blue-gray where fresh, weathering buff; sparingly fossiliferous	1	2
3. Limestone ("Cap-rock"), slabby; blue-gray where fresh, weathering dark gray; contains *Fusulinella* sp..........	1	6
2. Shale, laminated, black, hard (miner's "slate")............	4	
1. Coal (Rock Island No. 1) (total thickness not exposed) .... (reported)	4	

Not far from this exposure a thin gray, sandy clay underlies the coal in some places, and hard, massive, "Stigmarian" sandstone 2 to 5 feet thick is present below the clay, or directly below the coal where the clay is absent. A succession of strata similar in sequence and thickness and at accordant levels with the above geologic section was revealed in a mine shaft on the south side of the road at the head of the same gully, in sec. 23, T. 12 N., R. 2 W. (Spring Grove Twp.).

"Stigmarian" sandstone.—This member is designated the "Stigmarian" sandstone because siliceous casts of *Stigmaria* (the roots of *Lepidodendron* or *Sigillaria*) are particularly abundant in it. It varies in thickness from 2 to 5 feet, and in most places it includes 1 to 3 feet of thinly bedded, light-colored sandstone at its base and a single massive bed of very hard gray sandstone, 1 to 3 feet thick, in its upper part (fig. 12). This sandstone bed forms a small natural bridge over a creek in the SE. ¼ sec. 11, T. 14 N., R. 3 W. (Mercer Twp.), where the Rock Island (No. 1) coal outcrops at about the same level 300 yards farther north.

Excellent specimens of fossil *Stigmaria* may be found in old mine dumps. Although *Stigmaria* fossils are abundant in this sandstone their presence in a sandstone is not sufficient evidence by which it may be correlated with the particular sandstone in this suite, as they commonly occur in many Pennsylvanian sandstones. Fossils of marine invertebrates (Appendix A) are found in a sandstone, presumably the "Stigmarian" sandstone, cropping out below the Rock Island (No. 1) coal along Edwards River in sec. 29, T. 15 N., R. 1 W. (Richland Grove Twp.), about one mile north of the north line of the Alexis quadrangle.

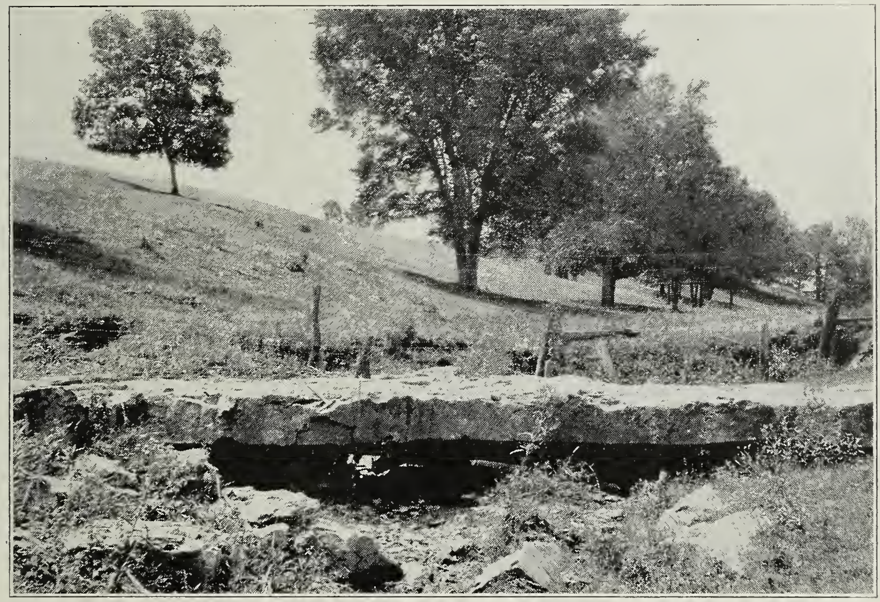


Fig. 12. A resistant ledge of "Stigmarian" sandstone in sec. 11, T. 14 N., R. 3 W. (Mercer Twp.).

Underclay of the Rock Island (No. 1) coal.—In some places in the Alexis quadrangle gray, sandy, slightly sulfurous clay occurs between the "Stigmarian" sandstone and the Rock Island (No. 1) coal. The clay is not known to exceed 4 feet in thickness, and in numerous exposures it is only 1 or 2 inches thick. It is well exposed at the entrance to a drift mine near the center of sec. 3, T. 14 N., R. 2 W. (Greene Twp.).

Rock Island (No. 1) coal.—The Rock Island (No. 1) coal is so designated because it is the principal commercial source of coal in the vicinity of Rock Island, Illinois. It varies from about 1 inch to 5 feet in thickness, but where it is typically developed it has an average thickness of 4 to 4½ feet. It consists of an upper bench of hard shiny coal, 12 to 20 inches thick, and a lower bench of somewhat duller and softer coal, 18 to 36 inches thick, which are separated by a bed of black carbonaceous shale in secs. 4, 5, and 6, T. 14 N., R. 2 W. (Greene Twp.). (Pl. III.) A bed of clay 1 to 4 feet thick appears as a parting in the Rock Island (No. 1) coal along a road-cut 100 yards west of the center of the east line of sec. 11, T. 14 N., R. 3 W. (Mercer Twp.). Pyrite concretions occur either as concretionary layers at various levels or are scattered through the coal. In several mines a pyrite band 1 to 3 inches thick occurs a few inches below the top of the lower bench; in other mines a pyrite band is in the lower part of the upper bench. Some pyrite and calcite are present along the faces of joints in the coal. In areas where only a few feet of limestone and shale intervene between the glacial drift and the Rock Island (No. 1) coal, wide solution cracks in the limestone cap-rock admit water to the coal, so that much white clay or sand has been washed in along minor faults or fissures in the coal bed and forms "clay seams", as the miners call them. The coal for a few feet on either side of these clay seams is much weathered.

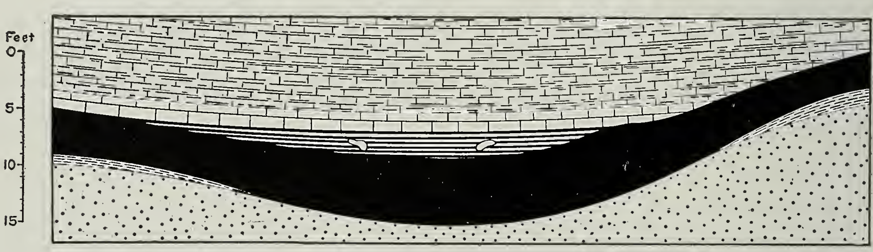


Fig. 13. Diagrammatic sketch representing variation in thickness of the Rock Island (No. 1) coal, the presence or absence and the variation in thickness of the overlying laminated shale, the variations in the "cap-rock" and "blue rock" above, variable thickness and absence of underclay and underlying sandstone in Williams' mine, NW. ¼ NW. ¼ sec. 32, T. 14 N., R. 2 W. (Greene Twp.).

Owing to the undulatory erosional surface on which Suite II lies, the altitude of the Rock Island (No. 1) coal varies greatly, as is evident in mine tunnels where the coal may be traced continuously for some distance. It may vary as much as 15 to 25 feet in a single mine. The coal is generally thicker in the depressions or "sloughs" than it is on the rises or "rolls" (fig. 13). Although the coal occurs in many separate basins, the sequence of strata in all of them is similar.

Black laminated shale.—In most outcrops in the Alexis quadrangle a pasty, carbonaceous clay or "clod" 1 to 3 inches thick forms the roof of the Rock Island (No. 1) coal, but in some mines and in a few outcrops where the coal has a thickness of three feet or more a hard, laminated, black, calcareous and carbonaceous shale or "slate" 1 to 4 feet thick occurs in place of the "clod." The character and thickness of the roof of the coal varies

according to its relation to the depressions or "sloughs," and the rises or "rolls" in the coal. The "clod" is present over the coal in rises, where the shale is absent, but in the depressions black, laminated shale reaches an average thickness of 2 feet and a maximum of 4 feet. When exposed to the air the shale "caves" and the iron sulfide (pyrite or marcasite) in the shale changes to ferrous sulfate.

Large spherical concretions or "niggerheads", composed of carbonaceous mud firmly cemented with calcium carbonate and iron sulfide, occur in the shale in some places where it is thick. Interruption of the even bedding of the shale where these concretions are especially numerous shows that they

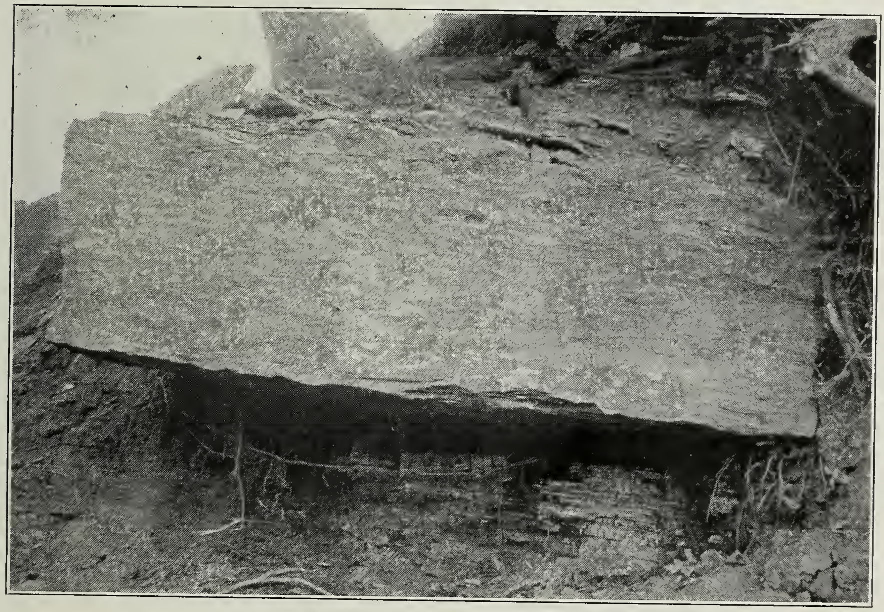
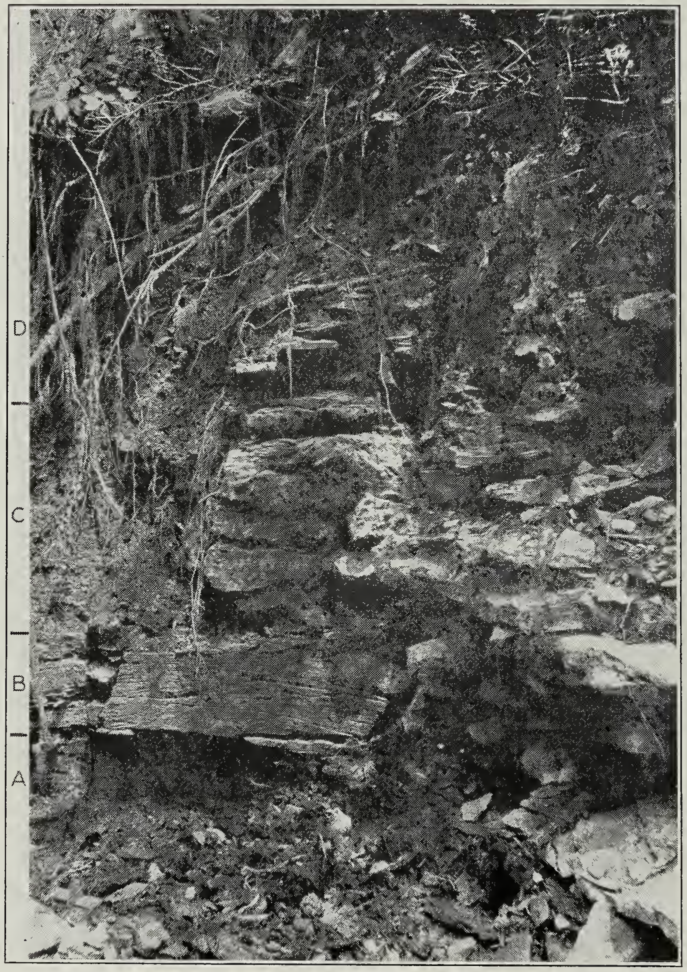


Fig. 14. Massive limestone cap-rock overlying the Rock Island (No. 1) coal near the center of sec. 3, T. 14 N., R. 2 W. (Greene Twp.).

are of secondary development. The concretions were observed in mines and mine dumps in secs. 3, 4, 5, and 6, T. 14 N., R. 2 W. (Greene Twp.). Similar concretions have been reported[66] in sec. 14, T. 12 N., R. 2 W. (Spring Grove Twp.), but none are reported in the mines now being operated in that vicinity. The concretions are conspicuously developed in the J. Snell mine, sec. 6, T. 14 N., R. 2 W. (Greene Twp.), in some parts of which they make the roof of the coal hummocky.

[66] Green, H. A., Geology of Warren County: Geol. Survey of Illinois, vol. 4, Geology and paleontology, p. 292, 1870.

Both the black laminated shale and the hard concretions in it contain marine fossils (Appendix A). Many of the fossils in the shale are crushed and poorly preserved, but perfect fossil shells can be extracted from the concretions. The internal and external casts of the shells in the concretions



LEGEND
A Shaly limestone
C Nodular limestone
B Typical cap-rock
A Laminated shale

Fig. 15. Limestone strata overlying the Rock Island (No. 1) coal in sec. 14, T. 12 N., R. 2 W. (Spring Grove Twp.).

are frequently pyritized. Many species abundant in the concretions have not been discovered in the black shale and conversely a few forms characteristic of the black shale have not been found in the concretions.

Limestone cap-rock.—An evenly bedded, dark blue or gray limestone, 10 inches to 3 feet thick, overlies the laminated shale above the Rock Island (No. 1) coal or rests directly upon the coal where the shale is absent (Pls. II and III, and fig. 13). The limestone weathers buff or brown and com-

LEGEND

D Shale
C Shaly limestone
B "Cap-rock"
A Rock Island (No. 1) coal

Fig. 16. Limestone strata overlying Rock Island (No. 1) coal along the south wall of a creek near the center of sec. 5, T. 14 N., R. 2 W. (Greene Twp.).

monly outcrops as a projecting ledge above the less resistant shale and coal below (fig. 14). It is a relatively pure limestone, much purer than the overlying shaly limestone, and a sample of it when dissolved in dilute hydrochloric acid left only a small residue of argillaceous and ferruginous material, including *Bryozoa* casts. The best exposures of this limestone in the north part of the quadrangle are near the center of sec. 3, T. 14 N., R. 2 W. (Greene Twp.). In the south part of the quadrangle it is best exposed in sec. 14, T. 12 N., R. 2 W. (Spring Grove Twp.), where a hard nodular limestone occurs immediately above typical cap-rock (fig. 15).

Both the usual cap-rock and the locally developed nodular limestone are fossiliferous. (Appendix A.) A *Fusulinella* sp. occurs in the cap-rock at nearly all of its outcrops, but its abundance varies greatly. The small size of the fossils suggests that the fauna is a dwarf fauna.

Shaly limestone ("Blue rock").—A shaly limestone, blue-gray to white in color, ranging in thickness from 1 to 20 feet, occurs above the limestone cap-rock. The shaly limestone splits into plates a few inches thick and a foot or more in diameter. The lower beds are thick, hard, and calcareous; the upper beds are thin and grade into calcareous shale (figs. 16 and 54). In a few exposures the upper beds of this series are buff-colored and chalky. The chalky phase is well shown at the entrance to an abandoned coal drift near the SE. corner SE. ¼ SW. ¼ sec. 14, T. 12 N., R. 2 W. (Spring Grove Twp.).

Large specimens of marine fossils are found throughout the shaly limestone. (Appendix A.) They are somewhat more abundant in the lower, more massive layers than in the upper, shaly layers. The buff-colored chalky limestone is also fossiliferous, but it contains fewer species than are found in the other places. (Appendix A.) Most of the larger fossils have been crushed or flattened by the pressure of the sediments, but in some specimens traces of the original color markings are preserved.

Shale.—At some places in the Alexis quadrangle the shaly limestone grades upward into a gray, nonfossiliferous shale which is never more than 3 feet thick except where the limestone members of the suite are absent (Geologic section 12). At some localities where the shale is overlain unconformably by a chert bed, the upper foot of the shale is hard and gritty as though it were cemented by silica which had filtered in from above.

STRATIGRAPHIC RELATIONS

The angular erosional unconformity that occurs between Suites I and II of Pottsville strata is mentioned above (pp. 53-55). The relief of the erosional surface was so great that the "Stigmarian" sandstone did not fill all the depressions, and the irregularities are reflected in the variation of thickness and altitude of the Rock Island (No. 1) coal, its overlying laminated shale, the limestone cap-rock and even the higher shaly limestone (Pls. II and III and fig. 13). The depressions appear to be old valleys or estuaries.

Suite II is separated from Suite III also by an erosional unconformity, as the basal strata of Suite III are in contact with nearly all of the members of Suite II at one place or another.

CORRELATION

Worthen in 1870[67] made the coal bed outcropping in the west bank of Spoon River near the village of Seville, Fulton County, the type of No. 1 coal in western Illinois. Subsequently the coal of Rock Island and Mercer counties was correlated with the No. 1 coal.[68]

It has been recently contended that the Rock Island coal may be a correlative of No. 6 instead of No. 1 coal,[69] in which case it would be Early McLeansboro instead of Pottsville in age. This contention was based on the facts: (1) that the foraminifer *Fusulinella girtyi,* called *Girtyina ventricosa* in former publications of the Survey and considered a reliable index fossil to the limestone cap-rock of the Herrin (No. 6) coal at the base of the McLeansboro formation in many parts of Illinois, was discovered in abundance in limestones above the Rock Island coal near the village of Andalusia, Rock Island County; and (2) that the succession of beds—"slaty" shale, argillaceous limestone, sandy shale, and sandstone—associated with the Rock Island Coal of Rock Island and northern Mercer County was closely similar to the succession near Buda and Sheffield, Illinois, where the coal has been considered the Herrin (No. 6) coal.[70] The Matherville coal in sec. 27, T. 15 N., R. 2 W. (Preemption Twp.), about one mile north of the Alexis quadrangle, has been correlated with the Herrin (No. 6) coal.[71]

The large collections of fossils (Appendix A) which were gathered from excellent exposures of Pennsylvanian rocks along the tributaries of Edwards River, Pope Creek, and Henderson Creek in the Alexis quadrangle provided a study of the marine fauna more complete than had hitherto been made in this area. Comparison of the faunas with those from other areas in Illinois, Ohio, Kansas, Missouri, Arkansas, Oklahoma, and Texas show that: (1) *Spirifer rockymontana* is nowhere recorded above the Pottsville (or lower Allegheny) formations or their equivalents; and (2) the species *Pro-*

[67] Worthen, A. H., Geology of Fulton County: Geol. Survey of Illinois, vol. 4, Geology and paleontology, p. 94, 1870.

[68] Worthen, A. H., and Shaw, James, Geology of Rock Island County: Geol. Survey of Illinois, vol. 5, Geology and paleontology, p. 221, 229-232, 1873.

[69] Savage, T. E., and Udden, J. A., Geology and mineral resources of the Edgington and Milan quadrangles: Illinois State Geol. Survey Bull. 38C, pp. 3, 37, 1921; Bull. 38, pp. 115, 149, 1922.

Culver, H. E., Pennsylvanian correlation in northwestern Illinois: Bull. Geol. Soc. Amer. vol. 35, pp. 321-328, 1924.

————————, Coal resources of District III (Western Illinois): Illinois State Geol. Survey Coop. Mining Ser. Bull 29, pp. 16-17, 19-20, 1925.

————————. Present status of correlation of Illinois coals: Illinois State Geol. Survey Rept. Inv. No. 14, 1927.

[70] Culver, H. E., Coal resources of District III (Western Illinois): Illinois State Geol. Survey Coop. Mining Ser. Bull. 29, pp. 36-37, 1925.

[71] Savage, T. E., and Udden, J. A., Geology and mineral resources of the Edgington and Milan quadrangles: Illinois State Geol. Survey Bull. 38C, p. 46, 1921; Bull. 38, p. 158, 1922.

ductus nanus, characteristic of the Pottsville formation, has been reported only in Illinois and only from strata older than the shales and limestones above the No. 5 coal. Consequently the older correlation of the Rock Island coal in the Alexis quadrangle with the No. 1 (Pottsville) coal of Fulton County seems to be substantiated.

The discovery of *"Girtyina ventricosa"* in the Rock Island district led to further investigation of its stratigraphic range. Fusulinidae closely resembling this form in external appearance were subsequently found widely distributed in Pottsville, Carbondale, and McLeansboro strata in many parts of the State. A recent restudy[72] of *Fusulina* revealed that forms having similar external appearance, which were formerly identified as *Girtyina ventricosa,* have different internal structures and belong to different genera and species. The name *Fusulinella girtyi* has been restricted to those forms which were originally described as *Girtyina ventricosa.* Specimens of Fusulinidae from the cap-rock of the Rock Island coal in the Alexis quadrangle have been identified[73] as two species of the genus *Fusulinella,* both different in internal structure from *Fusulinella girtyi* and probably both undescribed forms. The wide stratigraphic distribution of the Fusulinidae and the occurrence of various specific forms in the Pennsylvanian strata vitiate the correlation of the Rock Island coal with coal No. 6 solely on the basis of the presence of such forms in the cap-rock.

Abundant field evidence of an unconformity below the Rock Island (No. 1) coal, such as is assumed in adjacent areas, is found in the Alexis quadrangle. It is interpreted as occurring within the Pottsville formation, despite the fact that it is an angular as well as an erosional unconformity. Guide fossils have not yet been found to prove that late Carbondale or McLeansboro sandstones and coal beds overlap the earlier Pennsylvanian strata in any part of the Alexis quadrangle.

All of the limestone beds in Suite I taken together are equivalent to the formation that has been designated the Parks Creek limestone in Fulton County.[74]

SUITE III—STRATA BETWEEN THE UNCONFORMITY ABOVE THE ROCK ISLAND (NO. 1) COAL AND THE TOP OF THE GILCHRIST SHALE

The normal succession of strata in this suite, which varies more than Suite II, is: (a) a basal sandstone; (b) a variable series of sandstones, underclays, shales, and thin coal beds, all of which may be members of several suites, into which this suite may be subdivided as a result of future investigations in adjacent areas; and (c) a thick shale.

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[72] Dunbar, C. O., and Condra, G. E. The Fusulinidae of the Pennsylvanian System in Nebraska: Nebraska Geol. Survey Bull. 2, 2d ser., pp. 76-78, 1927.

[73] Identification made by Mr. Lloyd G. Henbest of the Illinois State Geological Survey.

[74] Savage, T. E., Significant breaks and overlaps in the Pennsylvanian rocks of Illinois: Am. Jour. Sci. vol. 14, pp. 309-310, 1927.

LITHOLOGIC CHARACTERISTICS

The following geologic sections provide good examples of the suite (see also geologic sections 4, 5, 7, and 13-17).

Geologic section 8.—Outcrop in the north-flowing creek in the SE. ¼ sec. 11, T. 14 N., R. 3 W. (Mercer Twp.)

	Thickness Feet	Inches
Pleistocene system		
18. Loess and glacial drift	(not measured)	
Pennsylvanian system		
Pottsville formation		
Suite III.		
17. Shale, gray	18	
16. Calcareous concretions, discoid		3
15. Shale, gray	2	
14. Sandstone	4	6
13. Shale, gray	4	
12. Sandstone, blue-gray, containing plant impressions	3	
11. Shale, gray, containing "ironstone" concretions	2	6
10. Shale, gray	4	6
9. Underclay	2	
8. Coal		3
7. Underclay	2	
6. Sandstone, thinly bedded	2	
Suite II.		
5. Rock Island (No. 1) coal		8–10
4. Shale, gray		6
3. "Stigmarian" sandstone, hard	2	
2. Sandstone, greenish-gray	2	
Suite I.		
1. Coal		6–8

Geologic section 9.—Road-cut south of North Henderson Creek, near the SE. corner sec. 20, T. 13 N., R. 2 W. (Suez Twp.)

	Thickness Feet	Inches
Recent and Pleistocene systems		
12. Loess and drift	25	

	Thickness Feet	Inches
Pennsylvanian system		
Pottsville formation		
Suite III.		
11. Clay, dark blue-gray, slightly laminated; grades into sandy shale below	1	6
10. Shale, sandy, light gray, micaceous, thinly bedded; grades into sandstone below	1	6
9. Sandstone, light gray, micaceous, thinly bedded	2	6
8. Coal, weathered and soft	1	3
7. Clay, very sandy, dark purplish-gray, blocky fracture; contains traces of roots; probably derived from sandstone below		8
6. Sandstone, yellowish-gray, fine grained, micaceous, laminated; some traces of carbonaceous material and of roots	8	
5. Limestone, ferruginous, weathered into band of "ironstone" concretions		2
4. Coal, weathered		5
3. Clay, slightly sandy, purplish-gray, blocky fracture		3
2. Clay, sandy, gray, blocky fracture	3	6
Suite II.		
1. Shale, dark blue-gray, thinly bedded; lighter gray in lower part		10+

Fig. 17. Pottsville strata cropping out along a gully in the center of the SW. ¼ NE. ¼ sec. 33, T. 14 N., R. 3 W. (Mercer Twp.) The hammer marks the irregular contact of sandstone with a 5-inch bed of weathered coal (member 16, geologic section 11) overlying gray underclay.

Geologic section 10.—Pennsylvanian strata in secs. 20 and 21, T. 13 N., R. 2 W. (Suez Twp.)[75]

	Thickness Feet	Inches
Pennsylvanian system		
Pottsville formation		
Suite III.		
6. Coal	trace	
5. Sandsone, or sandy clay	15	
Suite II.		
4. Limestone, impure and shaly	1	4
3. Shale, blue-gray, arenaceous		6–12
2. Coal (Rock Island No. 1)	2	6±
1. Clay (underclay?), blue; partially exposed	—	

Strata below member 5 of this geologic section are no longer exposed, but a few fragments of blue limestone (member 4), which were found near the old drift entrance, resemble the cap-rock of the Rock Island (No. 1) coal.

Geologic section 11.—Outcrop in gully in SW. ¼ NE. ¼ sec. 33, T. 14 N., R. 3 W. (Mercer Twp.) (Fig. 17)

	Thickness Feet	Inches
Pleistocene system		
22. Loess and drift	(not measured)	
Pennsylvanian system		
Pottsville formation		
Suite III.		
21. Sandstone, yellowish, soft	4	
20. Concretions, "ironstone," with septarian structure		10
19. Sandstone, yellow-gray, medium grained, fairly soft, loosely cemented, friable	2	6
18. Concretions, "ironstone," with septarian structure		2
17. Sandstone, yellow-gray, evenly bedded in beds 2-3 inches thick, basal surface slightly uneven; ripple-marked and conglomeratic in a nearby gully	4	
16. Coal		5½
15. Underclay, dark gray		3
14. Underclay, sandy, gray, blocky fracture; contains root impressions	1	10
Suite II.		
13. Underclay, light bluish-gray, blocky fracture; contains some traces of roots at top; bears smooth, blue-gray limestone concretions near base; contains layer of ironstone concre-		

[75] Green, H. A., Geology of Illinois, Mercer County: Illinois Geol. Survey vol. 4, p. 303, 1870.

	Thickness Feet	Inches
tions with pisolitic structure; underclay is probably from shale below	2	6
12. Shale, dark blue-gray; contains thin lenses of light gray sandstone interlaminated with blue shale	2	4
11. Shale, dark blue to black, thinly bedded	1	6
10. Coal (Rock Island No. 1), weathered		5
9. Underclay, sandy, purplish-gray		1
8. Sandstone ("Stigmarian") light gray to yellowish-gray, fine grained, massively bedded in upper part, slabby in lower part; contains root impressions	4	6
Suite I.		
7. Shale, sandy, blue-gray; contains nodules of sand and small concretions of limestone or "ironstone"	2	
6. Coal		½
5. Underclay, purplish-gray, blocky fracture	1	1
4. Underclay, very sandy, blocky fracture	1	
3. Shale, slightly sandy, blue-gray, blocky fracture		8
2. Covered (probably shale)	4	
1. Shale, blue-gray, thinly bedded	10±	

Geologic section 12.—Composite of outcrops along ravine in W. ½ NW. ¼ sec. 22, T. 12 N., R. 2 W. (Spring Grove Twp.)

	Thickness Feet	Inches
Pleistocene system		
20. Loess and drift	20–25	
Pennsylvanian system		
Pottsville formation		
Suite III.		
19. Clay, sandy, white to light gray; may be derived from sandstone below	2	
18. Sandstone, white to light gray, fine grained, regularly bedded in beds ½ to 3 inches in upper part, massive bed near middle	4	
17. Shale, sandy, micaceous, blue-gray, poorly bedded	3	6
16. "Ironstone" concretions, brown, fossiliferous		8
15. Shale, dark gray to black, laminated	1	
14. Coal, undulatory		6
13. Underclay, very sandy, purplish; thicker where coal is highest		5
12. Sandstone, light gray to purplish-gray, very fine grained, nodular, bedded, hard; contains *Stigmaria*	1	6
Suite II.		
11. Clay, very sandy, light gray to gray, blocky fracture; grades down into shale; contains root traces	2	4

		Thickness	
		Feet	*Inches*
10.	Shale, slightly sandy, gray to olive-gray; weathering blue-gray	2	6
9.	Shale, sandy, dark blue, well bedded; contains "ironstone" concretions	8	6
8.	Shale, black, soft		1
7.	Coal (Rock Island No. 1)	1	8
6.	Underclay, sandy, purplish-gray, slightly laminated		3
5.	Underclay, slightly sandy, light gray, rusty on fracture surfaces, blocky fracture	1	
Suite I.			
4.	Clay, dark gray, blocky fracture; grades down into shale		7
3.	Shale, dark blue, thinly bedded	1	10
2.	Sandstone, light gray to yellowish-gray, fine grained, slightly micaceous; contains traces of carbonized plants, probably *Stigmaria*		4
1.	Shale, slightly sandy, dark blue to black, fairly well bedded	2	

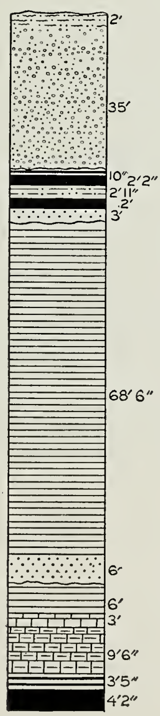


Fig. 18. Graphic log of coal-test boring in the NE. ¼ SE. ¼ sec. 17, T. 14 N., R. 2 W. (Greene Twp.) showing complete sequence of strata between the Rock Island (No. 1) and the Colchester (No. 2) coals.

A shale bed similar to member 16 in the last geologic section and containing many "ironstone" concretions is exposed in the main forks of a large gully about a third of a mile southeast of Center School in the SW. ¼ sec. 22, T. 12 N., R. 2 W. (Spring Grove Twp.). The concretions contain well preserved plant impressions which have been identified as follows: *Sphenophyllum emarginatum* (Brongniart) Koenig, *Calamocladus equisetiformis* (Schlotheim) Schimper, *Annularia sphenophylloides* (Zenker) Gutbier, *Neuropteris rarinveris* Bunbery, *Neuropteris clarksoni* Lesquereux, *Neuropteris crenulata* Brongniart, and *Neuropteris fasciculata* Lesquereux.

A complete succession of strata between the Rock Island (No. 1) and the Colchester (No. 2) coals was also penetrated by a coal-test boring made by the Alden Coal Company near the crossing of the Rock Island Southern

Fig. 19. Massive, cross-bedded sandstone in the center of the NE. ¼ NE. ¼ sec. 7, T. 14 N., R. 2 W. (Greene Twp.). This sandstone is probably the basal member of Suite III or Suite IV and fills a channel cut into Suite II.

Railway and the Chicago, Burlington and Quincy Railway, in the NE ¼ SE. ¼ sec. 17, T. 14 N., R. 2 W. (Greene Twp.) (fig. 18).

Basal sandstone.—The sandstone at the base of Suite III is cross-bedded and ripple-marked and contains an abundance of carbonaceous fragments. It is usually only a few (2 to 7) feet thick, but in some areas it is absent. At some localities a sandstone attaining a thickness of as much as 25 feet, as in a gully near the center of the NE. ¼ NE. ¼ sec. 7, T. 14 N., R. 2 W.

(Greene Twp.), where it fills a channel cut deeply into Suite II (Pl. II and fig. 19), may be the basal or a higher sandstone in Suite III or possibly the basal sandstone of Suite IV. Along the north side of Henderson Creek in the center of the E. ½ sec. 14, T. 12 N., R. 2 W. (Spring Grove Twp.), a 3-inch bed of coarse-grained sandstone, containing abundant spines of *Petrodus occidentalis* and numerous teeth and dermal plates of other fish, overlies the shaly limestone above the Rock Island (No. 1) coal and is immediately overlain by a six-inch bed of sandstone in which carbonized fragments of wood are numerous.

The sandstone cannot be always distinguished from the "Stigmarian" sandstone and other sandstone beds below the Rock Island (No. 1) coal where it rests unconformably on them. An irregular band of chert locally marks the base of the sandstone. The chert follows the line of the uncon-

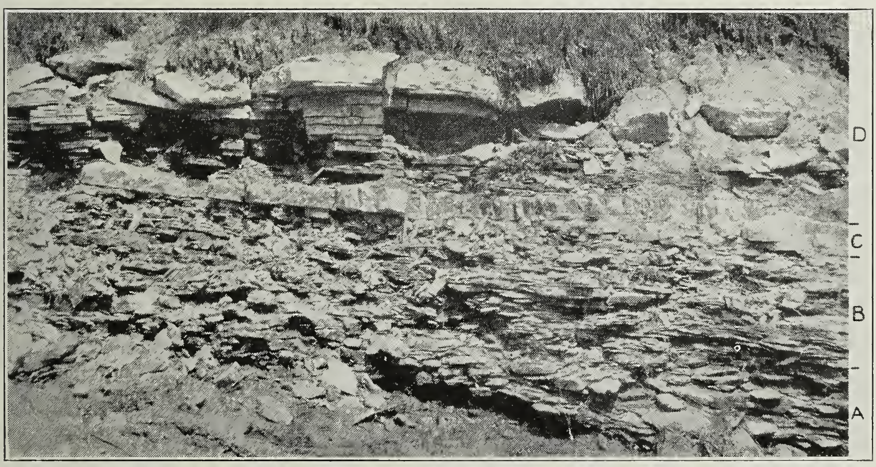


Fig. 20. Exposure of strata about 8 feet above the Rock Island (No. 1) coal in the NW. ¼ sec. 24, T. 12 N., R. 2 W. (Spring Grove Twp.). The 8-inch band of chert (C) separates the shale (B) and shaly limestone (A) ("blue rock") of Suite II below from the thin-bedded sandstone (D) of Suite III above.

formity between Suites II and III and rests on the topmost shale, the shaly limestone, or the limestone cap-rock in Suite II. It is well exposed at several outcrops in secs. 13, 14, and 24, T. 12 N., R. 2 W. (Spring Grove Twp.), where it is 8 to 12 inches thick (fig. 20), and on both sides of Pope Creek in the west part of sec. 32, T. 14 N., R. 2 W. (Greene Twp.).

The following geologic sections exemplify the strata in this series, including the coal beds found near the base:

Geologic section 13.—Outcrop in a gully 200 yards south of old Pleasant Valley mine, in the SW. ¼ SE. ¼ sec. 4, T. 14 N., R. 2 W. (Greene Twp.)

	Thickness Feet	Thickness Inches
Pleistocene system		
8. Loess and glacial drift	(not measured)	
Pennsylvanian system		
Pottsville formation		
Suite III.		
7. Shale, gray	3	
6. Sandstone, light-colored, containing charcoal fragments		4
5. Coal		6–10
4. Underclay	1	
Suite II.		
3. Shale, gray, blue-gray, or brown	6–8	
2. Limestone, shaly ("Blue rock")	10	
1. Limestone, blue ("Cap-rock")	1	2

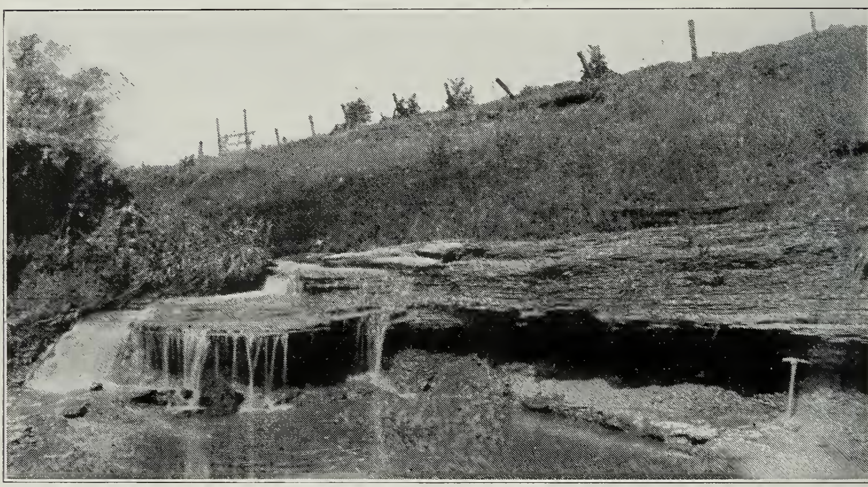


Fig. 21. A bed of shell marl in the lower part of Suite III, exposed in a small creek in the NW. ¼ sec. 24, T. 12 N., R. 2 W. (Spring Grove Twp.). It overlies a thin coal seam (marked by hammer) about 30 feet above the Rock Island (No. 1) coal, which in turn overlies underclay.

Geologic section 14.—Gully below the Richardson Mine; NW. ¼ sec. 24, T. 12 N., R. 2 W. (Spring Grove Twp.)

	Thickness Feet	Thickness Inches
Pennsylvanian system		
Pottsville formation		
Suite III.		
8. Sandstone, buff-colored, thinly bedded, containing abundant poorly preserved pelecypods; grades down into sandy shell marl in which there are charcoal fragments (fig. 21)	2	6
7. Coal		8

	Thickness Feet	Inches
6. Underclay, sandy, light-colored	2	6
5. Sandstone, massive		7
4. Sandstone, thinly bedded	1	6
3. Chert, gray		7
Suite II.		
2. Shale, siliceous, gray, hard	2	6
1. Limestone, shaly ("Blue rock")	—	

The coal in the above section is reported to be two feet thick in an adjacent coal-test boring.

Gilchrist shale.—This shale constitutes the greater part of Suite III as exposed in the eastern part of the quadrangle. It is micaceous in some beds, is blue-gray to greenish in color, and contains plant impressions irregularly distributed. Its thickness varies from 20 to 30 feet to more than 100 feet. Its complete thickness is penetrated by a coal-test boring (fig. 18) near Gilchrist, sec. 17, T. 14 N., R. 2 W. (Greene Twp.), for which reason the name Gilchrist is here proposed as a designation for the shale. The shale is well exposed in the pits of the Hydraulic Press Brick Company at Shale City, sec. 8, T. 14 N., R. 2 W. (Greene Twp.), and of the Northwestern Clay Manufacturing Company at Griffin, sec. 4, T. 14 N., R. 1 W. (Rivoli Twp.):

Geologic section 15.—Pit of the Hydraulic Press Brick Company at Shale City, sec. 8, T. 14 N., R. 2 W. (Greene Twp.)

	Thickness Feet	Inches
Pleistocene system		
16. Loess	14	
15. Till (Illinoian)	7	
Pennsylvanian system		
Carbondale formation?		
Suite IV?		
14. Shale, slightly sandy, greenish-gray, finely laminated; contains "ironstone" concretions	12	
13. Shale, blue-gray	2	
12. Clay, brownish, containing plant impressions		1½
11. Coal, weathered (Colchester No. 2?)		4–8
Pottsville formation		
10. Shale, dark, containing plant impressions	2	
9. Coal		½
8. Shale, dark gray, containing poorly preserved plant impressions		3
7. Shale, blue-gray, soft		8
6. Shale, sandy, blue-gray		7

	Thickness Feet	Inches
5. Sandstone, micaceous, yellowish, fine-grained	1	3
4. Shale, bluish, rather hard, laminated		11
3. Sandstone		3
Suite III.		
2. Shale, micaceous, blue-gray, evenly bedded, thicker bedded and harder than shales above; occasional layers contain well-preserved plant impressions	27	6
1. Shale, greenish-gray, laminated and thinner bedded than overlying shale	6	

Test borings in and near the pit penetrate immediately below the floor of the pit 80 feet of shale similar to that exposed in the pit.

Geologic section 16.—Pits of the Northwestern Clay Manufacturing Company, sec. 4, T. 14 N., R. 1 W. (Rivoli Twp.), ¼ mile east of the Alexis quadrangle

	Thickness Feet	Inches
Pleistocene system		
12. Loess and till (geologic section 27, p. 101)	—	
Pennsylvanian system		
Pottsville formation		
Suite III.		
11. Shale, gray, weathering to buff	10–15	
10. Shale, blue; contains scattered plant impressions, most abundant near base	20	
9. Clay, calcareous, blue, hard, containing numerous gypsum crystals	2–4	
8. Coal (local)		6
7. Underclay, gray	8	
6. Underclay, white, and other rock	3±	
Suite II.		
5. Limestone, shaly ("Blue rock")		11
4. Limestone, blue ("Cap-rock")		2
3. Rock Island (No. 1) coal	2	4
2. Underclay, sandy	1–0	
1. Sandstone, irregularly bedded, pyritic	—	

The foreman of the plant reported the character and approximate thickness of beds 1-6 as revealed in an abandoned drift mine.

STRATIGRAPHIC RELATIONS

At some localities the basal bed of Suite III rests with apparent conformity on the topmost shale of Suite II, but in most places an erosional unconformity intervenes between the two suites (Pl. II). The best exposure of the unconformable relations is in a road-cut on the west side of a large ravine near the SE. corner NE. ¼ sec. 11, T. 14 N., R. 3 W. (Mercer Twp.). The magnitude of this unconformity is sufficient that the basal beds of Suite III may lie on any member of Suite II or even on some horizon in Suite I. This shows that various amounts of the upper part or all of Suite II were removed by erosion before Suite III was deposited. (Geologic section 8, p. 65.) Neither the Rock Island (No. 1) coal nor its overlying limestone beds are present in many outcrops or are recorded in logs of test borings, and in some places the coal thins from four feet to a few inches or becomes completely absent within a lateral distance of a few hundred yards. For instance, the coal and associated beds outcrop at about the level of the bottom and within 200 yards of the Hydraulic Press Brick Company pit in sec. 8, T. 14 N., R. 2 W. (Greene Twp.), but they are entirely absent at the pit, as shale is reported for 80 feet below the pit. In at least two mines near the pit, the coal was reported to be "cut off by a fault". In the NE. ¼ NE. ¼ sec. 7, T. 14 N., R. 2 W. (Greene Twp.), within half a mile of the pit, a massive development of a cross-bedded sandstone occurs at the level of the Rock Island (No. 1) coal and associated beds.

The unconformity in this position occurs also in the Edgington, Milan, and Avon quadrangles,[76] and elsewhere in western Illinois.

An unconformity exists between Suites III and IV (Pl. II). The relation between the Gilchrist shale and the Colchester (No. 2) coal is best shown along a gully tributary to North Pope Creek, north of the middle of sec. 26, T. 14 N., R. 2 W. (Greene Twp.).

Geologic section 17.—Outcrops in a gully in the SW. ¼ NW. ¼ sec. 26, and SE. ¼ NE. ¼ sec. 27, T. 14 N., R. 2 W. (Greene Twp.)

	Thickness Feet	Inches
Pleistocene system		
11. Loess and till	—	
Pennsylvanian system		
Carbondale formation		
Suite IV.		
10. Limestone, fossiliferous, containing septarian concretions that form a nearly solid ledge		8
9. Shale, dark gray, soft	2	
8. Shale, black, hard, laminated, containing small calcareous concretions which give pitted or pimply appearance to bedding surfaces	2	
7. Colchester (No. 2) coal	2±	

[76] Savage, T. E., and Udden, J. A., Geology and mineral resources of the Edgington-Milan quadrangles: Illinois State Geol. Survey Bull. 38C, pp. 49-51, 1921; Bull. 38, pp. 161-163, 1922.
Savage, T. E., Geology and mineral resources of the Avon and Canton quadrangles: Illinois State Geol. Survey Bull. 38B, pp. 22-23, 1921; Bull. 38, pp. 226-227, 1922.
————, Significant breaks and overlaps in the Pennsylvanian rocks of Illinois: Am. Jour Sci. vol. 14, p. 311, 1927.

	Thickness Feet	Inches
Pottsville formation		
6. Underclay, white, containing a few silicified roots extending down from coal	5±	
5. Shale, sandy, and sandstone, thinly bedded	2–5	
Suite III.		
4. Shale, gray, containing calcareous concretions at various levels	18	
3. Shale, reddish	1	
2. Shale, gray, containing large, flattened, ovoid concretions at some levels	21±	
1. Sandstone, massive	—	

PALEONTOLOGY AND CORRELATION

Invertebrate fossils have been found only in the sandy marl roof of a thin coal near the base of the suite, in sec. 24, T. 12 N., R. 2 W. (Spring Grove Twp.) (Geologic section 14, p. 72). All of the pelecypod forms in the fauna appear to belong to one species, but the specimens are so poorly preserved that they can not be accurately determined. Fossil plants occur commonly in the shales at various horizons and are occasionally found in the sandstones. Fossil plants from the pit of the Hydraulic Press Brick Company plant (members 2 and 10, geologic section 15), were identified as *Sigillaria ovata* Sanveur, *Sigillaria brardi* Brongniart, *Pecopteris miltoni* Artis, and *Pecopteris vestita* Lesquereux. Fossil plants from the pit of the Northwestern Clay Manufacturing Company (member 10, geologic section 16) were *Sphenophyllum emarginatum* (Brongniart) Koenig, *Annularia radiata* (Brongniart) Sternberg, *Annularia sphenophylloides* (Zenker) Gutbier, *Stigmaria ficoides* (Sternberg) Brongniart, and *Neuropteris ovata* Hoffman. These flora include few Pottsville types but are similar to the flora associated with the No. 2 coal of northeastern Illinois.[77]

The basal sandstone of Suite III occupies the same stratigraphic position, and its unconformable relations with Suite II are similar to those of a sandstone in Fulton County, where the name Bernadotte was applied[78] to the member because it is well developed near the town of Bernadotte. The two members may be correlative. The rest of Suite III occupies the same stratigraphic position and has lithologic characteristics similar to those of a series of strata in Fulton County[79] which were designated by the name Avon, because they are well developed in the vicinity of the town of Avon.

[77] Noé, A. C., Pennsylvanian flora of Northern Illinois: Illinois State Geol. Survey Bull. 52, pp. 13-15, 1925, and personal communication.
[78] Savage, T. E., Significant breaks and overlaps in the Pennsylvanian rocks of Illinois: Am. Jour. Sci. vol. 14, p. 309, 1927.
[79] Idem.

SUITE IV

As only the lower two members of Suite IV occur in the Pottsville formation and most of the suite occurs in the Carbondale formation, the entire suite is discussed under the latter topic.

UNDIFFERENTIATED POTTSVILLE STRATA

The precise stratigraphic position of some Pennsylvanian strata exposed in the Alexis quadrangle can not be determined because their relations to recognizable horizons are not apparent. Most of such strata can be identified as belonging in the Pottsville formations.

BASAL CONGLOMERATE

Conglomerate composed chiefly of fragments of Burlington limestone and chert is exposed in a gully in the NW. ¼ SE. ¼ SE. ¼ sec. 22, T. 12 N., R. 2 W. (Spring Grove Twp.), and along the south side of Maids Run at the west side of sec. 12, T. 13 N., R. 3 W. (Ohio Grove Twp.), where rounded cobbles of chert and quartz are slightly cemented together. At the locality first cited the conglomerate lies on the Kinderhook shale and so marks the base of the Pennsylvanian strata. But it cannot be correlated either as the base of Suite I or with other basal Pennsylvanian beds, because the basal Pennsylvanian bed at any specific locality represents only the material first deposited along the margin of the Pennsylvanian sea as it submerged successively higher portions of the pre-Pennsylvanian land surface. Nor can such basal conglomerates be correlated with the beds of the same age deposited farther from the shores of the Pennsylvanian sea because the lithology of such beds differs radically.

CONGLOMERATIC SANDSTONE

A sandstone which is cross-bedded, exhibits ripple marks and raindrop impressions, and contains calcareous and "ironstone" concretions, and includes two conglomeratic layers in which the fragments are Burlington limestone and chert, is best exposed in an old quarry in the W. ½ sec. 19, T. 13 N., R. 2 W. (Suez Twp.) (fig. 22).

Geologic section 18.—Old quarry in the W. ½ SW. ¼ sec. 19, T. 13 N., R. 2 W. (Suez Twp.)

	Thickness *Feet*
Pleistocene system	
6. Glacial drift	(not measured)
Pennsylvanian system	
Pottsville formation	
5. Sandstone, heavy-bedded	3
4. Conglomerate, rather soft, weathered, containing chert pebbles	1
3. Sandstone, massive	4
2. Conglomerate, as above	3
1. Sandstone, massive	5

This sandstone is probably in Suite I but may belong in one of the other suites. It is at approximately the same level as the coal (member 8, geologic section 9) two miles east.

CARBONDALE FORMATION

The Carbondale formation is so named because it is well exposed in the vicinity of the town of Carbondale in Jackson County, Illinois.[80] It comprises the strata between the base of the Murphysboro (No. 2) coal and the

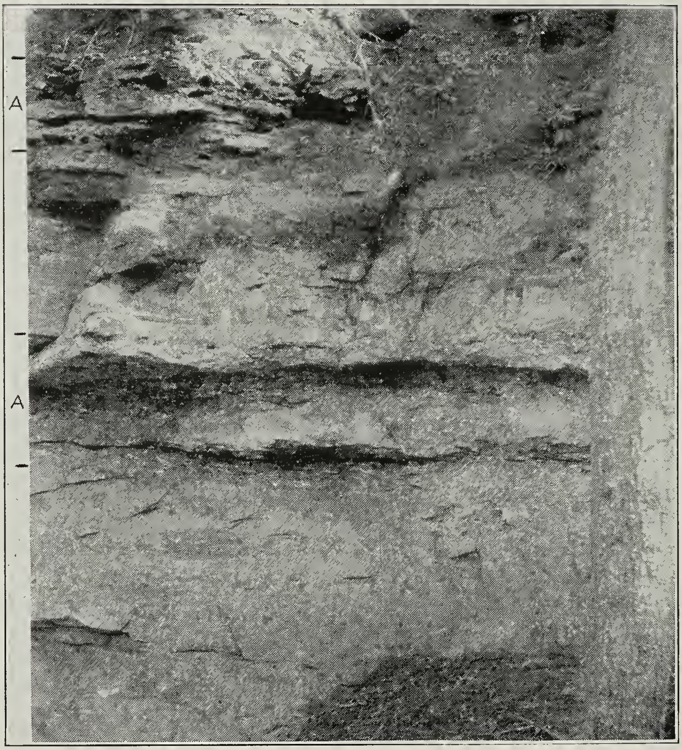


Fig. 22. Sandstone exposed in an old quarry along the south side of North Henderson Creek in the W. ½ SW. ¼ sec. 19, T. 13 N., R. 2 W. (Suez Twp.). The bands marked "A" are conglomeratic layers.

top of the Herrin (No. 6) coal, and consists of shales, sandstones, thin limestones, and most of the important coal beds of Illinois. It includes most of Suite IV and all of Suite V that is exposed in the Alexis quadrangle.

[80] Shaw, E. W., and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Murphysboro-Herrin folio (No. 185), p. 6, 1912.

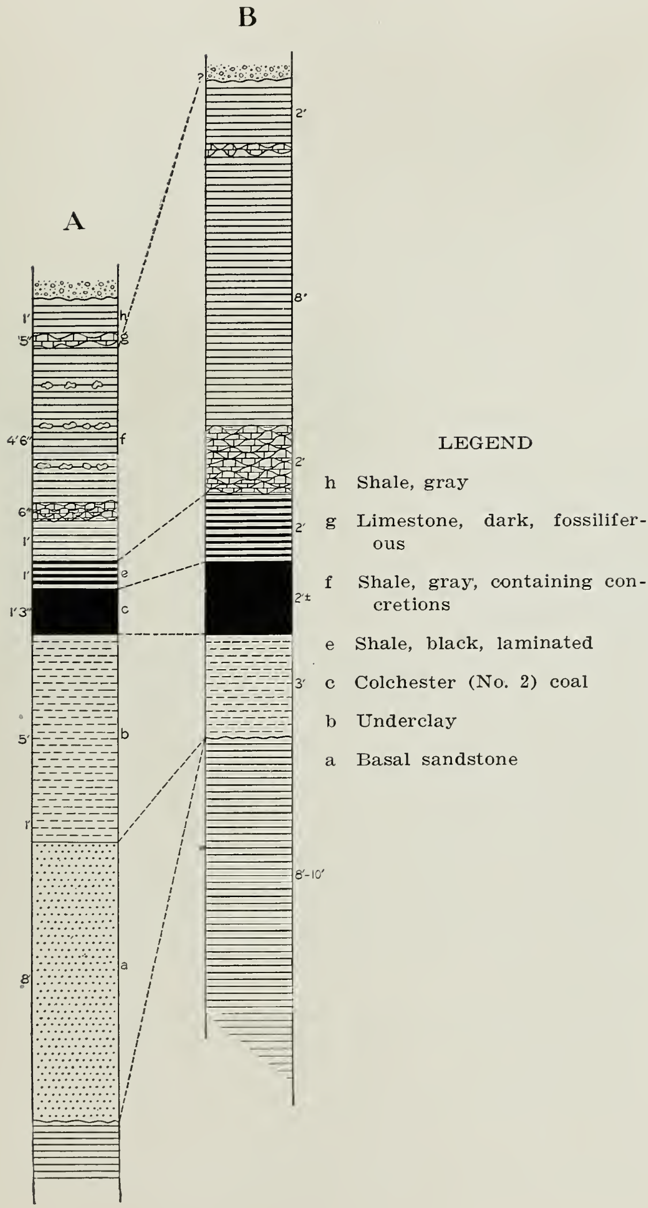


Fig. 23. Graphic representations of outcrops of Suite IV, Colchester (No. 2) coal and associated strata, in (A) NW. ¼ SW. ¼ sec. 23, T. 14 N., R. 2 W. (Greene Twp.) and (B) center of the E. ½ NE. ¼ sec. 30, T. 12 N., R. 1 W. (Kelly Twp.).

SUITE IV.—STRATA BETWEEN THE TOP OF THE GILCHRIST SHALE AND THE BASE OF THE PLEASANTVIEW SANDSTONE

LITHOLOGIC CHARACTERISTICS

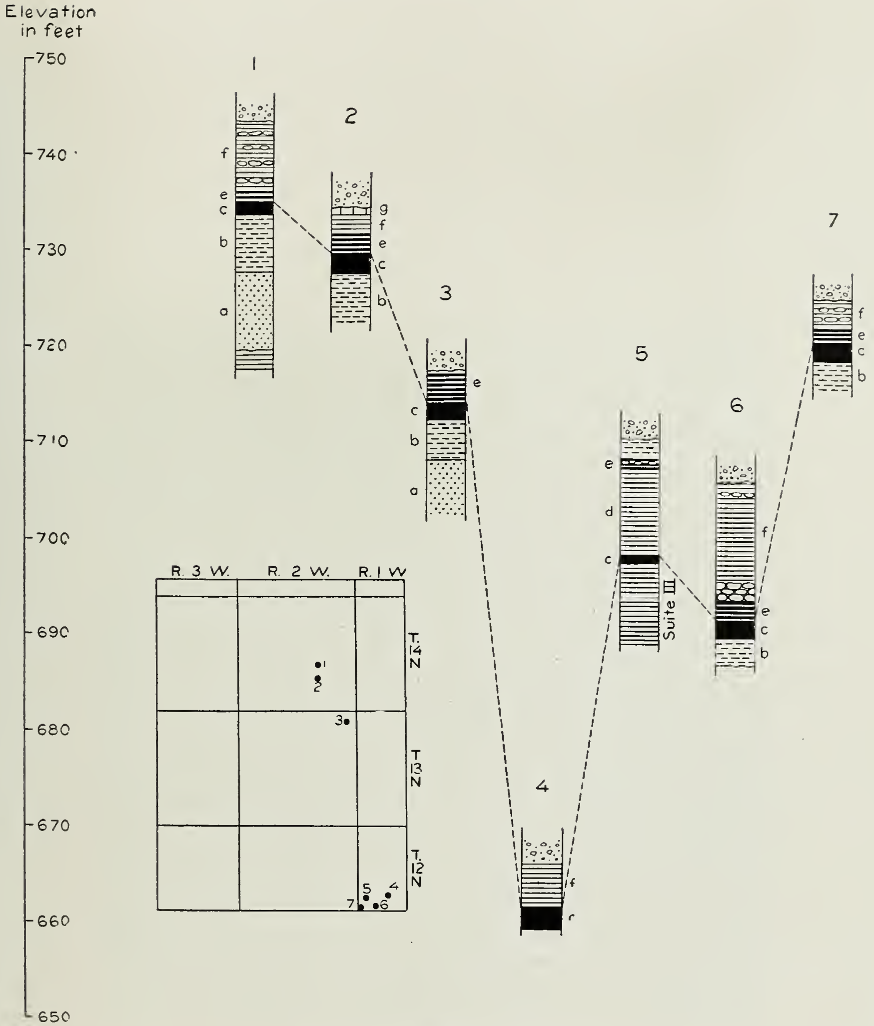
The typical succession of strata in this suite is as follows: (a) sandstone; (b) underclay; (c) Colchester (No. 2) coal; (d) gray soft shale (not always present); (e) black laminated shale containing concretions; (f) gray shale containing two or three levels of fossiliferous concretions; (g) dark, brownish, fossiliferous limestone; and (h) gray shale. (Fig. 23.) (Geologic sections 15, 17, and 19.)

Geologic section 19.—Outcrop in gully, NW. ¼ SW. ¼ sec. 23, T. 14 N., R. 2 W. (Greene Twp.) (Fig. 23A)

	Thickness Feet	Inches
Pleistocene system		
12. Loess and till	(not measured)	
Pennsylvanian system		
Carbondale formation		
Suite IV.		
11. Shale, gray, soft	1	
10. Limestone, brown, concretionary, very fossiliferous		5
9. Shale, gray, soft, containing flattened, septarian, fossiliferous, calcareous concretions at two or three horizons in lower part	4	6
8. Limestone concretions, gray, septarian, fossiliferous, in gray fossiliferous shale		6
7. Shale, gray, soft	1	
6. Shale, black, laminated, nodular, containing a few large calcareous and pyritic concretions and small calcareous concretions in which plant fragments are preserved	1	
5. Colchester (No. 2) coal, hard, uniform, strongly pyritic	1	3
Pottsville formation		
4. Underclay, strongly sulfurous, containing silicified roots	5	
3. Underclay, sandy, containing hard, spherical, gray, septarian concretions	1	
2. Sandstone, light, thinly bedded	8	
Suite III.		
1. Gilchrist shale, gray, soft	—	

The succession and thicknesses of the members of Suite IV vary considerably at different localities in the quadrangle (fig. 24).

Sandstone.—The basal sandstone of Suite IV is known to be as much as 15 feet thick. It is well exposed in a gully in the NE. ¼ SW. ¼ sec. 1, T. 13 N., R. 2 W. (Suez Twp.), where it is soft, thinly bedded, yellowish



LEGEND

g Limestone, dark, fossiliferous
f Shale, gray, containing concretions
e Shale, black, laminated
d Shale, gray, soft
c Colchester (No. 2) coal
b Underclay
a Basal sandstone

Fig. 24. Graphic representations of outcrops of Suite IV, Colchester (No. 2) coal and associated strata in the Alexis quadrangle, showing variation in altitude, succession, and thickness of the members. Numbers refer to locations shown on index map and to detailed descriptions given in Appendix B, Part II.

in color, and contains calcareous concretions as much as 8 or 10 feet in maximum diameter and slightly more than 3 feet thick, around which the beds of the sandstone appear to bend. Similar hard, gray, calcareous concretions occur in a sandstone (fig. 25) exposed in secs. 32 and 33, T. 14 N., R. 1 W. (Rivoli Twp.) and sec. 6, T. 13 N., R. 1 W. (North Henderson Twp.). As large calcareous concretions were observed in no other Pennsylvanian sandstone they may be locally indicative of this particular horizon. At some places they are as much as 6 or 7 feet thick and entirely displace the sandstone. A thick, cross-bedded sandstone with a little gravel at its base

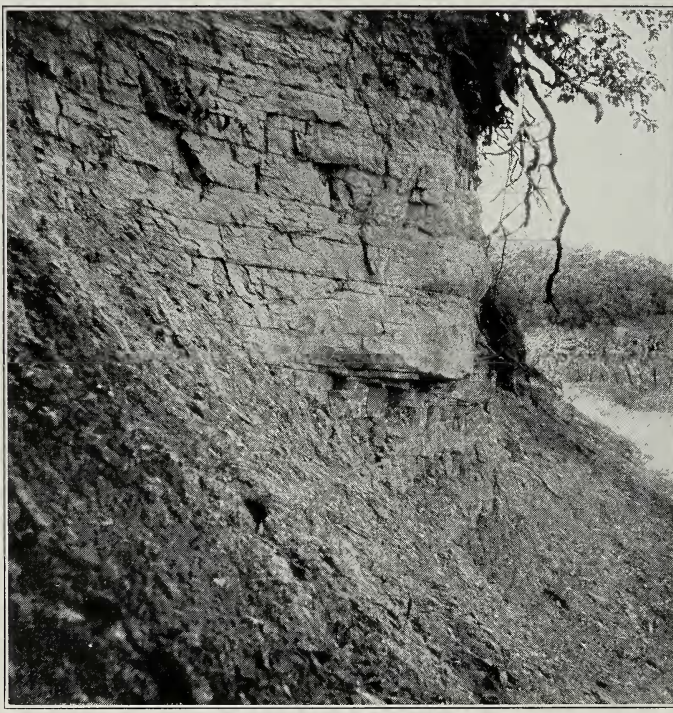


Fig. 25. Hard, massive, calcareous sandstone exposed along Pope Creek near the south edge of sec. 32, T. 14 N., R. 1 W. (Rivoli Twp.). It is the basal member of Suite IV and lies probably thirty feet below the Colchester (No. 2) coal.

forms bluffs about 11 feet high on each side of a gully in the SE. corner of the SW. ¼ sec. 19, T. 12 N., R. 1 W. (Kelly Twp.) (fig. 26). Soft, micaceous, cross-bedded sandstone that crops out along creeks in the S. ½ sec. 24, and near the center of sec. 23, T. 12 N., R. 2 W. (Spring Grove Twp.), only 35 to 40 feet above the Rock Island (No. 1) coal, may be the basal sandstone of Suite IV or may be the Pleasantview sandstone of Suite

V. In two exposures in sec. 30, T. 12 N., R. 1 W. (Kelly Twp.) the underclay below the Colchester (No. 2) coal lies on a soft, blue-gray shale resembling the Gilchrist shale (fig. 23B).

Underclay.—The clay which underlies the Colchester (No. 2) coal is sandy, light-colored, and sulfurous. It is usually 4 or 5 feet thick. Large, hard, septarian concretions occur in the lower part of the clay, and silicified roots of trees occur in the upper part below the coal. Some of these roots are hollow and contain doubly-terminated quartz crystals. The clay lies

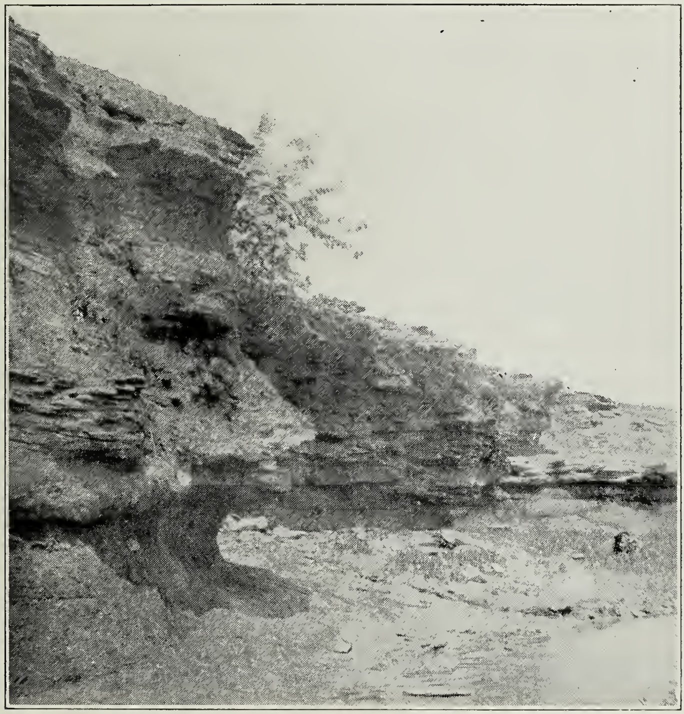


Fig. 26. The basal cross-bedded sandstone of Suite IV in the SW. ¼ sec. 19, T. 12 N., R. 1 W. (Kelly Twp.). The bluffs are about eleven feet high.

above the basal sandstone wherever the sandstone is found; elsewhere it lies on the Gilchrist shale.

Colchester (No. 2) coal.—The characteristics of the Colchester (No. 2) coal are uniform in all exposures (fig. 27). The banding in the coal is not pronounced, as all of the bands are nearly equally bright and lustrous, and there are no shale partings. Small pyritic concretions are scattered through the coal. Yellowish sulfurous stains on the coal outcrops result from the weathering of these concretions. The coal varies from 12 to 30 inches in thickness.

Soft gray shale above coal.—A soft gray shale, never more than 9 feet thick, overlies the Colchester (No. 2) coal at some places in the Alexis quadrangle. It was best exposed at the entrance to an abandoned coal drift, in the NE. ¼ SW. ¼ sec. 19, T. 12 N., R. 1 W. (Kelly Twp.), and in a gully about 100 yards south of the coal drift (fig. 24, No. 5). Poorly preserved plant impressions are scattered through the shale. The shale is not present everywhere in the Monmouth[81] and Galesburg[82] quadrangles either, but farther south it is generally found overlying the coal and attains a thickness ranging from 12 to 55 feet.[83]

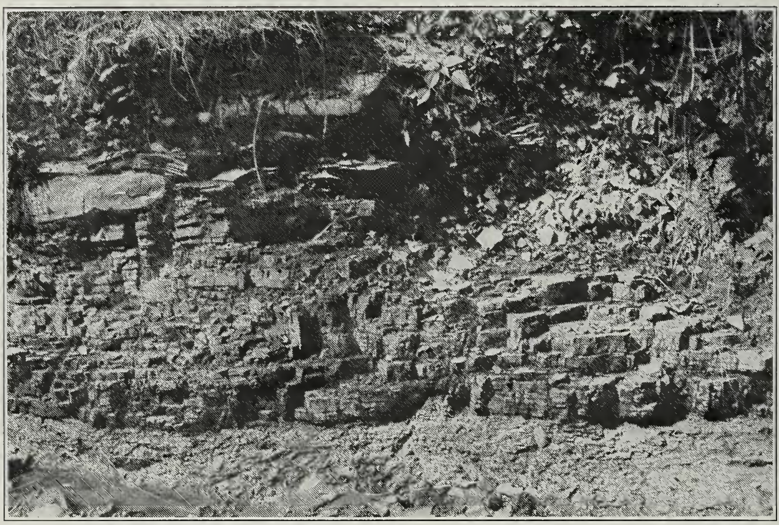


Fig. 27. Colchester (No. 2) coal exposed in wall of gully in the SW. ¼ sec. 1, T. 13 N., R. 1 W. (Suez Twp.). The upper part of the underclay below the coal is also well shown. The black laminated shale above the coal and one or two of the large "niggerhead" concretions in the shale may be seen.

Black laminated shale.—A hard, black, laminated shale ("slate") forms the roof of the Colchester (No. 2) coal in most localities in the Alexis

[81] Workman, L. E., personal communication.

[82] Poor, R. S., Geology and mineral resources of the Galesburg quadrangle, Illinois State Geol. Survey, unpublished manuscript.

[83] Savage, T. E., Geology and mineral resources of the Avon and Canton quadrangles: Illinois State Geol. Survey Bull. 38B, p. 26, 1921; Bull. 38, p. 230, 1922.

Savage, T. E., and Nebel, M. L., Geology and mineral resources of the Good Hope and La Harpe quadrangles, Illinois State Geol. Survey Bull. 43, p. 49, 1923.

Hinds, Henry, U. S. Geol. Survey Geol. Atlas, Colchester-Macomb folio (No. 208), p. 6, 1919.

Savage, T. E., Geology and mineral resources of the Vermont quadrangle, Illinois State Geol. Survey, unpublished manuscript.

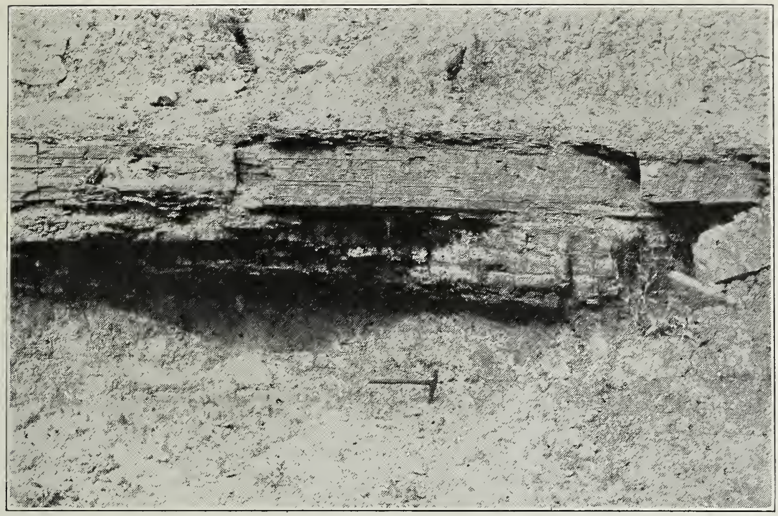


Fig. 28. Black laminated shale overlying Colchester (No. 2) coal exposed along a gully in the SW. ¼ NW. ¼ SW. ¼ sec. 23, T. 14 N., R. 2 W. (Greene Twp.). The underclay below the coal and the gray shale above the black shale are also shown. A few calcareous concretions derived from the gray shale lie on the slope.

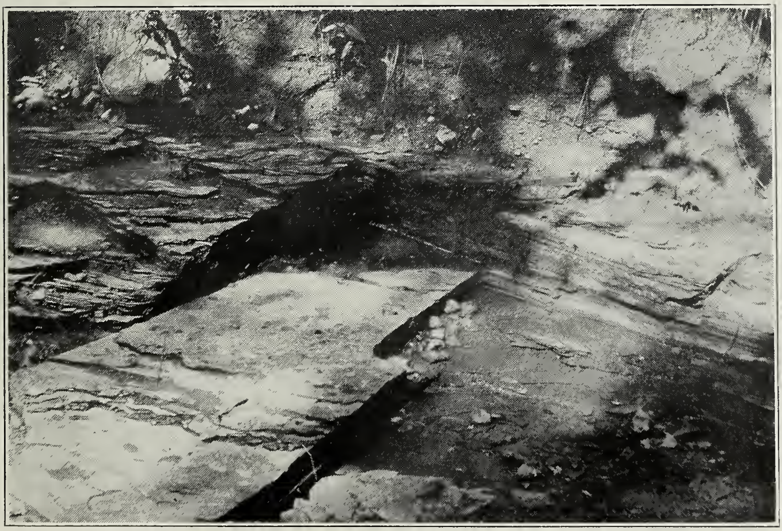


Fig. 29. Hard, black, laminated shale overlying Colchester (No. 2) coal in the SW. ¼ sec. 1, T. 13 N., R. 2 W. (Suez Twp.), showing the vertical jointing, the lamination and the sheets into which the shale splits, and the pitted, pimply appearance of bedding planes, due to the small concretions.

quadrangle (fig. 28). This shale splits into large thin sheets, bounded by well-developed joint-planes (fig. 29). Spherical or ellipsoidal calcareous concretions, which may contain small fragments of plant debris, occur in abundance in some beds of the shale. The laminations of the shale bend around these concretions, so that their weathered surfaces usually appear pitted and pimply. Concretions 18 inches or more in length and 10 inches or more thick, which resemble the concretions in the black shale above the Rock Island (No. 1) coal, also occur here and there in the shale (fig. 30). These large concretions generally contain no fossils.

Gray shale containing concretions.—A soft, gray, calcareous shale 6 to 10 feet thick lies above the black, laminated shale. The shale is very fossiliferous, at least in the lower part. (Appendix A.)

Calcareous concretions occur at several horizons in the shale (fig. 23), especially in the lower part. The lowest horizon consists of gray, septarian limestone concretions which lie on the black laminated shale or are separated from it by a foot or less of soft, gray shale. These concretions form nearly a solid ledge of dark gray limestone in sec. 23, T. 14 N., R. 2 W. (Greene Twp.) (Geologic section 19, p. 80.) An irregular layer of blue, concretionary limestone (fig 31), separated from the black laminated shale overlying the Colchester (No. 2) coal by about one foot of gray shale, crops out in a deep gully northeast of the center of sec. 36, T. 15 N., R. 3 W. (Perryton Twp.). In a gully near the center of the E. ½ NE. ¼ sec. 30, T. 12 N., R. 1 W. (Kelly Twp), the concretions are five feet or more in diameter, and show a regular succession of radial and concentric cracks (fig. 32). They are very fossiliferous. (Appendix A.)

Brownish, oval, septarian, calcareous concretions, 4 to 8 inches long and 1 to 2 inches thick and abundantly fossiliferous, occur at two or three levels from 1 to 2½ feet above the black, laminated shale in the NW. ¼ SW. ¼ sec. 23, T. 14 N., R. 2 W. (Greene Twp.) (Appendix A.) None of the fossils in these concretions occur in the larger concretions or gray shale below, nor in the dark concretionary limestone approximately 4 feet above.

Another horizon of gray, septarian concretions occurs 8 feet above the base of the gray shale in a gully in the SE. ¼ NE. ¼ sec. 30, T. 12 N., R. 1 W. (Kelly Twp.). These concretions are also fossiliferous, and the fauna in them is very similar to that in the other gray concretions at the base of the shale.

Dark fossiliferous limestone.—In the type section described a 5-inch layer of dark, concretionary, fossiliferous limestone (Appendix A), blue-gray in color when fresh but weathering brown, is found only one foot below the top of the Pennsylvanian strata exposed in a gully in the NW. ¼ SW. ¼ sec. 23, T. 14 N., R. 2 W. (Greene Twp.).

Gray shale.—The upper part of Suite IV is a gray calcareous shale. It is separated from similar shale below by the brown limestone member. This uppermost shale is exposed in the Alexis quadrangle only in a gully

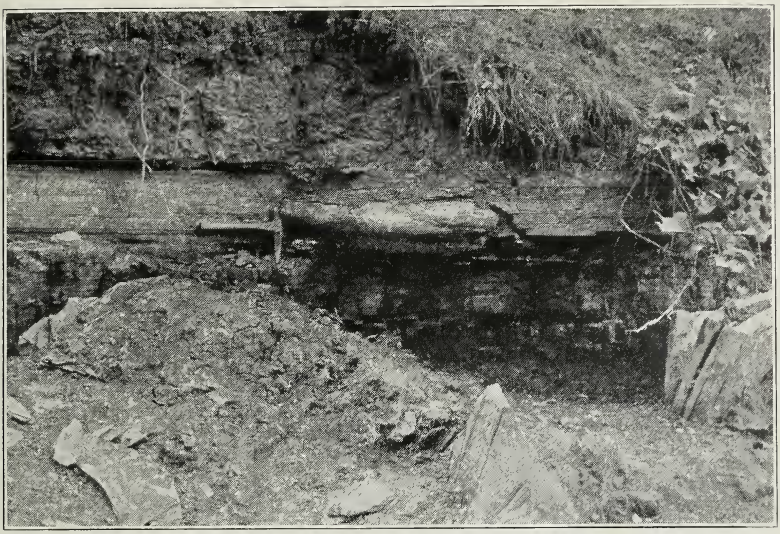


Fig. 30. Large calcareous concretions in the black, laminated shale overlying the Colchester (No. 2) coal in the SW. ¼ NW. ¼ SW. ¼ sec. 23, T. 14 N., R. 2 W. (Greene Twp.).

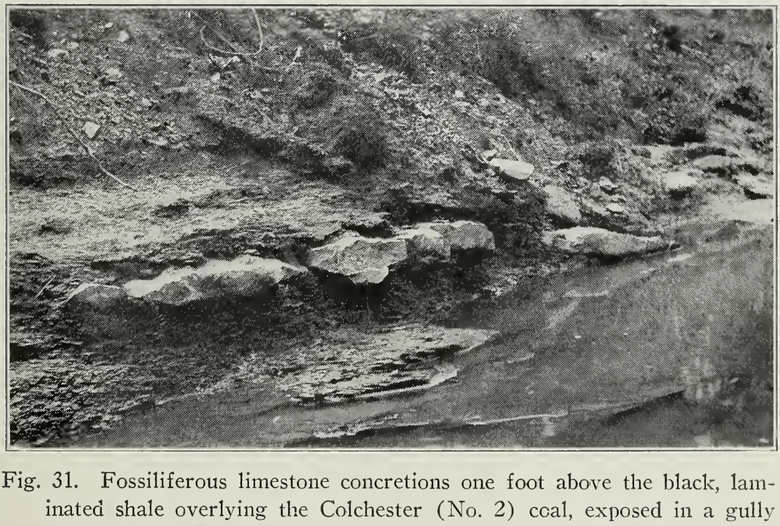


Fig. 31. Fossiliferous limestone concretions one foot above the black, laminated shale overlying the Colchester (No. 2) coal, exposed in a gully northeast of the center of sec. 36, T. 15 N., R. 3 W. (Perryton Twp.).

in the NW. ¼ SW. ¼ sec. 23, T. 14 N., R. 2 W. (Greene Twp.) (geologic section 19, p. 80) where it is only one foot thick.

STRATIGRAPHIC RELATIONS

Suite IV is separated from Suite III by an erosional unconformity which is best exposed in a ravine in the SE. ¼ SW. ¼ sec. 19, T. 12 N., R. 1 W. (Kelly Twp.). In this ravine 11 feet of strongly cross-bedded basal sandstone of Suite IV (fig. 26, p. 83) is exposed in both banks, just north of a public road. About two hundred feet farther north, on the east bank of the ravine, 10 feet of blue-gray to dark gray, thinly bedded, soft shale, presumably Gilchrist shale of Suite III, is exposed at the same level as the sandstone. The underclay and "coal blossom" of the Colchester (No. 2) coal occurs immediately overlying both the sandstone and the shale outcrops. Therefore, the sandstone is interpreted as a deposit in a channel excavated in the Gilchrist shale.

Fig. 32. A natural cross-section of a septarian concretion, four feet in diameter, in the gray shale above the Colchester (No. 2) coal, exposed in a gully near the center of the E. ½ sec. 30, T. 12 N., R. 1 W. (Kelly Twp.). Calcite veins fill the radial and concentric fractures.

Suite IV is separated from Suite V by a prominent erosional unconformity which has considerable relief within short distances. For instance, the Colchester (No. 2) coal and overlying beds of Suite IV that are exposed at one point in a deep gully northeast of the center of sec. 36, T. 15 N., R. 3 W. (Perryton Twp.) are replaced 100 feet farther north by a heavy-bedded sandstone.

In most areas in the Alexis quadrangle Suite IV is overlain by glacial drift, which fills channels that were cut into the Pennsylvanian strata.

CORRELATION

The strata in Suite IV are well exposed in the northeast part of the Monmouth quadrangle[84] and in various parts of the Galesburg quadrangle.[85] Farther south[86] the black laminated shale is separated from the coal by 10 to 55 feet of soft gray shale. The name Francis Creek has been applied[87] to all the strata of Suite IV above the Colchester (No. 2) coal, because they are well exposed along Francis Creek, in Fulton County, Illinois, but the cited type exposure does not well exhibit the upper members of the suite and so it is proposed that the name be applied only to the soft gray shale between the coal and the black shale.

A comparative study of the marine invertebrate fossils in Suite IV with other Pennsylvanian faunas shows that *Aviculopecten rectilaterarius* is most commonly reported from the Carbondale formation, and *Entolium aviculatum* has been listed as an index fossil of the Carbondale formation. *Spirifer rockymontana,* a reliable Pottsville guide fossil, is not present. Many forms typical of the McLeansboro formation are also absent. A large number of specimens of *Productus cora* var., *Chonetes mesolobus* var. *decipiens, Cardiomorpha missouriensis* var. A., and *Trepospira* aff. *convexa,* possess consistent characteristics that set them off as varieties of these species distinct from the forms of the same species found in the beds above the Rock Island (No. 1) coal. The age of the Colchester coal in many localities has been determined by the fossil plants in the roof shales, but no collections of fossil plants were made from the roof shales in the Alexis quadrangle, so this criterion can not be employed as a basis of correlation of the coal in this area.

SUITE V—PLEASANTVIEW SANDSTONE AND OVERLYING STRATA

Suite V is represented in the Alexis quadrangle by a basal sandstone and higher beds of shale, clay, and coal.

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[84] Workman, L. E., personal communication.

[85] Poor, R. S., Geology and mineral resources of the Galesburg quadrangle, Illinois State Geol. Survey, unpublished manuscript.

[86] Savage, T. E., Geology and mineral resources of the Avon and Canton quadrangles: Illinois State Geol. Survey Bull. 38B, p. 26, 1921; Bull. 38, p. 230, 1922.

Savage, T. E., and Nebel, M. L., Geology and mineral resources of the Good Hope and La Harpe quadrangles, Illinois State Geol. Survey Bull. 43, p. 49, 1923.

Hinds, Henry, U. S. Geol. Survey Geol. Atlas, Colchester-Macomb folio (No. 208), p. 6, 1919.

Savage, T. E., Geology and mineral resources of the Vermont quadrangle, Illinois State Geol. Survey, unpublished manuscript.

[87] Savage, T. E., Significant breaks and overlaps in the Pennsylvanian rocks of Illinois: Am. Jour. Sci., vol. 14, p. 309, 1927.

LITHOLOGIC CHARACTERISTICS

Geologic section 20.—Outcrops along ravine, SE. 1/4 NE. 1/4 sec. 26, T. 12 N., R. 2 W. (Spring Grove Twp.)

	Thickness Feet	Thickness Inches
Recent and Pleistocene systems		
6. Loess and drift	20±	
Pennsylvanian system		
Carbondale formation		
Suite V		
5. Clay, light gray, soft	5	
4. Coal and shale, coaly, black; coal is best developed where horizon is thickest; lower thin beds separated by thin beds of yellowish clay		2–7
3. Underclay, slightly sandy, calcareous, olive-gray to gray, weathers rusty; contains an abundance of small calcareous concretions	4	8
2. Shale, sandy, olive-gray to blue-gray, regularly bedded; contains numerous small calcareous concretions	7	
1. Sandstone, olive-gray to blue-gray, medium grained, very micaceous, cross-bedded, with foreset beds dipping 22°-23° westerly	35	

Pleasantview sandstone.—A similar massive sandstone is exposed in a gully northeast of the center of sec. 36, T. 15 N., R. 3 W. (Perryton Twp.). This sandstone is here designated the Pleasantview sandstone, a name proposed for a sandstone in similar stratigraphic position along Mill Creek, near Pleasantview, Schuyler County.[88] The local distribution of this sandstone and the marked irregularity of its basal surface suggest that it is largely a group of channel deposits.

STRATIGRAPHIC RELATIONS

The major unconformity that intervenes between Suites IV and V has been described on page 88. The relief of this unconformable surface is approximately 75 feet at least, and studies by many workers in western and southern Illinois show that it is widespread.

Except at the localities cited the Pleasantview sandstone is covered by glacial drift wherever it occurs in the Alexis quadrangle. If any Pennsylvanian strata younger than that described in geologic section 20 were deposited in the quadrangle, they have been subsequently eroded.

CORRELATION

This sandstone in the Alexis quadrangle is correlated with other similar sandstones that have identical stratigraphic positions and crop out at many

[88] Searight, Walter, personal communication.

localities in western Illinois. It is probably the correlative of a sandstone at a similar stratigraphic horizon in southern Illinois, which is designated as the Vergennes sandstone.[89] The coal in Suite V is correlated with a coal that is widespread in western Illinois and lies between the Colchester (No. 2) and the Springfield (No. 5) coals.

Post-Pennsylvanian, pre-Pleistocene Deposits

In common with the greater part of the upper Mississippi Valley region, the Alexis area has no deposits the age of which can be definitely placed between Pennsylvanian and Pleistocene times. Well-rounded quartz pebbles and fairly well-rounded pebbles of gray or brown chert which are abundant in the drift of the Alexis area may have been derived from Tertiary gravels which mantled the preglacial surface in this area.

Preglacial Surface

The surface on which the Pleistocene glacial deposits were laid is an erosional surface representing youthful dissection by a number of large deep valleys and an intricate set of tributary valleys developed after a long period of peneplanation. (Pl. IV.) The data provided by outcrops and wells in which the bedrock surface was recorded indicate that the bedrock surface has a total relief of 280 feet (472 to 752 feet above sea-level) and a local relief of 90 or 100 feet within 200 yards. The highest altitude of the preglacial surface is in T. 14 N., R. 2 W. (Greene Twp.), along the divide between Edwards River and Pope Creek.

The preglacial drainage is generally reflected in the present drainage, but many preglacial valleys have been filled with drift, and some preglacial interfluves have been dissected by recent streams. The valleys in the southwest part of the quadrangle, where they cross the weak Hannibal and Sweetland Creek shales, are broad and deep, but in the east part of the quadrangle, where more resistant Pennsylvanian sandstone was encountered, the valleys are not so well developed. The largest preglacial valley was an ancestor of the present valley of Henderson Creek. Other large preglacial valleys are followed by the present valleys of Edwards River and Cedar Creek. A large preglacial valley between North Henderson and Pope valleys deeply filled with glacial deposits is revealed by several wells, some of which derive water from a stratum of sand in the valley. The rock outcrops high on both sides of the valley of Pope Creek in many places indicate that it does not follow a large preglacial valley.

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[89] Shaw, E. W., and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Murphysboro-Herrin folio (No. 185) p. 7, 1912.
Savage, T. E., Significant breaks and overlaps in the Pennsylvanian rocks of Illinois: Am. Jour. Sci. vol. 14, p. 311, 1927.

Pleistocene System

INTRODUCTION

The term Pleistocene was introduced in 1839,[90] but the original stratigraphic application of the term was revised and defined in its present status in 1846.[91] The Pleistocene system in America is divided into five glacial and four interglacial series. (Table 1, p. 30.) All of these series occur in Illinois, but only the Kansan and Illinoian glacial drifts and the Yarmouth, Sangamon, and Peorian interglacial deposits occur in the Alexis quadrangle.

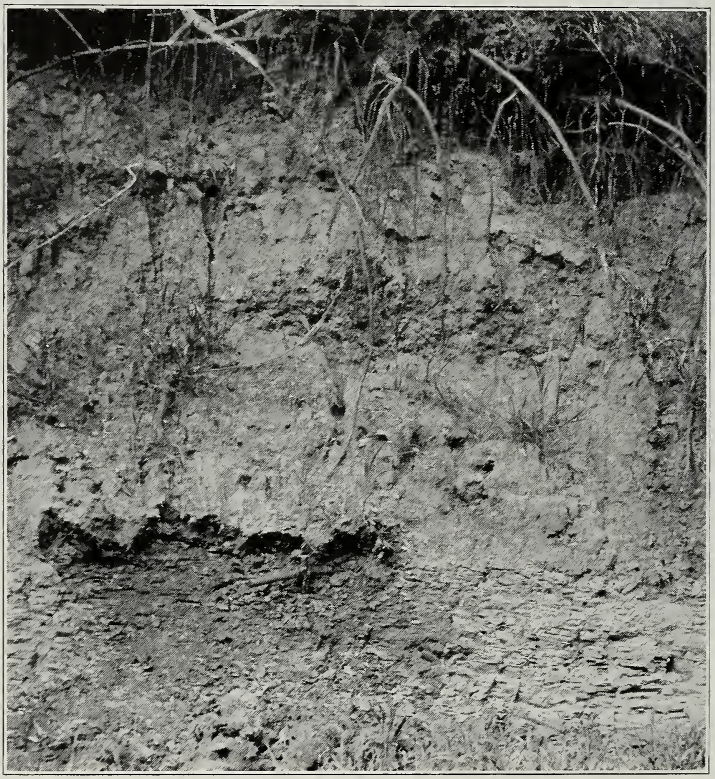

Fig. 33. Unconformable contact between glacial drift (Pleistocene) and gray shale of the Pennsylvanian system, SW. ¼ NW. ¼ sec. 26, T. 14 N., R. 2 W. (Greene Twp.).

They overlie the Paleozoic system unconformably, as they are in contact with rocks of Pennsylvanian, Mississippian, and Devonian systems (fig. 33).

[90] Lyell, C., Elements of Geology, French translation, appendix, pp. 616-621, Paris, 1839. ————, Charlesworth's Magazine of Natural History, vol. 3, p. 323, footnote, 1839.

[91] Forbes, Edward, On the connection between the distribution of the existing fauna and flora of the British Isles, and the geological changes which have affected their area, especially during the epoch of the Northern Drift: Great Britain Geol. Survey Memoir, vol. 1, pp. 402-403, 1846.

Pleistocene deposits cover the entire surface of the quadrangle except locally where postglacial erosion has exposed the bedrock. Their maximum known thickness is 185 feet. The following geologic section is the most complete section of Pleistocene deposits in the quadrangle:

Geologic section 21.—Exposure in gully on south side of Henderson Creek, NE. ¼ NE. ¼ sec. 10, T. 12 N., R. 3 W. (Sumner Twp.)

	Thickness Feet	Inches
Recent system		
11. Soil	1	9
Pleistocene system		
Peorian series		
10. Loess, leached, brown to buff	10	6
9. Loess, calcareous, gray to buff	8	9
Sangamon (Late) series		
8. Silt, noncalcareous, sandy, brown to chocolate-colored; contains humus and traces of carbonized plants	2	9
Illinoian series		
7. Gumbotil, brownish, contains a few chert pebbles; fracture surfaces pitted	1	10
6. Till, very sandy, rusty colored	15	
5. Boulder concentrate	1	
Yarmouth series		
4. Silt, sandy, noncalcareous, light yellow, cross-bedded	1	
3. Sand, reddish colored in irregular bands, cross-bedded	18	
Kansan series		
2. Till, leached (not typical gumbotil), with minor gravel concentrate at surface, light blue-gray	4	6
1. Till, highly calcareous, black or dark blue-gray, weathers whitish as a result of efflorescence of calcium salts	20 (exposed)	

Another satisfactory geologic section of the Pleistocene system in the quadrangle is as follows:

Geologic section 22.—Exposure in gullied slope on the east side of a large tributary north of North Pope Creek, SW. ¼ NW. ¼ sec. 19, T. 14 N., R. 1 W. (Rivoli Twp.)

	Thickness Feet	Inches
Pleistocene system		
Peorian series (includes Recent system)		
8. Soil and loess	7	
Sangamon series		
7. Soil, black or gray-black		8

	Thickness Feet	Inches
Illinoian series		
6. Gumbotil, brownish-gray	3	
5. Till, rusty		8
4. Gravel and sand		6
3. Till, gray, compact, leached, pebbly (see p. 99 for pebble count)	1	10
Kansan series		
2. Gumbotil, grayish-brown	1	6
1. Till brownish, limestone pebbles almost completely leached (see p. 99 for pebble count)	3	

The various divisions of the Pleistocene system are also recognized in the following record of a coal-test boring.

Log of a coal-test boring in the SW. ¼ NE. ¼ sec. 29, T. 14 N., R. 2 W. (Greene Twp.)

	Thickness Feet
Recent system	
5. Soil	2
Pleistocene system	
Peorian, Sangamon, and Illinoian series	
4. Clay, yellow (Peorian loess, Sangamon loesslike silt, and Illinoian gumbotil and oxidized till)	22
Illinoian series	
3. Clay, blue (calcareous, unoxidized till)	4
Yarmouth and Kansan series	
2. Clay, yellow (Yarmouth silt and Kansan oxidized till)	8
Kansan series	
1. Clay, blue (calcareous, unoxidized till)	70

KANSAN SERIES[92]

The term Kansan was proposed for this series of glacial deposits because it has wide surficial distribution in the State of Kansas, where it is free from complication with other drifts.[93]

The Kansan drift may be identified with certainty only where a weathered zone, a soil, or some deposit of definite interglacial character separates it from overlying Illinoian till. Its extent in Illinois has not been determined, but it underlies much of the western part of the State. It doubtless underlies most of the Alexis quadrangle, although it has been recognized only in sec. 19, T. 14 N., R. 1 W. (Rivoli Twp.) (geologic section 22); in secs. 10, 11, and 12, T. 12 N., R. 3 W. (Sumner Twp.) (geologic section 21);

[92] Chamberlin, T. C., in Geikie, James, The Great Ice Age, pp. 753-764, 1894.
[93] Chamberlin, T. C., The classification of American glacial deposits: Jour. Geol., vol. 3, pp. 270-277, 1895.

and in secs. 18 and 24, T. 12 N., R. 2 W. (Spring Grove Twp.). It may constitute a considerable part of the total thickness of the Pleistocene system in this area. In several exposures the calcareous Kansan till is highly carbonaceous and black or dark blue-gray in color. It is bouldery, more so than the overlying Illinoian till where both are present in exposures south of Henderson Creek. Bouldery Kansan till is well exposed in the lower part of a large gully in the SE. ¼ NW. ¼ sec. 18, T. 12 N., R. 2 W. (Spring Grove Twp.), where boulders 6 inches or more in diameter were identified as follows:

Count of boulders from Kansan drift

	Per cent
Sedimentary Rocks:	
Chert (chiefly crinoidal chert from the Burlington limestone)	7.8
Limestone (probably Burlington)	1.6
Sandstone (chiefly Pennsylvanian white sandstone)	18.1
Crystalline Rocks:	
Amphibolite and gneiss	4.7
Basalt, diorite, and gabbro	16.7
Granite and syenite	36.9
Graywacke	1.6
Quartzite	4.7
Rhyolite and quartz porphyry	7.9

The largest boulder in the quadrangle, (fig. 2, p. 19) having a diameter of 7-8 feet, was found at this locality.

The count indicates that 27.5 per cent of the boulders may have been derived from local sources but the remaining 72.5 per cent must have been transported from distant sources.

In many exposures the upper portion of the Kansan till consists of gumbotil, which is quite evidently an alteration product developed by prolonged weathering under poor drainage conditions.[94] It is ashen or dark brownish-gray in color, tenaceous when wet, hard when dry, and fresh fractures show a pitted surface. It contains only a few small pebbles consisting mostly of chert, quartz, quartzite, jasper, and dense igneous rocks. Limestone and dolomite pebbles have been dissolved and pebbles of silicate rocks have been almost completely decomposed. Some large boulders are outlined, but they are so weathered that they crumble easily.

Kansan gumbotil has been reported to be as much as 10 feet thick in Iowa, but in the Alexis quadrangle and vicinity it is 4 feet or less in thickness. In the Alexis quadrangle typical Kansan gumbotil 1½ feet thick with rusty zone of oxidized and leached till in its usual position under the gumbotil, occurs in sec. 19, T. 14 N., R. 1 W. (Rivoli Twp.), (geologic

[94] Kay, G. F., Gumbotil, a new term in Pleistocene Geology: Science, N. S., vol. 44, pp. 637-638, 1916.

section 22, p. 93). A thin gumbotil believed to be of the same age is exposed in a road-cut about 150 yards north of the SE. corner sec. 24, T. 12 N., R. 2 W. (Spring Grove Twp.). The upper part of the Kansan till which underlies thick sand deposits in sec. 10, T. 12 N., R. 3 W. (Sumner Twp.), and in sec. 18, T. 12 N., R. 2 W. (Spring Grove Twp.) is not a typical gumbotil but is thoroughly leached and light, blue-gray in color. (Geologic section 21.)

YARMOUTH SERIES

The name Yarmouth was proposed for this interglacial series because it was first recognized in a well near Yarmouth, Des Moines County, Iowa.[95]

A black humus soil, a silt, or a sand deposit is found above the Kansan gumbotil in some places in the vicinity of the Alexis quadrangle. No humus belonging to this series was discovered in the quadrangle, but an excellent exposure of it occurs a few miles north of the quadrangle,[96] where 1 foot 9 inches of black soil overlies 2 feet 6 inches of Kansan gumbotil.

Numerous non-identifiable fragments of gastropods were reported[97] in samples of the cuttings at a depth of 85 feet, or 10 feet above the base of the till in Aledo city well No. 2. These suggest a horizon of fossiliferous silts of Yarmouth age. Well drillers report that limbs or branches of trees are encountered in some wells at depths greater than 30 feet. In an oil-test drilling in sec. 2, T. 13 N., R. 2 W. (Suez Twp.) (Appendix C, well No. 22) logs were reported at 110 feet, near the base of 30 feet of sand. This may be a Yarmouth horizon. Logs are also reported at a depth of 40 feet in a farm well in sec. 11, T. 12 N., R. 3 W. (Sumner Twp.).

A series of steep-sided gullies on the south side of Henderson Creek in secs. 3, 10, 11, and 12, T. 12 N., R. 3 W. (Sumner Twp.) (geologic section 21), and in secs. 6, 7, and 18, T. 12 N., R. 2 W. (Spring Grove Twp.) expose thick deposits of reddish, noncalcareous, cross-bedded sands and silts, and occasional gravel lenses. These deposits lie above leached Kansan till and below Illinoian till, calcareous except where it is so thin that it is completely leached. They vary in thickness from less than 15 feet to 30 feet. A small gorge cut by a long tributary on the south side of Henderson Creek, near the west edge of sec. 12, T. 12 N., R. 3 W. (Sumner Twp.) provides the best exposure of the deposits. (See fig. 34.) Cross-bedding, most of which was produced by deposition in a stream channel as foreset beds, dipping in opposite directions in different beds, is well developed.

[95] Leverett, Frank, The weathered zone (Yarmouth) between the Kansan and Illinoian till sheets: Proc. Iowa Acad. Sci., vol. 5, pp. 81-86, 1898; Jour. Geol., vol. 6, pp. 238-243, 1898.

[96] Savage, T. E., and Udden, J. A., Geology and mineral resources of the Edgington and Milan quadrangles: Illinois State Geol. Survey Bull. 38C, p. 53, 1921; Bull. 38, p. 165, 1922.

Wanless, H. R., Pleistocene and recent history of the Alexis quadrangle and vicinity: Trans. Illinois State Acad. Sci. for 1927, vol. 20, pp. 254-260, 1928.

[97] Workman, L. E., personal communication.

Some of the layers have strongly colored, wavy bands, suggestive of ripple marks (fig. 35).

Fig. 34. Yarmouth sand in a gully in the west-central portion of sec. 12, T. 12 N., R. 3 W. (Sumner Twp.). Thirty feet of sand is exposed.

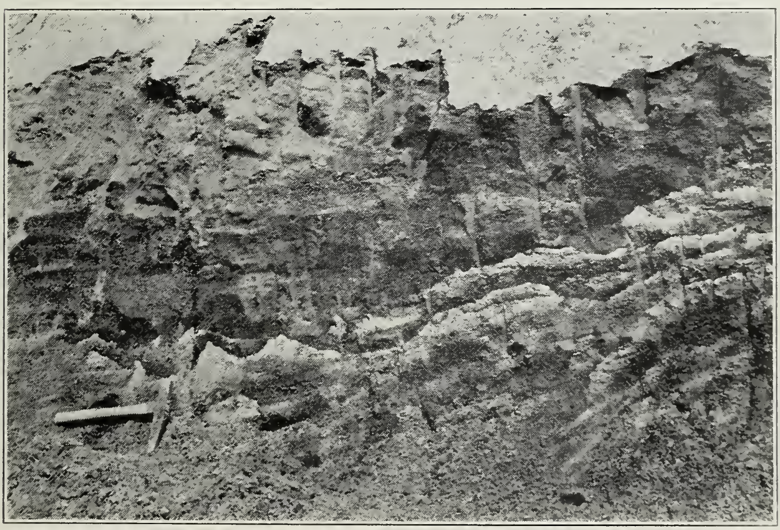

Fig. 35. Detail of the sand exposed in a gully in the west central portion of sec. 12, T. 12 N., R. 3 W. (Sumner Twp.), showing the secondary color banding which suggests ripple marks.

Thick sands are reported in several wells in the quadrangle, chiefly along an east-west zone centering along the Mercer-Warren county-line west of

Alexis and also in another channel-like belt in the vicinity of Burgess. The sand underlies the Illinoian drift, which outcrops at several places.

ILLINOIAN SERIES

The name Illinoian, which was first used in 1896,[98] was assigned to this series of glacial deposits because it is most extensively exposed and best developed in the State of Illinois.[99]

The Illinoian drift, which is distributed over most of Illinois, covers nearly all parts of the Alexis quadrangle. Its thickness is variable and impossible to determine because in well records it cannot be distinguished from the underlying Kansan till unless Yarmouth deposits or weathered Kansan drift intervenes between them. At some places the Illinoian till rests directly on the bedrock surface, and soft shales beneath it may be buckled in a series of sharp folds.

The altered Illinoian till is light blue-gray and highly calcareous. It is lighter in color, less carbonaceous, and when treated with dilute hydrochloric acid effervesces less strongly than the Kansan till. Counts of pebbles from the Illinoian and Kansan drifts, both leached and calcareous zones, revealed no diagnostic differences. (See table p. 99.) The pebbles in both drifts are derived from pre-Cambrian rocks in Canada and northern United States, pre-Pennsylvanian limestones, dolomites, and ferruginous sandstones, Pennsylvanian sandstones, shales, coals, and limestones, and Tertiary (?) concentrations of rounded chert and quartz pebbles, all probably of more or less local derivation. The direction from which the glacier that deposited the drift must have moved is indicated by the fact that it contains fragments of jasper conglomerate, which is probably derived from the Lorraine quartzite formation that is known to occur only north of Lake Huron, and of coralline limestone, believed to be derived from a limestone below the Springfield (No. 5) coal which is known to occur only south of the Alexis quadrangle.

Fragments of crinoidal chert and limestone derived from the Burlington formation are common in the Illinoian drift in the south part of the quadrangle, particularly in the drainage basin of Henderson Creek in T. 12 N., R. 2 W. (Spring Grove Twp.) and T. 12 N., R. 1 W. (Kelly Twp.). They are less abundant and generally absent in the north part of the quadrangle. Detailed descriptions of Illinoian till are included in geologic sections Nos. 21 and 22 (p. 93) and in geologic sections 23-27.

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[98] Chamberlin, T. C., Editorial: Jour. Geol., vol. 4, pp. 872-876, 1896.

[99] Leverett, Frank, The weathered zone (Yarmouth) between the Kansan and Illinoian till sheets: Proc. Iowa Acad. Sci., vol. 5, pp. 81-86, 1898; Jour. Geol., vol. 6, pp. 238-243, 1898.

Comparative counts of pebbles from Kansan and Illinoian tills

Kind of Rock	Calcareous till Kansan[a] Per cent	Calcareous till Illinoian[b] Per cent	Leached till Kansan[c] Per cent	Leached till Illinoian[c] Per cent	Leached till Illinoian[a] Per cent
SEDIMENTARY ROCKS:					
Arkose and graywacke....	0	8.9	11	10.7	9
Chert	24	21.3	47	37	58
Coal	1	0	0	0	0
Dolomite	16	29.3	0	0	0
Ironstone concretions	3	8.9	0	7.1	0
Limestone	16	3.5	0	0	0
Sandstone	17	8.9	1	0.7	3
Shale	0	0.9	0	0	0
CRYSTALLINE ROCKS:					
Amphibolite and gneiss....	3	0.9	0	0	1
Basalt (Greenstone)	2	5.3	17	20	2
Granite and syenite........	7	2.6	5	6.5	3
Jasper	1	1.8	2	0	2
Quartz	5	6.2	14	10	19
Quartzite and quartzitic conglomerate	4	0	1	7.1	1
Rhyolite and quartz porphyry	1	0	2	0	0

a Gully on south side of Henderson Creek, NE. ¼ NE. ¼ sec. 10, T. 12 N., R. 3 W. (Sumner Twp.).
b Stream bank on south side of Toms Creek, NW. ¼ SW. ¼ sec. 36, T. 13 N., R. 2 W. (Suez Twp.).
c Gullied slope on east side of a large tributary north of North Pope Creek, SW. ¼ NW. ¼ sec. 19, T. 14 N., R. 1 W. (Rivoli Twp.).

Geologic section 23.—Road-cut near the middle of the west line NW. ¼ sec. 21, T. 14 N., R. 2 W. (Greene Twp.)

	Thickness Feet	Inches
Pleistocene system		
Peorian series		
5. Loess, leached, yellow....................................	10	6
4. Loess, calcareous, yellow-gray..........................	2	
Sangamon series		
3. Silt, noncalcareous, yellowish; harder than loess; contains a few pebbles	2	
Illinoian series		
2. Gumbotil, brownish-gray	3	
1. Till, mottled yellow and blue-gray; leached.......(exposed)	4	

Geologic section 24.—Auger borings on spurs between small gullies just west of the middle of the east line NE. ¼ sec. 27, T. 14 N., R. 2 W. (Greene Twp.)

	Thickness Feet	Inches
Pleistocene system		
Peorian series		
9. Loess, leached, yellowish at surface, brownish-gray below....	7	
8. Loess, calcareous, gray..................................	3	9
Sangamon series		
7. Silt, noncalcareous, brown, grading down into gray loess....	1	
6. Soil, black	1	
Illinoian series		
5. Gumbotil, grayish-brown	1	8
4. Till, pebbly, oxidized, rusty...........................		5
3. Till, calcareous, gray..................................	5	8
2. Sand and gravel...	1	
1. Till, calcareous, gray..................................	5	6

Geologic section 25.—Auger borings on spurs about 100 yards west of the center of the east line NE. ¼ sec. 29, T. 14 N., R. 2 W. (Greene Twp.)

	Thickness Feet	Inches
Pleistocene system		
Peorian series		
7. Loess, leached, buff....................................	6	6
Sangamon series		
6. Soil, black or gray-black; contains a few small pebbles.....	1	8
Illinoian series		
5. Gumbotil, gray; fracture surfaces pitted..................	2	
4. Till, leached, rusty.....................................	1	6
3. Sand, yellow		8
2. Till, calcareous, oxidized, yellow or brown................	4	
1. Till, calcareous, gray..................................	15	

Geologic section 26.—Road-cut near the SE. corner SW. ¼ NE. ¼ sec. 9, T. 14 N., R. 3 W. (Mercer Twp.)

	Thickness Feet	Inches
Pleistocene system		
Peorian series		
5. Loess, leached, light brown..............................	6	
4. Loess, calcareous, light tan; contains some fossils..........	5	6
Sangamon series		
3. Silt, noncalcareous, brown to reddish-brown...............	1	
Illinoian series		
2. Till, leached, red.......................................	2	
1. Till, calcareous, gray..................................	15	

Geologic section 27.—Old pit of the Northwestern Clay Manufacturing Company, at Griffin, NE. ¼ NE. ¼ sec. 4, T. 14 N., R. 1 W. (Rivoli Twp.)

	Thickness	
	Feet	*Inches*
Pleistocene system		
Peorian series		
5. Loess, leached, buff .... }	10	
4. Loess, calcareous; contains abundant calcareous concretions, small limonite concretions, and gastropod fossils .... }		
Sangamon series		
3. Silt, brownish, loesslike, noncalcareous	2	9
Illinoian series		
2. Gumbotil, with slight pebble concentrate at top	1	6
1. Till, calcareous, rusty at top; sand lens; and till, gray	11	
Pennsylvanian system (Geologic section 16, p. 74)	—	

Fig. 36. Typical exposure of Pleistocene deposits in road-cut on the south side of Camp Creek, sec. 28, T. 15 N., R. 3 W. (Perryton Twp.). The lower portion is Illinoian till with gumbotil (marked by hammer) at its surface; the middle portion is Late Sangamon, hard, loesslike silt; and the upper portion is Peorian loess.

Grayish-brown gumbotil, similar to that which is found on the Kansan till, is found on the surface of the Illinoian till on upland divides (geologic sections 21-25, and 27). It is widely distributed in the Alexis quadrangle and is well exposed in road-cuts on the walls of the smaller valleys (fig. 36).

On well-drained spurs near the larger stream valleys a reddish, thoroughly leached and oxidized till (geologic section 26), developed as the result

Fig. 37. Peorian loess overlying Illinoian till as exposed in a road-cut near the north margin of sec. 4, T. 14 N., R. 3 W. (Mercer Twp.). A notable pebble concentrate (marked by hammer) occurs on the surface of the till.

of good drainage and frequent wetting and drying, and named the ferretto zone,[100] is found instead of the gumbotil that was developed on poorly drained upland surfaces. The till below the ferretto zone is yellowish or rust-colored,

[100] Bain, H. F., Geology of Decatur County: Iowa Geol. Survey Ann. Rept. 1897, vol. 8, p. 284, 1898.

being stained with limonite (hydrated iron-oxide) developed by oxidation and hydration of iron minerals in the till. Although oxidized it is calcareous and limestone pebbles are present. Below the oxidized till is blue-gray, unaltered till.

Concentrates of larger boulders and pebbles on the surface of the Illinoian drift and beneath overlying loess or loesslike silt are exposed in some places (fig. 37) and reveal the location of erosional slopes during Sangamon time.

SANGAMON SERIES

The name Sangamon was proposed for this interglacial series because it was first described from Sangamon County, Illinois,[101] and has its most conspicuous development in the drainage basin of Sangamon River.[102]

A fine-grained, rather compact, noncalcareous silt and soil containing a few pebbles overlies the earlier Pleistocene series unconformably (fig. 37). It is exposed at many places and is found not only on the uplands, but also on the slopes and valley-plains. (Geologic sections 21-27, and below.) It ranges from 8 inches to 2 feet 9 inches thick. In some exposures impressions of stems and wood are preserved in the silt. On the more level surfaces, such as upland plains and valley-flats, there is so much carbonaceous material in the silt that it is black or dark gray in color, but on slopes the plant debris has been oxidized and the silt is usually brownish-gray. Pseudolaminations in the silt have been developed during the process of soil-formation. This silt is correlated with a typical loess, showing both an upper leached and a

Geologic section 28.—Composite from outcrops and auger borings, SE. corner sec. 32, T. 13 N., R. 3 W. (Ohio Grove Twp.)

	Thickness *Feet*	*Inches*
Pleistocene system		
Peorian series		
4. Loess, leached, yellow-brown	10	
3. Loess, calcareous, yellowish-gray; contains minute fragments of shells	3	6
Sangamon series		
2. Silt, dense, gray; contains minute fragments of shells; (includes Peorian-Sangamon transition beds and Sangamon loesslike silt)	2	6
Illinoian series		
1. Gumbotil, leached; gray, with rusty spots in streaks	4	6
	(to base of boring)	

[101] Worthen, A. H., Geology of Sangamon County: Geological Survey of Illinois, vol. 5, pp. 306-319, 1873.

[102] Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey Monograph 38, p. 125, 1899.

Geologic section 29.—Auger boring in terrace along Cedar Creek, near center of SW. ¼ sec. 26, T. 12 N., R. 3 W. (Sumner Twp.)

	Thickness	
	Feet	*Inches*
Recent system		
4. Soil, black	2	6
Pleistocene system		
Peorian series		
3. Loess, leached, buff	4	
2. Loess, calcareous, gray	6	6
Sangamon series		
1. Loesslike silt, noncalcareous	1	
	(to base of boring)	

lower calcareous zone, that is exposed along Farm Creek, east of Peoria.[103] It is known to be of Late Sangamon age, because it lies upon Illinoian gumbotil or upon erosion surfaces that truncate Illinoian till and Yarmouth sand.

Peat beds assigned to the Sangamon series are reported in many areas adjacent[104] to the Alexis quadrangle. They were encountered at a depth of 20 feet in a coal-test boring near the center of the SW. ¼ sec. 32, T. 14 N., R. 2 W. (Greene Twp.). Logs reported at depths of 20 to 30 feet in many wells probably mark the Sangamon horizon.

IOWAN AND PEORIAN SERIES

The name Iowan was proposed for the fourth glacial series of the Pleistocent system because it has its best known expression in eastern Iowa.[105] The name Peorian was proposed for the subsequent interglacial deposits because they are best displayed in the vicinty of Peoria, Illinois.[106]

A deposit of loess which covers nearly the entire Alexis quadrangle, including valleys, slopes, and uplands, represents Iowan and Peorian series. The loess is usually a fine, dustlike silt, composed of fine angular particles, but in some exposures near Mississippi River, stratified sandy layers which are distinctly laminated are present.[107] No gravel or boulders are found in the loess itself. In the Alexis quadrangle the loess is in general uniform in texture, but stratified sand below or in the loess is noted in the following geologic section:

[103] Leighton, M. M., The Farm Creek exposure near Peoria, Illinois—a typical Pleistocene section: Trans. Illinois State Acad. Sci. for 1925, vol. 28, pp. 401-407, 1925. Reprinted in Illinois State Geol. Survey Rept. Inv. No. 11, 1926.

[104] Savage, T. E., and Nebel, M. L., Geology and mineral resources of the LaHarpe and Good Hope quadrangles: Illinois State Geol. Survey Bull. 43, pp. 52-55, 1923.

Savage, T. E., and Udden, J. A., Geology and mineral resources of the Edgington and Milan quadrangles: Illinois State Geol. Survey Bull. 38, pp. 173-174, 1922.

Cady, G. H., Geology and mineral resources of the La Salle and Hennepin quadrangles: Illinois State Geol. Survey Bull. 37, pp. 73-76, 1919.

[105] Chamberlin, T. C., in Geikie, James, The Great Ice Age, pp. 753-764, 1894.

————————, The classification of American glacial deposits: Jour. Geol. vol. 3, pp. 270-277, 1895.

[106] Leverett, Frank, The Peorian soil and weathered zone: Jour. Geol., vol. 6, pp. 244-249, 1898.

[107] Savage, T. E., and Udden, J. A., Geology and mineral resources of the Edgington and Milan quadrangles: Illinois State Geol. Survey Bull. 38C, p. 63, 1921; Bull. 38, p. 175, 1922.

Geologic section 30.—Face of terrace remnant and auger boring along Pope Creek in the NW. ¼ NW. ¼ sec. 4, T. 13 N., R. 3 W. (Ohio Grove Twp.)

	Thickness Feet	Inches
Pleistocene system		
Peorian series		
6. Loess, or loesslike silt, leached, light gray-brown, soft, crumbly	2	
5. Loess or clay, light yellow-brown, more compact than above.	3	
4. Clay, slightly sandy, becoming more sandy toward base	3	6
3. Sand, stratified, brownish at top, yellowish in lower portion, probably alluvial	3	6
2. Silt, strongly calcareous, blue-gray, probably alluvial	4	
Sangamon series		
1. Soil, black clay, with no pebbles	3 (to creek level)	

The loess normally includes two zones—an upper, oxidized, buff and yellow zone of which the upper part is leached and the lower part calcareous, and a lower calcareous, unoxidized gray zone. Gastropod shells are found in some exposures and irregularly shaped lime concretions ("loess-kindchen") are usually present in the calcareous loess. No recognizable fragments of plant debris have been found in the loess in this quadrangle. In road-cuts or stream-banks the loess stands in vertical or nearly vertical faces. It is, however, slightly less resistant to erosion than the underlying Sangamon silt and is slightly more dissected where both are exposed. (Fig. 37.)

Fossils from the Peorian loess

x indicates presence at specified localities:

(1) Road-cut a little south of the center of sec. 9, T. 14 N., R. 3 W. (Mercer Twp.).

(2) Gully south of Henderson Creek in NE. ¼ sec. 12, T. 12 N., R. 3 W. (Sumner Twp.).

(3) Pit of the Northwestern Clay Manufacturing Company, at Griffin, sec. 4, T. 14 N., R. 1 W. (Rivoli Twp.).

	1	2	3
Polygyra thyroides (Say)	..	..	x
Succinea ovalis pleistocenica Baker	x	x	x
Succinea grosvenori gelida Baker	x	x	x
Gonyodiscus shimekii (Pilsbry)	x	x	x
Vitrea hammonis (Strom)	..	..	x
Vertigo ventricosa Morse	..	..	x
Vertigo modesta Gould	..	x	x
Hendersonia occulta (Say)	x	x	x
Cochlicopa lubrica (Mull.)	..	..	x
Helicodiscus parallelus (Say)	x	..	..
Columella alticola (Ingersoll)	x	x	..
Galba parva Say	x	..	..

Geologic sections 21 to 30 inclusive, show that the loess is normally from 6 to 20 feet thick in the Alexis quadrangle and that the leached zone is 5 to 10 feet thick. The calcareous zone is usually absent wherever the loess is less than 10 feet thick.

In the Alexis quadrangle the loess rests unconformably on Sangamon, Illinoian, and Yarmouth series and on Pennsylvanian strata. The contact between the loess and the underlying Sangamon soil is not always sharp, and in some exposures a calcareous silt above grades into noncalcareous silt below. There is a sharp break between the loess and the Illinoian till or older beds. (Fig. 37.) A portion of the loess may be Wisconsin or post-Wisconsin in age, as the Bloomington moraine and other portions of the Wisconsin drift-plain are usually mantled with a thin deposit of loesslike silt.

Recent System

POST-GLACIAL DEPOSITS

The post-glacial deposits include alluvial deposits in the valleys of the streams, slope wash on the steeper slopes, and some eolian dust or loess.

Gravels, sands, and silts of alluvial origin are found along practically all of the streams, even in the small head branches of many ravines (Pl. I). The alluvial valleys of the larger streams are from a quarter of a mile to half a mile in width (fig. 7, p. 27). Near the mouths of tributaries the larger valley-flats are veneered with sands, gravels, and silts washed in by these tributaries. Alluvial fans occur at the lower ends of many small gullies.

Slope wash, consisting of sands or silts, mantles most of the lower slopes. The coarser materials, such as pebbles from glacial drift, remain on the upper slopes and may cover the surface. Slump and landslide deposits are common on the steeper slopes.

Soils have been developed on the surface of the uplands, slopes, and valleys.

CHAPTER IV—STRUCTURAL GEOLOGY

Introductory Statement

Structural geology is the phase of geologic science that treats with the determination of the attitude of rock strata and the interpretation of structural features as related to earth movements.

In regions where there are abundant outcrops, the rock structures may be determined with considerable accuracy by actual measurements of the amount and direction of dip or slope of the rocks at numerous points or by an accurate survey of the location and elevation of outcrops of key beds. But in most of Illinois, as in many other regions, outcrops are so few that most of the structural data must be derived from records of wells and other borings. The absolute elevation of any key-bed penetrated in the borings may be easily ascertained if the elevation at the surface and the depth to the key-bed are known.

The geologic structure in such regions may be best depicted by maps on which contours show the elevation of the key-bed (figs. 38, 39, and 40). Graphic representations of the position, elevation, and attitude of the strata (Pls. II, III, V, and VI) are desirable supplements to structure maps.

Structural maps are of importance, not only because they reveal the nature and time of deformation, but also because they provide data by which it is possible to determine the depth to aquifers, the probable distribution of coal beds, and localities worthy of testing for oil and gas and other mineral resources.

Data Used in Making Structural Maps of Alexis Quadrangle

The data on structural geology for the Alexis quadrangle were obtained from outcrops and from the records of wells, mine shafts, and test-borings for coal and oil. The altitudes of the borings and of numerous outcrops of the Colchester (No. 2) and the Rock Island (No. 1) coals were determined by a planetable survey. The approximate altitudes of a number of coal-test borings that could not be accurately located were estimated from the topographic map and except on steep slopes these approximations have a maximum possible error of not more than 20 feet. As the records of coal-test borings were compiled by the drillers at the time of drilling, they are essentially accurate. The records of most of the wells were less carefully compiled.

The datum points on which the structural contours are based are unevenly distributed over the Alexis quadrangle (figs. 38, 39, 40). The strata below the Pennsylvanian system are penetrated in such a small number of drillings in the Alexis quadrangle that their detailed structure cannot be

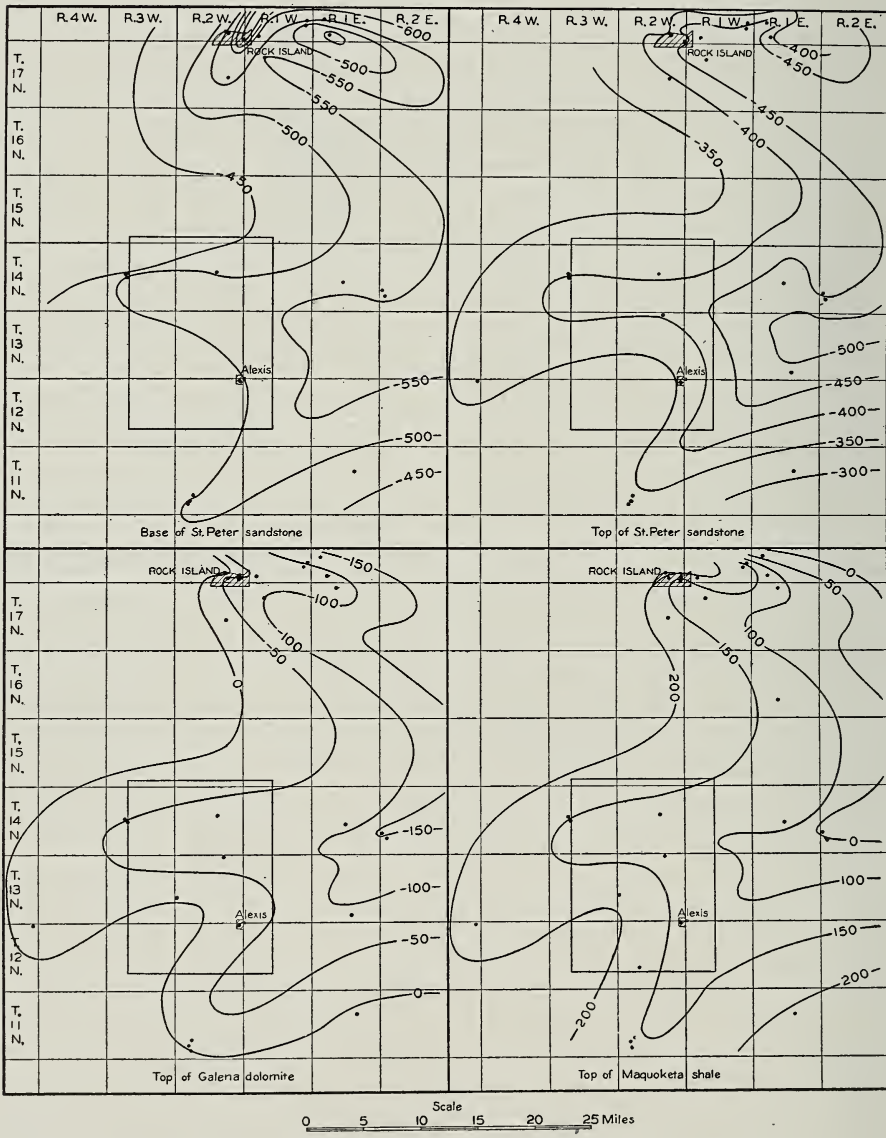

Fig 38. Structure maps showing the elevations of four Paleozoic horizons for the area in and near the Alexis quadrangle. The boundary of the quadrangle is outlined. Datum, sea-level. Logs of wells are given in Appendix C.

determined but the general structural features of the part of Illinois included between Rock Island and Moline on the north, Alpha and Woodhull on the east, Mississippi River on the west, and Monmouth and Galesburg on the south, are revealed by data from the drillings in the whole region. (See Pls. V and VI, and figs. 38 and 39.)

Structural Features

TOP OF DRESBACH FORMATION

Reliable information regarding the elevation of this horizon is available at only six widely scattered localities in the region, so that its structure cannot be satisfactorily determined. As its elevation at Moline is 1399 feet below sea-level and at Monmouth it is 1576 feet below sea-level, a general southward slope is suggested.

BASE OF ST. PETER FORMATION; TOP OF ST. PETER FORMATION; TOP OF GALENA FORMATION; TOP OF MAQUOKETA FORMATION

All of these horizons reveal essentially similar structure (fig. 38). A synclinal depression pitches easterly across the north part of the Alexis quadrangle, and east of the quadrangle it merges with another synclinal depression that pitches northeasterly across the southeast corner of the quadrangle. The synclines are separated by a northeasterly pitching anticlinal elevation in the southwest corner of the quadrangle. A broad anticlinal elevation pitching south of east lies just north of the quadrangle and is separated from a narrow anticlinal ridge farther northeast by a narrow synclinal depression which pitches southeasterly. Thus the general slope in the region is easterly. The parallelism of the structures at all four horizons is noteworthy.

The erosional unconformity that is known to exist at the base of the St. Peter formation is well revealed in the north part of the region, where the elevations in two wells only a few blocks apart in Rock Island are respectively 558 and 721 feet below sea-level. Likewise the elevations in two wells at Aledo are respectively 424 and 501 feet below sea-level. Similar great differences in elevation doubtless occur elsewhere in the region. The slight erosional unconformities that occur at the other horizons are insufficient to reveal themselves on the maps.

TOP OF NIAGARAN SERIES; TOP OF DEVONIAN SYSTEM

Datum points by which the elevation of these two horizons may be determined are much more numerous than they are for lower horizons, and consequently the contours can be drawn in more detail (fig. 39). The features revealed by the contours on both horizons are strikingly similar. A major depression opening southward occupies the southeast part of the Alexis quadrangle. A broad branch of this depression extends northeast, and a very narrow branch extends northwest across the northwest corner of the quadrangle. Another large branch depression appears to exist southwest of the quadrangle and connects with the northwest branch by a narrow depression. Short depressions extend from these depressions in the southwest

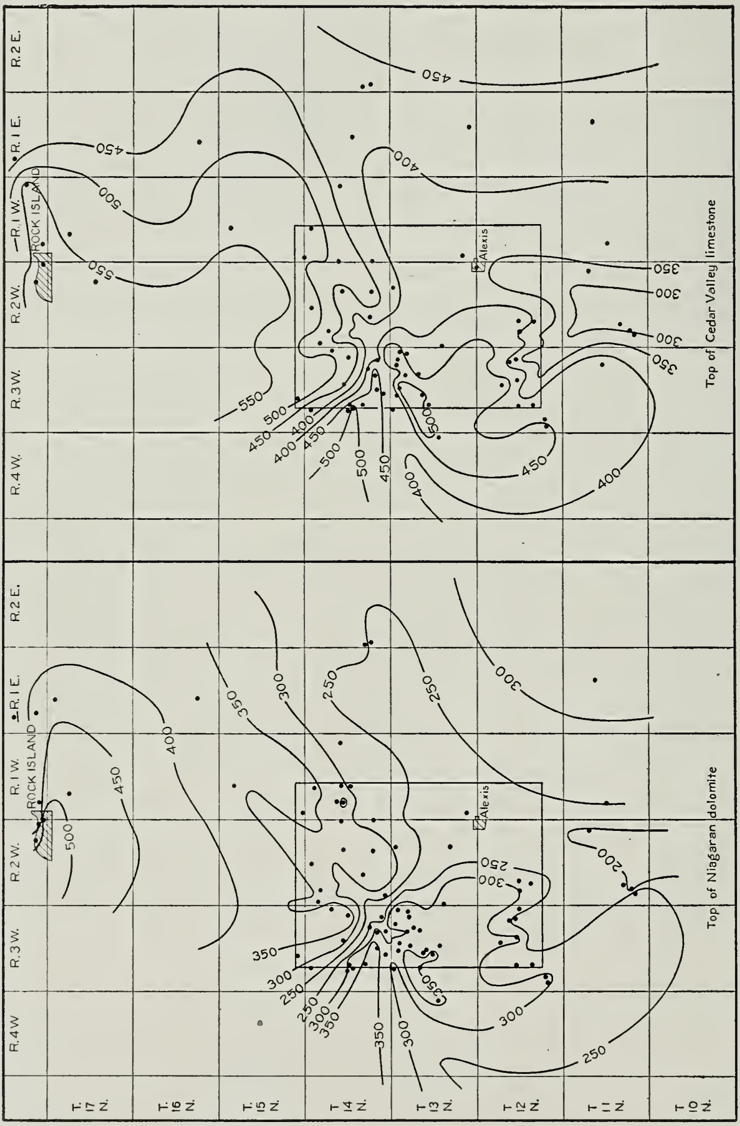

Fig. 39. Structure maps showing the elevation above sea-level of the tops of the Niagaran dolomite and the Cedar Valley limestone in and near the Alexis quadrangle. The area of the quadrangle is outlined. Logs of wells are given in Appendix C.

corner and the north end of the quadrangle. An irregular dome occupies the southwest part of the quadrangle. A broad elevation exists north of the quadrangle, and probably another one exists east of the quadrangle.

The interpretation of these features is open to question. The general aspect of the depressions suggest that they constitute part of a river system, in which case the surface is principally erosional. But the marked similarity of the two surfaces raises the question why river courses developed at the ends of two successive geologic periods should be so nearly identical, and supports the theory of a structural origin of the features. However, the top of the Niagaran series at many of the datum points is assumed to be the base of the porous zone from which many wells derive water, and this porous zone may be actually in the Niagaran series, not at the top. It may be a porous zone developed by solution at the same time that the present surface of the Devonian system was developed by erosion, and consequently it may be only a reflection of that surface.

PENNSYLVANIAN STRUCTURES

STRUCTURE OF THE ROCK ISLAND (NO. 1) COAL

The Rock Island (No. 1) coal in the north part of the Alexis quadrangle has a very uneven surface (fig. 40). The elevation of workable coal for which records are available varies between 596 and 678 feet above sea-level, and lies in a number of small basins which are either entirely disconnected or are connected only by very thin coal. The general structure of the coal appears to be comprised of domes separated by gentle depressions. A general northward dip toward the Matherville coal district, sec. 27, T. 15 N., R. 2 W. (Preemption Twp.), in the Milan quadrangle, is indicated near the northern margin of the quadrangle, especially in secs. 3, 4, and 5, T. 14 N., R. 2 W. (Greene Twp.), and secs. 34 and 35, T. 15 N., R. 2 W. (Preemption Twp.). A gentle eastward dip is indicated by a few drill records in secs. 23, 25, and 34, T. 14 N., R. 2 W. (Greene Twp.) and sec. 30, T. 14 N., R. 1 W. (Rivoli Twp.). This eastward dip probably carries the coal to such a depth in an area of high surface altitude that it has not yet been penetrated in drilling. The highest area of the coal lies in the western part of T. 14 N., R. 2 W. (Greene Twp.) and the eastern part of T. 14 N., R. 3 W. (Mercer Twp.) and it is probable that west of this area the coal occurred at such high altitude that it was stripped away by post-Pennsylvanian erosion.

A fault, along which a 4-foot bed of coal is reported to have ended abruptly, is reported by miners as extending from Wanlock in sec. 9 to Shale City in sec. 8, and perhaps also to the SW. ¼ sec. 6, T. 14 N., R. 2 W. (Greene Twp.). However, in outcrops near Shale City it appears that a sandstone fills a channel that cut through the coal and the "fault" may be only an abrupt erosional contact. None of the mines reported to extend to the fault surface were in operation at the time field studies were made.

In the south part of the Alexis quadrangle, the Rock Island (No. 1) coal lies near the western edge of the southern flank of an eastward plunging syncline (fig. 41). The altitude of the coal ranges from 609 to 657 feet.

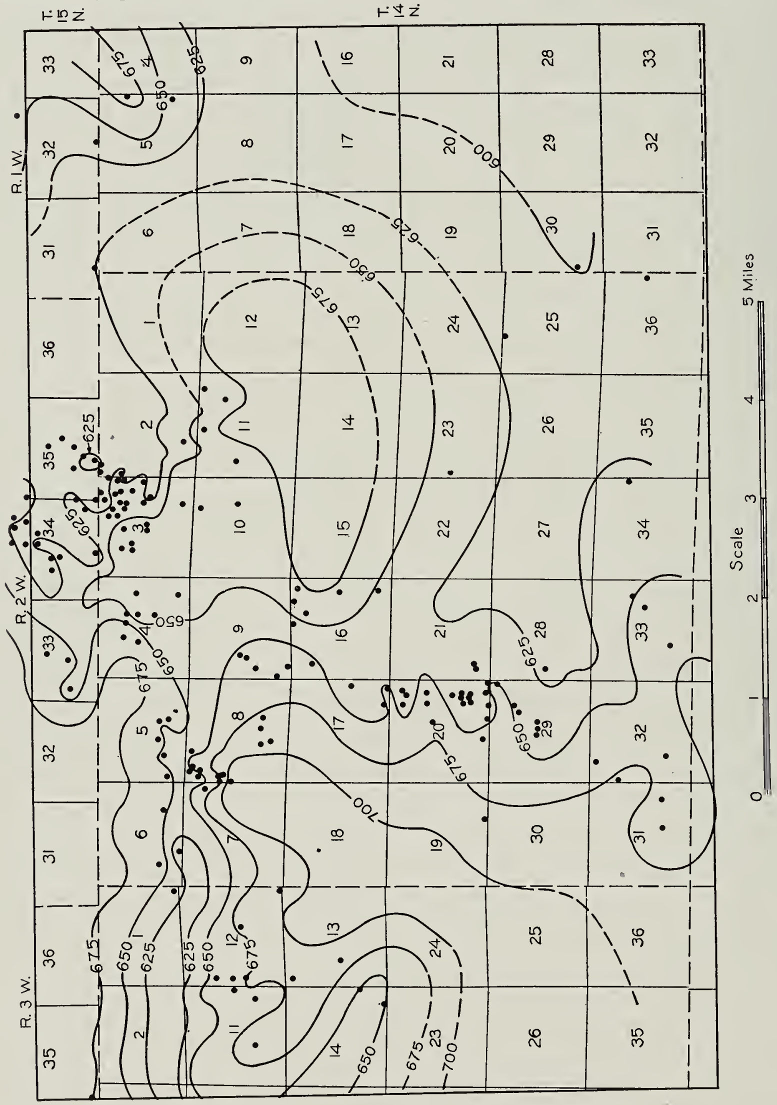

Fig. 40. Structure map of Rock Island (No. 1) coal in the north part of the Alexis quadrangle. Dots show locations of test borings, mines, or other sources of data giving information on the elevation of the coal.

STRUCTURE OF THE COLCHESTER (NO. 2) COAL

As the elevation of the Colchester (No. 2) coal can be determined at only 7 datum points in the north part of the Alexis quadrangle, its structure cannot be ascertained satisfactorily. The altitudes of this coal range from 713 to 750 feet, with a possible structural rise centering in the northeast corner of the quadrangle.

In the southeast part of the quadrangle the Colchester (No. 2) coal lies on the south side of a synclinal basin plunging toward the east or southeast (fig. 41). The altitudes of the Colchester coal in this area range from 654 to 720 feet.

MINOR STRUCTURAL FEATURES

Minor faults or displacements that occur in the coal beds may be the result of uneven settling during the process of consolidation. Such faults are commonly exposed in mines and usually show displacements not exceeding one or two feet. The fault planes may be often detected by clay in the fissures. One small normal fault of this class is exposed in the west bank of the creek about 150 feet north of the west entrance of the shale pit of the Hydraulic Press Brick Company, in sec. 7, T. 14 N., R. 2 W. (Greene Twp.).

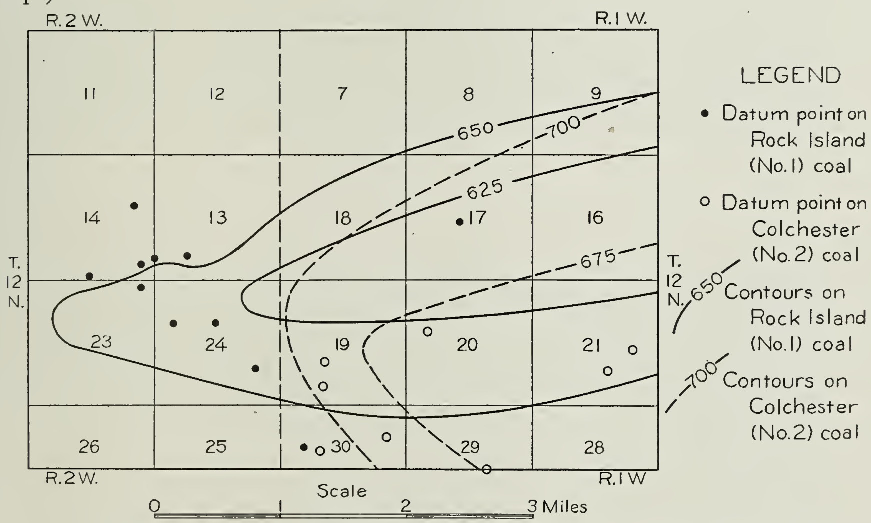

Fig. 41. Structure map of the Rock Island (No. 1) and Colchester (No. 2) coals in the southeast part of the Alexis quadrangle.

The sandstones, shales, clays, and coals lying below the "Stigmarian" sandstone underlying the Rock Island (No. 1) coal were warped into a system of folds, which were truncated by erosion before the deposition of the sandstone (Plate II, p. 50). The dips of these beds are locally as high as 3° to 10° (fig. 42). Single beds in this suite can not be traced over sufficiently wide areas to map the structure of this warped surface.

Where soft shales occur under the glacial drift they have been deformed at some places into sharply overturned folds as the result of ice shove. Such structures are well exposed in a small ravine west of the north-south road in the SW. ¼ SE. ¼ sec. 4, T. 14 N., R. 2 W. (Greene Twp.), and at numerous other exposures (fig. 43).

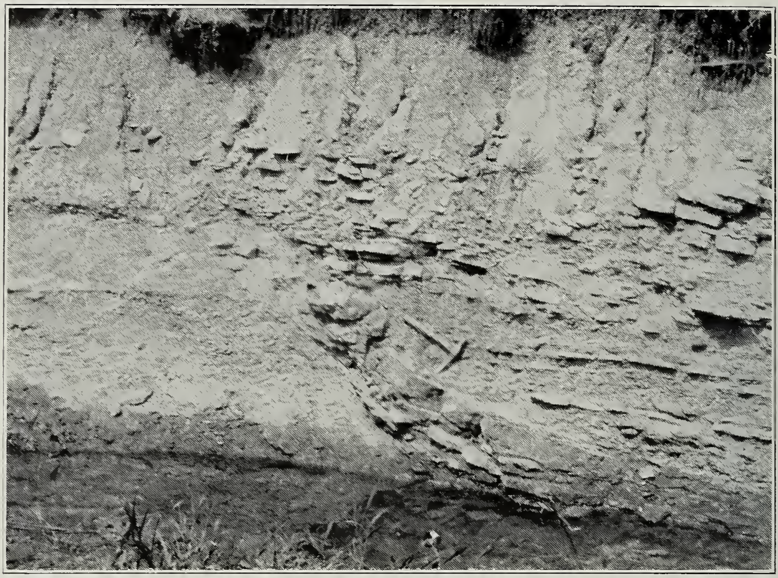

Fig. 42. Minor faulting in lower Pennsylvanian sandstone, exposed in cut bank of creek in the NE. ¼ NE. ¼ sec. 11, T. 14 N., R. 2 W. (Greene Twp.).

Fig. 43. A small overturned fold in the lower part of the Gilchrist shale, exposed in a creek bank west of the center of sec. 7, T. 14 N., R. 2 W. (Greene Twp.). The hammer lies along the axis of the fold, which is most easily traced by the concretionary layer above the hammer.

CHAPTER V—GEOLOGIC HISTORY

Introduction

The geologic history of any area is recorded in the rock formations, the surficial deposits, and the existent topography of that area. The character of the rock formations, their attitude, and their relations reflect the conditions under which they were deposited and the alterations which they have subsequently undergone. From these data geologists are enabled to read the geologic history.

Through all ages continental land masses have been sources of oceanic sediments. Gravel, sand, silt, clay, and mineral matter in solution have been transported, worked over and assorted, and deposited beneath the seas, the coarser material being generally deposited near the shore and the finer farther out. After consolidation by compaction and cementation, gravel becomes conglomerate, sand becomes sandstone, silt becomes siltstone, clay becomes shale, and chemical precipitates and organic secretions of calcium carbonate become limestone, or dolomite if mixed with magnesium carbonate.

Cross-bedding, ripple and rill marks, channel fills, etc., record water movements, and together with sun-cracks, rain-drop impressions, and worm borings they record shallow-water conditions. Widespread limestone formations indicate that the continents adjacent to the sea in which the limestone was deposited were low or distant; coarse clastic sediments indicate that the continents were high or near the sea.

Warped, folded, or faulted strata record earth movements. Erosion between two epoches of marine deposition is recorded by irregular contacts between the formations deposited during those epochs, by evidences of weathering in the upper part of the older formation, by residual detritus in the base of the upper formation, or by the occurrence in the younger formation of fossils of organisms more advanced in their evolution than those in the older formation. The history of life development may be traced by the changes in life forms as revealed by the fossils in successively younger formations.

The geologic history of Illinois is read partly from rock outcrops and partly from records of wells and borings and is supplemented by knowledge derived from similar data in adjacent regions. Similarly, the geologic history of the Alexis quadrangle as interpreted from the local bedrock formations which are exposed or are penetrated by borings may be supplemented by facts gleaned from studies of adjacent areas, because processes which were operative within the quadrangle were generally also operative over considerable areas outside.

Pre-Paleozoic Eras

An involved series of sedimentary periods interspersed with epochs of diastrophism, vulcanism, and igneous intrusion and separated by erosional epochs is recorded in the pre-Cambrian rocks where they are exposed. A similar series of events presumably occurred in Illinois during those eras. A long period of erosion, during which the pre-Cambrian peneplain that is known to occur in Wisconsin was developed,[1] immediately preceded the Paleozoic era. The present southward tilt of this peneplain surface may be due partly to its original slope, but it is probably due largely to subsequent diastrophic movements.

Paleozoic Era

The Alexis quadrangle lies within an era that is frequently designated as the Eastern Interior Basin. During the Paleozoic Era this basin was always a low-lying area and was frequently submerged by epi-continental seas. The alternate depression and elevation of the area relative to the level of the sea created alternate epochs of deposition and erosion, and the strand line changed radically many times and probably varied constantly in minor degree. The sediments deposited in the seas were derived from highland areas to the north in the vicinity of Lake Superior, from the Ozark highland area to the southwest, and sometimes from the Appalachian highland to the east. Some of the breaks in deposition reflecting changes in conditions are marked by discordant or unconformable strata, but others are marked only by a change of the fauna which is revealed by the fossils in the rocks.

CAMBRIAN PERIOD

The erosional interval that marks the close of the pre-Cambrian era apparently continued through Early and Middle Cambrian epochs in Illinois, as no formations of those series are known in the region. But in the Late Cambrian epoch the lowland surface was submerged and materials that now form the Croixan series were deposited. The fact that the series is thickest at the south and thins to the north suggests that the sea in which it was deposited advanced from the south, and the off-shore phases that occur to the south show that the open sea was in that direction. The variable character of the rocks in the series show that conditions were neither stable nor precisely the same over large expanses, although the formational divisions of the series which can be recognized in regular succession over wide areas show

[1] Weidman, S., and Schultz, A. R., Water supplies of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 35, Pl. I, 1915.
Knappen, R. S., Geology and mineral resources of the Dixon quadrangle, Illinois State Geol. Survey Bull. 49, p. 34, 1926.

that generally the gross conditions were similar. So many factors, such as the rate of weathering and erosion on land, in turn due to climatic conditions, diastrophic movements, amount of rainfall, et cetera; the depth, extent, temperature, and clarity of the sea; the relative position and configuration of the strand line; and the number and size of streams, enter into the conditions affecting sedimentation that the alteration of no one condition or set of conditions can be definitely ascribed as the cause of the change in character of rocks.

The first deposits in the advancing sea were the sands that now form the Mt. Simon sandstone. The great thickness of the formation shows that conditions remained constant for a considerable time. Then conditions changed and the finer sediments of the Eau Claire formation were deposited. A recurrence of the earlier conditions brought about the deposit of the Dresbach sands, to be followed in turn by deposition of the finer sediments of the Mazomanie-Franconia formation. The abundance of glauconite in the formation shows that there were then present some conditions not present during the other stages. Conditions changed only so as to be more favorable for the deposition of more calcareous sediments during the Trempealeau stage. Conditions favoring the deposition of sand recurred during the Jordan stage.

In this region the Cambrian period was terminated by emergence of the land above sea-level, during which time the Madison and Mendota formations that occur in Wisconsin were completely eroded, if they had been deposited, in Illinois, and the Jordan formation was so eroded that only an irregular thickness of it remains.

ORDOVICIAN PERIOD

EARLY ORDOVICIAN EPOCH

The Ordovician period was inaugurated by an invasion by the sea. This time the sea was clearer than during Late Cambrian time, for the sediments that were deposited were largely organic or chemical precipitates now comprising the Oneota dolomite, as compared with the clastic deposits of the Croixan series. Then conditions changed and the sand that now composes the New Richmond formation was next deposited. A recurrent clearing of the sea again brought conditions favorable for the accumulation of limy muds, which now form the Shakopee dolomite. Ripple-marks, mud-cracks, and breccia in Shakopee dolomite exposed near Franklin Grove, Lee County, Illinois, indicate that it was deposited in shallow water and was frequently exposed on tidal flats.[2]

An emergence of the whole region and a prolonged period of erosion terminated the Early Ordovician marine inundation. Relief of several hun-

[2] Knappen, R. S., Geology and mineral resources of the Dixon quadrangle: Illinois State Geol. Survey Bull. 49, pp. 82-85, 1926.

dred feet was locally developed[3] and in some parts of northern Illinois all of the Prairie du Chien series was eroded during this erosional interval,[4] but in other places a considerable thickness of the series is left.

MIDDLE ORDOVICIAN EPOCH

To open the Middle Ordovician epoch the sea again advanced over this area, which erosion had sculptured into hills and valleys. The valleys were first inundated and were filled either with coarse sediments, now forming conglomerate, in which chert fragments derived from the underlying dolomites are included, or with fine sediments probably representing soil material washed down the slopes and now forming shale. Eventually the entire surface was submerged, and in this sea the well-assorted, well-rounded grains of the St. Peter sandstone were deposited. The frosting and pitting of the sand grains show that before they were deposited in the sea they were much worn by the wind, probably in a desert bordering the ocean,[5] but marine fossils and the prevalence of horizontal bedding in the formation show that it is a marine deposit. The St. Peter stage was closed by slight emergence which may have been only local in effect, as at some places there is an erosional unconformity between the St. Peter sandstone and the overlying formation and at other places there seem to be transition beds, showing continuous deposition from St. Peter to Glenwood stages.

After a brief interval of erosion, conditions similar to those during the early part of the St. Peter stage recurred, as evidenced by the Glenwood sediments which consist of dolomitic sandstone and shale. Some unique environmental factor was present to cause the green color typical of the formation. Gradually conditions changed and lime mud free from sand was deposited. Organic life thrived in great profusion, and calcareous ooze, with occasionally a little mud, was the dominant sediment throughout Platteville and Galena stages. The calcareous deposits have been largely converted to dolomite by the addition of magnesium carbonate. As the Platteville formation is thin-bedded and compact and the Galena formation is porous and thick-bedded, it is believed that the dolomitization of the Platteville limestone took place before its consolidation and that of the Galena dolomite may have taken place after consolidation.[6] The sea withdrew at the close of the Galena stage, and erosion and weathering prevailed for a time.

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[3] Fisher, D. J., Geology and mineral resources of the Joliet quadrangle: Illinois State Geol. Survey Bull. 51, p. 20 and Pl. III, 1925.

[4] Thwaites, F. T., Stratigraphy and geologic structure of northern Illinois: Illinois State Geol. Survey Rept. Inv. No. 13, pp. 22-23, 1927.

[5] Dake, C. L., The problem of the St. Peter sandstone: Univ. of Missouri School of Mines and Metallurgy Bull., technical series, vol. 6, No. 1, 1921.

Lamar, J. E., Geology and economic resources of the St. Peter sandstone of Illinois: Illinois State Geol. Survey Bull. 53, pp. 26-31, 1928.

[6] Knappen, R. S., Geology and mineral resources of the Dixon quadrangle: Illinois State Geol. Survey Bull. 49, pp. 89-90, 1926.

LATE ORDOVICIAN EPOCH

After an erosional interval, the sea again inundated the region, at which time conditions favored the accumulation of masses of silt, mud, and calcareous debris that now compose the shales and limestones of the Maquoketa formation. Then followed an emergence with which the Ordovician period terminated.

SILURIAN PERIOD

ALEXANDRIAN EPOCH

After an erosional interval of considerable duration, Illinois was largely submerged during the Early Silurian or Alexandrian epoch by seas which advanced from the Gulf of Mexico,[7] but there is no positive evidence that the Alexis quadrangle was submerged. It is possible: (1) that Alexandrian strata occur in the quadrangle and have not been distinguished from overlying Niagaran strata; (2) that Alexandrian strata were deposited in the quadrangle but were eroded during the interval between Alexandrian and Niagaran epochs; or (3) that the quadrangle remained a land area during the Alexandrian epoch. The erosional unconformity that occurs between the Alexandrian and Niagaran series at some localities in the State shows that there was an erosional interval between the two epochs, although at other localities there is apparent only a disconformity in strata and a notable difference in fauna to mark the interval.

NIAGARAN EPOCH

During the Middle Silurian or Niagaran epoch Illinois was again invaded by a sea, this time from the north or Hudson Bay region. Conditions favored deposition of calcareous ooze, which, like similar deposits in earlier seas, became dolomitized. The chert that is widespread in the Niagaran dolomites was formed in part by precipitation from circulating ground-waters subsequent to the consolidation of the sediments, and in part by direct chemical precipitation from the sea-water at the time of their deposition.[8] The Middle Silurian inundation was terminated by uplift of the area above sea-level. The Alexis quadrangle was a land area during the Late Silurian epoch, at which time erosion and weathering proceeded.

DEVONIAN PERIOD

The land conditions existing during the Late Silurian epoch continued through the Early and Middle Devonian epochs. Erosion produced a local relief of as much as 50 feet, and at the same time weathering developed a porous zone in the upper part of the Niagaran series. At some places the

[7] Savage, T. E., Silurian rocks of Illinois: Bull. Geol. Soc. America, vol. 37, pp. 513-534, 1926.

[8] Fisher, D. J., Geology and mineral resources of the Joliet quadrangle: Illinois State Geol. Survey Bull. 51, pp. 41 and 44, 1925.

Silurian system is so thinned by erosion that the entire remaining thickness is weathered, in which case the porous zone extends to the base of the system. During the Late Devonian epoch the sea reinvaded the Alexis quadrangle. Surficial residual fragments of Niagaran chert and dolomite were reworked and concentrated by waves and currents and deposited in the bottom of the sea. Thus a porous zone consisting in part of weathered Niagaran dolomite in place, and in part of detrital dolomite and chert in the base of the Devonian rocks occurs at the horizon between the Silurian and Devonian systems, and it is impossible to determine a precise contact between them. Drillers report the entire porous zone as a "blue sand".

The Late Devonian sea invaded the Alexis region from the north contemporaneous with the Tully sea invasion in New York State. The sea was comparatively clear, and the adjacent lands supplied little detrital material. Life flourished abundantly and locally coral reefs were developed. The calcareous deposits which accumulated form the Wapsipinicon and Cedar Valley limestones. These formations have not been subsequently dolomitized, as were the limestones deposited earlier in this area. The sea withdrew again after the deposition of these calcareous sediments, and a long erosion interval followed, during which valleys 40 or 50 feet in depth were carved in some places, but in the Alexis quadrangle there is no evidence of erosion.

MISSISSIPPIAN PERIOD

In the early part of the Mississippian period the Alexis quadrangle was occupied by a sea in which dark muds containing numerous spores of *Sporangites huronense* (a lycopod plant of the fern group) were deposited. These muds have been consolidated into the Sweetland Creek shale. Their dark color and the presence of the spores suggest that they were deposited in a sheltered embayment.

Deposition of muds apparently continued uninterruptedly from the Sweetland Creek stage through the succeeding stage, but the lighter, bluish-gray color and occasional fossils in the Hannibal shales show that the sea had become more open.

During the Burlington stage the sea became clearer, so that the deposits were principally calcareous ooze. Marine life flourished. Some of the brachiopods became unusually large; other brachiopods and crinoids became abundant and diverse, fragments of crinoid stems making up a large part of the Burlington limestone. Alteration of the limestone since its consolidation has produced layers and irregular nodes of chert, in which many of the fossils exist only as molds and casts, the shells having been dissolved.

The Alexis quadrangle was probably occupied by the sea for a long time during the Mississippian period after the Burlington stage, as deposits of the Keokuk, Warsaw, Salem, and St. Louis stages occur only 40 to 50 miles south and once probably extended across the quadrangle. But if so, they were stripped away by erosion before the overlying Pennsylvanian strata were laid down, so that the time of the final withdrawal of the Mississippian sea from the Alexis area can not be determined.

After the deposition of the latest Mississippian sediment in Illinois and before the deposition of the earliest Pennsylvanian there was considerable deformation. The La Salle anticline, the major structural feature of eastern and central Illinois, was uplifted and a basin which lay parallel to and south and west of the anticline, including the area of the Alexis quadrangle, was moderately depressed.

A long erosion interval followed these movements. The younger Mississippian sediments were completely stripped from the Alexis quadrangle, if they had been deposited. The Burlington limestone was left only in a small area near the southern margin of the quadrangle, where it forms an escarpment. A lowland several miles in width and covering most of the Alexis quadrangle was developed on the soft shales of the Hannibal and Sweetland Creek formations northward from this escarpment. A channel cut entirely through these shales to the Devonian limestone below exists along the east side of the quadrangle, and similar channels may have been cut in the northwest part of the quadrangle. All of the shales in the central west part of the quadrangle may have been eroded at this time.

PENNSYLVANIAN PERIOD

POTTSVILLE EPOCH

The post-Mississippian erosion continued until the middle or latter part of the Pottsville epoch. Then the Alexis area was again invaded by marine waters, which inundated only the lowest portions of the lowland plain north of the Burlington limestone escarpment. The varied character of the first suite of Pottsville strata shows that conditions were not persistent over any considerable areas, that they differed greatly within short distances, and that they changed frequently.

The deposition of the first Pottsville suite in the Hannibal-Sweetland Creek lowland was terminated by an interval of warping and uplift, followed by erosion which truncated the tilted beds.

Upon the truncated beds sand, in which fragments of trunks, leaves, and roots of trees were included, was deposited by streams and slope-wash. The sand forms the "Stigmarian" sandstone. After the deposition of the sand, parts of the area became brackish-water or fresh water swamps, in which grew a luxuriant forest. The forest debris developed peat, later changed into the Rock Island coal. Alteration processes prior to, contemporaneous with, or since the plant growth changed the underlying material to underclay. In a part of the swamp the accumulation of plant debris was interrupted by the deposition of a layer of mud, which now forms the clay parting in the coal. The mud appears to have been washed in from the northwest, because the clay parting thickens in that direction. Vegetable growth was then resumed and persisted until the next marine invasion killed the vegetation, which was buried under black carbonaceous muds. The currents of the advancing sea mixed humus material and organic matter, derived from adjacent, deeply weathered land surfaces, with floating and suspended organic debris from the submerged forests to form sheets of black mud under which the peat was buried. Marine life, especially such mud-loving forms as gastropods and pelecypods, and swimming forms, such as sharks that fed on the molluscan life, invaded the area and contributed shells, teeth, and spines to the accumulating debris. Eventually the supply of land plant debris was exhausted, the water became clearer, and animal life flourished in greater abundance. Corals and crinoids, which can not exist in muddy waters, spread into the area, and the spindle-shaped colonial foraminifera (fusulinids) lived in such abundance that their shells make up a considerable part of the calcareous sediment which now forms the limestone cap-rock of the coal. Again the water became muddy, more clayey calcareous beds that now form shaly limestone ("blue rock") were laid down, and the character of the life gradually changed. Finally the calcareous material was no longer deposited, the water became more muddy, and the sea was no longer a suitable habitat for marine life.

After deposition of the last mud, the region was drained of its marine waters for a short time, and streams cut channels over the area, locally cutting down to and even below the peat which now forms the Rock Island (No. 1) coal. Soon sand began to fill up these channels. At a much later time, after the sand had become partially consolidated into sandstone, silica carried in solution in circulating ground-water was precipitated along the contact between the sandstone and the less porous shale below, forming a band of chert which is widely associated with the base of the sandstone. After the channels were filled with sand, marsh conditions again prevailed and luxuriant forests again covered large portions of the area, in which areas the accumulating vegetable debris again formed peat beds which have been subsequently changed to the thin coal beds that lie about 20 feet above the Rock Island (No. 1) coal. Other portions of the area were occupied by wide lagoons in which the water was too deep for forest growth. In such lagoons and in the shallow sea which shortly occupied the whole quadrangle, including the south portion which had not been previously inundated, the fine silt and clay that now compose the Gilchrist shale was laid down. The water was not greatly disturbed by waves, for the branches and even the fragile leaves of trees (ferns, club mosses, horsetails, et cetera) from nearby shores floated out and settled without serious mutilation to the bottom, where they have been preserved so well that the delicate venation of the leaves is retained.

A third time the waters were again withrawn and streams again began to channel the surface. The period of emergence was shorter than that after the deposition of Suite II, as the underlying strata are less thinned by erosion and channeling is less pronounced. The period of active cutting was followed by another accumulation of sands until the channels were nearly filled and marsh conditions again prevailed. The return to marsh conditions marked the close of the Pottsville epoch.

CARBONDALE EPOCH

The Carbondale epoch began with a widespread marsh filled with a luxuriant swamp vegetation. This marsh differed from those in which the Rock Island (No. 1) coal was accumulated in that it was continuous over hundreds of square miles in northern, western, and central Illinois, including the Alexis quadrangle. The rate of accumulation of vegetable debris in this marsh was so uniform that over wide areas the thickness of the Colchester (No. 2) coal formed from it varies only a few inches. The swamp may have spread into the Alexis area from the southeast, as the coal is thinner than in Knox and Fulton counties. The growth of vegetation and accumulation of peat was uninterrupted, as the coal has no bedded impurities, but it was terminated when the marsh was submerged by the sea. The sea was but little agitated, for stems and fragile leaves of trees floated out from forested shores and sank bodily to the floor of the sea, where they were buried in the soft, fine mud and silt that now forms the roof shales of the Colchester (No. 2) coal. The gray shale which occurs only locally either accumulated only in the lower parts of the submerged swamp or was removed by erosion from the higher portions. The origin of the black mud, which has since been compressed and consolidated to form the black laminated shale above the coal, can not at present be satisfactorily explained. It may be an ordinary mud deposited in stagnant or semi-stagnant water in which floating carbonaceous material, that became waterlogged and sank, decayed under the influence of bacterial action instead of being buried in mud. The vegetation from which the Colchester (No. 2) coal was formed could not have been the source of carbonaceous material for the black shale as the shale is in immediate contact with the coal only in small areas, and even in such places the coal shows no evidence of having been thinned by erosion. Furthermore, the black shale is nearly as widespread a formation as is the coal. The sand grains and leaf fragments that are commonly found in the small calcareous concretions in the shale were probably dropped from masses of floating vegetation. The fact that the papery laminae of the shale bend around the concretions makes it appear that the concretions were formed before the mud had become consolidated. Conditions so changed after the deposition of the black mud that succeeding deposits were lighter gray muds, some times calcareous, and marine life entered this region in abundance. For a short time, when the calcareous muds now forming the gray septarian limestone were precipitated, corals and crinoids occupied the area, but during the times when the water was more muddy, pelecypods, gastropods, ostracods, and worms constituted the dominant life. The alternation of limestones and shales is probably the result of widespread changes in conditions, as the succession of calcareous beds above black shale is similar over hundreds of square miles of western Illinois. The sedimentation was terminated by the withdrawal of the sea from the whole region.

Again streams began to dissect the surface, cutting channels through the muds and calcareous beds of the last marine inundation, through the peat that became the Colchester (No. 2) coal, and even 30 or 40 feet lower. After a period of active erosion, the stream channels were filled by sand that now forms the Pleasantview sandstone.

If any Pennsylvanian strata younger than the shale above the Pleasantview sandstone were deposited in the Alexis quadrangle, they were completely removed by erosion between the Pennsylvanian and Pleistocene periods.

Post-Pennsylvanian, pre-Pleistocene Interval

This interval includes the Permian period of the Paleozoic era, all of the Mesozoic era, and all of the Cenozoic era except the Pleistocene period. Since the withdrawal of the sea in late Pennsylvanian times the Upper Mississippi Valley appears to have been a land area, subjected to continuous erosion and intermittent uplift so that at least two recognizable peneplains have developed. In southwestern Wisconsin and adjacent parts of Illinois, Iowa, and Minnesota (the district known as the "driftless area"), a high-level peneplain, called the Dodgeville peneplain,[9] possibly represents erosion to the Cretaceous period. Following uplift, this peneplain was largely reduced to another peneplain at a lower level, known as the Lancaster peneplain,[10] so that by the Pliocene period the region stood in low relief with remnants of the Cretaceous peneplain rising above the general level. Mississippi River was the master stream of the Interior Province, but it flowed eastward from the vicinity of what is now Clinton toward the present position of the "big bend" in the Illinois River at Hennepin, whence it flowed south in a valley approximately followed now by Illinois River. The Alexis quadrangle was drained by preglacial streams that occupied the approximate position of the lower parts of Cedar Creek, Pope Creek, and Edwards River. A marked elevation of the land relative to sea level occurred at the close of the

[9] Trowbridge, A. C., The erosional history of the driftless area, Pt. II: Univ. of Iowa Studies in Natural History, vol. 9, No. 3, pp. 55-127, 1922.
[10] Grant, U. S., and Burchard, E. F., U. S. Geol. Survey Geol. Atlas, Lancaster-Mineral Point folio (No. 145), p. 10, 1907.

Pliocene Period. As a result streams were rejuvenated and cut valleys into the Pliocene peneplain as much as 100 feet lower than the present valleys.

Pleistocene Period

World-wide climatic changes at the close of the Pliocene period caused snow and ice to accumulate over large areas in the northern hemisphere. These accumulations began as continental ice caps in the higher latitudes

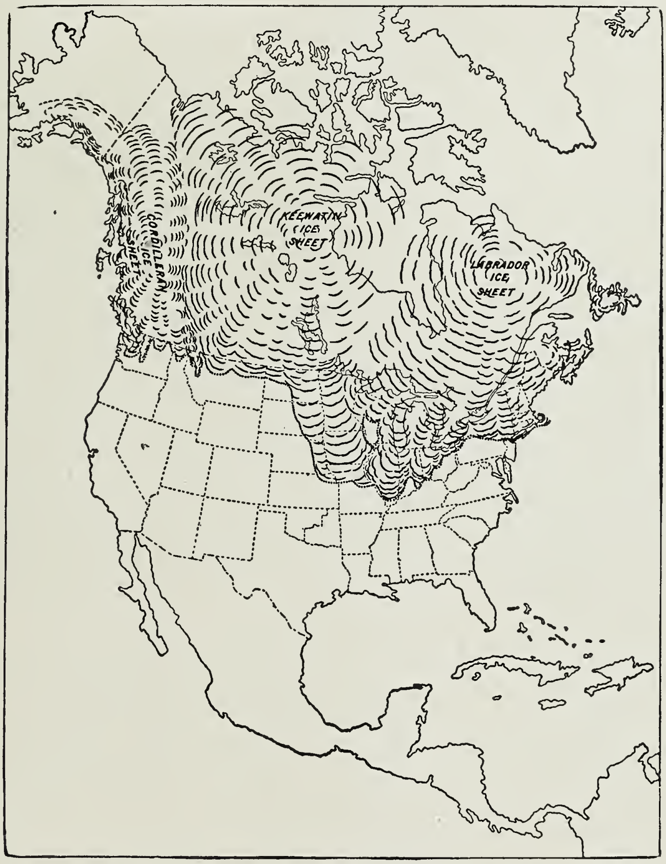

Fig. 44. Map of North America showing the centers of ice accumulation and the area of glaciation.

but eventually increased in size and thickness and moved outward in all directions from the centers of accumulation. The continental glaciers which affected North America are known to have spread from three principal centers: (1) the Labradorean center, in the highlands of eastern Quebec and Labrador; (2) the Keewatin center, west and southwest of Hudson Bay; and (3) the Cordilleran center, in the Canadian Rocky Mountains. (Fig. 44.) The northern Mississippi Valley was invaded five times by glaciers advancing from either or both the Keewatin and Labradorean centers, each invasion being followed by an epoch of milder climate during which the ice sheets melted away. (Table 1, p. 30.) The history of the Alexis quadrangle during the Nebraskan and Aftonian epochs cannot be determined, as there are no deposits of those series.

KANSAN EPOCH

The first known glacial invasion of the Alexis area occurred during the Kansan epoch, when a glacier originating in the Keewatin center spread southward through central Minnesota and north-central Iowa into Missouri as far as the present valley of Missouri River and expanded radially eastward into Illinois, so that in the Alexis quadrangle it advanced from a westerly or even a southwesterly direction. As the glacier advanced, it incorporated within itself the soil that had been developed during the preceding emergent periods and also much of the underlying rocks in the areas over which it moved. When the ice melted, this material was deposited as a heterogeneous mixture of clay, sand, gravel, and boulders. The clay, which consists not only of the older soil but also of material derived by the pulverization of most of the soft rocks and some harder rocks, serves as a matrix in which larger fragments of the harder rocks, both of distant and of local origin (boulder count, p. 95) are scattered. The dark color of the Kansan drift may be due to the large proportion of old soil that was picked up by the glacier. The Kansan epoch was terminated by ameliorated climatic conditions during which the ice melted away and with which the Yarmouth epoch was introduced.

YARMOUTH EPOCH

The Yarmouth interglacial interval, which was probably the longest of all the interglacial epochs, was marked through most of its time by a mild and humid climate in Illinois so that vegetation flourished, the Kansan till was deeply weathered, and the Kansan drift plain was extensively dissected by streams. Some of the Yarmouth drainage lines may be detected by the silt and sand deposited in their valleys. The largest Yarmouth valley in the Alexis quadrangle was near the present valley of Henderson Creek. It was locally two and one half to three miles in width, and its flood-plain was 35 or 40 feet lower than the present flood-plain of Henderson Creek. A smaller drainage line appears to follow the present valley of Goose Run rather closely. On flat or nearly flat surfaces where products of plant decay accumulated the soil waters were so acid that they dissolved or decomposed many of the pebbles and boulders in the drift, especially the calcareous rocks and the coarse-grained silicate rocks, and developed the gumbotil as a residual product. A dark soil was formed over most of the surface. Decayed vegetation accumulated in bogs, as revealed by well drillings and by the common occurrence of natural gas in wells 80 to 150 feet deep.

ILLINOIAN EPOCH

The long Yarmouth epoch was terminated by the recurrence of glacial conditions which inaugurated the Illinoian epoch. A glacier originating in the Labradorean center spread southwestward across Quebec, southern Ontario, and Michigan, and expanded radially in Illinois and Indiana, so that it advanced over the Alexis quadrangle from the east and southeast. Pebbles of jasper conglomerate from the Lorraine (upper Huronian) quartzite of the Cobalt district, northeast of Lake Huron in Ontario; and fragments of Burlington limestone from a few miles southeast of the Alexis area; all of which occur in the Illinoian till, reveal the path that the glacier followed. Where the Illinoian glacier overrode Kansan drift, it mixed the upper weathered portion of the Kansan till so thoroughly with new material that the contact between the two drifts can seldom be distinguished in borings. Where the Illinoian ice moved over the soft Pennsylvanian shales it locally buckled them into sharp folds.

The surface over which the Illinoian ice-sheet advanced was uneven, as a result of erosion during the long Yarmouth interval. Some of the Yarmouth valleys were completely filled by Illinoian drift, but many of the valleys, especially the larger ones, were only partially filled and are reflected in the present topography. The pre-Illinoian valley of Edwards River appears to have been both wider and deeper than the present valley, because outcrops of pre-Pleistocene rocks are practically absent along the banks of the stream and for a few hundred yards up along the tributary valleys, beyond which Pennsylvanian strata are exposed at altitudes 50 to 75 feet above the present flood-plain of the river.

The escarpment of Burlington limestone near the southern margin of the Alexis quadrangle was undoubtedly scoured by the ice and yielded numerous fragments of this rock which characterize the till in the southern portion of the quadrangle, but it protected the lowland north of the escarpment so that the weak, unconsolidated Yarmouth sands are preserved without contortion of the cross-bedding and other original structures.

The recurrence of a milder climate caused the Illinoian glacier to melt away steadily and slowly. Its recession across the Alexis quadrangle must have been uniform, for there are no morainic ridges as would occur if there were halts. The complete absence of sand and gravel terraces along the streams indicates that the flow of water from the ice was not sufficient to carry sand and gravel, and this also suggests a slow melting of the ice.

SANGAMON EPOCH

The Sangamon epoch was shorter than the Yarmouth epoch, shown by the fact that the Illinoian till was not weathered as deeply during Sangamon time as was the Kansan till during the Yarmouth epoch. As in the Yarmouth epoch, vegetation flourished, a rich dark soil was formed everywhere, gumbotil was developed on surfaces of low relief where the subsurface drainage conditions were poor, a reddish or rusty colored zone in the upper part of the drift was produced nearer the valleys of the larger streams where the subsurface drainage conditions were better, and stream erosion progressed. Although the main, westward-flowing streams of the area occupy valleys of pre-Illinoian origin, their larger tributaries occupy valleys carved chiefly during the Sangamon epoch. The slopes of the main stream valleys, which had been mantled with Illinoian till, were steepened by the lateral cutting of the meandering streams, and locally the Illinoian till was completely removed, as for instance on the south valley slope of Henderson Creek, where Late Sangamon deposits lie unconformably on Yarmouth sands. Remnants of low terraces that occur along Pope Creek in secs. 4 and 5, T. 13 N., R. 3 W. (Ohio Grove Twp.), and along Cedar Creek in secs. 20, 21, 22, 26, and 27, T. 12 N., R. 3 W. (Sumner Twp.), and that are covered in one case at least (geologic section 30 p. 105) by a black soil underlying calcareous silt, are interpreted as Sangamon in age and indicate that the valleys at that time were about the same as at present. On gently sloping upland surfaces the silt and clay content of the drift was washed out, so that the boulders and pebbles were concentrated on the surfaces and now underlie the late Sangamon loesslike silt or Peorian loess.

In Late Sangamon time loesslike silt accumulated on the uplands, slopes, and valley floors. This deposit may have been calcareous originally, but if so it was entirely leached before the deposition of the overlying Peorian loess.

IOWAN EPOCH

The Sangamon interglacial epoch was terminated by a recurrence of conditions favorable for the accumulation of glaciers during the Iowan epoch. A glacier from the Keewatin center pushed southward through central Minnesota into northern and central Iowa, where its terminal position was less than 100 miles northwest of the Alexis quadrangle, near the location of Iowa City, Iowa.[11] The climate in the Alexis quadrangle was probably so cold that erosion was materially retarded, but the only changes which may have occurred in the area during the Iowan epoch are a slight amount of erosion and weathering. The epoch was probably shorter than either the Kansan or the Illinoian epoch, as the Iowan drift is thinner and covers a

[11] Alden, W. C., and Leighton, M. M., The Iowan drift; a review of the evidences of the Iowan stage of glaciation: Iowa Geol. Survey, vol. 26, pp. 49-212, 1917.

smaller area than either of the others. At the close of the Iowan epoch the main, westward-flowing streams were lower in altitude than they are at present, the longer lateral tributaries were present but not as deeply entrenched as they now are, the drainage system was simpler, and the interfluves were more extensive than at present.

PEORIAN EPOCH

Another epoch of milder climate, the Peorian, terminated the Iowan glacial epoch. In the early part of the Peorian epoch the wind picked up fine silt and dust from the surface of the exposed Iowan drift and from the valley-trains of streams which had served as glacial outwash channels and distributed it over wide areas where it completely mantled the uplands, the valley-slopes, and the flood-plains of streams beyond the area of Iowan glaciation. The distribution and character of the loess in the Alexis quadrangle and in the districts west and northwest of the quadrangle indicate that the source of the loess in these areas was primarily the flood-plain of Mississippi River, which drained extensive areas of both the Keewatin and Labradorean lobes of the Iowan glacier. The loess deposit smoothed and rounded the eroded Sangamon surface, filled the larger Sangamon valleys to a depth of ten to twenty feet, and forced these streams to change their work from valley-widening to down-cutting through the loess. Not all of the Peorian loess has yet been removed in some of the larger stream valleys.

The loess contains numerous fossil shells of terrestrial or amphibious gastropods comparable with living species that inhabit damp, shady places, and feed on vegetation, and thus the conditions in the areas of deposition can be interpreted.[12] Although the loess may have accumulated so slowly that all vegetation completely decayed, its calcareous content shows that it accumulated faster than it could be leached. The calcium carbonate in the loess is mainly fine particles of limestone or other calcareous rocks ground up by the glacier.

Loess accumulation during the Peorian epoch ceased when the Iowan till plain became covered with vegetation. A brief period of weathering and soil formation[13] comprised the latter part of the Peorian epoch, the shortest of all the interglacial epochs.

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[12] Chamberlin, T. C., Supplementary hypothesis respecting the origin of loess of the Mississippi valley: Jour. Geol., vol. 5, pp. 795-802, 1897.
Calvin, S., The Iowan drift: Jour. Geol., vol. 19, pp. 577-602, 1911.
Shimek, B., Papers on the loess: Iowa Univ. Lab. Nat. Hist. Bull. 5, pp. 298-381, 1904 (and many other papers).
Alden, W. C., and Leighton, M. M., The Iowan drift; a review of the evidences of the Iowan stage of glaciation: Iowa Geol. Survey, vol. 26, pp. 140-164, 1917.

[13] Leighton, M. M., A notable type Pleistocene section:—The Farm Creek exposure near Peoria, Illinois: Illinois State Geol. Survey Rept. Inv. No. 11, p. 5, 1926.

WISCONSIN EPOCH

The brief Peorian epoch was terminated by a recurrence of glacial conditions, so that great ice-sheets once more formed in the three centers of accumulation. During this epoch Illinois was invaded only by a Labradorean glacier which advanced to a point a few miles west of Princeton, about 80 miles east of the Alexis quadrangle. In the Alexis area erosion and weathering were probably greatly retarded during this epoch. Some loess may have been deposited, but it cannot be distinguished from the early Peorian loess. Mississippi and Rock rivers were loaded with outwash material from the melting glacier and their valleys were considerably aggraded. As a result of this filling in the Mississippi valley, the valleys of Pope Creek, Edwards River, and Henderson Creek were dammed and converted into lakes which may have extended up as far as the west part of the Alexis quadrangle. If any lacustrine silts were deposited, they have become weathered and indistinguishable from the Peorian and other loesses which had been deposited earlier in these valleys.

Recent Period

With the recurrence of a milder climate the Wisconsin glaciers melted away and the present period was initiated. The streams began to remove the fine, slack-water silt that had been deposited in their valleys, but they have not been able to widen their valleys since Sangamon time. They have developed an intricate meander system unrelated to the earlier, larger, simpler meanders. The largest four streams in the quadrangle have not entirely cut away the Peorian loess in their valleys, and broad stretches of the deposit remain as terraces ten to fifteen feet above the present alluvial plains. The smaller streams, such as North Henderson and North Pope creeks, have removed the Peorian loess completely and are actively enlarging their valleys. The lateral tributaries of the large streams have also removed the Peorian loess, are cutting into the underlying Illinoian till and pre-Pleistocene rocks, and are working headward into the interfluves.

Weathering of the surface materials, which was checked during the Wisconsin glacial epoch was resumed. The calcareous Peorian loess has been leached to depths of 6 to 10 feet. Soils have been developed. The accumulation of decaying plant material on the level interfluves and poorly drained flood-plains has there produced a black soil.

The whole quadrangle was covered by vegetation—a prairie vegetation on the more level interstream divides and a forest vegetation on the slopes and on the bottom-land—which materially retarded surficial erosion. A large part of the local precipitation soaked into the soil instead of running off, and the flow of streams was more moderate and more permanent as the result of this subsurface supply of water. But since man occupied the district about 100 years ago and cut the forests and broke the sod, there has been more concentrated run-off with consequent gullying of the slopes (fig. 4), local development of bad-land topography (fig. 5), eventual abandonment of the fields, and the entrenchment of the smaller streams in narrow channels 10 to 30 feet deep below the older alluvial flats (fig. 6). Alluvial fans have been formed at the mouths of many of the smaller ravines. In a few places on slopes the finer silts are being removed, so that soils on the slopes are becoming more pebbly. Artificial drainage—the tiling of the upland flats and the straightening of the smaller streams—enables the water of heavy rains to reach the main streams more quickly and increases both the frequency and the degree of flooding of their alluvial plains. Coal mining has caused some subsidence of the surface at a few localities, thus altering the natural drainage, and creating a serious problem for land owners.

CHAPTER VI—ECONOMIC GEOLOGY

Mineral Resources

The mineral resources of the Alexis quadrangle consist of coal, shale and clay, sand and gravel, building stone, and water. Soil is also a very important economic asset. The possible occurrence of oil and natural gas is of interest.

Coal

Workable coal beds are scattered over all except the west side and southwest part of the Alexis quadrangle (fig. 45), which is included in Illinois Coal District III.[1] In the Alexis quadrangle the Rock Island (No. 1) coal is commercially important, and the Colchester (No. 2) coal, two Pottsville coals other than Rock Island (No. 1) coal, and two lenticular coals of uncertain age may eventually become so. The oldest mine in the quadrangle, located on the south side of Pope Creek in sec. 32, T. 14 N., R. 2 W. (Greene Twp.), has been in more or less continuous operation since 1861. There have been no shipping mines in operation in the quadrangle since 1920 although a shipping mine located at Matherville in sec. 27, T. 15 N., R. 2 W. (Preemption Twp.), about half a mile north of the quadrangle, was operating in 1926. Fifteen local mines exploiting the Rock Island (No. 1) coal were operating in 1926 (Pl. I).

ROCK ISLAND (NO. 1) COAL

GENERAL STATEMENT

Rock Island (No. 1) coal has been worked for many years in T. 15 N., R. 2 W. (Preemption Twp.), T. 14 N., R. 3 W (Mercer Twp.), T. 14 N., R. 2 W. (Greene Twp.), and T. 12 N., R. 2 W. (Spring Grove Twp.) (fig. 45). It varies notably in thickness, thinning from 4 or 5 feet to less than one foot or even disappearing completely within a quarter of a mile. In most mines only coal 3½ or more feet thick is mined (fig. 46). Consequently mining areas are isolated (fig. 45). The coal seam usually consists of an upper bench of bright, hard coal 12 to 20 inches thick and a lower thicker bench of duller coal (fig. 47). In mines in secs. 4, 5, 6, and 8, T. 14 N., R. 2 W. (Greene Twp.) the two benches are separated by a carbonaceous shale 10 to 18 inches thick. In a few mines about 6 inches of hard carbonaceous shale, known as "false bottom", is found at the bottom of the coal.

[1] Culver, H. E., Coal resources of District III: Illinois State Geol. Survey Coop. Mining Series Bull. 29, pp. 84-91, 115-120, 1925.

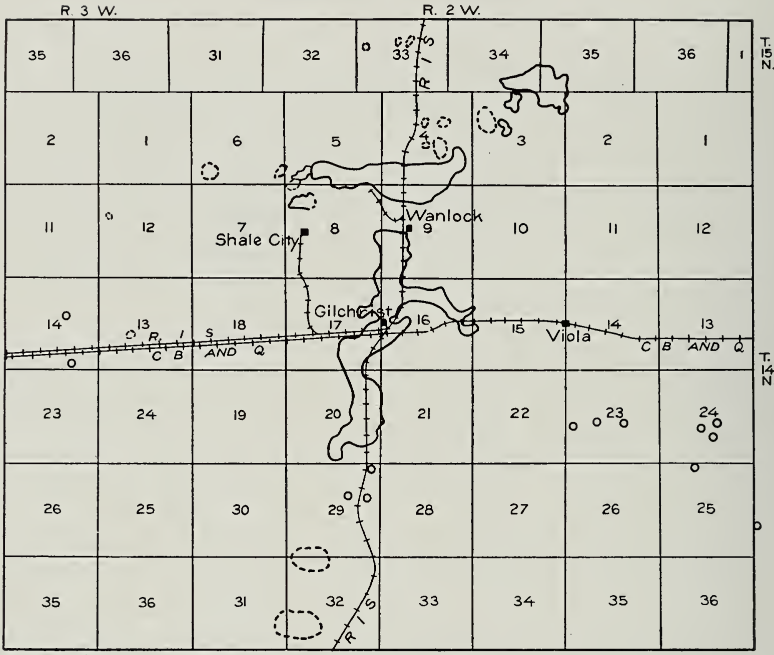


Fig. 45. Approximate areas from which the Rock Island (No. 1) coal has been mined out in the north part of the Alexis quadrangle. Solid lines indicate data from mine maps. Circles show wells or test borings that report the coal in workable thickness in unmined areas.

Fig. 46. Rock Island (No. 1) coal in an old drift mine along south bank of Donahue Run, SE. ¼ NW. ¼ sec. 3, T. 14 N., R. 2 W. (Greene Twp.).

A concretionary pyrite band 2 to 6 inches thick is found locally about 18 inches below the top of the coal. Small pyrite concretions are scattered irregularly through the coal.

Chemical analyses (Table 2) show that the coal has a very high moisture content, high ash content, and nearly equal parts of volatile matter and fixed carbon. The volatile matter includes much carbon dioxide, which does not add to the heating value of the coal. It ranks as a low-grade bituminous coal.

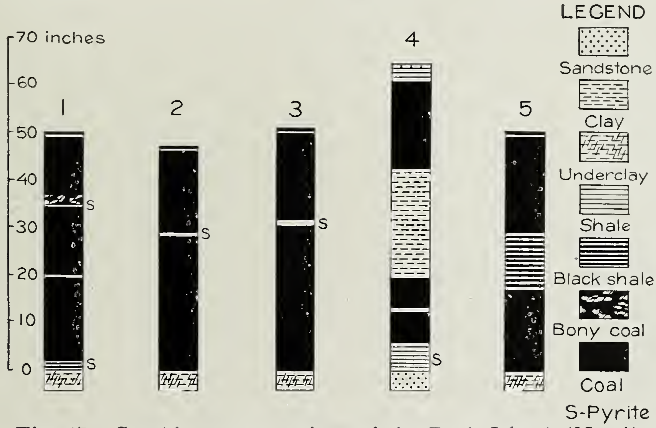


Fig. 47. Graphic representations of the Rock Island (No. 1) coal.

1. Richardson mine, SW. ¼ NW. ¼ sec. 24, T. 12 N., R. 2 W. (Spring Grove Twp.).
2. Williams mine, NW. ¼ NW. ¼ sec. 32, T. 14 N., R. 2 W. (Greene Twp.).
3. Black Diamond mine, SE. ¼ SW. ¼ sec. 2, T. 14 N., R. 2 W. (Greene Twp.).
4. Lillaman mine, NW. ¼ SE. ¼ sec. 4, T. 14 N., R. 2 W. (Greene Twp.).
5. Snell mine, SW. ¼ SW. ¼ sec. 6, T. 14 N., R. 2 W. (Greene Twp.).

TABLE 2.—*Analyses of mine samples of coal No. 1 from the Alexis quadrangle and vicinity (Not exactly indicative of commercial output)*

Proximate analysis of coal
1st: "As rec'd" with total moisture
2nd: "Dry" or moisture-free

Lab. No.	File No.[a]	Date	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	CO_2	B. t. u.	Unit Coal
Warren County										
15416[b]	0224	7/26	13.03	40.77	39.56	6.64	4.88	.04	11,583	.....
			Dry	46.88	45.49	7.63	5.61	.05	13,318	14,703
15417[b]	0224	7/26	10.21	42.44	40.68	6.67	4.70	.05	11,946	.....
			Dry	47.27	45.31	7.42	5.23	.06	13,304	14,636
(Mine average)			11.62	41.61	40.12	6.65	4.74	.05	11,764	.....
			Dry	47.08	45.40	7.52	5.36	.06	13,311	14,666

Lab. No.	File No.[a]	Date	Mois-ture	Vola-tile Matter	Fixed Carbon	Ash	Sul-phur	CO_2	B. t. u.	Unit Coal
Mercer County										
13812[c]	1132	1/23	16.19	36.17	37.35	10.29	3.82	Tr.	10,428	.....
			Dry	43.16	44.56	12.28	4.56	Tr.	12,442	14,500
13813[c]	1132	1/23	16.49	36.97	38.63	7.91	3.13	.29	10,739	.....
			Dry	44.27	46.26	9.47	3.75	.35	12,860	14,448
13814[c]	1132	1/23	15.35	38.43	38.43	7.79	3.72	.11	10,945	.....
			Dry	45.40	45.40	9.20	4.39	.13	12,930	14,501
(Mine average)			16.01	37.19	38.14	8.66	3.55	.20	10,704	.....
			Dry	44.27	45.41	10.32	4.23	.24	12,744	14,483
1857[c]	1120	9/08	17.56	36.61	36.28	9.55	4.52	..	10,442	.....
			Dry	44.40	44.02	11.58	5.47	..	12,666	14,668
15414[b]	1102	7/26	16.38	37.80	38.96	6.86	4.35	.66	11,001	.....
			Dry	45.21	46.59	8.20	5.20	.79	13,156	14,608
15415[b]	1102	7/26	14.51	37.94	38.71	8.84	5.04	.68	11,024	.....
			Dry	44.38	45.28	10.34	5.90	.80	12,895	14,721
(Mine average			15.44	37.87	38.84	7.85	4.69	.67	11,012	.....
last two analyses only)			Dry	44.79	45.94	9.27	5.55	.80	13,024	14,660
5338[d]	C19	8/12	13.23	40.29	37.20	9.28	4.37	.41	11,104	.....
	0227a		Dry	46.43	42.88	10.69	5.04	.47	12,797	14,641
5339[d]	C19	8/12	15.24	37.66	35.73	11.37	4.80	1.47	10,353	.....
	0227a		Dry	44.44	42.15	13.41	5.66	1.73	12,214	14,478
5340[d]	C19	8/12	15.15	39.06	38.48	7.31	3.30	.17	11,252	.....
	0227a		Dry	46.03	45.36	8.61	3.89	.19	13,260	14,760
5363[d]	C19	8/12	14.97	38.27	37.07	9.69	3.75	.33	9,637	.....
	0227a		Dry	44.99	43.61	11.40	4.95	.43	12,749	14,712
5364[d]	C19	8/12	14.46	40.42	35.33	9.79	4.23	.69	10,780	.....
	0227a		Dry	47.24	41.32	11.44	4.94	.59	12,603	14,551
5365[d]	C19	8/12	14.07	39.95	34.01	11.97	4.55	.78	10,525	.....
	0227a		Dry	46.49	39.59	13.92	5.29	.91	12,247	14,604
(Mine average)			14.52	39.26	36.32	9.90	4.16	.64	10,609	.....
			Dry	45.93	42.49	11.58	4.96	.72	12,411	14,349
5359[d]	C18	8/12	14.58	39.49	36.82	9.11	5.60	.15	10,894	.....
	0227		Dry	46.23	43.09	10.68	6.56	.18	12,754	14,642
5360[d]	C18	8/12	15.07	38.14	37.44	9.35	4.85	.34	10,790	.....
	0227		Dry	44.91	44.07	11.02	5.71	.38	12,705	14,618
5361[d]	C18	8/12	14.10	39.60	36.73	9.57	3.92	.23	10,956	.....
	0227		Dry	46.09	42.76	11.15	4.56	.27	12,753	14,660
(Mine average)			14.58	39.07	37.00	9.35	4.79	.24	10,880	.....
			Dry	45.74	43.31	10.95	5.61	.27	12,737	14,640
(Average Mercer County			15.64	38.51	36.89	8.96	4.44	.47	10,708	.....
Coals)			Dry	45.65	43.73	10.62	5.26	.56	12,693	14,515

[a] Analyses having the same file number are from the same mine. Analyses having file number 0227 are from the Matherville district, just north of the Alexis quadrangle.
[b] Samples collected by H. R. Wanless; analyses hitherto unpublished.
[c] Samples collected prior to 1926 by members of the State Geological Survey; analyses hitherto unpublished.
[d] Analyses published in Illinois Cooperative Mining Investigations Bull. 27, p. 8, 1923.

The coal is immediately overlain by either 2 to 6 inches of sticky carbonaceous clay, called "clod," or a hard, laminated, carbonaceous shale ("slate") which has a maximum thickness of about 3 feet. If thick enough, shale forms a good roof except near mine openings where it has been exposed to the air. Locally large calcareous or pyritic concretions are numerous in this shale and reduce its strength as a roof. Where the shale is thin it is removed with the coal. A massive blue limestone ("cap-rock") 8 to 24 inches thick overlies the shale and generally serves as an excellent roof. In some mines the limestone roof in rooms abandoned for sixty years has not fallen. Solution fissures in the limestone in some mines admit a large flow of water. "Slips," faults, and "rolls" occur in the coal in many mines. Clay seams follow some of the "slips" and faults, and the coal is weathered for a few feet back from these seams. Here and there much water gains access to the mines along minor faults.

The coal generally lies on sandy clay which averages 6 to 8 inches in thickness and overlies a hard sandstone from which in some mines a good deal of water emerges. Locally the coal rests directly upon this sandstone.

For additional data relating to specific mines, see Appendix B, Part III, pp. 173-176.

UNEXPLORED AREAS PROBABLY UNDERLAIN BY ROCK ISLAND (NO. 1) COAL

A large portion of Alexis quadrangle underlain by the Pennsylvanian rocks, in which coal beds of workable thickness may be present, has not been tested by drilling. Certain areas near and others more remote from transportation lines appear to merit the attention of anyone interested in determining the coal resources of the region.

AREAS NEAR TRANSPORTATION

Three areas along the Chicago, Burlington and Quincy Railroad between Aledo and Viola and one area east of Viola (fig. 47) are recommended for testing:

(1) It is probable that the 4 feet of coal reported at an approximate depth of 110 feet with limestone "cap-rock" in sec. 14, T. 14 N., R. 3 W. (Mercer Twp.), continues along the railroad eastward into sec. 13, and into secs. 17 and 18, T. 14 N., R. 2 W. (Greene Twp.).

(2) Coal may underlie the town of Viola in sec. 15, T. 14 N., R. 2 W. (Greene Twp.), as its presence is reported by Mr. B. McLaughlin of Viola, although it is not recorded in the log of the Viola city well.

(3) Coal reported near the railroad in sec. 16, T. 14 N., R. 1 W. (Rivoli Twp.), may extend north into secs. 9 and 4, along the spur of the railway from Hopewell to the Griffin shale pits, where coal was formerly mined at a depth of 60 feet.

(4) Coal of workable thickness reported in the SE. ¼ sec. 14, T. 14 N., R. 2 W. (Greene Twp.) east of Viola indicates the probable existence of a body of workable coal within half a mile of the railroad southeast of Viola.

AREAS REMOTE FROM TRANSPORTATION

(1) Several test drillings and water wells show that the Rock Island (No. 1) coal underlies a large part of the southeast fourth of T. 14 N., R. 2 W. (Greene Twp.) and perhaps underlies adjacent portions of T. 14 N., R. 1 W. (Rivoli Twp.), at depths of 160 to 180 feet below the flat upland. Secs. 22, 23, 24, 25, 26, 27, and 34, T. 14 N., R. 2 W. (Greene Twp.), and sec. 30, T. 14 N., R. 1 W. (Rivoli Twp.), particularly deserve testing.

(2) The coal bed (possibly Rock Island [No. 1] coal) discovered near New Windsor and mined in the Schuler Mine at Alpha,[2] Henry County, has been encountered in a number of wells west and southwest of New Windsor and may extend as a bed of workable thickness in the eastern tier of sections of the Alexis quadrangle, in T 14, N., R. 1 W. (Rivoli Twp.). Tests in this area should be sunk 200 feet or more below the upland plain, because the surface elevation rises toward the eastern margin of the quadrangle and the altitude of the coal declines.

(3) The Henderson Creek area of the Rock Island (No. 1) coal may extend eastward into secs. 17 and 18, T. 12 N., R. 1 W. (Kelly Twp.), where coal is reported about 100 feet below the upland surface.

(4) Deeper testing may reveal the Rock Island (No. 1) coal under parts of T. 13 N., R. 2 W. (Suez Twp.), and T. 13 N., R. 1 W. (North Henderson Twp.), where most wells obtain water from Pleistocene sands or Pennsylvanian sandstones and so are not satisfactory coal tests. Tests in the western tier of sections in Suez Township are not recommended, as the area is underlain by marginal Pennsylvanian sandstones or conglomerates or by Devonian or Mississippian shales and no coal beds are reported.

COAL BEDS BELOW THE ROCK ISLAND (NO. 1) COAL

Thin coal beds which are known or believed to underlie the Rock Island (No. 1) coal are exposed in secs. 3, 9, 10, 11, and 12, T. 14 N., R. 3 W. (Mercer Twp.), and sec. 35, T. 15 N., R. 3 W. (Perryton Twp.). Three such coals are exposed in creeks in secs. 9 and 10, T. 14 N., R. 3 W. (Mercer Twp.). They are thinner and more irregular than the Rock Island (No. 1) coal, as their thickness ranges from a few inches to 36 inches. The beds dip more steeply than does the Rock Island (No. 1) coal, and the character of the roof is more variable than that over the Rock Island (No. 1) coal. In general they are at present of no economic importance. Coal 24 inches

[2] Culver, H E., Coal resources of District III, Illinois State Geol. Survey, Coop. Mining Series Bull. 29, p. 67, 1925.

thick, apparently below the "Stigmarian" sandstone underlying the Rock Island (No. 1) coal, crops out in the bed of a creek in the NW. corner of the SW. ¼ sec. 12, T. 14 N., R. 3 W. (Mercer Twp.). A well near the NW. corner of the SW. ¼ sec. 3, T. 14 N., R. 3 W. (Mercer Twp.), passed through the following strata:

Geologic section No. 31.—Well near NW. corner SW. ¼ sec. 3, T. 14 N., R. 3 W. (Mercer Twp.)

	Thickness Feet	Inches
Recent and Pleistocene systems		
4. Loess and drift	16	
Pennsylvanian system		
3. Sandstone	13	
2. Shale, blue	4	6
1. Coal	2	6

Near the SW. corner of sec. 35, T. 15 N., R. 3 W. (Perryton Twp.), a drift was driven on a coal bed only 2 inches thick in outcrop but 36 inches thick 50 feet from the entrance. This may be the Rock Island (No. 1) coal, but if so, the association of strata is unusual:

Geologic section No. 32.—Drift mine near the SW. corner of sec. 35, T. 15 N., R. 3 W. (Perryton Twp.)

	Thickness Feet	Inches
Pennsylvanian system		
5. Sandstone, light gray, massive, hard	2	
4. Underclay, white	1	
3. Shale, black, laminated		1
2. Coal	3	
1. Shale, gray	3	

A test-boring in sec. 8, T. 14 N., R. 2 W. (Greene Twp.), near the Shale City plant of the Hydraulic Press Brick Company, and near exposures of Rock Island (No. 1) coal at an altitude of 652 feet, encountered at an altitude of 541 feet, 1 foot 6 inches of coal under hard, gray shale.

A relatively persistent coal seam, averaging 27 to 30 inches thick, underlying blue limestone ("cap-rock") 11 inches thick, crops out along Pope Creek in secs. 32 and 33, T. 14 N., R. 2 W. (Greene Twp.) (fig. 10). This coal lies 8 to 15 feet below and is locally more persistent than the Rock Island (No. 1) coal. It appears to be free from bedded impurities, and the roof appears to be satisfactory. There are one or two abandoned drifts in this coal.

COAL BEDS BETWEEN ROCK ISLAND (NO. 1) AND COLCHESTER (NO. 2) COALS

Many test holes in the mining district south of Edwards River in Greene Township penetrated a coal 8 to 24 inches thick, 20 to 40 feet above the Rock Island (No. 1) coal. The roof of this coal is usually sandstone, but in a few places it is shale. The coal is not known to have a workable thickness at any place in the Alexis quadrangle.

An 8-inch bed of coal underlying a sandy shell marl occurs about 20 feet above the Rock Island (No. 1) coal in sec. 24, T. 12 N., R. 2 W. (Spring Grove Twp.). (Fig. 21, p. 72.) A test boring in the same section encountered a 2-foot bed of coal at this horizon. This coal may be correlative with the coal near Edwards River.

COLCHESTER (NO. 2) COAL

The Colchester (No. 2) coal underlies parts of secs. 17, 23, and 27, T. 14 N., R. 2 W. (Greene Twp.), secs. 1 and 12, T. 13 N., R. 2 W. (Suez Twp.), and secs. 19, 20, 21, 29, and 30, T. 12 N., R. 1 W. (Kelly Twp.).

In T. 13 N., R. 2 W. (Suez Twp.) and T. 14 N., R. 2 W. (Greene Twp.), the coal ranges from 15 to 30 inches thick, according to five records. It is soft, evenly textured, and without bands of pyrite or bedded clay. The coal is directly overlain by hard, laminated, black shale having a "pimply" concretionary structure (fig. 28). The shale would form an excellent roof for mines. The coal is underlain by soft, white underclay, in which silicified plant-roots may be found.

In T. 12 N., R. 1 W. (Kelly Twp.), the coal ranges from 10 to 36 inches thick. (Fig. 24.) Where thickest it is separated from the usual hard, black, laminated shale roof by 2 to 9 feet of soft gray shale, which makes a poor roof. Small drift mines have been opened in this coal in a few places but no systematic mining has been attempted. Several drift mines have been abandoned because the soft shale caves so badly. At the present time the coal can be profitably mined only for local farm use.

COALS OF UNCERTAIN STRATIGRAPHIC POSITION

Two coal beds which occur respectively above and below the Rock Island (No. 1) coal are exposed in the west part of sec. 22, T. 12 N., R. 2 W. (Spring Grove Twp.), but are not known to occur elsewhere. The upper bed is 6 inches thick, and the lower one is 21 inches thick.

MINING METHODS

The room-and-pillar system of mining is employed in all mines, and entrance is gained by shafts and slope or horizontal drifts. The mine cars are moved by mules or men. Gasoline engines are used to hoist the coal in the larger mines; in others mules are used for hoisting the coal.

Mine drainage is most difficult near the shaft. Water enters the mine from the sandstone underlying the coal, through solution openings in the overlying limestone, through faults or "clay-seams" and in some cases from abandoned rooms of old mines. The water is usually pumped out, but in a few mines it is hoisted in buckets under the cage.

The bedded impurities are usually left in the mine, but the small, scattered concretions are separated after hoisting. Much of the coal is sold as lump or "block" coal to local farmers.

Shale and Clay

Shale and clay suitable for the manufacture of brick and tile occur in the Pennsylvanian and Pleistocene systems in the Alexis quadrangle.

GILCHRIST SHALE

The Gilchrist shale of Pennsylvanian age, which lies between the Rock Island (No. 1) and Colchester (No. 2) coals, is the only shale used at present for the manufacture of ceramic products. It is a thick, blue-gray, clay shale, generally free of sand. Calcareous concretions are scattered through the entire formation and are numerous at certain horizons. Formerly a number of ceramic plants exploited the Gilchrist shale, but at present only the Hydraulic Press Brick Company and the Northwestern Clay Manufacturing Company are operating.

Excellent exposures of the Gilchrist shale are found in gullies west of North Pope Creek in sec. 26, T. 14 N., R. 2 W. (Greene Twp.). A small kiln was once operated at this locality, and it is reported that white brick was produced from certain beds of the outcrop. Other good exposures of the Gilchrist shale where the overburden is thin are found in small valleys in sec. 33, T. 15 N., R. 1 W. (Richland Grove Twp.), not far from the Northwestern Clay Manufacturing Company plant at Griffin, and in the valley and tributaries of the large creek in sec. 7, T. 14 N., R. 2 W. (Greene Twp.), about a mile west of Shale City.

CLAYS

The clay below the Rock Island (No. 1) coal in the mines at Matherville, sec. 27, T. 15 N., R. 2 W. (Preemption Twp.), about one mile north of the Alexis quadrangle has been tested. The tests showed that certain parts of the underclay could be used to make common and face brick, but in general the samples were not sufficiently plastic to flow smoothly through a die and therefore much of the material was considered of doubtful value.[3]

[3] Stull, R. T., and Hursh, R. K., Tests on clay materials available in Illinois Coal Mines, Illinois State Geol. Survey Coop. Mining Series Bull. 18, pp. 75-79, 1917.

The same clay is found below the Rock Island (No. 1) coal in the Alexis quadrangle.

The pebbles and boulders in the glacial drift make it unsuitable for ceramic purposes. It might be utilized for common brick and tile, but even for this purpose the pebbles and boulders would be troublesome.

It is possible that the upper 8 to 10 feet of the loess, which is leached, could be used for the manufacture of common brick or tile. The lower part of the loess is usually calcareous and contains calcareous concretions, and it is therefore of extremely doubtful value for ceramic uses of any sort.

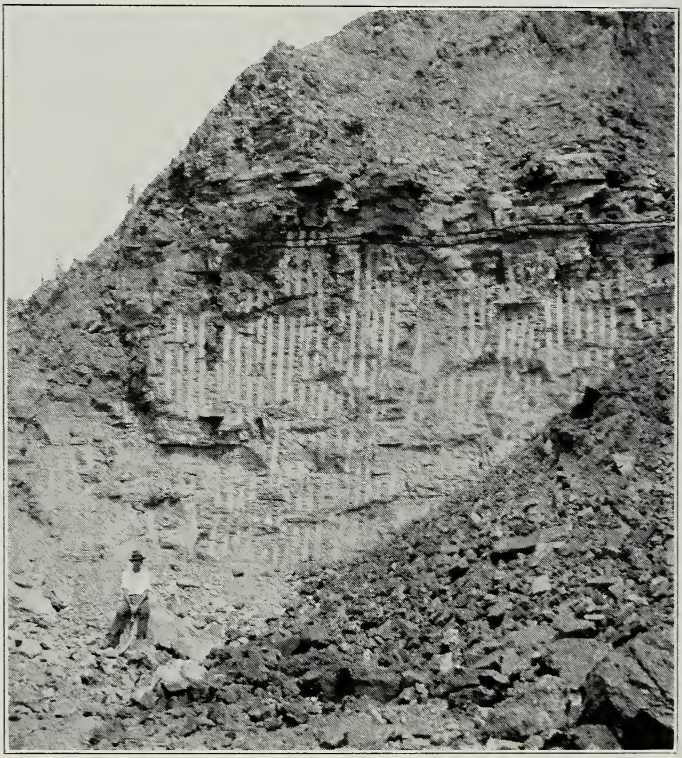


Fig. 48. Typical exposure of the Gilchrist shale in the pit face of the Hydraulic Press Brick Company's plant at Shale City. A thin coal bed, No. 11 of geologic section 14, is indicated by lines.

CERAMIC PLANTS

HYDRAULIC PRESS BRICK COMPANY

The plant of Hydraulic Press Brick Company is located at Shale City in the SW. corner NW. ¼ sec. 8, T. 14 N., R. 2 W. (Greene Twp.). The working face exposes about 40 feet of Gilchrist shale (fig. 48) overlain by about 20 feet of glacial drift and loess. The shale and the drift are mixed in a ratio of two to one, so that stripping is required only where the drift is more than half as thick as the shale. The shale includes a 4-inch band of coal and a 12-inch bed of fine-grained sandstone which are not separated. The blue shale which constitutes the lower 27½ feet of the working-face is reported to be the highest quality material. Shale of good quality is known to extend to a depth of 80 feet below the level of the present excavation.

The plant produces a high grade face-brick. Horses draw the loaded cars to the plant, and the empty cars return by gravity to the working-face. The company operates 18 kilns (figs. 49 and 50). A one and a quarter mile spur to the Rock Island Southern Railroad provides transportation facilities.

NORTHWESTERN CLAY MANUFACTURING COMPANY

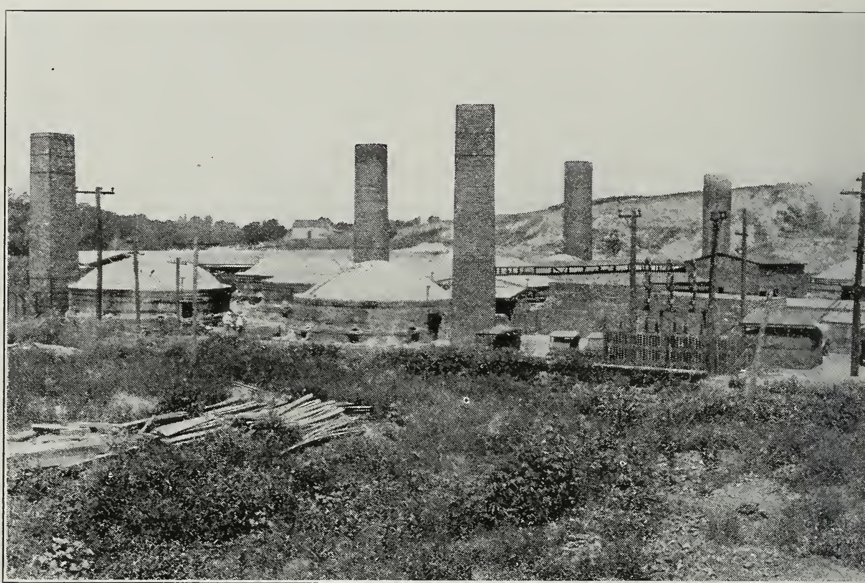
The plant of Northwestern Clay Manufacturing Company is located at Griffin, on the line between sec. 4, T. 14 N., R. 1 W. (Rivoli Twp.), and sec. 33, T. 15 N., R. 1 W. (Richland Grove Twp.) about a quarter of a mile east of the Alexis quadrangle.

The Gilchrist shale is exploited at this plant, and is overlain by glacial drift and loess. (Geologic section 16.) An attempt some years ago to exploit for ceramic purposes the loess, which is generally calcareous and contains numerous concretions, met with no success. A 5-foot bed of calcareous underclay lying below the shale was tested in 1926 for use in the manufacture of flue-tile. The results were not entirely satisfactory, but this was attributed to the fact that a band of highly siliceous material which occurs in the clay, was included. Additional tests of the underclay from which the siliceous bed will be excluded, are to be made. The underclay could be easily mined with the shale and from the floors of abandoned pits.

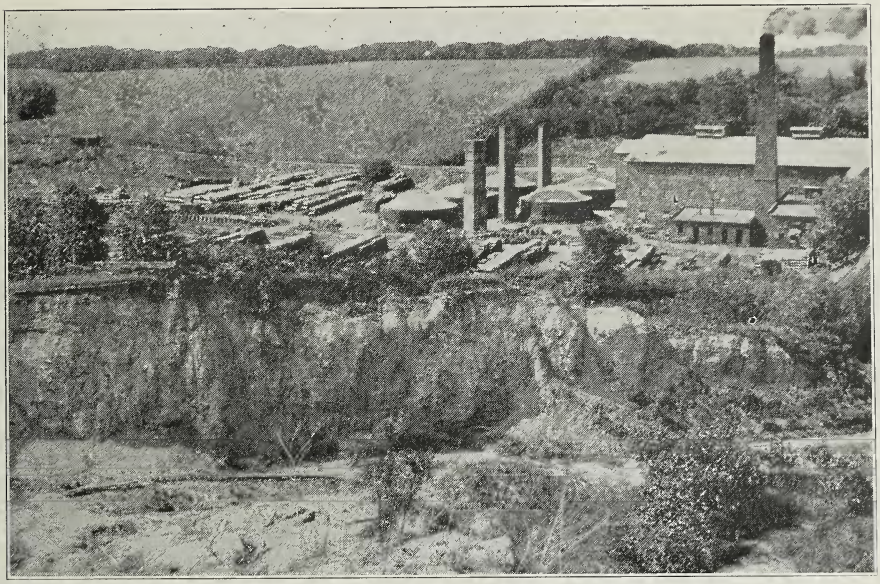
The topography in the region in which this plant is located is undulatory, and the shale is quarried only at the terminal portions of spur-like ridges where the overburden is thinner. An area of about ten acres, involving a number of pits, has been worked in this fashion. The pit being worked in June, 1926, had a 20-foot face of shale and 2 feet of overburden. The shale is first stripped with a tractor and scraper, then it is blasted, and then loaded by hand into cars. Impurities, such as hard concretions, are picked out during loading. The loaded cars are drawn by horses to the plant. The company operates 18 kilns (figs. 51, 52). The product is sewer-pipe, large sizes of drain-tile, wall-coping, and flue-tile. A 3-mile switch to the Chicago, Burlington and Quincy Railroad at Hopewell station provides transportation.

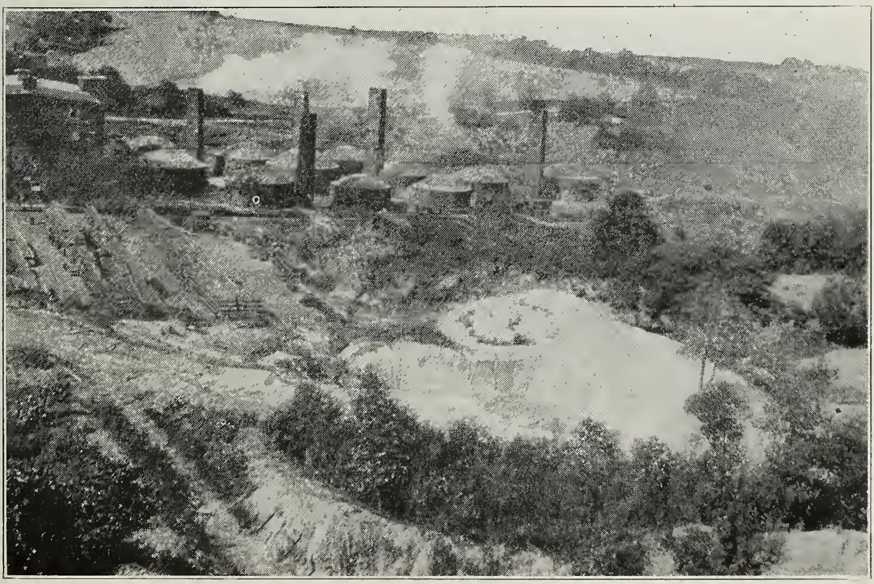
MONMOUTH CLAY MANUFACTURING COMPANY

A large pit near the NE. corner sec. 8, T. 14 N., R. 2 W. (Greene Twp.), about a mile northeast of the Hydraulic Press Brick Company pit,



Figs. 49 and 50. General view of the kiln, mill, and shale pits of the Hydraulic Press Brick Company at Shale City, sec. 8, T. 14 N., R. 2 W. (Greene Twp.).





Figs. 51 and 52. General view of the kilns, plant, and two pits of the Northwestern Clay Manufacturing Company at Griffin, sec. 4, T. 14 N., R. 1 W. (Rivoli Twp.) and sec. 33, T. 15 N., R. 1 W. (Richland Grove Twp.). The pit shown in the upper view is an abandoned shale pit, the one shown in the lower view is a fire-clay pit. Note the piles of sewer pipe and drain tile, which are the chief products.

was formerly operated by Monmouth Clay Manufacturing Company. A face of 30 feet of Gilchrist shale, said to be of good quality, was worked. The shale was shipped over the Rock Island Southern Railroad to the company's plant at Monmouth. High cost of operation is assigned as the cause of abandonment of the pit.

Sand and Gravel

The Alexis quadrangle contains no extensive gravel deposits. Gravel, concentrated from the glacial drift, is found in the alluvial plains and bars of nearly all the larger stream valleys, but these deposits are so small that they are of value only for local use.

Extensive deposits of pre-Illinoian sand are exposed on the south side of Henderson Creek, especially in secs. 3, 10, and 12, T. 12 N., R. 3 W. (Sumner Twp.) (fig. 33). The sand is loosely cemented, has a low clay content, and is stained yellow by iron oxide which may be largely removed by washing. A sieve analysis of a sample of this sand from a road-cut in the SW. ¼ sec. 3, T. 12 N., R. 3 W. (Sumner Twp.), is as follows:

Sieve analysis of pre-Illinoian sand

	Per cent
Retained on 10-mesh sieve	Trace
Passing 10-mesh, retained on 20-mesh sieve	11.9
Passing 20-mesh, retained on 40-mesh sieve	71.0
Passing 40-mesh, retained on 60-mesh sieve	14.0
Passing 60-mesh, retained on 100-mesh sieve	2.4
Passing 100-mesh sieve	0.7
	100.0

The bulk of the sand is quartz grains, but small chert grains, some of them iron-stained, and other black grains are also present in small amounts. The grains vary in shape from sharp and angular to rounded. The rounded grains have frosted surfaces.

The coarseness of the sand, its highly siliceous character, and its freedom from clay and calcareous material make it worthy of consideration for special uses such as sandblast sand, filter sand, engine sand, and molding sand where a coarse sand with high gas-venting properties is required. The valley of the large creek in the western part of sec. 12, T. 12 N., R. 3 W. (Sumner Twp.), where 30 feet of sand is known to occur locally, appears to be the best site for commercial exploitation of this deposit. The deposit is two and a half miles from the Rock Island Southern Railroad.

Building Stone

The building stone industry was at one time of considerable importance in the Alexis quadrangle. The massive Pennsylvanian sandstones and the "blue rock"—a slabby, blue-gray, shaly limestone overlying the "cap-rock" limestone of the Rock Island (No. 1) coal—were formerly extensively quarried,[4] and the foundations of many of the older farm buildings are of these materials. Quarries in the "blue rock" were located west of the Neverseen Coal Company mine in sec. 3, T. 14 N., R. 2 W. (Greene Twp.), (see fig. 53); near the local mine on the T. F. Mack farm, sec. 4, T. 14 N., R. 2 W. (Greene Twp.); and in sec. 34, T. 15 N., R. 2 W. (Preemption Twp.). Massive sandstones of quality suitable for foundations were formerly quarried in sec. 9, T. 14 N., R. 3 W. (Mercer Twp.), north of Aledo; in secs. 33 and 36, T. 15 N., R. 3 W. (Perryton Twp.); in secs. 26 and 34, T. 14 N., R. 2 W. (Greene Twp.); and in secs. 19 and 21, T 13 N., R. 2 W. (Suez Twp.) (fig. 31). Lack of demand caused abandonment of all these quarries. Large amounts of sandstone of satisfactory quality might be easily obtained.

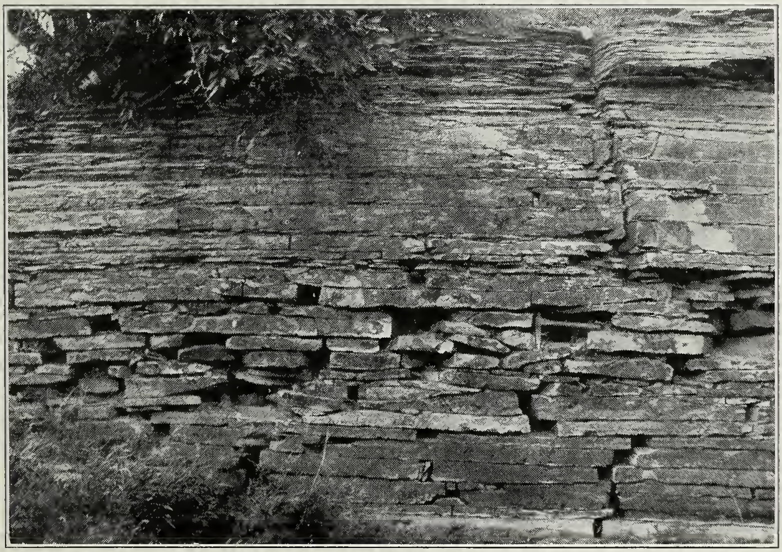


Fig. 53. Face of an old quarry in shaly limestone ("Blue rock") above the "cap-rock" of the Rock Island (No. 1) coal, in the NW. ¼ sec. 3, T. 14 N., R. 2 W. (Greene Twp.).

Limestone

Many years ago some of the "blue rock" was burned for lime. The product was fairly satisfactory, but it usually had to be screened before using.[5]

The Burlington limestone is a source for much rubble, lime, road metal, and agricultural limestone in many places in the State, but the single ex-

[4] Green, H. A., Geology of Mercer County: Illinois Geol. Survey, vol. 4, pp. 307-308, 1870.

[5] Green, H. A., Geology of Mercer County: Illinois Geol. Survey, vol. 4, p. 308, 1870.

posure of it in the Alexis quadrangle in sec. 30, T. 12 N., R. 2 W. (Spring Grove Twp.), is not thick enough to be of any importance. Large quantities of it have been quarried a mile or two south of the quadrangle in secs. 32, 33, 34, and 35, T. 12 N., R. 3 W. (Sumner Twp.).

Water Resources

POSSIBLE WATER-BEARING FORMATIONS

CAMBRIAN SYSTEM

The Mt. Simon sandstone and the Dresbach sandstone yield large quantities of water. The coarser layers which are the most prolific aquifers in the Mt. Simon sandstone are lenticular. The water from the Dresbach sandstone, which was designated formerly and is well known as the "Potsdam" sandstone, usually has a smaller proportion of dissolved solids than that of any other water-bearing formation of wide distribution in northern Illinois.

ORDOVICIAN SYSTEM

Porous zones in the Prairie du Chien series are lenticular and do not usually yield much water. The St. Peter sandstone is an excellent aquifer but normally gives a somewhat smaller yield than the Dresbach sandstone, and the water usually contains a larger proportion of dissolved solids than the water from the Dresbach formation. Sulfates resulting from the oxidation of pyrite in the dolomites overlying the sandstone are sometimes present in large quantities in the water.

Lenticular porous zones in the Platteville and Galena formations may yield much water, but commonly it is too highly charged with sulfates to be potable. Little or no water may be expected from the Maquoketa formation.

SILURIAN SYSTEM

The porous zone in the upper part of the Niagaran series yields a large quantity of water in all the wells which have been drilled to this horizon. It probably occurs under all of the quadrangle, and its approximate depth at any point may be determined from the structure contour map (fig. 39). The water is somewhat less mineralized than the water from the St. Peter sandstone.

DEVONIAN SYSTEM

The Devonian system yields very little water. One farm well obtains water from a porous zone near the top of the Devonian limestone.

MISSISSIPPIAN SYSTEM

The Sweetland Creek shale is almost without porous zones, and water is rarely obtained from it. A few farm wells near the southern border of

Well number
Appendix C and Plate IV
Depth in feet
Aquifer
Depth of casing (feet)
Gals. per minute yield
Date sample was collected
Determinations made
(Parts per million)
Potassium[a]
Sodium
Ammonium
Magnesium
Calcium
Iron
Manganese

14
p
G
o
3

q
ir
s
d
t
I

u
b
a
t
c
P

y
I

c
]
a

s

i

the Alexis quadrangle get water from "soapstone" (shale) at a depth which indicates that the aquifer occupies a position near the base of the Hannibal or between the Hannibal and the Sweetland Creek formations.

PENNSYLVANIAN SYSTEM

The Pennsylvanian system includes many water-bearing sandstones, but in some cases the water is so strongly charged with hydrogen sulfide that it is undesirable for domestic use. In some localities water is obtained from the Rock Island (No. 1) coal or the sandstone underlying it.

PLEISTOCENE SYSTEM

The principal water horizons in the Pleistocene deposits are: (1) sands and gravels deposited in Yarmouth channels, which were subsequently covered by Illinoian glacial till; (2) lenticular sands and gravels in the Illinoian till; and (3) the Peorian loess.

CITY WATER SUPPLIES

The city of Aledo obtains water from two deep wells, No. 1 drilled about 1889, and No. 2 drilled in 1925. (Appendix C, wells Nos. 20 and 21.) Well No. 1 was originally drilled to a depth of 3114 feet to a low level in the Mt. Simon sandstone, but was filled up to a depth of 1450 feet below the surface because of the high salinity of the water from lower levels.[6] The average daily yield to February, 1924, was 148,000 gallons. During a test 200 gallons a minute was drawn. The water level in 1913 was about 100 feet below the ground surface. City well No. 2 was sunk to a depth of 1172 feet. It is situated only a short distance from well No. 1. The well was pumped at a rate of 500 gallons a minute during a test in 1926. When the pump was not in operation, the water level was 146 feet below the ground surface.

The village of Alexis obtains its water from a well 1200 feet deep, drilled in 1898. The principal yield is from the St. Peter sandstone, and the bottom of the well is at or near the base of this formation. The average daily yield from April, 1922, to January, 1923, was about 21,000 gallons per day, with a production of approximately 67 gallons per minute, operating five hours a day. When the pump was not operating, the water-level was reported to be about 70 feet below the ground surface in 1915, and 120 feet below in March, 1924.[7]

The village of Viola obtains water from a well 1281 feet deep, drilled in 1916. The principal yield is from the St. Peter sandstone and the bottom

[6] Habermeyer, G. C., Public ground-water supplies in Illinois: Illinois State Water Survey Bull. No. 21, p. 15, 1925.
[7] Habermeyer, G. C., op. cit., p. 16.

of the well is near the base of this formation. The average amount of water pumped daily in 1926 was estimated at from 10,000 to 15,000 gallons. At the time of installation the pump delivered 71 gallons a minute. When the well was first completed, the water-level was 175 feet below the ground surface,[8] and in 1926 it was said to be 22 feet lower.

The village of Little York obtains water from a well drilled in 1915, to a depth of 326 feet. The water comes chiefly from a basal Devonian or Upper Silurian aquifer. The daily yield in 1922 was estimated as about 4,000 gallons. Pumping tests showed a yield of about 33 gallons per minute. In 1922 the water-level was 45 feet below the ground surface.[9]

The communities of Burgess, Gilchrist, and Norwood have no public water supplies, but are supplied by several privately owned shallow wells deriving water from the glacial drift. At the old coal mining community of Wanlock a well 1230 feet deep into the St. Peter sandstone was sunk about 23 years ago and obtained a yield of water. The Hydraulic Press Brick Company at Shale City uses a well 361 feet deep, in which the water is derived from the porous horizon in the Niagaran series.

FARM WELLS

WELLS DERIVING WATER FROM ROCK

Many farms in the vicinity of the Sunbeam School, T. 13 N., R. 3 W. (Ohio Grove Twp.), and many others between the valleys of Cedar Creek and Henderson Creek in T. 12 N., R. 3 W. (Sumner Twp.), east and northeast of Little York, obtain water from the porous zone in the upper part of the Niagaran series. The wells range in depth from 280 to 550 feet (Appendix C, wells Nos. 32 and 84, and Pl. VI).

Most of the farm wells in the southeast quarter of the quadrangle obtain water from Pennsylvanian sandstones which immediately underlie the Pleistocene deposits. The depths to the sandstone are usually 65 to 100 feet.

WELLS DERIVING WATER FROM THE GLACIAL DRIFT

Most farm wells in the Alexis quadrangle obtain water from the Pleistocene deposits. The wells are either dug wells, 20 to 30 feet deep, in which surficial water collects, or are bored wells 50 feet or more in depth which penetrate sand or gravel beds in or below the Illinoian till. Sands and gravels in the form of valley-train deposits associated with either the recession of the Kansan glacier or the advance of the Illinoian glacier apparently serve as the chief source of water for the bored wells.

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[8] Habermeyer, G. C., op. cit., pp. 659-661.
[9] Habermeyer, G. C., op. cit., pp. 361-362.

The wells of the farms along the county-line road between Mercer and Warren counties west ten miles from the crossing of Toms Creek, two miles west of Alexis, obtain water from sand and gravel at depths of 80 feet to 110 feet. North of Duck Creek valley the sands are absent.

A group of flowing wells bored 50 to 60 feet deep is situated in the alluvial plain of Goose Run in secs. 16, 17, 18, 19, T. 13 N., R. 2 W. (Suez Twp.). Although some of these were drilled thirty or more years ago, the wells are still flowing. The boring of new wells is reported to have appreciably diminished the flow of older wells. In wells on the sides of the valley the water does not quite reach the surface. The wells derive their water from sands in a pre-Illinoian drainage channel sealed off by Illinoian till.

SPRINGS

Several farms use water obtained from springs that issue where gravel lenses in glacial drift crop out. Most of these springs have a small flow. The largest spring in the quadrangle is located at the base of the Yarmouth sands, in the SW. ¼ SW. ¼ sec. 3, T. 12 N., R. 3 W. (Sumner Twp.) south of Henderson Creek and west of a wagon road. A permanent stream issues from this spring.

SURFACE WATER

At several places in the quadrangle surficial water sufficient for local use is collected in small reservoirs costructed by building earth dams across narrow gullies. The abundant streams throughout the area provide a supply of surficial water adequate for animals in pasture. It is reported that the Chicago, Burlington and Quincy Railroad at Little York obtains water from Cedar Creek but that the quality of the water is poor because it is polluted by sewage from Galesburg and Monmouth.[10]

Soils

INTRODUCTION

Soil is the chief source of wealth in the Alexis quadrangle, as the chief industry, agriculture, depends on it. The materials out of which the present soil has been formed are principally loess, till, slope-wash, and alluvial deposits. The soils differ in texture, color, and calcareous and carbonaceous content according to, (1) the character of the sediment from which they have been formed, and (2) the action of the surface and subsurface drainage since the beginning of soil formation. The distribution of numerous types of soil in the quadrangle has been mapped in detail.[11]

[10] Habermeyer, G. C., Public ground-water supplies in Illinois: Illinois State Water Survey Bull. No. 21, p. 361, 1925.

[11] Smith, R. S., DeTurk, E. E., Bauer, F. C., and Smith, L. H., Mercer County soils: University of Illinois Agr. Exp. Sta. Soils Report 29, 1925. See map opposite page 4.

Warren County Soils: University of Illinois Agr. Exp. Sta. unpublished map.

SOILS CLASSIFIED ACCORDING TO PARENT MATERIAL

SOILS ON LOESS

The soils developed on the loess, which is found on uplands, on gentle slopes leading down to the larger stream valleys, and on terraces, are classified[12] as brown silt loam (uplands and terraces), yellow-gray silt loam (uplands, slopes, and terraces), black clay loam (uplands), and brown-gray silt loam on tight clay (terraces).

Black clay loam is developed only on poorly drained, flat uplands and is unimportant in the Alexis quadrangle. Brown silt loam is characteristic of the level or gently rolling portion of the upland plain and also occurs in small areas on the terrace remnants along Pope Creek, Henderson Creek, Cedar Creek, and Edwards River. The yellow-gray silt loam is also a characteristic upland soil but occurs only near deep drainage lines. It is most abundant in the dissected uplands near the valleys of the main creeks. The more prominent terrace remnants along Pope Creek also have yellow-gray silt loam soil. The brown-gray silt loam on tight clay is reported to be developed on portions of a gently sloping terrace along Edwards River north and east of Aledo. The surficial loam, 6 to 7 inches deep, varies in color from brown with a gray cast to grayish-brown. It is underlain to a depth of 18 to 20 inches by a floury, friable silt loam, gray in color, with some streaks and splotches of yellow. The tight clay is a plastic, compact, mottled, grayish-drab clay containing brownish-red iron concretions and extends to a depth of about 38 inches.[13]

SOILS ON GLACIAL DRIFT AND SLOPE-WASH

The chief soil on thin loess, glacial drift, and slope-wash, is yellow silt loam. This is developed on the steeper slopes over the entire quadrangle and constitutes nearly one-fifth of its total area. The loess is washed down from higher on the slope and generally forms a thin cover over the drift, which is exposed in recent gullies and slopes. The yellowish color is due to frequent wetting and drying on the slopes and to good drainage conditions. As this soil occurs chiefly on slopes, which are subject to active erosion if cultivated and deforested, it is usually left as pasture land.

SOILS ON ALLUVIAL DEPOSITS

The soil type most widespread on the alluvial plains of rivers is dark brown silt loam. It is developed on the valley plains along all of the larger streams and along the lower courses of the larger tributaries. It is slightly acid where not subject to flood. The upper seven inches of the soil along

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[12] Smith, R. S., DeTurk, E. E., Bauer, F. C., and Smith, L. H., Mercer County Soils: University of Illinois Agr. Exp. Sta. Soils Report 29, 1925.

[13] Op. cit., p. 19.

the margins of the alluvial plain along North Henderson Creek is a plastic, black, clay loam, alkaline because the drainage is poor.

SOILS CLASSIFIED ACCORDING TO CONDITIONS OF DEVELOPMENT

The processes which result in the formation of a soil affect the unexposed subsoil zone as well as the surface of the soil. The principal changes are: (1) the oxidation of iron minerals and carbonaceous material; (2) the leaching of soluble compounds, such as calcium carbonate; (3) the solution of various silicate minerals by waters charged with organic acids; (4) the mechanical downward wash of finer particles or colloidal materials; (5) the precipitation in the subsoil of material dissolved nearer the surface; and (6) the precipitation of humate salts in the soil and, to some extent, in the subsoil. On poorly drained surfaces, such as level interstream divides and swampy lowlands, the decaying vegetation accumulates so rapidly that the soil has a black or dark gray color. Better drainage conditions result in more rapid oxidation and reduction of carbonaceous material, so that the soil is light brown to buff in color.

Possibilities of Oil and Gas Production

INTRODUCTORY STATEMENT

No oil or gas has ever been produced in the Alexis quadrangle, and a show of oil has been reported in only one of the four test wells drilled in the quadrangle. There appears little likelihood that oil or gas in commerial quantities will ever be produced in the quadrangle. However there are some structures that would be favorable sites for testing if other factors are favorable, and as some formations from which oil has been produced elsewhere in the State underlie the quadrangle, the remote possibilities of such production must not be ignored.

POSSIBLE OIL-BEARING FORMATIONS

The lowest horizon at which oil has ever been discovered in Illinois is the "Trenton", which is represented in the Alexis quadrangle by the Platteville-Galena formations. However, no commercial production has ever been obtained from this horizon in northern Illinois. The next higher possible oil-bearing horizon is the Silurian system—the Hoing sand in the Colmar oil field several miles south of the Alexis quadrangle is believed to represent the base of the Silurian system. The porous zone at the top of the Niagaran series is a possible oil-bearing horizon, but analyses of water taken from several wells that exploit the horizon show that the water has a low salinity and this indicates that there is little chance of oil in the zone. Sandstone strata or lenses in the Mississippian and Pennsylvanian systems are sources of large production in southeastern Illinois, but they have been penetrated by so many wells in the Alexis quadrangle without showing any oil that they can be considered barren.

FAVORABLE STRUCTURAL AREAS

The only structure affecting the middle Paleozoic rocks that appears favorable is the anticlinal nose in the southwest corner of the quadrangle (fig. 38, p. 108). Favorable structures affecting the Silurian and Devonian systems occur in the north and the southwest parts of the quadrangle (fig. 39, p. 110). Favorable structures affecting the Pennsylvanian system are not well determined, although the domes in the north part of the quadrangle (fig. 40, p. 112) are most promising.

PREVIOUS OIL-TESTS

One test on the farm of H. E. Robbins, NW. ¼ NW. ¼ sec. 2, T. 13 N., R. 2 W. (Suez Twp.), was sunk to a depth of 1300 feet into the Shakopee dolomite, 20 feet below the base of the St. Peter sandstone. The surface elevation is 733 feet. According to Mr. B. McLaughlin of Viola, two oil shows were encountered. The first was at a depth of about 800 feet in a sand 11 feet thick, which would be approximately at the top of the Galena dolomite below the Maquoketa shale. The other was at a depth of nearly 1200 feet, near the top of the St. Peter sandstone.

A test on the farm of Will Laird, NW. ¼ SE. ¼ sec. 14, T. 14 N., R. 3 W. (Mercer Twp.), surface elevation 753 feet, was sunk to 912 feet and finished near the middle of the Galena dolomite. No shows of oil were reported except at a depth of 95 feet at the top of the Pennsylvanian. The oily substance found here may be the product of organic decay of the surface soil material under the glacial drift, and no significance is attached to this report.

A test situated in the alluvial plain of North Henderson Creek, on the farm of Elder Smith, near the southern margin of the SE. ¼ SW. ¼ sec. 19, T. 13 N., R. 2 W. (Suez Twp.), surface elevation 628 feet, was sunk to a depth of 885 feet, probably ending near the base of the Galena dolomite. Samples at intervals of 5 feet from a depth of 200 feet to the bottom of the well were examined by the State Geological Survey. No shows of oil from this well were reported to the writer.

A test situated on the Cook farm, near the SW. corner NW. ¼ SE. ¼ sec. 31, T. 14 N., R. 2 W. (Greene Twp.), was sunk to a depth of 806 feet, probably ending near the top of the Galena dolomite. Neither details of the log nor reports regarding shows of oil were obtained for this test.

Other wells which have entered the St. Peter sandstone are the village well of Alexis, NE. ¼ NE. ¼ sec. 1, T. 12 N., R. 2 W. (Spring Grove Twp.), the village well of Viola which is situated in the NE. ¼ SE. ¼ sec. 15, T. 14 N., R. 2 W. (Greene Twp.), two city wells of Aledo, SW. ¼ SE. ¼ sec. 17, T. 14 N., R. 3 W. (Mercer Twp.), and a water well drilled by the Alden Coal Company at Wanlock near the center of the N. line SW. ¼ sec. 9, T. 14 N., R. 2 W. (Greene Twp.). City well No. 1, Aledo, was drilled to a depth of 3,165 feet, ending about 700 feet below the top of the Mt. Simon sandstone (Cambrian).

AREAS MOST FAVORABLE FOR TESTING

Each of the anticlinal areas (figs. 38, 39, and 40) is outlined on very incomplete data. Therefore two or more shallow tests should be made before deeper drilling is attempted. These shallow tests should be carried to the top of the Devonian limestone, which is the shallowest pre-Pennsylvanian guide horizon that will be encountered at most places in the quadrangle. (Fig. 39.)

None of the four oil-tests so far made and none of the deep water wells appear to be located favorably for testing any of the structures. Areas which at present are considered most favorable for testing are: (1) sec. 15, T. 12 N., R. 3 W. (Sumner Twp.); (2) secs. 19 and 20, T. 12 N., R. 2 W. (Spring Grove Twp.); and (3) secs. 13 and 14, T. 14 N., R. 3 W. (Mercer Twp.). Deep tests should go through the Galena dolomite in these areas.

APPENDIX A

Tabulated List of Fossils from Pennsylvanian Strata in the Alexis Quadrangle

KEY TO STRATA

Suite I: I—Limestone bed.

Suite II: IIa—"Stigmarian" sandstone; IId_1—black carbonaceous shale overlying Rock Island (No. 1) coal; IId_2—concretions in the black carbonaceous shale; IIe_1—limestone cap-rock; IIe_2—hard nodular limestone above the cap-rock; IIf_1—shaly limestone ("Blue rock"); IIf_2—chalky limestone.

Suite IV: IVf_1—Gray calcareous shale above the black laminated shale; IVf_2—septarian concretions near base of the gray shale; IVf_3—small calcareous concretions in the gray shale; IVg—brown concretionary limestone above the gray shale.

KEY TO LOCALITIES

1. Secs. 32 and 33, T. 14 N., R. 2 W. (Greene Twp.).
2. Along Edwards River, sec. 29, T. 15 N., R. 1 W. (Richland Grove Twp.).
3. J. Snell mine, sec. 6, T. 14 N., R. 2 W. (Greene Twp.).
4. Dump of old mine 200 feet east of bridge over creek south of center of sec. 5, T. 14 N., R. 2 W. (Greene Twp.).
5. Dump of Neverseen Coal Co. mine, about 300 yards north of center of sec. 3, T. 14 N., R. 2 W. (Greene Twp.).
6. Dump of old mine 300 yards north of bridge over creek, west of center of south line of sec. 6, T. 14 N., R. 2 W. (Greene Twp.).
7. Dump of old mine 131 feet northeast of SW. corner sec. 5, T. 14 N., R. 2 W. (Greene Twp.).
8. Dump of old mine in small gully about 200 feet southwest of bridge over Donahue Run, sec. 3, T. 14 N., R. 2 W. (Greene Twp.).
9. Road-cut on south side of Henderson Creek at east line of sec. 14, T. 12 N., R. 2 W. (Spring Grove Twp.).
10. Outcrop in bank of gully northwest of bridge south of middle of sec. 5, T. 14 N., R. 2 W. (Greene Twp.).
11. Outcrop in gully near southeast corner of sec. 14, T. 12 N., R. 2 W. (Spring Grove Twp.).
12. Old drift mine entrance, ¼ mile north of quadrangle, near NE. corner sec. 32, T. 15 N., R. 1 W. (Richand Grove Twp.).
13. Small gully south of Pope Creek, 100 yards west of east line of sec. 31, T. 14 N., R. 2 W. (Greene Twp.).
14. Old drift mine on east side of creek, 60 yards north of center of south line of sec. 14, T. 12 N., R. 2 W. (Spring Grove Twp.).
15. Gully in NW. ¼ SW. ¼ sec. 23, T. 14 N., R. 2 W. (Greene Twp.).
16. Gully near center of E. ½ NE. ¼ sec. 30, T. 12 N., R. 1 W. (Kelly Twp.).
17. Outcrop near center of E. ½ NW. ¼ sec. 30, T. 12 N., R. 1 W. (Kelly Twp.).
18. Gully northeast of center of sec. 36, T. 15 N., R. 3 W. (Perryton Twp.).

PENNSYLVANIAN FOSSILS

Strata	I	a	d_1			d_2			
Locality	1	2	3	4	5	3	6	7	4
Foraminifera									
Bradyina sp.									
Fusulinella sp.									
Corals									
Lophophyllum profundum (Milne-Edwards & Haime)									
Worms									
Spirorbis carbonarius Dawson									
Worm borings						×			
Crinoids ("sea-lilies")									
Stem fragments		×							
Bryozoa ("leaf-corals")									
Fenestella sp.				×					
Polypora sp.						×	×		
Rhombopora lepidodendroidea Meek				×					
Fragments	×								
Brachiopods (lamp-shells)									
Lingula umbonata Cox						×		×	×
Palaeoglossa waverlyensis (Herrick)							×		
Orbiculoidea capuliformis (McChesney)									?
Orbiculoidea missouriensis (Shumard)			×		×	×		×	×
Orbiculoidea sp.									
Crania modesta White & St. John						×	×		
Crania sp.	×								
Derbya crassa (Meek & Hayden)			×			×			×
Chonetes geinitzanus Miller									
Chonetes mesolobus Norwood & Pratten			×	×	×	×	×	×	×
Chonetes mesolobus var. decipiens Girty									
Chonetes mesolobus var. euampygus Girty									
Productus cora D'Orbigny						×	×		×
Productus cora var.									
Productus costatus Sowerby									
Productus nanus Meek & Worthen	×	×							
Productus semireticulatus (Martin)									
Productus sp.	×								
Pustula nebrascensis (Owen)									
Marginifera muricata (Norwood & Pratten)		×	×	×	×	×	×	×	×
Marginifera splendens (Norwood & Pratten)				×					
Pugnax rockymontana (Marcou)					×	×°		×°	×°
Pugnoides osagensis (Swallow)									
Dielasma bovidens (Morton)									
Spirifer cameratus Morton				×					
Spirifer rockymontana Marcou									
Squamularia perplexa (McChesney)	×					×	×		×
Ambocoelia planoconvexa (Shumard)			×	×		×		×	×
Spiriferina kentuckyensis (Shumard)				×**		×			×
Hustedia moroni (Marcou)				×**					×
Cleiothyridina orbicularis (McChesney)				×**					
Composita argentea (Shepard)			×	×	×	×°			×°
Composita sp.	×								
Pelecypods (clams, mussels, etc.)									
Solenomya parallela Beede & Rogers						×°	×°		
Solenomya trapezoides Meek									
Clinopistha radiata (Hall)						×		×	×
Cardiomorpha missouriensis Shumard type A									
Cardiomorpha missouriensis Shumard type B						×°	×°	×°	×°
Cardiomorpha sp.									
Edmondia aspenwallensis Meek						×°		×°	×°
Edmondia gibbosa (McCoy)							×		×

** Abundant.
° Characteristic.
* Common.
a Small wide form with a prominent central band.
b Dwarfed.

Pennsylvanian Fossils

II															IV						
d_2		e_1			e_2	f_1						f_2			f_1	f_2				f_3	g
5	8	8	9	10	11	12	13	14	10	11	9	12	13	14	15	16	17	15	18	15	15
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×°	×°																				×
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Key to strata and locality is given on page 157.

Pennsylvanian Fossils

Strata	I	a	d₁			d₂			
Locality	1	2	3	4	5	3	6	7	4
Edmondia nebrascensis (Geinitz)									
Edmondia ovata Meek & Worthen									
Edmondia reflexa Meek									
Edmondia sp.									
Anthraconeilo knoxensis (McChesney)									
Nucula anodontoides Meek									
Nucula parva McChesney									×
Nuculopsis ventricosa (Hall)						×			×
Leda bellistraita Stevens									
Leda meekana Mark									
Yoldia glabra Beede & Rogers									
Alula geinitzi (Meek)									
Parallelodon tenuistratus (Meek & Worthen)									
Parallelodon sp.									
Aviculopinna illinoisensis Worthen									×
Pteria ohioensis (Herrick)									
Pseudomonotis sp.									
Myalina kansasensis Shumard									
Myalina swallovi McChesney									
Schizodus alpinus (Hall)									
Schizodus curtus Meek & Worthen									
Schizodus rossicus De Verneuil									×°
Schizodus spellmani Herrick									
Schizodus sp. nov						×	×		×
Schizodus sp.									
Acanthopecten carboniferus (Stevens)									
Aviculopecten germanus Miller & Faber									
Aviculopecten hertzeri Meek						?			
Aviculopecten tenuilineatus (Meek & Worthen)									
Aviculopecten mazonensis Worthen									
Aviculopecten menardi Worthen						aff			
Aviculopecten rectilaterarius (Cox)									
Aviculopecten sp.		×				×			
Deltopecten scalaris (Herrick)									
Deltopecten sp.									
Euchondria neglecta (Geinitz)									
Streblopteria sp.									
Entolium aviculatum (Swallow)						?			
Lima retifera Shumard						×			
Placunopsis recticardinalis Meek									
Allorisma costatum Meek & Worthen						×			×
Allorisma terminale Hall									
Astartella compacta Girty									
Astartella vera Hall									
Pleurophorus oblongus Meek						×°		×°	×°
Pleurophorus subcostatus Meek & Worthen									
Pleurophorus tropidophorus Meek						×			×
Pleurophorus sp. nov						×°	×°	×°	×°
Gastropods (snails)									
Pleurotomaria sp.	×								
Phanerotrema grayvillensis (Norwood & Pratten)						×	×	×	×
Phanerotrema sp.									
Trepospira illinoisensis (Worthen)						×°	×°	×°	×°
Worthenia marcouiana (Geinitz)									
Bellerophon crassus Meek & Worthen						×			
Bellerophon incomptus Gurley									
Bellerophon sp.									
Bucanopsis elliptica (McChesney)									
Bucanopsis tenuilineata (Gurley)									
Euphemus carbonarius (Cox)				×					
Patellostium montfortianum (Norwood & Pratten)						×°	×°		×°
Patellostium sp. nov. cf. nodocostatum (Gurley)									
Pharkidonotus percarinatus (Conrad)									×

** Abundant.
° Characteristic.
* Common.
a Small wide form with a prominent central band.
b Dwarfed.

PENNSYLVANIAN FOSSILS

II															IV						
d_2		e_1			e_2	f_1						f_2			f_1	f_2				f_3	g
5	8	8	9	10	11	12	13	14	10	11	9	12	13	14	15	16	17	15	18	15	15
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Key to strata and locality is given on page 157.

Pennsylvanian Fossils

Strata	I	a	d₁			d₂			
Locality	1	2	3	4	5	3	6	7	4
Schizostoma catilloides (Conrad)				×					
Zygopleura nodosa Girty									
Zygopleura sp.									
Holopea sp.									
Sphaerodoma brevis (White)									
Sphaerodoma gracilis (Cox)									
Sphaerodoma humilis (Keyes)									
Sphaerodoma intercalaris (Meek & Worthen)									
Sphaerodoma medialis (Meek & Worthen)									
Sphaerodoma paludinaeformis (Hall)						×			×
Sphaerodoma primogenia (Conrad)									
Sphaerodoma ventricosa (Hall)									
Sphaerodoma sp.									
Meekospira nitidula (Meek & Worthen)						×	×		×
Bulimorpha inornata (Meek & Worthen)									aff
Aclisina pumila Mark									
Aclisina robusta Stevens									
Aclisina robusta var									
Ianthinopsis grayvillensis (Worthen)									
Conularia crustula White									
Cephalopods									
Pseudorthoceras knoxense (McChesney)				×	×	×			×
Coloceras liratum Girty									
Coloceras sp.						×		×	
Metacoceras cornutum Girty						?			?
Metacoceras dubium Hyatt									
Metacoceras perelegans Girty									
Temnocheilus latus (Meek & Worthen)									
Nautilids						×			×
Gastrioceras sp. nov						×°	×°		×°
Stearoceras sp.									
Goniatites						×			
Schistoceras ? sp.									×
Trilobites									
Griffithides sangamonensis (Meek & Worthen)									
Griffithides sp. nov									
Pygidia									
Crustaceans									
Estheria ortoni Clarke									
Fish									
Petrodus occidentalis Newberry & Worthen				×					
Teeth				×					
Spines						×			

** Abundant.
° Characteristic.
* Common.
a Small wide form with a prominent central band.
b Dwarfed.

PENNSYLVANIAN FOSSILS

II															IV						
d_2		e_1			e_2	f_1						f_2			f_1	f_2				f_3	g
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Key to strata and locality is given on page 157.

APPENDIX B

Part I.—Measured geologic sections of Suite II, Rock Island (No. 1) coal and associated strata

The following geologic sections are graphically represented in Plate III (p. —).

1. *At entrance to abandoned drift mine in the NE. ¼ NE. ¼ sec. 32, T. 15 N., R. 1 W. (Richland Grove Twp.)*

Altitude of top of coal 652 feet

	Thickness Feet	Thickness Inches
Suite II		
4. Shale, calcareous, fossiliferous		2
3. Limestone, shaly (Blue rock) fossiliferous		9
2. Limestone, blue, (Cap-rock) fossiliferous		2
1. Rock Island (No. 1) coal	Only top exposed	

2. *Road-cut 100 yards west of the center of the east line of sec. 11, T. 14 N., R. 3 W. (Mercer Twp.)*

Altitude of top of coal 671 feet

	Thickness Feet	Thickness Inches
15. Loess and drift (Pleistocene)	Not measured	
Suite III		
14. Sandstone, white, thinly bedded, soft	3	
13. Clay, gray, slightly sandy	1	6
12. Shale, carbonaceous, or thin coal parting		½
11. Clay, light gray	1-2	
10. Sandstone, thinly bedded	2-4	
9. Sandstone, massive, hard, bluish	1	6
Suite II		
8. Concretions, calcareous and ferruginous	1	
7. Limestone, blue (Cap-rock)	1	3
6. Chert		1
5. Rock Island (No. 1) coal, top bench		13
4. Clay parting		10-48
3. Rock Island (No. 1) coal, lower bench		3-10
2. Underclay	1½-2	
1. Sandstone, "Stigmarian"	Exposed at base	

3. *Gully west of the center of the SW. ¼ NW. ¼ sec. 12, T. 14 N., R. 3 W. (Mercer Twp.)*

Altitude of top of coal 655 feet

	Thickness Feet	Thickness Inches
10. Loess and drift (Pleistocene)	Not measured	
Suite III		
9. Sandstone, massive	1	
8. Sandstone, soft, thinly bedded, micaceous, and shale	3	
7. Sandstone, hard, containing carbonized plant fragments	3	
6. Chert, dark blue, or cherty limestone	1	
Suite II		
5. Limestone, shaly, fossiliferous (Blue rock)		8
4. Limestone, blue, massive, containing *Fusulinella* sp. (Cap rock)		11-30
3. Rock Island (No. 1) coal, only top exposed in drift	..	..
2. Clay, sandy (covered)	..	..
1. Sandstone, hard, "Stigmarian" (exposed down-stream)	..	..

4. *J. Snell and Sons mine, near the middle of the north line of the SW. ¼ SW. ¼ sec. 6, T. 14 N., R. 2 W. (Greene Twp.)*

Altitude of top of coal 633 feet

		Thickness Feet	Inches
Suite II			
8.	Limestone, shaly (Blue Rock)	14	
7.	Limestone, blue (Cap-rock)	1±	
6.	Shale, black, laminated, fossiliferous, with abundant large pyritic and calcareous concretions or niggerheads, also fossiliferous	1	
5.	Rock Island (No. 1) coal, upper bench	1	8
4.	Clay parting, carbonaceous	1	
3.	Rock Island (No. 1) coal, lower bench	1	6
2.	Underclay, light		6
1.	Sandstone	Exposed at base	

5. *Hydraulic Press Brick Co. mine near the center of the SW. ¼ sec. 5, T. 14 N., R. 2 W. (Greene Twp.)*

Altitude of top of coal 644 feet

		Thickness Feet	Inches
Suite II			
7.	Limestone, shaly and blue (Blue rock and Cap-rock)	7	
6.	Shale, black, laminated, hard (miners' slate)	3 or less	
5.	Rock Island (No. 1) coal, upper bench	1	8
4.	Clay parting, carbonaceous	1	
3.	Rock Island (No. 1) coal, lower bench	2	4
2.	Clay, light, sandy		0-6
1.	Sandstone, hard	Exposed at base	

6. *Abandoned drift mine near the center of the east line of the SW. ¼ sec. 5, T. 14 N., R. 2 W. (Greene Twp.)*

Altitude of top of coal 655 feet

		Thickness Feet	Inches
Suite II			
6.	Limestone, light gray, shaly, fossiliferous	2	
5.	Limestone, blue-gray, shaly, fossiliferous (Blue rock)	8	
4.	Limestone, blue, massive (Cap-rock)	1	8
3.	Clay, carbonaceous (clod)		2
2.	Rock Island (No. 1) coal	3	2
1.	Clay, sandy, or sandstone	Exposed at base	

7. *Coal-test boring near SE. corner SW. ¼ NW. ¼ sec. 9, T. 14 N., R. 2 W. (Greene Twp.)*

Altitude of top of coal 651 feet

		Thickness Feet	Inches
10.	Soil	3	
9.	Clay, yellow (loess and weathered till)	27	
8.	Clay, blue (unoxidized till)	27	
7.	Shale, yellow	18	
6.	Shale, blue	22	
Suite II			
5.	"Slate" (shale)	6	5
4.	Limestone, shaly (Blue rock)	12	9
3.	"Slate" (laminated shale)		2
2.	Limestone (Cap-rock)	2	8
1.	Rock Island (No. 1) coal	4	8

8. *Composite exposure at Peterson mine and gully south of mine, near the center of the NW. ¼ SE. ¼ sec. 4, T. 14 N., R. 2 W. (Greene Twp.)*

Altitude of top of coal 655 feet

	Thickness Feet	Inches
Suite III		
11. Shale	3	
10. Sandstone, containing fragments or carbonized wood		4
9. Coal		10
8. Underclay, light	1	
Suite II		
7. Shale, brown and gray	8	
6. Limestone, shaly (Blue rock)	8	
5. Limestone, blue (Cap-rock)	1	2
4. Clay, carbonaceous (clod)		0-3
3. Rock Island (No. 1) coal, with 1 foot parting of carbonaceous clay	4	6
2. Underclay	1	
1. Sandstone	Exposed at base	

9. *Abandoned drift mine near the center of the SW. ¼ NE. ¼ sec. 4, T. 14 N., R. 2 W. (Greene Twp.)*

Altitude of top of coal 647 feet

	Thickness Feet	Inches
Suite II		
5. Limestone, shaly (Blue rock)	6	
4. Limestone, blue (Cap-rock)	1	1
3. Clay, carbonaceous (clod)		1
2. Rock Island (No. 1) coal, including carbonaceous clay parting	4	7
1. Underclay	Not exposed	

10. *Abandoned drift mine near the center of sec. 33, T. 15 N., R. 2 W. (Preemption Twp.)*

Altitude of top of coal 665 feet

	Thickness Feet	Inches
Suite II		
5. Limestone, shaly, fossiliferous (Blue rock)	1	8
4. Limestone, blue, (Cap-rock)	2	1
3. Shale, gray and yellowish, slightly sandy		3
2. Rock Island (No. 1) coal, weathered in outcrop	1	9
1. Underclay	Only top exposed	

11. *At entrance to abandoned drift mine in the SE. ¼ NW. ¼ sec. 34, T. 15 N., R. 2 W. (Preemption Twp.)*

Altitude of top of coal 627 feet (estimated)

	Thickness Feet	Inches
Suite III		
8. Sandstone, gray	1	
Suite II		
7. Shale, light, calcareous	1	2
6. Limestone, shaly, fossiliferous (Blue rock)	2	10
5. Limestone, massive, blue (Cap-rock)	1	6
4. Shale and sand (clod)		6
3. Rock Island (No. 1) coal	3	7
2. Underclay, light	1	
1. Sandstone (exposed in creek)	6	

12. *Coal-test boring in the SE. corner sec. 34, T. 15 N., R. 2 W. (Preemption Twp.)*

Altitude of top of coal approximately 620 feet

		Thickness Feet	Inches
	9. Loess (Pleistocene)	10	
	8. Sand and gravel	12	
	7. Clay, blue	2	3
	6. Sand and gravel	6	
Suite II			
	5. Limestone, shaly (Blue rock)	12	
	4. Limestone, blue (Cap-rock)	1	6
	3. Shale, black, laminated	1	8
	2. Rock Island (No. 1) coal	4	9
	1. Shale	1	

13. *Neverseen Coal Co. mine near SE. corner NE. ¼ NW. ¼ sec. 3, T. 14 N., R. 2 W. (Greene Twp.)*

Altitude of top of coal 654 feet

		Thickness Feet	Inches
Suite II			
	6. Limestone, shaly, fossiliferous (Blue rock)	12	
	5. Limestone, blue (Cap-rock)	1	8
	4. Shale, black, laminated, fossiliferous, containing large pyritic, calcareous, fossiliferous concretions (niggerheads)	2 or less	
	3. Rock Island (No. 1) coal, with pyrite parting	4	6
	2. Underclay, light	1	
	1. Sandstone	Only top exposed	

14. *Neverseen Coal Co. abandoned drift mine, near the center of the NW. ¼ sec. 3, T. 14 N., R. 2 W. (Greene Twp.)*

Altitude of top of coal 658 feet

		Thickness Feet	Inches
Suite II			
	5. Limestone, shaly (Blue rock)	2	6
	4. Limestone, blue (Cap-rock)	1	
	3. Shale, carbonaceous (clod)		2
	2. Rock Island (No. 1) coal	3	6
	1. Underclay	1	

15. *Bonick drift mine, about 300 feet west of No. 16, sec. 3, T. 14 N., R. 2 W. (Greene Twp.)*

Altitude of top of coal 662 feet

		Thickness Feet	Inches
Suite II			
	5. Limestone, blue, rather laminated, abundant *Fusulinella* sp. (Cap-rock)	2	
	4. Clay, black, carbonaceous (clod)		2
	3. Rock Island (No. 1) coal	1	6
	2. Underclay, light sandy	1	3
	1. Sandstone, light (exposed)	2	

16. *Entrance to abandoned drift mine, near the NW. corner SE. ¼ sec. 3, T. 14 N., R. 2 W. (Greene Twp.)*

Altitude of top of coal 663 feet

		Thickness Feet	Inches
Suite II			
	6. Limestone, shaly (Blue rock)	6	9
	5. Limestone, blue, fossiliferous, containing *Fusulinella* sp. (Cap-rock)	2	6
	4. Shale, black, carbonaceous (clod)		3
	3. Rock Island (No. 1) coal	3	
	2. Clay, blue-gray		4
	1. Underclay, white or light gray	1	

17. *Black Diamond Coal Co. mine shaft, center of the SE. ¼ SW. ¼ sec. 2, T. 14 N., R. 2 W. (Greene Twp.)*

Altitude of top of coal 646 feet	Thickness Feet	Thickness Inches
7. Drift and sand	17	
Suite II		
6. Limestone, shaly (Blue rock)	14	
5. Limestone, blue (Cap-rock)	2	
4. Shale, black, hard, laminated (miners' "slate")	1	6
3. Rock Island (No. 1) coal	4	3
2. Underclay		0-6
1. Sandstone	Only top exposed	

18. *At entrance to Kness Coal Co. mine near the center of the SW. ¼ NW. ¼ sec. 11, T. 14 N., R. 2 W. (Greene Twp.)*

Altitude of top of coal 656 feet	Thickness Feet	Thickness Inches
8. Drift and sand	23	
Suite III		
7. Sandstone, yellowish, and shale	5	
Suite II		
6. Limestone, shaly (Blue rock)	2	4
5. Limestone, blue (Cap-rock)	1	8
4. Clay, carbonaceous, soft		1-2
3. Rock Island (No. 1) coal, with discontinuous level of pyrite concretions	4	
2. Underclay, light		6
1. Sandstone, with some hard, flinty layers	Base of mine	

19. *Coal-test boring near the center of the south line of the SE. ¼ NE. ¼ sec. 16, T. 14 N., R. 2 W. (Greene Twp.)*

Altitude of top of coal 670 feet	Thickness Feet	Thickness Inches
7. Clay (loess and weathered till)	26	
6. Till	60	9
5. Sandstone	7	1
Suite II		
4. Limestone, shaly (Blue rock)	6	11
3. Limestone, blue (Cap-rock)		5
2. "Slate" (shale)		2
1. Rock Island (No. 1) coal	4	10

20. *Coal test boring near the center of the west line of the NE. ¼ NE. ¼ sec. 20, T. 14 N., R. 2 W. (Greene Twp.)*

Altitude of top of coal 637 feet	Thickness Feet	Thickness Inches
11. Soil	3	
10. Clay	21	
9. Clay and sand	8	
8. Clay, blue ("sea mud")	10	7
Suite III		
7. Shale ("soapstone")	57	5
6. Sandstone	2	
5. Shale	10	8
Suite II		
4. Slate	7	8
3. Limestone, shaly (Blue rock)	10	2
2. "Slate" (shale)	3	5
1. Rock Island (No. 1) coal	3	8

21. *W. B. Williams mine shaft, near the NE. corner of the NW. ¼ NW. ¼ sec. 32, T. 14 N., R. 2 W. (Greene Twp.)*

Altitude of top of coal 659 feet

	Thickness Feet	Thickness Inches
8. Loess and till (Pleistocene)	50	
Suite III		
7. Sandstone, chert, and shale (Suite II)	8	
Suite II		
6. Limestone, shaly (Blue rock)	4	
5. Limestone, blue, massive (Cap-rock)	2	0-3
4. Shale, black, laminated, containing marine fossils	1	0-8
3. Rock Island (No. 1) coal	4	
2. Underclay, thin or absent		0-5
1. Sandstone, "Stigmarian"	Exposed at base	

22. *Composite of sections in vicinity of G. H. Smith mine, near the center of the SW. ¼ sec. 32, T. 14 N., R. 2 W. (Greene Twp.)*

Altitude of top of coal 665 feet

	Thickness Feet	Thickness Inches
17. Loess and till (Pleistocene)	40±	
16. Sandstone	0-2	
15. Chert		5-12
Suite II		
14. Shale	1½-2	
13. Limestone, shaly (Blue rock)	8-16	
12. Limestone, massive, blue (Cap-rock)	1-1½	
11. Shale, black, laminated		4-10
10. Rock Island (No. 1) coal	3⅓-5	
9. Underclay		6-0
8. Sandstone, "Stigmarian", or sandy clay-shale	8 or less	
Suite I		
7. Underclay, light, soft	4	
6. Covered, probably shale or underclay	6	
5. Limestone, blue, hard, evenly bedded, sparingly fossiliferous		8
4. Coal	2	6
3. Underclay, gray, sandy, lower part blue-gray	5	6
2. Underclay, gray, sandy	4	
1. Shale, blue, containing ironstone concretions	4	6

23. *Cut bank on north side of Henderson Creek about 250 yards northwest of the center of the east line of sec. 14, T. 12 N., R. 2 W. (Spring Grove Twp.)*

Altitude of top of coal 657 feet

	Thickness Feet	Thickness Inches
8. Loess and till	Not measured	
7. Sandstone, thinly bedded, soft	2	
6. Sandstone, thin, brownish, soft, blocky, containing abundant poorly preserved traces of charcoalized wood and numerous remains of the hard parts of fish (*Petrodus occidentalis*, etc.)		6
Suite II		
5. Limestone, shaly, and shale, calcareous (Blue rock)	5	
4. Limestone, blue, massive (Cap-rock)	3	6
3. Rock Island (No. 1) coal (exposure covered by slump). Reported	3	
2. Underclay	3-4	
1. Sandstone, thinly bedded, light colored, containing traces of *Calamites* and *Stigmaria*	12	

24. *At entrance to abandoned drift mine near the SE. corner SW. ¼ sec. 14, T. 12 N., R. 2 W. (Spring Grove Twp.)*

Altitude of top of coal 652 feet

	Thickness Feet	Inches
8. Loess and till (Pleistocene)	Not measured	
7. Chert	1	
Suite II		
6. Shale		8
5. Limestone, chalky, fossiliferous; weathers yellowish	1	
4. Limestone, shaly, fossiliferous (Blue rock)	3	
3. Limestone, hard, nodular, slightly fossiliferous	1	8
2. Limestone, blue, hard, evenly bedded (Cap-rock)		10
1. Rock Island (No. 1) coal (exposed)	2	6

25. *Exposures in gully about 200 yards west of the east line of sec. 14, T. 12 N., R. 2 W. (Spring Grove Twp.)a*

Altitude of top of coal 651 feet

	Thickness Feet	Inches
14. Loess and till (Pleistocene)	5±	
13. Sandstone, thinly bedded, black to yellowish, shaly	7	6
12. Clay, most covered	6	6
11. Shale, black, carbonaceous (horizon of thin coal bed)		10
10. Sandstone, hard, containing *Stigmaria*		4
9. Sandstone, thinly bedded, soft	3	4
8. Chert, in two benches		8±
Suite II		
7. Shale, light gray, hard, silicified	1	5
6. Shale, calcareous, dark gray, rather hard	1	
5. Limestone, shaly, blue-gray, slabby, splitting in broad thin plates, fossiliferous (Blue rock)	3	6
4. Limestone, hard, nodular, with wavy lines of bedding; blue-gray where fresh, weathering buff; sparingly fossiliferous	1	2
3. Limestone, slabby, blue-gray where fresh, weathering dark gray; containing *Fusulinella* sp. (Cap-rock)	1	6
2. Shale, laminated, black, hard	2	
1. Rock Island (No. 1) coal	4	

a This exposure is similar to the section in Bailey mine shaft at head of this gully in sec. 23, same township.

26. *Richardson mine shaft near the center of the SW. ¼ NW. ¼ sec. 24, T. 12 N., R. 2 W. (Spring Grove Twp.)*

Altitude of top of coal 647 feet

	Thickness Feet	Inches
9. Alluvium and till (Recent and Pleistocene)	13	
8. Coal		8
7. Underclay and sandstone	8	
Suite II		
6. Limestone (Blue rock and Cap-rock)	3-4	
5. Shale, black, laminated	1	8
4. Rock Island (No. 1) coal	4	
3. Shale, pyritic, coaly (false bottom)		2
2. Underclay	3	
1. Sandstone	Exposed	

27. *McCartney mine shaft (abandoned) near the center of the east line of the SE. ¼ NW. ¼ sec. 24, T. 12 N., R. 2 W. (Spring Grove Twp.)*

Altitude of top of coal 635 feet

	Thickness Feet	Inches
5. Loess and till (Pleistocene)	23±	
Suite II		
4. Limestone (Blue rock and Cap-rock)	15	
3. Shale, black, laminated	2	
2. Rock Island (No. 1) coal	4	
1. Sandstone	Exposed at base	

Part II.—Measured geologic sections of Suite IV, Colchester (No. 2) coal and associated strata

The following sections are graphically represented in figure 24, p. 81.

1. *Outcrop near the middle of the west line of the NW. ¼ SW. ¼ sec. 23, T. 14 N., R. 2 W. (Greene Twp.)*

Altitude of top of coal 735 feet

	Thickness Feet	Inches
12. Loess and till (Pleistocene)	Not measured	
Suite IV		
11. Shale, gray, soft	1	
10. Limestone, brown, concretionary, very fossiliferous		5
9. Shale, gray, soft, with flattened septarian calcareous concretions at two or three levels. Concretions fossiliferous (Appendix A	4	6
8. Limestone, concretionary, gray, septarian, fossiliferous, in gray shale which is also fossiliferous at this level (Appendix A)		6
7. Shale, gray, soft	1	
6. Shale, black, laminated, nodular, with very small plant fragments preserved in small calcareous concretions. Few large calcareous and pyritic concretions or "niggerheads" irregularly distributed	1	
5. Colchester (No. 2) coal, rather hard, even, strongly pyritic, sulfur stains prominent in outcrop face	1	3
4. Underclay, strongly sulfurous, containing silicified roots	5	
3. Underclay, sandy, containing hard spherical concretions of septarian structure	1	
2. Sandstone, light, thinly bedded	8	
Suite III		
1. Shale, gray, soft	—	

2. *Composite section of exposures in gully near the middle of the east line of the SE. ¼ NE. ¼ sec. 27, T. 14 N., R. 2 W. (Greene Twp.)*

Altitude of top of coal 729 feet

	Thickness Feet	Inches
11. Loess and till (Pleistocene)	Not measured	
Suite IV		
10. Limestone, septarian concretions, forming nearly solid ledge..		8
9. Shale, dark gray, soft	2	
8. Shale, black, hard, laminated, containing small calcareous concretions which give pitted or pimply appearance to bedding surface	2	
7. Colchester (No. 2) coal	2+	
6. Underclay, white, containing a few silicified roots extending down from coal bed	5±	

	Thickness Feet	Inches
Suite III		
5. Shale, sandy, and sandstone, thinly bedded	2-5	
4. Gilchrist shale, gray, with calcareous concretions at various levels	18	
3. Shale, reddish	1	
2. Shale, gray, with large flattened ovoid concretions at some levels	21±	
1. Sandstone, massive	—	

Nos. 1 to 4 of the above section are exposed further down this gully than location given, in sec. 26, T. 14 N., R. 2 W. (Greene Twp.).

3. *Exposures in gully near the middle of the east line of the NE. ¼ SW. ¼ sec. 1, T. 13 N., R. 2 W. (Suez Twp.)*

Altitude of top of coal 713 feet

	Thickness Feet	Inches
7. Loess and till (Pleistocene)	Not measured	
Suite IV		
6. Shale, black, hard, laminated, containing small concretions giving pimply surface	1	8
5. Shale, black, carbonaceous, soft	0-2	
4. Colchester (No. 2) coal, containing irregular 1- to 2-inch partings of pyrite about 4 inches from base	1	6
3. Underclay, light	4	
2. Sandstone, rather soft, weathers yellow, containing many large, irregular, egg-shaped concretions 1 foot in diameter	5	
1. Sandstone, containing hard, blue-gray, calcareous concretions having maximum diameter of 8 to 10 feet. Bedding of sandstone appears to bend around concretions	10+	

4. *Entrance to abandoned drift mine near the middle of the south line of the SW. ¼ NW. ¼ sec. 20, T. 12 N., R. 2 W. (Spring Grove Twp.)*

Altitude of top of coal 661 feet

	Thickness Feet	Inches
3. Loess, slump, and till	Not measured	
Suite IV		
2. Shale, soft, gray	5	
1. Colchester (No. 2) coal, weathered and poorly exposed; reported	2	4

5. *Exposure in small gully near the center of the SE. ¼ SW. ¼ sec. 19, T. 12 N., R. 1 W. (Kelly Twp.)*

Altitude of top of coal 698 feet

	Thickness Feet	Inches
6. Loess and till (Pleistocene)	Not measured	
Suite IV		
5. Clay, soft	2	
4. Shale, hard, black, laminated, upper part rather pimply, containing small concretions	1	
3. Shale, soft, gray	9	
2. Colchester (No. 2) coal, poorly exposed		10+
Suite III		
1. Shale, soft, gray, grading down into thinly bedded micaceous shale	8	6

6. *Exposure in gully near the center of the E. ½ NE. ¼ sec. 30, T. 12 N., R. 1 W. (Kelly Twp.)*

Altitude of top of coal 691 feet

		Thickness Feet
	8. Loess and till (Pleistocene)	Not measured
Suite IV		
	7. Shale, blue-gray, calcareous, containing large septarian limestone concretions, fossiliferous	2
	6. Shale, gray, without septarian concretions	8
	5. Concretions, massive, septarian, with concentric and radial structure of calcite veins	2
	4. Shale, black, laminated, with pimply surface	2
	3. Colchester (No. 2) coal, poorly exposed	2±
	2. Clay, light	3
Suite III		
	1. Shale, greenish-gray, containing some plant fossils	8-10

7. *Exposure in gully near the SW. corner of the SE. ¼ NW. ¼ sec. 30, T. 12 N., R. 1 W. (Kelly Twp.)*

Altitude of top of coal 720 feet

		Thickness Feet	Inches
	6. Loess and till (Pleistocene)	Not measured	
Suite IV			
	5. Shale, gray, containing large septarian limestone concretions, fossiliferous	3	
	4. Shale, black, hard, laminated, with pimply surface due to numerous small concretions	1	6
	3. Colchester (No. 2) coal, even, rather hard, a little pyrite	2	
	2. Underclay, light gray, rather sandy	3+	
Suite III			
	1. Shale, blue-gray, evenly bedded	10	

Part III.—Mine data

Kness Coal Company

Location: Center of SW. ¼ NW. ¼ sec. 11, T. 14 N., R. 2 W. (Greene Twp.). Entrance: Shaft 32 feet deep. Altitude of top of coal: 667 feet. Roof: Massive blue limestone ("Cap-rock"); excellent. Coal: 42-48 inches thick; local pyrite concretions 2-18 inches below top of coal. Floor: Sandy clay, 6 inches thick, overlying massive sandstone, 5 feet or more thick.

Black Diamond Coal Company

Location: Center of SE. ¼ SW. ¼ sec. 2, T. 14 N., R. 2 W. (Greene Twp.). Entrance: Shaft 35 feet deep. Altitude of top of coal: 645 feet. Roof: Black laminated shale 18 inches thick, underlying limestone ("Cap-rock"); shale forms excellent roof, but checks where exposed to air for several years; some "roof falls." Coal: 48-54 inches thick; thin pyrite concretions in some places, 18 inches below top of coal. Floor: Sandy clay, 1 foot thick, overlying sandstone.

Neverseen Coal Company

Location: Near SE. corner NE. ¼ NW. ¼ sec. 3, T. 14 N., R. 2 W. (Greene Twp.). Entrance: Slope 6 feet down. Altitude of top of coal: 660 feet. Roof: Black laminated shale, 2 feet or less thick, in depressions; limestone roof on "rolls"; shale forms good roof except where thinner than 8 inches, where it weathers to "clod" and may fall; some concretions ("niggerheads") in shale. Coal: 48-54 inches thick; locally contains pyrite concretions as much as 5 inches thick, 30 inches below top of coal. Floor: Sandy clay, thin, or sandstone where clay is absent. Special features: Small faults with clay seams are present in coal; water enters through these faults or through sandstone floor.

Bonick Mine

Location: Near center of sec. 3, T. 14 N., R. 2 W. (Greene Twp.). Entrance: Drift not completed when visited. Altitude of top of coal: 662 feet. Roof: Clay or "clod," 2 inches thick, underlying blue limestone ("Cap-rock"). Coal: 18 inches thick at drift entrance. Floor: Light, sandy clay and sandstone; 2 feet 6 inches were removed with coal when driving drift

Peterson Mine
(Formerly Pleasant Valley Coal Company Mine)

Location: Near center of NW. ¼ SE. ¼ sec. 4, T. 14 N., R. 2 W. (Greene Twp.). Entrance: Slope about 15 feet down to coal. Altitude of top of coal: 655 feet. Roof: Clay, 2 to 3 inches thick, underlying massive blue limestone ("Cap-rock"); clay removed with coal. Coal: 40-54 inches thick, including bedded carbonaceous clay band 10-24 inches thick, 18 inches below top of coal. Floor: "False bottom," 6 inches thick, overlying sandstone. Special features: Wide solution cracks common in limestone; large amount of bedded impurities is a handicap in mining.

Mack Mine

Location: Near NE. corner SW. ¼ NE. ¼ sec. 4, T. 14 N., R. 2 W. (Greene Twp.). Entrance: Slope drift; mine not in operation when visited, but an old drift near entrance showed conditions similar to those in Peterson mine.

Lee Mine

Location: 150 yards west of Peterson mine, NW. ¼ SE. ¼ sec. 4, T. 14 N., R. 2 W. (Greene Twp.); this mine, newly opened in 1925, was not in operation when visited; Conditions reported are similar to those in Peterson mine.

Hydraulic Press Brick Company Mine
(Abandoned February, 1926)

Location: Near NE. corner of SW. ¼ SW. ¼ sec. 5, T. 14 N., R. 2 W. (Greene Twp.); a mine of same company half a mile south was abandoned about January, 1923. Entrance: Slope about 12 feet down to coal. Altitude of top of coal: 638 feet. Roof: Black laminated shale up to 3 feet thick, underlying limestone ("Cap-rock"); good roof except for some caving where shale is thin. Coal: Average thickness, 60 inches, including 12 inches bedded clay 20 inches below top of coal; thin pyritic concretions in a band 16 inches below top of coal. Floor: "False bottom" a few inches thick, overlying sandstone. Special features: This mine was close to Alden Coal Company No. 1 (Old Gilchrist) mine which was abandoned 30 years ago, several times it was flooded by tapping water-filled rooms of the old mine; one of these floods caused abandonment of mine. Core-drilling tests in 1923 showed coal thinned to 6 inches a quarter of a mile south of the working face.

J. Snell and Sons Coal Mine

Location: Near middle of north line of SW. ¼ SW. ¼ sec. 6, T. 14 N., R. 2 W. (Greene Twp.). Entrance: Slope 14 feet down to coal. Altitude of top of coal: 663 feet. Roof: Black laminated shale, 1 foot or less thick, underlying limestone ("Cap-rock"); many large concretions ("niggerheads") in shale cause poor roof in some parts of mine; limestone forms roof in some places. Coal: 46-50 inches thick including 12 inches of bedded black carbonaceous clay 20 inches below top of coal. Floor: 2 feet of gray clay overlying hard sandstone. Special features: The large concretions in the roof shale were more numerous in this mine than in any other visited.

McNeill Mine
(Abandoned in 1926)

Location: Near NW. corner of SW. ¼ sec. 33, T. 15 N., R. 2 W. (Preemption Twp.). Entrance: Slope about 6 feet above coal. Altitude of top of coal: 643 feet. Roof: 2-3 inches soft clay underlying blue limestone ("Cap-rock"). Coal: 27 inches thick, no shale or pyrite parting. Floor: Clay 12 inches thick overlying sandstone. Special features: Cracks 8 inches wide in limestone admit much water.

Williams Mine
(Formerly George Martin mine)

Location: Near NE. corner of NW. ¼ NW. ¼ sec. 32, T. 14 N., R. 2 W. (Greene Twp.). Entrance: Shaft 70 feet. Altitude of top of coal: 639 feet. Roof: Black shale 20 inches thick in depressions, thins out on "rolls" under limestone ("Cap-rock"); fine-grained, nodular, shaly limestone ("Blue-rock") overlies coal in a prominent "roll"; roof is best where shale is thick; shale shows some tendency to check after a few years exposure to air. Coal: 38-50 inches thick; locally contains thin pyrite concretion band 17 inches below top of coal; no clay or shale bands. Floor: Sandy clay, a few inches thick, overlying hard sandstone.

G. H. Smith Mine
(Formerly J. B. Martin mine)

Location: Near NE. corner of SW. ¼ SW. ¼ sec. 32, T. 14 N., R. 2 W. (Greene Twp.). Entrance: Shaft 38 feet deep. Altitude of top of coal: 665 feet. Roof: 1-2 inches clay ("clod") underlying massive limestone ("Cap-rock"); excellent roof, still sound in entrances and rooms 60 years old. Coal: 42-48 inches thick; thin concretionary band of pyrite near middle of coal in some places; no shale or clay impurities. Floor: Sandstone.

Richardson Mine
(Formerly Gilmore and Houston mine)

Location: Near center of SW. ¼ NW. ¼ sec. 24, T. 12 N., R. 2 W. (Spring Grove Twp.). Entrance: Shaft 30 feet deep. Altitude of top of coal: 647 feet. Roof: Black laminated shale, 20 inches thick, underlying limestone ("Cap-rock"); good roof. Coal: 43-52 inches thick; one-half inch pyrite concretions in places, 12 inches below top of coal. Floor: Carbonaceous, pyritic shale ("false bottom") 2 inches thick above gray sandy clay, overlying hard sandstone.

Bailey Mine

Location: Near NE. corner sec. 23, T. 12 N., R. 2 W. (Spring Grove Twp.). Entrance: Shaft 33 feet deep. Altitude of top of coal: 650 feet. Roof: Black laminated shale, 20 inches thick, underlying limestone ("Cap-rock"). Coal: Reported 48 inches thick. Floor: Probably like floor of Richardson mine. Special features: Shaft was being repaired when visited; shaft is a third of a mile north of coal to be mined, as large masses of fine silt caved in shaft nearer coal.

McCartney Mine
(Abandoned March, 1926)

Location: Near middle of east line of SE. ¼ NW. ¼ sec. 24, T. 12 N., R. 2 W. (Spring Grove Twp.). Entrance: Shaft 40 feet deep. Altitude of top of coal: 635 feet. Roof: Black laminated shale, 2 feet thick, underlying limestone ("Cap-rock"). Coal: Reported to average 48 inches thick; no bedded impurities. Floor: Probably same as in Richardson mine.

The following mines were formerly large shipping mines which have been abandoned for a number of years.

Alden Coal Company Mine No. 1
(Old Gilchrist mine)

Location: Near NE. corner SW. ¼ SW. ¼ sec. 4, T. 14 N., R. 2 W. (Greene Twp.). Entrance: Shaft about 70 feet deep. Altitude of top of coal: Approximately 650 feet. Coal: 4 feet or more thick. Special features: Coal was mined from parts of secs. 4, 5, 8, and 9, T. 14 N., R. 2 W. (Greene Twp.) (fig. 47); the workings extended about a third of a mile east and one and an eighth miles west from the shaft; the Peterson and the Hydraulic Press Brick Company mines adjoin these old workings.

Alden Coal Company Mine No. 2
(Wanlock mine)

Location: Near NE. corner NW. ¼ SW. ¼ sec. 9, T. 14 N., R. 2 W. (Greene Twp.). Entrance: Shaft 132 feet deep. Altitude of top of coal: Approximately 650 feet. Roof:

Boring near shaft shows rock, probably limestone, 3 feet 8 inches thick, over coal. Coal: 4 feet 8 inches reported in boring. Floor: No data. Special features: This mine extended north to a "fault," reported to cut out the coal between Wanlock and Old Gilchrist mines; this reported fault may be a channel cutting out the coal, for channel sandstones are exposed about 1 mile west of here. Coal was removed from part of the SW. ¼ sec. 9, and part of sec. 16, also from small areas in secs. 8 and 17, T. 14 N., R. 2 W. (Greene Twp.). (Fig. 47.)

Alden Coal Company Mine No. 3
(New Gilchrist mine)

Location: Near middle of west line of NE. ¼ NE. ¼ sec. 20, T. 14 N., R. 2 W. (Greene Twp.). Entrance: Shaft 134 feet deep. Altitude of top of coal: 640 feet. Roof: Gray shale, 0 to 3 feet thick, underlying limestone ("Cap-rock"), 6-18 inches thick, underlying shaly limestone, 6-12 feet thick. Coal: 48-78 inches thick. Floor: Shale 2 feet thick, overlying sandstone. Special features: This mine extended about half a mile north and one mile south of shaft; the coal was mined from a narrow strip about a quarter of a mile wide and lying chiefly in the eastern part of sec. 20, and the SE. ¼ sec. 17; test drillings in the SE. ¼ SE. ¼ sec. 20 revealed a preglacial channel 80-90 feet deep which cuts out the coal.

Alden Coal Company Mine No. 4

Location: SE. ¼ NE. ¼ sec. 16, T. 14 N., R. 2 W. (Greene Twp.). Entrance: Shaft, approximately 100 feet deep. Altitude of top of coal: Approximately 650 feet. Roof: Laminated shale or limestone ("Cap-rock"). Coal: 4 feet to 4 feet 10 inches thick. Special features: The coal mined from this shaft lay chiefly in sec. 16, and was connected with working of Alden mines 2 and 3 (fig. 47).

Coal Valley Mining Company Mine No. 3

Location: SW. ¼ SW. ¼ sec. 35, T. 15 N., R. 1 W. (Preemption Twp.). Entrance: Shaft, depth unknown. Coal: Average approximately 4 feet thick; mine map shows entries ended with coal 3 feet 3 inches to 4 feet thick. Special features: Coal has been removed from SW. ¼ SW. ¼ sec. 35, SE. ¼ SE. ¼ sec. 34, T. 15 N., R. 2 W. (Preemption Twp.) and NE. ¼ NE. ¼ sec. 3, T. 14 N., R. 2 W. (Greene Twp.); coal was shipped by a spur of the Rock Island Southern Railway.

APPENDIX C

WELL LOGS

Deep Wells, Detailed Records

(Logs of wells 1-31 are shown graphically on Plate V)

1. *State Asylum well; Watertown, Rock Island County, Illinois,*[1] *S. ½ NW. ¼ SW. ¼ sec. 20, T. 18 N., R. 1 E. (Hampton Twp.)*

Altitude approximately 575 feet, estimated from Cordova quadrangle topographic map

	Thickness *Feet*	Depth *Feet*
Recent and Pleistocene systems		
Sand, fine	85	85
Pennsylvanian system		
Pottsville (?) formation		
Limestone, shaly, and "slate" (shale), black	50	135
Devonian system		
Cedar Valley and Wapsipinicon formations		
Limestone, gray	115	250
Silurian system		
Niagaran series[a]		
Limestone, white (dolomite?)	300	550
Ordovician system		
Maquoketa formation		
Shale, blue	168	718
Mohawkian series		
Galena formation		
Limestone, dark gray	107	825
Limestone, light gray	100	925
Limestone, white, very hard	15	940
Platteville formation		
Limestone, dark gray	100	1040
Glenwood formation		
Shale, gray	10	1050
St. Peter formation		
Sandstone, containing a few layers of limestone 1 foot thick	90	1140
Limestone	10	1150
Sandstone	10	1160
Prairie du Chien series		
Shakopee formation		
Limestone	60	1220
Sandstone	20	1240
Limestone	20	1260
Sandstone	5	1265
Limestone, sandy	126	1391

[1] Record submitted by power plant engineer.
[a] In this and the rest of the well records, the rocks assigned to the Niagaran series may include also the Alexandrian series, which cannot be differentiated.

Deep Wells, Detailed Records—Continued

2. *City well; Silvis, Rock Island County, Illinois,*[2] *N. center of the SE. ¼ NW. ¼ sec. 32, T. 18 N., R. 1 E. (Hampton Twp.)*

Altitude approximately 580 feet, estimated from Cordova quadrangle topographic map

	Thickness *Feet*	Depth *Feet*
Recent and Pleistocene systems		
Sand and clay	36	36
Pennsylvanian, Devonian, Silurian, and Ordovician systems, undifferentiated		
Limestone with "veins" of bluish shale, (no trace of coal)	714	750
Includes Pottsville? (Pennsylvanian), Cedar Valley (Devonian), and Wapsipinicon (Devonian) formations, Niagaran (Silurian) and Maquoketa (Ordovician) formation, and part of Galena formation		
Ordovician system		
Mohawkian series		
Galena formation		
Large crevice followed by layer of sand	50	800
Galena, Platteville, Glenwood, and St. Peter formations and Prairie du Chien series, undifferentiated		
Limestone with a few "veins" (beds) of sandstone	650	1450
Prairie du Chien series		
Gravel, fine	3	1453
Rock (probably dolomite)	72	1525
Cambrian system		
Jordan (?) formation		
Gravel, fine	10	1535
Trempealeau formation		
Rock, hard (probably dolomite)	55	1590
Trempealeau and Mazomanie-Franconia formations, undifferentiated		
Limestone, very hard, with a few veins of sandstone	320	1910
Franconia formation		
Limestone, soft	15	1925
Dresbach (?) formation		
Sandstone, soft	55	1980
Limestone, very hard	5¼	1985¼

[2] Record submitted by Mr. F. W. Crawford.

3. *Continental Ice Company well, Silvis, Rock Island County, Illinois,*[3] *sec. 32 (?), T. 18 N., R. 1 E. (Hampton Twp.)*

Altitude approximately 575 feet, estimated from Cordova quadrangle topographic map

Recent and Pleistocene systems		
No record	32	32
Pennsylvanian and Devonian systems		
Shale	118	150
Silurian system		
Niagaran series		
Limestone	285	435
Ordovician system		
Maquoketa formation		
Shale	235	670

[3] Driller's record.

DEEP WELLS, DETAILED RECORDS—Continued

	Thickness Feet	Depth Feet
Mohawkian series		
Galena and Platteville formations		
Limestone	310	980
St. Peter formation		
Sandstone	40	1020
Prairie du Chien series		
Shakopee (?) formation		
Shale	130	1150
Ordovician (Prairie du Chien series) and Cambrian systems, undifferentiated		
Includes probably New Richmond and Oneota formations of the Prairie du Chien series and Jordan and Trempealeau formations of the Cambrian system		
Limestone and sandstone, alternating	520	1670

4. *City well No. 1, East Moline, Rock Island County, Illinois,*[4] *sec. 25 (?), T. 18 N., R. 1 W. (Moline Twp.)*

Altitude 579 feet

	Thickness Feet	Depth Feet
Recent and Pleistocene systems		
Drift	28	28
Devonian and Silurian systems, undifferentiated		
Cedar Valley and Wapsipinicon (Devonian) formations and Niagaran (Silurian) series		
Limestone and dolomite, white, with green shale and red marl	402	430
Ordovician system		
Maquoketa formation		
Shale, light to dark, bituminous, pyritic	265	695
Mohawkian series		
Galena formation		
Limestone and dolomite, sandy, gray to white, subgranular	205	900
Platteville formation		
Limestone, dark gray and buff, pyritic, flaky	95	995
Glenwood formation		
Shale, greenish, pyritic	30	1025
St. Peter formation		
Sandstone	50	1075
Prairie du Chien series		
Shakopee formation		
Limestone	105	1180
Marl, red	35	1215
Limestone	60	1275
Sandstone	3	1278
Limestone	64	1342
New Richmond (?) formation		
Limestone, sandy	23	1365
Oneota (?) formation		
Limestone, with streaks of sandstone	135	1500
Cambrian system		
Jordan and Trempealeau (?) formations		
Sandstone and limestone	32	1532

[4] Compiled from drillers' logs and samples studied by J. A. Udden.

Deep Wells, Detailed Records—Continued

5. *City well No. 2, East Moline, Rock Island County, Illinois,*[5] *sec. 25 (?), T. 18 N., R. 1 W. (Moline Twp.)*

Altitude 573 feet

	Thickness *Feet*	Depth *Feet*
Recent and Pleistocene systems		
Gravel, sand, clay	22	22
Devonian and Silurian systems, undifferentiated		
Cedar Valley and Wapsipinicon (Devonian) formations and Niagaran (Silurian) series		
Limestone	413	435
Ordovician system		
Maquoketa formation		
Shale	90	525
Limestone	45	570
Shale	25	595
Shale, brown	53	648
Mohawkian series		
Galena formation		
Limestone	172	820
Limestone, sandy	46	866
Decorah formation		
Shale	5	871
Platteville formation		
Limestone	29	900
Limestone, sandy	60	960
Limestone, brown	27	987
Glenwood formation		
Sandstone	22	1009
Shale	16	1025
Limestone	10	1035
St. Peter formation		
Sandstone	55	1090
Shale	32	1122
Limestone, sandy	38	1160
Prairie du Chien series		
Shakopee formation		
Limestone	211	1371
New Richmond and Oneota formations		
Limestone and sandstone in streaks	59	1430
Sandstone, heavily pyritic	20	1450
Limestone	10	1460
Sandstone and limestone in streaks	25	1485
Cambrian system		
Jordan formation		
Sandstone, soft	20	1505
"Quartz rock" (hard sandstone)	5	1510
Sandstone "flinty" (hard)	20	1530
Sandstone, soft	10	1540
Sandstone, sharp	48	1588
Trempealeau formation		
Limestone	12	1600
Shale	8	1608
Shale, sandy	8	1616
Limestone	24	1640
Limestone and sandstone in streaks	135	1775
Marl, red	1	1776
Mazomanie-Franconia (?) formation		
Shale, sandy	64	1840
Limestone	10	1850

[5] Driller's record.

DEEP WELLS, DETAILED RECORDS—Continued

6. *Paper Mill Company well, Moline, Rock Island County, Illinois,*[6] *NE. corner NW. ¼ SW. ¼ sec. 32, T. 18 N., R. 1 W. (Moline Twp.)*
Altitude 564 feet

	Thickness Feet	Depth Feet
Recent and Pleistocene systems		
Surface soil	7	7
Devonian system		
Cedar Valley and Wapsipinicon formations		
Limestone	113	120
Silurian system		
Niagaran series		
Limestone	275	395
Ordovician system		
Maquoketa formation		
Shale	220	615
Mohawkian series		
Galena and Platteville formations		
Limestone	320	935
Glenwood formation		
Shale, sandy, and streaks of sandstone	141	1076
St. Peter formation		
Sandstone	65	1141
Prairie du Chien series		
Limestone and marl, red	316	1457
Cambrian system		
Jordan formation		
Sandstone	121	1578
Trempealeau formation		
Limestone	50	1628

[6] Driller's record.

7. *Mitchell and Lynde well, Rock Island, Rock Island County, Illinois,*[7] *between East and West Seventeenth Streets, north of Second Avenue; NE. corner of the SE. ¼ NW. ¼ sec. 35, T. 18 N., R. 2 W.*
Altitude 558 feet

	Thickness Feet	Depth Feet
Devonian system		
Cedar Valley and Wapsipinicon formations		
Limestone	60	60
Silurian system		
Niagaran series		
Limestone	276	336
Ordovician system		
Maquoketa formation		
Shale	180	516
Mohawkian series		
Galena formation (includes some Maquoketa)		
Limestone	353	869
Platteville formation		
Limestone	90	959
St. Peter formation		
Sandstone	145	1104
Ordovician and Cambrian systems, undifferentiated; Prairie du Chien (Ordovician) series and Jordan, Trempealeau and Mazomania-Franconia (?) (Cambrian) formations		
Limestone	811	1915
Cambrian system		
Mazomanie-Franconia formation		
Sandstone, dense	30	1945
Limestone	35	1980

[7] Record published in U. S. Geological Survey Seventeenth Ann. Rept., pt. 2, p. 845, 1896.

Deep Wells, Detailed Records—Continued

	Thickness Feet	Depth Feet
Dresbach formation		
Sandstone	130	2110
Eau Claire formation		
Limestone, shaly, and shale	75	2185
Sandstone	97	2282

8. *Modern Woodmen's well,*[8] *Rock Island, Rock Island County, Illinois, near Seventeenth Street and Third Avenue; SW. ¼ NE. ¼ sec. 35, T. 18 N., R. 2 W.*
Altitude about 565 feet

	Thickness Feet	Depth Feet
Devonian and Silurian systems, undifferentiated		
Cedar Valley and Wapsipinicon (Devonian) formations and Niagaran (Silurian) series		
No record	160	160
Silurian system		
Niagaran series		
Dolomite, white, gray, and cream-colored, coarsely crystalline, porous, with some fragments of sandstone and lumps of green clay locally, cherty at base	245	405
Ordovician system		
Maquoketa formation		
Shale, calcareous, light gray	35	440
Shale, light gray, with fragments of pyritiferous dolomitic limestone	85	525
Limestone, shaly, dolomitic, gray, with some flaky shale	25	550
Shale, slightly calcareous, greenish-gray	17	567
Limestone, dolomitic, dark gray, fine-grained	15	582
Shale, dark gray, bituminous	18	600
Shale, dark, nearly black when wet	20	620
Mohawkian series		
Galena formation		
Dolomite, yellowish-gray, cherty in lower part	245	865
Platteville formation		
Limestone, gray	85	950
Glenwood formation		
Sandstone composed of small rounded, clear quartz grains	15	965
Shale, greenish-gray	15	980
Sandstone composed of coarse rounded grains, with fragments of stiff green shale	25	1005
St. Peter formation		
Sandstone, clean quartz grains	50	1055
Sandstone, cream-colored, fine in texture	15	1070
Sandstone, yellowish, fine in texture	40	1110
Shale, green (probably base of St. Peter)	13	1123

[8] Record compiled from samples of well cuttings examined by J. A. Udden.

9. *Atlantic Brewery Company well, Rock Island, Rock Island County, Illinois,*[9] *NE. corner NW. ¼ SE. ¼ sec. 36, T. 18 N., R. 2 W.*
Altitude 577 feet

	Thickness Feet	Depth Feet
Pennsylvanian (?) system		
Sandstone (?)	150	150
Silurian system		
Niagaran series		
No record	50	200
Dolomite, grayish-white	10	210

[9] Record derived mostly from samples studied by J. A. Udden.

DEEP WELLS, DETAILED RECORDS—Continued

	Thickness Feet	Depth Feet
Dolomite, grayish-white, cherty, and sandstone, white	20	230
Sandstone, white, and clay, green	30	260
Dolomite white, and sandstone	20	280
Sandstone, white	10	290
Dolomite, white, and sandstone	90	380
Sandstone	10	390
Chert, dolomite, and sandstone	10	400
Ordovician system		
Maquoketa formation		
Shale, silty, slightly calcareous, greenish, fossiliferous	80	480
Shale, sandy, gray, pyritic	20	500
Shale, gray, with fossiliferous limestone	30	530
Shale, calcareous, gray, with darker lumps	70	600
Shale, calcareous, dark, bituminous	20	620
Mohawkian series		
Galena formation		
Dolomite, grayish-white, cherty	30	650
Dolomite, yellowish-gray, with green clay and chert locally	140	790
No record	310±	1100±

10. *Rock Island Brewing Company,*[10] *Rock Island, Rock Island County, Illinois, Elm Street near Ninth Avenue; NE. corner of the SE. ¼ SE. ¼ sec. 36, T. 18 N., R. 2 W.*

Altitude 654 feet

Recent, Pleistocene, and Pennsylvanian systems, undifferentiated		
No record	100	100
Devonian system		
Cedar Valley and Wapsipinicon formations		
Limestone, gray, with some shale in lower 20 feet	50	150
Silurian system		
Niagaran series		
Dolomite, yellowish-brown, with cavities filled with sandy shale	375	525
Ordovician system		
Maquoketa formation		
Shale, bluish-gray	205	730
Maquoketa formation		
Galena and Platteville formations		
Limestone	330	1060
Glenwood formation		
Shale, blue	25	1085
St. Peter formation		
Sandstone, with some shale below	204	1289
Shale	61	1350
Marl, red	25	1375
Prairie du Chien series		
Limestone	229	1604
Cambrian system		
Jordan and Trempealeau formations		
No record	346	1950
Mazomanie-Franconia and Dresbach formations		
Sandstone of various colors	207	2157

[10] Record published in Illinois State Geol. Survey Bull. 38, p. 132, 1921; driller's record 1289 to 1565 feet.

DEEP WELLS, DETAILED RECORDS—Continued

11. *Town well, Milan, Rock Island County, Illinois,*[11] *center of the NE. ¼ sec. 23, T. 17 N., R. 2 W. (Blackhawk Twp.)*

Altitude 566 feet

	Thickness Feet	Depth Feet
Recent and Pleistocene systems		
Drift	7	7
Devonian and Silurian systems, undifferentiated		
Cedar Valley and Wapsipinicon (Devonian) formations and Niagaran (Silurian) series		
Limestone, white, with some shale	383	390
Ordovician system		
Maquoketa formation		
Shale	160	550
Shale, with streaks of limestone	55	605
Mohawkian series		
Galena formation		
Limestone, brown	95	700
Limestone, white	140	840
Platteville formation		
Limestone, brownish	90	930
Glenwood formation		
Shale	30	960
St. Peter formation		
Sandstone	90	1050
Limestone, sandy	10	1060
Sandstone and limestone, with some shale	35	1095
Sandstone, hard and sharp	20	1115
Marl, red	10	1125
Prairie du Chien series		
Shakopee formation		
Limestone, white	32	1157

[11] Record published in U. S. Geol. Survey Seventeenth Ann. Rept., pt. 2, p. 846, 1896.

12. *Tri-City Railway Company's well in Prospect Park, Moline,*[12] *Rock Island County, Illinois, near center of east line of sec. 8, T. 17 N., R. 1 W. (South Moline Twp.)*

Altitude 611 feet

	Thickness Feet	Depth Feet
Recent, Pleistocene, and Pennsylvanian (?) systems, undifferentiated		
No record	71	71
Devonian system		
Cedar Valley and Wapsipinicon formations		
Limestone, calcareous, dense, pyritic; sandy in upper part	60	131
Silurian system		
Niagaran series		
Dolomite, yellowish-white, grayish-white, bluish-white, and white, porous; contains pockets of clay; chert in lower part	350	481
Ordovician system		
Maquoketa formation		
Shale, sandy, gray, with tinges of buff, blue, and green; pyritic	90	571
Shale, sandy, bluish-gray, with thin beds of limestone	30	601
Shale, gray and bluish-gray; contains microscopical spherules (sand grains?) and pyrite crystals	60	661
Shale, dark gray, bituminous	50	711

[12] Record to 1170 feet compiled from samples studied by J. A. Udden; record below 1170 feet compiled from driller's record.

DEEP WELLS, DETAILED RECORDS—Continued

	Thickness *Feet*	Depth *Feet*
Mohawkian series		
Galena formation		
Dolomite, gray and yellowish-gray, granular, with some chert and green clay	180	891
Platteville formation		
Limestone, yellowish-gray and bluish-gray, with some chert	150	1041
Glenwood formation		
Shale, greenish-gray, with rounded grains of sand, chert, and pyrite	50	1091
St. Peter formation		
Sandstone	50	1141
Clay or shale, greenish, pyritic	20	1161
Prairie du Chien series		
Limestone	449	1610
Cambrian system		
Jordan formation		
Sandstone, sharp	30	1640
Trempealeau formation		
Limestone, hard and soft	285	1925
Mazomanie-Franconia formation		
Shale	25	1950
Sandstone	30	1980
Limestone	30	2010
Dresbach formation		
Sandstone, hard, soft, and streaked	80	2090
Eau Claire formation		
Shale, sandy	60	2150
Shale	25	2175
Limestone and shale	40	2215
Shale, sandy	125	2340
Mt. Simon formation		
Sandstone	28	2368

13. *Argillo Works well, Carbon Cliff, Rock Island County, Illinois,*[13] *sec. ¼ (?), T. 17 N., R. 1 E. (Hampton Twp.)*

Altitude 592 feet

	Thickness *Feet*	Depth *Feet*
Recent, Pleistocene, Pennsylvanian (?), and Devonian systems, undifferentiated		
No record	150	150
Silurian system		
Niagaran series		
Dolomite, white, with some sand and some gray shale	330	480
Ordovician system		
Maquoketa formation		
Shale, calcareous, green	120	600
Shale, calcareous, very dark, pyritic	80	680
Mohawkian series		
Galena and Platteville formations		
Dolomite, gray, granular, with some shale	135	815
No record	135	950

[13] Record compiled from samples studied by J. A. Udden.

Deep Wells, Detailed Records—Continued

14. *City well, Orion, Henry County, Illinois,*[14] *sec. 28, T. 16 N., R. 1 E.*
Altitude approximately 750 feet, estimated from State geologic map

	Thickness *Feet*	Depth *Feet*
Recent and Pleistocene systems		
Loess, noncalcareous, brown, includes some till	80	80
Till, sandy, calcareous, dark gray	83	163
No sample	17	180
Sand, calcareous, brown, medium-grained	5	185
Till, gravelly, calcareous, dark gray	5	190
Pennsylvanian system		
Pottsville formation		
Shale, black, soft	2	192
Shale, silty, gray, soft	38	230
Shale, dark gray, firm, micaceous	15	245
Sandstone, calcareous, gray, dense, fine-grained, pyritic	31	276
Devonian system		
Cedar Valley and Wapsipinicon formations		
Limestone, brownish to light gray, granular	94	370
Shale, noncalcareous, light blue, fine-grained, with subrounded sand grains and chips of light gray, pink, and brown sandy dolomite	5	375
Silurian system		
Niagaran series		
Dolomite, light gray with dark gray spots, finely crystalline, dense or vesicular	30	405
Limestone, grayish-brown, coarsely granular, bituminous	15	420
Dolomite, white, buff, very finely or medium crystalline; porous, vesicular, or dense	195	615

[14] Record compiled from samples examined by L. E. Workman.

15. *High School well, Sherrard, Mercer County, Illinois,*[15] *SE. ¼ SW. ¼ sec. 4, T. 15 N., R. 1 W. (Richland Grove Twp.)*
Altitude approximately 790 feet, estimated from Milan quadrangle topographic map

	Thickness *Feet*	Depth *Feet*
Pleistocene and Pennsylvanian systems, undifferentiated		
No record	180	180
Pennsylvanian system		
Pottsville formation		
Limestone and shale, calcareous	26	206
Coal (Rock Island No. 1) (thickness estimated)	5	211
No record	32	243
Devonian system		
Cedar Valley and Wapsipinicon formations		
Limestone	182	425
Devonian or Silurian system		
Sand, soft, blue (probably dolomitic sand)	23	448
Limestone, soft (probably dolomite)	2	450

[15] Driller's record.

16. *Village well No. 1, Woodhull, Henry County, Illinois,*[16] *NW. ¼ sec. 30, T. 14 N., R. 2 E. (Clover Twp.)*
Altitude approximately 854 feet, estimated

	Thickness *Feet*	Depth *Feet*
Pleistocene and Pennsylvanian systems, undifferentiated		
Drift and shale	160	160
Pennsylvanian system		
Carbondale (?) and Pottsville formations		
Shale	23	183
"Fireclay" (includes sandstones, shales, etc.)	192	375

[16] Driller's record.

Deep Wells, Detailed Records—Continued

	Thickness Feet	Depth Feet
Mississippian system (?)		
Sweetland Creek formation (?)		
Shale	35	410
Devonian system		
Cedar Valley and Wapsipinicon formations		
Limestone	131	541
Shale	59	600
Silurian system		
Niagaran series		
Limestone	225	825
Ordovician system		
Maquoketa formation		
Shale	185	1010
Mohawkian series		
Galena and Platteville formations		
Limestone	280	1290
St. Peter formation		
Sandstone	104	1394

17. *Village well No. 2, Woodhull, Henry County, Illinois,*[17] *NE. ¼ SW. ¼ sec. 30, T. 14 N., R. 2 E. (Clover Twp.)*

Altitude approximately 824 feet, estimated from State geologic map

	Thickness Feet	Depth Feet
Pleistocene system		
Glacial drift	100	100
Pennsylvanian system		
Carbondale (?) and Pottsville formations		
Shale, silty, slightly calcareous or noncalcareous, medium gray, micaceous, very soft	45	145
Shale, calcareous, dark gray to black, noncarbonaceous, nonlaminated, tough or soft	15	160
Shale, noncalcareous, medium gray, soft, with coal	5	165
Underclay, light gray, soft, micaceous; contains many pieces of yellowish-brown, granular, fine-grained limestone	10	175
Underclay, silty, light gray, soft, micaceous	15	190
Shale, dark gray, soft, and some black laminated, brittle	5	195
Shale, silty, light yellowish-gray, brownish-gray, and dark gray, soft, with coal at base	30	225
Shale, silty, dark gray to black, micaceous, with streaks of light gray, argillaceous siltstone	25	250
Underclay, silty, medium brownish-gray, soft, micaceous; coal, shaly, impure, dull; siltstone argillaceous, light gray; and dolomite, argillaceous, brown, tough	15	265
Shale, dark and light gray, micaceous, poorly laminated; locally calcareous and concretionary	65	330
Sandstone, calcareous, medium gray, pyritic, grains fine to medium, poorly sorted	5	335
Shale, dark and light gray	5	340
Sandstone, calcareous, well cemented, dense, pyritic	5	345
Shale, silty, dark and medium gray, nonlaminated	15	360
Sandstone, dolomitic, pyritic; grains are fine, clear, and angular or rounded, frosted	5	365
Mississippian system		
Sweetland Creek formation[a]		
Shale, silty, sandy, dolomitic; black, light gray, micaceous and pyritic, contains *Sporangites huronense*	15	380

[17] Record derived from samples studied by L. E. Workman.

[a] Although the Sweetland Creek formation is assigned to the Mississippian System, it may belong in the Devonian System.

Deep Wells, Detailed Records—Continued

	Thickness *Feet*	Depth *Feet*
Devonian system		
Cedar Valley and Wapsipinicon formations		
Limestone, dolomitic; finely sandy, silty, and argillaceous; light gray, brownish and buff; finely granular, porous, some gray, silty shale; pyritic	100	480
Limestone, slightly dolomitic, light gray and buff, finely to coarsely granular, porous, and some shale, brown	40	520
Shale, silty, slightly dolomitic, light gray, soft	5	525
Dolomite, light gray, fine-grained, mixed with gray shale..	35	560
Shale, noncalcareous, medium gray, waxy, brittle	10	570
Shale, gray, waxy, brittle and shale, silty, noncalcareous, black, nonlaminated, tough	10	580
Silurian system		
Niagaran series		
Dolomite, light gray and white, finely crystalline	170	750
Ordovician system		
Maquoketa formation		
Shale, silty, calcareous, light bluish-gray, porous, pyritic..	70	820
Siltstone, very argillaceous, calcareous, light bluish-gray, finely cross-bedded	18	838
Shale, silty, calcareous, medium gray, and grayish-brown..	127	965
Mohawkian series		
Galena and Platteville formations		
Dolomite, light brown to light buff, fine-grained, crystalline, slightly porous	303	1268
Glenwood formation		
Sandstone, dolomitic, white, and buff, fine to medium round frosted and angular glassy grains	32	1300
St. Peter formation		
Sandstone, white, grains, fine and coarse, rounded	69	1369

18. *Chicago, Burlington and Quincy Railroad well, Alpha,*[18] *Henry County, Illinois, SE. ¼ NE. ¼ sec. 21, T. 14 N., R. 1 E. (Oxford Twp.)*

Altitude approximately 800 feet

	Thickness *Feet*	Depth *Feet*
Pennsylvanian system		
Carbondale (?) and Pottsville formations		
"Slate" (shale) and coal (probably includes some glacial drift at top)	92	92
Clay, gray	26	118
Limestone	12	130
Shale, black	20	150
"Black material" (shale and coal?)	75	225
"Sticky formation" (shale)	40	265
Sandstone	10	275
Pennsylvanian or Mississippian system		
Pottsville (Pennsylvanian) formation or Sweetland Creek (Mississippian) formation		
"Soapstone" (shale)	75	350
Mississippian system		
Sweetland Creek formation		
Shale, white	15	365
Devonian and Silurian systems		
Cedar Valley and Wapsipinicon (Devonian) formations and Niagaran (Silurian) series		
Limestone	325	690

[18] Driller's record.

Deep Wells, Detailed Records—Continued

	Thickness *Feet*	Depth *Feet*
Ordovician system		
Maquoketa formation		
Shale	200	890
Mohawkian series		
Galena and Platteville formations		
Limestone	320	1210
Glenwood formation		
Sandstone	50	1260
Shale	10	1270
St. Peter formation		
Sandstone	70	1340
Shale	4	1344
Prairie du Chien series		
Shakopee formation		
Limestone, brown and red	20	1364

19. *City well, Viola, Mercer County, Illinois,*[19] *NE. ¼ SE. ¼ sec. 15, T. 14 N., R. 2 W. (Greene Twp.)*

Altitude 790 feet

	Thickness *Feet*	Depth *Feet*
Recent and Pleistocene systems		
Surface soil	15	15
Sand	27	42
Clay, blue, and fine sand	58	100
Pennsylvanian system		
Pottsville formation		
Shale	15	115
Limestone	15	130
Shale and limestone	10	140
Shale, sandy	5	145
"Slate" (shale), blue	37	182
"Slate" (shale), black	18	200
Shale, white, and limestone	25	225
Shale, black	20	245
Shale, (may be Sweetland Creek formation)	5	250
Devonian system		
Cedar Valley and Wapsipinicon formations		
Limestone and shale (may include some shale of Sweetland Creek formation)	50	300
Limestone	40	340
Shale	4	344
Limestone	106	450
Silurian system		
Niagaran series		
Limestone and shale	91	541
Limestone	109	650
Ordovician system		
Maquoketa formation		
Shale	75	725
Shale and limestone	50	775
Limestone, brown	50	825
Shale, brown	25	850
Mohawkian series		
Galena and Platteville formations		
Limestone, brown	306	1156
St. Peter formation		
Sandstone	127	1283

[19] Driller's record.

DEEP WELLS, DETAILED RECORDS—Continued

20. *City well No. 1, Aledo, Mercer County, Illinois,*[20] *SW. corner SW. ¼ SE. ¼ sec. 17, T. 14 N., R. 3 W. (Mercer Twp.)*

Altitude 739 feet

	Thickness *Feet*	Depth *Feet*
Recent and Pleistocene systems		
Clay	70	70
Coal (probably in drift)	2	72
Clay, blue	38	110
Pennsylvanian system		
Pottsville formation		
"Soapstone" (shale)	45	155
"Slatestone" (shale)	5	160
Coal	1½	161½
Mississippian system		
Sweetland Creek formation		
"Soapstone" (shale, may include some Pennsylvanian shale and also probably includes some argillaceous limestone of Devonian age)	163½	325
Devonian system		
Cedar Valley and Wapsipinicon formations		
"Fireclay" (probably shaly limestone, white)	25	350
"Sandstone" (probably dolomite)	10	360
Limestone	15	375
"Quartz rock" (probably cherty limestone or dolomite)	55	430
Shale, calcareous, bluish-gray	10	440
"Slate" (shale)	5	445
Shale, black	1	446
Silurian system		
Niagaran series		
Dolomite, gray, sandy	6	452
Dolomite, light gray	140	592
Ordovician system		
Maquoketa formation		
Limestone, shaly	8	600
Shale, calcareous, gray	71	671
Limestone, dolomitic, with a small amount of shale	15	686
Shale, calcareous, finer grained than above	20	706
Limestone, (dolomite)	10	716
Shale, calcareous, gray	39	755
Limestone, gray	15	770
Shale, slightly calcareous, gray	37	807
Mohawkian series		
Galena and Platteville (?) formations		
Limestone, dolomitic, gray	3	810
Dolomite, calcareous, gray	250	1060
Decorah (?) formation		
Shale, slightly calcareous, gray	10	1070
Platteville formation		
Dolomite, light gray, with some shale	50	1120
Glenwood formation		
Sandstone, very finely grained, cream-colored, with a little dolomite	10	1130
Dolomite, gray, and sandstone	25	1155
Shale, sandy, slightly dolomitic, very fine-grained, gray	25	1180
St. Peter formation		
Sandstone, white	35	1215
Sandstone, light yellow	10	1225
Sandstone, slightly dolomitic, gray	15	1240

[20] Compiled from driller's record and samples of well cuttings studied by T. E. Savage.

Deep Wells, Detailed Records—Continued

	Thickness Feet	Depth Feet
Prairie du Chien series		
Shakopee formation		
Dolomite, gray, with a little white sand	15	1255
Dolomite, gray	25	1280
Dolomite, gray, with considerable shale	5	1285
Limestone, dolomitic, very light gray, with some sandstone.	40	1325
Limestone, chocolate-colored, with some fine-grained shale.	5	1330
Limestone, slightly dolomitic, light buff-colored	25	1355
Limestone, dolomitic	10	1365
New Richmond formation		
Sandstone, calcareous, chocolate-colored	15	1380
Sandstone, calcareous, light brown	10	1390
Sandstone, white	5	1395
Sandstone, dolomitic, light buff-colored and gray	75	1470
Oneota formation		
Dolomite, grayish-white	5	1475
Dolomite, slightly sandy, grayish	72	1547
Sandstone, cherty, gray	5	1552
Dolomite, sandy, very fine-grained, grayish-white	5	1557
Dolomite, gray, slightly sandy	83	1640
Dolomite, slightly calcareous, grayish-white, with some sand	22	1662
Dolomite, slightly calcareous, light buff-colored	13	1675
Cambrian system		
Jordan formation		
Sandstone, slightly dolomitic, light gray, to buff	50	1725
Sandstone, "blue"	40	1765
Trempealeau formation		
Shale, calcareous, chocolate-colored	140	1905
Dolomite, gray, with a little dark shale	10	1915
Shale, calcareous and dolomitic, chocolate-colored	30	1945
Dolomite, light brown	15	1960
Mazomanie-Franconia formation		
Sandstone, white	5	1965
Limestone and shale	10	1975
Shale, blue, with dolomite, slightly sandy, at base light brown	37	2012
Dolomite, gray, sandy	73	2085
Shale, gray, dolomitic	40	2125
Shale, gray, dolomitic, sandy	40	2165
Dresbach formation		
Sandstone, gray, some dolomite	10	2175
Sandstone, gray, fine-grained	55	2230
Sandstone, fine-grained, white	45	2275
Sandstone, flesh-colored, fine-grained	25	2300
Sandstone, light brown, fine-grained	15	2315
Eau Claire formation		
Shale, sandy, gray, hard	65	2380
Shale, calcareous, light gray	10	2390
Shale, dark, hard, gray	67	2457
Mt. Simon formation		
Sandstone, dark brown, fine-grained	113	2570
Sandstone, flesh-colored and white	50	2620
Sandstone, pink and gray, fine-grained	175	2795
Sandstone, red, fine-grained	276	3071
Sandstone, white, hard	43	3114

Deep Wells, Detailed Records—Continued

21. *City Well No. 2, Aledo, Mercer County, Illinois,*[21] *SW. corner SW. 1/4 SE. 1/4 sec. 17, T. 14 N., R. 3 W. (Mercer Twp.); 200 feet from city Well No. 1*

Altitude 736.2 feet

	Thickness *Feet*	Depth *Feet*
Recent and Pleistocene systems		
Till, pebbly and sandy, dolomitic, greenish-gray to brownish-yellow	55	55
Clay, calcareous, dark gray	10	65
Gravel	10	75
Clay, silty, calcareous, brownish-gray	10	85
Till, pebbly, slightly dolomitic, brownish-yellow	15	100
Pennsylvanian system		
Pottsville formation		
Shale, slightly calcareous, light gray, soft	5	105
Clay (shale), black	9	114
Limestone, argillaceous, dark bluish-gray and brown	1	115
"Clay" (shale), black	10	125
Shale, dark gray to black, carbonaceous	10	135
Mississippian system		
Sweetland Creek formation		
Shale, slightly calcareous, light gray, contains *Sporangites huronense*	80	215
Shale, slightly calcareous, brownish-gray, contains *Sporangites huronense*	20	235
Shale, calcareous, gray and brown to chocolate-colored, contains *Sporangites huronense*	30	265
Devonian system		
Cedar Valley and Wapsipinicon formations		
Dolomite, argillaceous, gray, finely granular, porous	20	285
Limestone, brownish-gray, finely to medium granular, porous, fossiliferous	20	305
Limestone, argillaceous, gray, finely granular, fossiliferous, with green, waxy shale at top	45	350
Shale, white	5	355
Limestone, argillaceous, gray, finely granular, fossiliferous.	10	365
Dolomite, calcareous, light gray, very finely crystalline, porous	63	428
Shale, gray, soft, contains *Sporangites huronense*	2	430
Silurian system		
Niagaran series		
Dolomite, light to dark gray, finely crystalline to dense, vesicular	65	495
Dolomite, light cream-gray with dark spots, finely crystalline	65	560
Ordovician system		
Maquoketa formation		
Shale, dolomitic, medium to light bluish-gray	73	633
Dolomite, gray with dark pyritic spots, fine-grained	15	648
Shale, dolomitic, light bluish-gray	50	698
Shale, dolomitic, light brown	35	733
Dolomite, argillaceous, brownish-gray	10	743
Shale, dolomitic, dark brown	20	763
Mohawkian series		
Galena and Platteville (?) formations		
Dolomite, light brown, finely crystalline	92	855
Dolomite, buff, finely crystalline, cherty	95	950
Dolomite, light gray and white	15	965
Dolomite, white and brown, pyritic, brown portion is porous	30	995

[21] Record compiled from samples studied by L. E. Workman.

Deep Wells, Detailed Records—Continued

	Thickness Feet	Depth Feet
Decorah (?) formation		
Shale, dolomitic, green	5	1000
Platteville formation		
Limestone, brown to light buff, dense to medium-grained	10	1010
Dolomite, brownish-gray with dark spots, fine, sandy at bottom	40	1050
Glenwood formation		
Sandstone, dolomitic, light brownish-gray; fine, rounded grains	40	1090
Shale, bluish-gray, waxy	15	1105
St. Peter formation		
Sandstone, white, medium-grained, rounded grains	30	1135
Sandstone, white, medium-grained; dolomite, sandy, fine-grained, light brownish-gray; chert, white and buff, some oolitic; and shale, light blue	25	1160
Prairie du Chien series		
Shakopee formation		
Dolomite, sandy, brownish-gray	12	1172

22. *Oil test boring, Mercer County, Illinois,*[22] *NW. ¼ NW. ¼ sec. 2, T. 13 N., R. 2 W. (Suez Twp.)*

Altitude 733 feet

	Thickness Feet	Depth Feet
Recent and Pleistocene systems		
Clay (till)	40	40
"Hardpan" (dense till), light gray	50	90
No record (till with boulders)	40	130
Pennsylvanian system		
Pottsville formation		
"Slate" (shale), white	5	135
"Soapstone" (shale), blue	40	175
Mississippian system		
Sweetland Creek formation		
Shale, brown	150	325
Devonian system		
Cedar Valley and Wapsipinicon formations		
Limestone, brown	55	380
Limestone, gray	45	425
No record	15	440
Silurian system		
Niagaran series		
Dolomite, gray	15	455
Limestone, gray (dolomite)	151	606
Dolomite, gray	4	610
Ordovician system		
Maquoketa formation		
Shale, white	77	687
Limestone, blue	20	707
Shale, white	20	727
Shale, brown	44	771
Shale, red	31	802
Mohawkian series		
Galena and Platteville formations		
Dolomite, gray, and brownish, subcrystalline	251	1053
Limestone, dark gray	55	1108

[22] Record compiled from driller's record and samples of well cuttings studied by T. E. Savage.

Deep Wells, Detailed Records—Continued

	Thickness *Feet*	Depth *Feet*
Glenwood formation		
Dolomite, grayish or brownish, with a few quartz grains....	5	1113
Sandstone, gray, with some dolomite........................	21	1134
St. Peter formation		
Sandstone	18	1152

23. *Oil-test well, Mercer County, Illinois,*[23] *SW. ¼ sec. 19, T. 13 N., R. 2 W. (Suez Twp.)*

Altitude 635 feet

	Thickness *Feet*	Depth *Feet*
Recent and Pleistocene systems		
Soil, glacial drift..	40	40
Pennsylvanian and Mississippian systems		
Pottsville (Pennsylvanian) and Sweetland Creek (Mississippian) formations		
"Soapstone" (shale), with pyrite..........................	155	195
Devonian system		
Cedar Valley and Wapsipinicon formations		
Limestone, dolomitic, gray, pyritic........................	35	230
Limestone, light gray, fine and coarse textured, with chert fragments	50	280
Limestone, dolomitic at top and bottom, gray, with some chert	40	320
Silurian system		
Niagaran series		
Limestone, light gray, with fragments of dull brown dolomite	10	330
Dolomite, crystalline, dull, brown..........................	10	340
Dolomite, light and dark gray, crystalline.................	35	375
Dolomite, fine-grained, very light gray, with some pyrite..	10	385
Dolomite, fine-grained, light gray, cherty, pyritic..........	60	445
Ordovician system		
Maquoketa formation		
Shale gray to greenish-gray, with dolomite................	5	450
Dolomite, shaly, gray..	5	455
Shale, gray, with a little dolomite..........................	5	460
Shale, dolomitic, gray to drab..............................	45	505
Limestone, dolomitic, gray to drab..........................	15	520
Limestone, shaly, dolomitic, light drab.....................	5	525
Dolomite, shaly, gray..	5	530
Shale, dolomitic, gray.......................................	10	540
Dolomite, slightly shaly, gray, fine-grained.................	20	560
Dolomite, shaly, drab, with pyrite at base..................	70	630
Limestone, dolomitic, gray and dark, subcrystalline, with considerable pyrite	10	640
Galena and Platteville (?) formations		
Dolomite, light brownish-gray, subcrystalline..............	65	705
Dolomite, gray, with fragments of white chert.............	175	880
Decorah (?) formation		
Dolomite, gray, with a few grains of quartz sand..........	5	885

[23] Record derived from samples studied by T. E. Savage.

DEEP WELLS, DETAILED RECORDS—Continued

24. *Chicago, Burlington and Quincy Railway well,*[24] *Knox County, Illinois, NE. ¼ sec. 34 (?), T. 13 N., R. 1 E. (Rio Twp.)*

Altitude 810 feet

	Thickness Feet	Depth Feet
No record (includes glacial drift [Pleistocene], Pottsville [Pennsylvanian] formation, and probably Sweetland Creek [Mississippian] formation). Rock (Devonian) at	375	375
No record (includes Cedar Valley and Wapsipinicon [Devonian] formations, Niagaran [Silurian] series, and Maquoketa [Ordovician] formation)	525	900
Ordovician system		
Galena, Platteville, and Glenwood formations		
Limestone	400	1300
St. Peter formation		
Sandstone	20	1320

[24] Skeleton record supplied by Division Engineer of railway.

25. *City well, Alexis, Warren County, Illinois,*[25] *NW. corner NE. ¼ NE. ¼ sec. 1, T. 12 N., R. 2 W. (Spring Grove Twp.)*

Altitude 704 feet

	Thickness Feet	Depth Feet
Recent and Pleistocene systems		
Loam and yellow clay	30	30
Clay, blue	35	65
Pennsylvanian system		
Pottsville formation		
Sandstone	40	105
"Soapstone" (shale), blue	5	110
Limestone streak		110
Pennsylvanian and Mississippian systems, undifferentiated		
Pottsville (Pennsylvanian), Hannibal (Mississippian), and Sweetland Creek (Mississippian) formations		
Shale, blue	238	348
Devonian and Silurian systems, undifferentiated		
Cedar Valley and Wapsipinicon (Devonian) formations and Niagaran (Silurian) series		
Limestone and dolomite	222	570
Ordovician system		
Maquoketa formation		
Shale	120	690
Shale and limestone	40	730
Mohawkian series		
Galena and Platteville formations		
Limestone	326	1056
St. Peter formation		
Sandstone	144	1200

[25] Driller's record.

Deep Wells, Detailed Records—Continued

26. *Farm well, SE. corner NE. ¼ NE. ¼ sec. 29, T. 12 N., R. 2 W. (Spring Grove Twp.), Warren County, Illinois*[26]

Altitude 703 feet

	Thickness *Feet*	Depth *Feet*
Recent and Pleistocene systems		
Surficial material	30	30
Pennsylvanian system		
Pottsville formation		
Sandstone	5	35
Coal "blossom"		35
Underclay, white	60	95
Sandstone		95
Mississippian system		
Hannibal and Sweetland Creek formations		
"Soapstone" (shale)	210	305
Devonian and Silurian systems, undifferentiated		
Cedar Valley and Wapsipinicon (Devonian) formations and Niagaran (Silurian) series		
Limestone	220	525
Ordovician system		
Maquoketa formation		
Shale, blue, plastic, pyritic	2	527

[26] Driller's record.

27. *Oil-test well, Henderson County, Illinois,*[27] *NW. ¼ NE. ¼ NE. ¼ sec. 1, T. 12 N., R. 5 W. (Bold Bluff Twp.)*

Altitude approximately 590 feet

	Thickness *Feet*	Depth *Feet*
Recent and Pleistocene systems		
Sand and gravel	220	220
Devonian system		
Cedar Valley and Wapsipinicon formations		
Limestone, dolomitic, argillaceous, gray and brown, finely crystalline	131	351
Silurian system		
Niagaran series		
Dolomite, cherty, light buff-gray, finely crystalline	59	410
Ordovician system		
Maquoketa formation		
Shale, silty, slightly dolomitic, bluish-gray	28	438
Shale, silty, dolomitic, grown and gray; and dolomite, gray, finely crystalline	8	446
Shale silty, dolomitic, brown and gray	138	584
Shale, dolomitic, gray, and dolomite, argillaceous, brownish-gray, crystalline	26	610
Mohawkian series		
Galena formation		
Dolomite, buff, finely crystalline	40	650
No record; probably dolomite	190?	840
Platteville formation		
Dolomite, argillaceous, reddish-brown, very finely crystalline	?	?
No record; probably dolomitic limestone	116	956
St. Peter formation		
Sandstone		956

[27] Record compiled from samples of well cuttings studied by L. E. Workman.

Deep Wells, Detailed Records—Continued

28. *City well No. 2 (old), Monmouth, Warren County, Illinois,*[28] *center of S. ½ N. ½ sec. 29, T. 11 N., R. 2 W.*

Altitude slightly less than 740 feet, according to Monmouth quadrangle topographic map

	Thickness Feet	Depth Feet
Recent and Pleistocene systems		
Soil, loessial, clayey, sandy	2	2
Clay, (till) sandy, yellow	12	14
Sand, and clay, yellow	4	18
Silt, yellow, buff, and drab	16	34
Clay (till), sandy, yellow	3	37
Sand and gravel, yellow	16	53
Pennsylvanian system		
Pottsville formation		
Shale, soft, drab, with fine sand	14	67
Shale, gray or drab, pyritic	5	72
Mississippian system		
Burlington formation		
Limestone, gray, cherty, occasional crinoid stems	83	155
Limestone, dolomitic, porous	5	160
Limestone, dolomitic, cherty	8	168
Hannibal formation		
Shale, calcareous, greenish-gray, with crinoid stems and pyrite	122	290
Sweetland Creek formation		
Shale, black or dark gray, contains *Sporangites huronense*.	139	429
Dolomite, finely granular, and some shale	15	444
Devonian system		
Cedar Valley and Wapsipinicon formations		
Limestone, pyritic, mixed with shale	28	472
Limestone	6	478
Shale, gray, stony, with fragments of fossils	5	483
Limestone, shaly, gray	34	517
Limestone, gray	5	522
Limestone, white, dense, brittle (may be Silurian)	5	527
Silurian system		
Niagaran series		
Limestone, dolomitic, gray, dense	58	585
Ordovician system		
Maquoketa formation		
Shale, bluish-gray, pyritic at top	31	616
Shale, dark gray, with spherical concretions of pyrite and fragments of black, bituminous limestone	5	621
Shale, gray	33	654
Shale, dark gray, granular	7	661
Limestone, dolomitic, gray	27	688
Dolomite, shaly, dark	10	698
Limestone, dolomitic, dark brownish-gray	39	737
Limestone, dolomitic, shaly, greenish-gray	9	746
Limestone, dolomitic, dark gray	19	765
Limestone, dolomitic, some gray, some straw-colored, and some greenish; pyritic	15	780
Mohawkian series		
Galena and Platteville formations		
Limestone, dolomitic, dull straw-colored	75	855
Limestone, dolomitic, dull straw-colored with some green shale	9	864
Limestone, dolomitic straw-colored	12	876
Limestone, dolomitic, cream-colored, with some white chert.	14	890
Limestone, dolomitic, cream-colored	5	895

[28] Compiled from samples studied by J. H. Southwell and J. A. Udden.

DEEP WELLS, DETAILED RECORDS—Continued

	Thickness Feet	Depth Feet
Shale, green	5	900
Limestone, dolomitic, shaly, cream-colored, cherty	35	935
Limestone, dolomitic, cream-colored, somewhat porous	37	972
Limestone, dolomitic, shaly, cream-colored, pyritic	32	1004
Limestone, dolomitic, cream-colored, with fragments of black rock containing about 50 per cent bitumen	11	1015
Limestone, dolomitic, cream-colored, cherty	7	1022
Limestone, dolomitic, dull brown, with some chert and some green shale	13	1035
Limestone, dolomitic, gray, with some gray chert	15	1050
Limestone, dolomitic, dull straw-colored, with some white limestone	3	1053
Limestone, dull straw-colored	7	1060
Limestone, somewhat dolomitic, gray	9	1069
Limestone, dolomitic, gray, with some green shale marked by foliated black blotches (Glenwood?)	5	1074
St. Peter formation		
Sandstone; coarse to medium fine rounded grains of quartz	139	1213
Sandstone, moderately coarse grains, and green shale	5	1218
Sandstone, coarse, rounded, quartz grains	3	1221
Sandstone, fine, quartz grains	4	1225
Sandstone, coarse grained, and green shale	5	1230
Prairie du Chien series		
Shakopee formation		
Limestone, dolomitic, white, with some sand	2	1232

29. *City well No. 4 (Geiger No. 1) Monmouth, Warren County, Illinois,*[29] *SW. corner sec. 29, T. 11 N., R. 2 W.*

Altitude 769 feet

	Thickness Feet	Depth Feet
Recent, Pleistocene, and Pennsylvanian systems, and probably some of Mississippian system		
No record	135	135
Mississippian system		
Burlington formation		
Limestone, dolomitic, greenish-buff, finely crystalline, crinoidal, very cherty	20	155
Limestone, dolomitic, greenish-buff, finely crystalline, porous, little chert	35	190
Hannibal formation		
Shale, calcareous, light bluish-gray with black laminae	90	280
Sweetland Creek formation		
Shale, dolomitic, brown and brownish-gray with greenish-gray and black laminae, contains *Sporangites huronense*, abundant in lower 45 feet	105	385
Shale, dolomitic, light brownish-gray contains a few *Sporangites huronense*	80	465
Devonian system		
Cedar Valley and Wapsipinicon formations		
Limestone, dolomitic sandy, buff, finely granular, porous, soft	50	515
Limestone, argillaceous, sandy, medium gray with dark spots, finely to coarsely granular	45	560
Silurian system		
Niagaran series		
Dolomite, light gray, finely crystalline, dense	20	580
Dolomite, light gray, finely crystalline, porous, contains white chert	20	600

[29] Compiled from samples studied by L. E. Workman.

DEEP WELLS, DETAILED RECORDS—Continued

	Thickness *Feet*	Depth *Feet*
Ordovician system		
Maquoketa formation		
Shale, dolomitic, light gray and brown, and siltstone, argillaceous, dolomitic, brownish-gray	70	670
Dolomite, argillaceous, brown and light gray; shale, dolomitic, brown and greenish-gray; siltstone, dolomitic, argillaceous, brownish-gray	85	755
Mohawkian series		
Galena and Platteville formations		
Dolomite, brownish-gray, finely crystalline, dense	205	960
Dolomite, light brownish-gray and pink, finely crystalline, dense	10	970
Dolomite, light gray and pink, finely crystalline, dense, cherty	40	1010
Dolomite, brownish-gray, finely crystalline, with white and light brown chert	100	1110
St. Peter formation		
Sandstone, white; medium, rounded to angular, frosted grains; a few chips of bluish-gray shale	150	1260
Shale, sandy, bluish-gray, light green	8	1268
Sandstone, coarse grained; and shale, light gray, interlaminated with white, fine-grained sandstone	7?	1275
Prairie du Chien series		
Dolomite, sandy, light gray, and pinkish-gray, fine-grained, dense, cherty, with green shale	225	1500
Dolomite, white to light gray, finely crystalline, vesicular, cherty	170	1670
Dolomite, white and light gray, pinkish, medium crystalline, vesicular, very cherty	130	1800
Cambrian system		
Jordan formation		
Sandstone, dolomitic, fine to medium grained, and dolomite, very sandy, finely crystalline, white and light pinkish-gray	30	1830
Trempealeau formation		
Dolomite, sandy, light to medium gray with pink and tan tints, tan, finely crystalline, dense	225	2055
Dolomite, light gray, and pink, finely crystalline, glauconitic	35	2090
Mazomanie-Franconia formation		
Dolomite, very sandy, light greenish-gray; finely crystalline, contains much glauconite	20	2110
Sandstone, greenish-gray to green, very fine grained, compact, very glauconitic	125	2235
Dolomite, sandy, light bluish-gray, finely crystalline	30	2265
Sandstone, dolomitic, gray, very fine grained, glauconitic, interlaminated with shale, sandy, dolomitic, glauconitic, gray, and greenish-pink, buff, very fine	45	2310
Sandstone, dolomitic, light brownish-gray, medium to fine, angular to rounded grains, little or no glauconite	35	2345
Dresbach formation		
Sandstone, slightly dolomitic, light brownish-gray, buff and white, medium to coarse, angular to rounded grains	100	2445

Deep Wells, Detailed Records—Continued

30. *City well No. 5 (Geiger No. 2), Monmouth, Warren County, Illinois,*[30] *SW. corner sec. 29, T. 11 N., R. 2 W.*
Altitude 769 feet

	Thickness *Feet*	Depth *Feet*
Recent and Pleistocene systems		
Drift	95	95
Pennsylvanian system		
Pottsville formation		
Coal	1	96
Shale	14	110
Mississippian system		
Burlington formation		
Limestone, gray, soft	80	190
Hannibal formation		
Shale, gray, soft	20	210
Shale, blue	30	240
Shale, gray, hard	10	250
Shale, blue, soft	30	280
Sweetland Creek formation		
Shale, gray, hard	20	300
Shale, dark gray, soft	30	330
Shale, brown, soft	30	360
Shale, blue, soft	80	440
Shale, gray, hard	10	450
Shale, blue, hard	5	455
Shale, hard, and limestone	20	475
Devonian system		
Cedar Valley and Wapsipinicon formations		
Limestone, brown, hard	95	570
Silurian system		
Niagaran series		
Limestone, light gray, hard	10	580
Limestone, gray and brown	30	610
Ordovician system		
Maquoketa formation		
Shale, light colored, soft	45	655
Shale, dark, hard	35	690
Limestone, dark, hard	78	768
Limestone and shale, hard	12	780
Mohawkian series		
Galena formation		
Limestone, brown, hard	218	998
Platteville (?) formation		
Limestone, gray, hard	41	1039
Decorah (?) formation		
Shale, soft	3	1042
Platteville formation		
Limestone, brown, hard	58	1100
St. Peter formation		
Sandstone, dark gray, hard	70	1170
Sandstone, white, soft	75	1245
Sandstone, white, hard	5	1250
Shale, blue, soft	4	1254
Limestone, shaly, and sandstone; hard	6	1260
Shale, green, soft	5	1265
Shale, sandy, soft	10	1275
Prairie du Chien series		
Limestone, brown, and gray, hard	175	1450
Limestone, pink, hard	50	1500

[30] Driller's record.

Deep Wells, Detailed Records—Continued

	Thickness Feet	Depth Feet
Limestone, brown and gray, hard	50	1550
Sandstone, white, soft	5	1555
Ordovician and Cambrian systems, undifferentiated		
Prairie du Chien (Ordovician) series and Jordan, Trempealeau, and Mazomanie-Franconia (Cambrian) formations		
Limestone, gray and brown, hard	740	2295
Cambrian system		
Mazomanie-Franconia formation		
Sandstone, gray, hard	35	2330
Dresbach formation		
Sandstone, white, soft	80	2410
Sandstone, white and dark, "shelly" (dolomitic and shaly)	35	2445

31. *City well (Geiger well No. 1), Galesburg, Knox County, Illinois*,[31] *NE. ¼ NE. ¼ sec. 15, T. 11 N., R. 1 E. (Galesburg Twp.)*

Altitude 754.10 feet

	Thickness Feet	Depth Feet
Recent and Pleistocene systems		
No record	50	50
Sand, yellowish-brown and brownish-gray, medium-grained, calcareous in lower part	45	95
Pennsylvanian system		
Carbondale and Pottsville formations		
Shale, silty, calcareous, medium gray	20	115
Shale, very silty, non-calcareous and very calcareous, with streaks of limestone, greenish-gray	5	120
Shale, silty, more or less sandy with fine grains, calcareous, medium gray, with some coal locally at 150 and 165 feet	70	190
Coal, and underclay, light gray, soft	10	200
Shale, dark gray, soft	30	230
Shale, slightly sandy, slightly calcareous, grayish-brown, with chert	15	245
Mississippian system		
Sweetland Creek formation		
Shale, light gray and brown	20	265
Shale, slightly gritty, brown and gray, with *Sporangites huronense*	55	320
Devonian system		
Cedar Valley and Wapsipinicon formations		
Limestone, argillaceous, light brownish-gray	110	430
Silurian system		
Niagaran series		
Chert, white and gray, oolitic and banded, some weathered	5	435
Dolomite, light gray, powdered	15	450
Silurian and Ordovician systems, undifferentiated		
No record (includes about 100 feet of Niagaran [Silurian] series, about 200 feet of Maquoketa [Ordovician] series, and about 50 feet of Galena [Ordovician] formation)	350	800
Ordovician system		
Mohawkian series		
Galena and Platteville formations		
Dolomite, buff, finely crystalline	245	1045
Glenwood formation		
Dolomite, sandy, buff	15	1060
St. Peter formation		
Sandstone, white, fine to medium grained	130	1190

[31] Record derived from samples studied by L. E. Workman.

Deep Wells, Detailed Records—Continued

	Thickness Feet	Depth Feet
Chert pebbles, white and buff, oolitic, dense and porous; with sandstone and green shale	35	1225
Shale, sandy, green, with chert and sandy dolomite	5	1230
Prairie du Chien series		
Shakopee formation		
Dolomite, gray, buff and pink, with cherty and sandy layers	205	1435
Dolomite, light brown, with whitish chert	50	1485
New Richmond (?) formation		
Sandstone, dolomitic, very fine to medium-grained	25	1510
Oneota formation		
Dolomite, cherty, light, gray to white	215	1725
Cambrian system		
Jordan (?) formation		
Dolomite, sandy, cherty, white, with sandstone, white, fine-grained	10	1735
Trempealeau formation		
Dolomite, light gray and pink, very fine-grained, with sand grains at some horizons	285	2020
Dolomite, light brownish-gray, glauconitic	10	2030
Mazomanie-Franconia formation		
Sandstone, very glauconitic, light gray, with greenish tint; very fine, angular grains; dolomitic cement	130	2160
Dolomite, sandy, gray, with sandstone, glauconitic	30	2190
Sandstone, dolomitic, glauconitic, gray	25	2215
Shale, dolomitic, glauconitic, yellow-green, mixed with sandstone	20	2235
Dresbach formation		
Sandstone, white and yellow; fine to coarse, rounded grains, loosely cemented with dolomite	70	2305

Farm Wells

(Logs of wells 32-84 are shown graphically on Plate VI)

Key No. on map	Location by township and quarter section	Altitude	Description and correlation		Thickness Feet	Depth Feet
	Mercer County **T. 15 N., R. 1 W.** **(Richland Grove Twp.)**					
32	31 SW SE SW	722	1, 2, 3?	No record	206	206
			4, 5?	Limestone; hard and white at base	130	336
				"Blue sand"		336
	T. 14 N., R. 1 W **(Rivoli Twp.)**					
33	4 SW SE	794	1.	Loess and drift	80	80
			2B, 3C.	Shale, underclay, and beds of rock (sandstone and limestone)	171	251
			4.	Limestone, with some chert at depth of 385 feet	178	429
34*c*	13	808 (est)				

Key: 1, Recent and Pleistocene systems; 2, Pennsylvanian system—A, Carbondale formation, B, Pottsville formation; 3, Mississippian system—A, Burlington formation, B, Hannibal formation, C, Sweetland Creek formation; 4, Devonian system, Cedar Valley and Wapsipinicon formations, (may include part of 5); 5, Silurian system, Niagaran series.

c Log of city well, New Windsor; record derived from samples studied by G. E. Ekblaw.

FARM WELLS—Continued

Key No. on map	Location by township and quarter section	Alti- tude	Description and correlation	Thick- ness *Feet*	Depth *Feet*
			1 a. No record	15	15
			b. Till, sandy and pebbly, calcareous, dark brownish-gray	75	90
			c. Sand, with some till	5	95
			d. Till, sandy and pebbly, calcareous, dark brownish-gray	15	110
			e. Gravel, fine, and coarse sand, mainly quartz and chert, tan-colored	10	120
			f. Till, silty, calcareous, light bluish-gray, greenish, or brownish, dense	15	135
			g. Gravel, fine and coarse, and sand	10	145
			2Ba. Sandstone, faintly dolomitic, fine-grained, gray, pyritic, micaceous; and siltstone, non-calcareous, light gray-green and black, with dark carbonaceous partings	95	240
			b. Shale, bluish-black or dark bluish-gray, laminated, pyritic	15	255
			c. Shale, bluish-black, with siltstone and fine-grained sandstone, calcareous, gray, pyritic	10	265
			d. Shale, gray, with carbonized plant fragments	10	275
			e. Shale, gray, soft or dark blue-black and brown, dense, hard, with carbonized plant fragments	20	295
			f. Shale, black, hard, laminated	5	300
			g. Shale and siltstone, noncalcareous, gray mottled with brown	15	315
			h. Shale and siltstone, carbonaceous, dark gray, with gray, fine-grained, quartzitic sandstone and black, hard, laminated shale	20	335
			i. Siltstone, calcareous, fine-grained, light greenish-gray	5	340
			j. Shale, soft and greenish-gray; or hard and bluish-black	5	345
			k. Sandstone, fine-grained, pyritic, with hard, brittle, black shale and siltstone	10	355
			l. Sandstone, fine-grained, dark gray, with soft green shale and white chert	5	360
			m. Shale, hard, laminated, black or gray-green, with quartz and chert	5	365
			4 a. Limestone, sandy, brownish-gray, granular, very fossiliferous	20	385
			b. Limestone, argillaceous, bluish-gray, finely granular	20	405
			c. Limestone, argillaceous, dark bluish-gray, or buff-gray, cherty.	30	435

FARM WELLS—Continued

Key No. on map	Location by township and quarter section	Altitude		Description and correlation	Thickness Feet	Depth Feet
Key: 1, Recent and Pleistocene systems; 2, Pennsylvanian system—A, Carbondale formation, B, Pottsville formation; 3, Mississippian system—A, Burlington formation. B, Hannibal formation, C, Sweetland Creek formation; 4, Devonian system, Cedar Valley and Wapsipinicon formations, (may include part of 5); 5, Silurian system, Niagaran series.						
			d.	Limestone, argillaceous, light bluish-gray, with some bands drab, buff, or brown	110	545
35	18 SW cor. NW	792	1.	Loess and drift	160	160
			2B, 3C?	Shale, underclay, "slate," sandstone and limestone	150	310
			4.	Limestone	160	470
36	30 NW SW	764	1 a.	Loess and drift	60	60
			b.	Gravel	2	62
			c.	Drift	88	150
			2Ba.	Shale, black, hard, laminated	14	164
			b.	Coal (Rock Island No. 1)	3½	167½
			2B, 3C.	Shale	165½	333
			4 a.	Limestone	140	473
			b.	Limestone, porous ("sand")	2	475
	T. 14 N., R. 2 W. (Greene Twp.)					
37	4 SW SE NE	693	1, 2, 3C?	Surficial clay and sand (1); coal, sandstone, limestone, shale, etc. (2)	160	160
			4 a.	Limestone	200	360
			b.	Sandstone (dolomite?)	8	368
38	6 SE SW	693	1.	Loess and drift	28	28
			2Ba.	"Rock" (shale, sandstone, etc.)	47	75
			c.	Coal (Rock Island No. 1)	3	78
			d.	Sandstone; "soapstone" (soft shale), and "slate" (hard, laminated shale), black (may include part of 3C)	159	237
			4.	Limestone	130	367
39	8 SW NW	700	1.	Clay	12	12
			2Ba.	Shale, gray and dark	92	104
			b.	Coal	1⅙	105⅙
			c.	Shale, black	½	105⅔
			d.	Shale, dark	2⅓	108
			e.	Shale, light gray	4	112
			f.	Shale, dark	22	134
			g.	Coal	⅔	134⅔
			h.	Shale, gray, hard	24⅚	159½
			i.	Coal	2½	162
			j.	Shale, dark	38	200
			k.	Shale, gray, soft	27	227
			4 a.	Limestone, brown	1	228
			b.	Shale, gray, hard	13	241
			c.	Limestone, dark	3	244
			d.	Limestone, shaly, gray	13	257
			e.	Shale, gray, hard	5	262
			f.	Limestone, gray, with shale partings	8	270
			g.	Limestone, gray	32	302

FARM WELLS--Continued

Key No. on map	Location by township and quarter section	Altitude		Description and correlation	Thickness Feet	Depth Feet
40	27 SE SE	752	1.	Surface material	40	40
			2B, 3C.	"Slate" (hard, laminated shale), shale, underclay, etc.	260	300
			4.	Limestone	117	417
41	28 NW SW	749	1, 2,	No record	130+	130+
			2Ba.	Coal	3?	130-140?
			2B, 3C.	No record	170?	302
			4.	Limestone	130	432
	T. 15 N., R. 3 W. (Perryton Twp.)					
42*d*	33 NE SW	723	1.	Loess and drift	100	100
	d Log of County Home well; driller's record.					
			2B, 3C.	Shale	120	220
			4.	Limestone	168	388
	T. 14 N. R. 3 W. (Mercer Twp.)					
43	5 NE SE	673	1.	Surface clay and drift	100	100
			2B, 3C?	"Solid soapstone" (shale)	170	270
			4 a.	Limestone	130	400
			b.	Limestone, porous ("sand")	1	401
44	12 SE cor.	761	1, 2.	No record	79	79
			2Ba.	Coal	1	80
			b.	No record	17	97
			c.	Coal (Rock Island No. 1) with "slate" (black shale) roof	4	101
			2B, 3C,	No record	165	266
			4.	Limestone	130	396
45	15 SW SE	753	1.	Clay and sand	160	160
			2B, 3C?	"Soapstone" (shale, etc.)	142	302
			4.	Limestone	130	432
46	17 SW SE	736	1.	Surface material	120	120
			2B, 3C.	"Soapstone" (shale)	115	235
			4.	Limestone	180	415
47	24 NW NE NW	753	1.	Surface material	140	140
			2B, 3C.	Shale, underclay, etc	130	270
			4.	Limestone	126	396
48	26 SW cor. NE	732	1.	Surface material	150	150
			2B, 3C?	"Soapstone" (shale) and a little sandstone	180	330
			4.	Limestone	150	480
49	26 SW cor.	725	1.	Loess and drift	90	90
			2B, 3C.	Shale	150	240
			4.	Limestone	165	405
50	28 NW cor.	708	1.	Soil, clay, and sand	70	70
			2B, 3C.	Shale, soapstone, etc. (no coal)	159	229
			4 a.	Limestone	100±	329
			b.	"Mud," blue (shale?)	25	354
			5.	"Solid rock, very hard" (probably chert or limestone)	5	359
51	33 NE SE	641	1, 2, 3.	Surface materials and shale	200	200
			4.	Limestone	130	330
52	34 NW NW	728	1.	Surface material	101	101
			2B, 3C.	Shale	159	260
			4.	Limestone	100	360

FARM WELLS—Continued

Key No. on map	Location by township and quarter section	Altitude		Description and correlation	Thickness Feet	Depth Feet
Key: 1, Recent and Pleistocene systems; 2, Pennsylvanian system—A, Carbondale formation, B, Pottsville formation; 3, Mississippian system—A, Burlington formation, B, Hannibal formation, C, Sweetland Creek formation; 4, Devonian system, Cedar Valley and Wapsipinicon formations, (may include part of 5); 5, Silurian system, Niagaran series.						
	T 13 N., R. 4 W. (Abington Twp.)					
53*f*	24	615±	1 a.	Soil (and drift?)	40	40
f Log of Seaton village well; driller's record.						
			b.	Sand (and drift?)	83	123
			4.	Limestone	121	244
	T. 13 N., R. 3 W. (Ohio Grove Twp.)					
54	1 SW NE	697	1.	Loess and drift	120	120
			2B, 3C.	Shale	120	240
			4.	Limestone	135	375
55	1 NW SW	687	1, 2, 3.	Surface clay and sand, and shale	220	220
			4.	Limestone	40	260
56	2 NE NE	685	1.	Clay and sand	60	60
			2B, 3C.	"Soapstone" (shale); cemented gravel ledge well down in soapstone is interpreted as basal conglomerate of Pennsylvanian.	130	190
			4.	Limestone	150±	340±
57	3 SW NW	679	1.	Drift	60	60
			2B, 3C.	"Soapstone" (shale) with 1 foot of coal	100	160
			4.	Limestone	210	370
58	4 SE NE	655	1, 2, 3.	"Soapstone" (shale)	209	209
			4.	Limestone	100+	309+
59	5 NE NE	693	1.	Surface clay and sand	160	160
			2B, 3C.	Shale	120	280
			4.	Limestone	120	400
60	11 NW cor.	676	1.	Surface clays, sands, etc.	?	?
			2B, 3C.	"Strips of rock" (sandstone, shale, limestone)	?	?
				"Soapstone" (shale)	?	216?
			4.	Limestone	160?	376
61	11 SE SW	776	1.	Surface material	60	60
			2B, 3C.	"Soapstone, solid" (shale)	168	228
			4.	Limestone	116	344
62	12 NE NE	701	1.	Drift	80	80
			2B, 3C.	Shale	180	260
			4.	Limestone	116	376
63	16 SW NE	665	1.	Loess and drift	100	100
			2B, 3C.	No record, except 18 inches coal reported under limestone	60	160
			4 a.	Limestone	160	320
			b.	Rock, hard (limestone or cherty limestone; Silurian?)	16	336
64	16 SW. cor. NW	652	1.	Surface clay and sand	160	160
			2B, 3C.	"Soapstone" (shale), brownish, (may be residual soil on limestone)	1	161
			4 a.	Limestone	140	301
			b.	Limestone, porous, or "sand"	2	303

FARM WELLS—Continued

Key No. on map	Location by township and quarter section	Altitude		Description and correlation	Thickness *Feet*	Depth *Feet*
	T. 13 N., R. 2 W. (Suez Twp.)					
65	26 NW NW	730	1.	Surface material	140	140
			2B.	Coal	2	142
			2B, 3C.	"Soapstone" (shale)	83	225
			4.	Limestone (probably includes part of 3C), "rotten" at bottom	283	508
	T. 13 N., R. 1 W. (North Henderson Twp.)					
66	31 NW cor. NE	725	1.	Loess and drift	100	100
			2B, 3C.	Shale, "slate," and strips of rock and "fireclay"	250	350
			4 a.	Limestone	140	490
			b.	"Sand," (porous limestone)	18	508
	Warren County T. 12 N., R. 2 W. (Spring Grove Twp.)					
67	17 SW cor. SE	700±	1.	Clay, blue	70	70
			2B, 3B, 3C.	Shale	210	280
			4.	"Rock" (limestone) brown, red, yellow, and other colors	166	446
68	17 SE SW	700±	1 a.	Clay, red	30	30
			b.	Clay, blue	40	70
			2B, 3B, 3C.	"Soapstone" (shale)	230	300
			4.	"Sandrock" (limestone), white	100	400
69	20 SW SE	703	1.	Surface materials	100	100
			2B? 3C.	"Soapstone" (shale)	120	220
			4.	Limestone (may include part of 3C)	212	432
	T. 12 N., R. 3 W. (Sumner Twp.)					
70	10 SE SW	666	1.	Loess and drift	50	50
			3C.	"Soapstone (shale)	140	190
			4.	Limestone	175	365
71	13 SW NW	693	1.	Surface clays and sands	115	115
			3B, 3C.	"Soapstone (shale)	185	300
			4.	Limestone	135	435
72	13 NW SW	680	1, 3.	Surface clays with black "slate" (shale) (3C)	225	225
			3C.	Shale, gray	100	325
			4.	Limestone	135	460
73	13 SE SE	693	1.	Dirt and clay, red and blue	90	90
			3B, 3C.	"Soapstone" (shale)	200	290
			4.	"Rock" (limestone) light colored	128	418
74	15 NE SE	655	1.	Surface material	100	100
			3C.	"Soapstone" (shale)	120	220
			4.	Limestone	120	340
75	17 SE cor.	618	1.	Surface materials	145	145
			3C.	Shale, black, soft	55	200
			4.	Limestone	150	350
76	20 SE SE	626	1.	Clay and sand	100	100
			3C.	Shale	100	200
			4.	Limestone	140	340
77	28 NW SW	615	1.	Loess and drift	65±	65±
			3, 4.	Limestone	20±	85±
				"Soapstone" (shale)	?	?
				Limestone, blue	?	450

Farm Wells—Concluded

Key: 1, Recent and Pleistocene systems; 2, Pennsylvanian system—A, Carbondale formation, B, Pottsville formation; 3, Mississippian system—A, Burlington formation, B, Hannibal formation, C, Sweetland Creek formation; 4, Devonian system, Cedar Valley and Wapsipinicon formations, (may include part of 5); 5, Silurian system, Niagaran series.

Key No. on map	Location by township and quarter section	Altitude	Description and correlation		Thickness Feet	Depth Feet
78	30 SE SE	675±	1.	Loam and clay	70	70
			3C.	"Soapstone" (shale)	131	201
			4 a.	Limestone	170	371
			b.	Sandstone (porous limestone) (Niagaran?)	4	375
79	30 SE SE	675±	1.	Soil and clay, yellow	65	65
			3B, 3C.	"Soapstone" (shale)	167	232
			4.	Limestone	140	372
	T. 11 N., R. 3 W. (Hale Twp.)					
80	14 Cen. SE	745±	1.	Soil and clay	40	40
			3A.	Limestone	15±	55
			3B, 3C.	"Soapstone" (shale)	260	315
	T. 11 N., R. 2 W. (Monmouth Twp.)					
81	12 SW SE	748±	1 a.	Loam, black	4	4
			b.	Clay, yellow	36	40
			c.	Clay, blue, with sand and gravel.	80	120
			3A.	Limestone, white	30	150
			3B, 3C.	"Soapstone" (shale)	250	400
			4.	"Sandstone, containing some lime" (limestone, porous and dolomitic)	150	550
82	29 NE NE	750±	1 a.	Loam and clay, yellow	60	60
			b.	Clay, blue	30	90
			3Aa.	Limestone, blue	70	160
			b.	Limestone, white	40	200
			3B.	"Soapstone" (shale)	5	205
83	30 NE NE	760±	1.	Dirt and clay	110	110
			3Aa.	Limestone, blue	60	170
			b.	"Sandstone" (cherty limestone).	10	180
			c.	Limestone, white	30	210
			3B.	"Soapstone" (shale)	40	250
	T. 11 N., R. 1 W. (Coldbrook Twp.)					
84	20 NW NW	765±	1 a.	Clay, red	30	30
			b.	Clay, blue	50	80
			3Aa.	Limestone, "bastard" (probably cherty)	30	110
			b.	Limestone, white	90	200
			3B, 3C.	"Soapstone" (shale)	200	400
			4 a.	"Sandrock" (limestone), white...	70	470
			b.	Limestone, various colors	45	515

Shallow Wells and Wells with Incomplete Records

Key No. on map	Location by township and quarter section	Altitude	Description and correlation		Thickness Feet	Depth Feet
	Mercer County T. 15 N., R. 1 W. (Richland Grove Twp.)					
85	32 SW SE	730	1.	Loess and drift	80	80
			2Ba.	Sandstone	20	100
			b.	"Blue rock" (shaly limestone); sandstone at base	3	103

Shallow Wells and Wells with Incomplete Records—Continued

Key No. on map	Location by township and quarter section	Altitude		Description and correlation	Thickness Feet	Depth Feet
	T. 14 N., R. 1 W. (Rivoli Twp.)					
86	5 NE SE	780+	1.	Glacial drift	60	60
			2Ba.	Sandstone	30	90
			b.	"Blue rock" (shaly limestone)	8	98
			c.	"Cap-rock" (limestone)	2	100
			d.	Coal (Rock Island No. 1)	1½	101½
			e.	Shale, black		101½
87	7 NW SW	783		Reported to end in sandstone (may be sand in drift)		35
88	7 NW SW	783		Water from limestone; also water from sand at 130 feet		402
89	7 SE NE	780+	1.	Glacial drift	120	120
			2Ba.	Shale	2	122
			b.	Sandstone	18	140
90	16 NE SW	780+		No record. Coal present but thin; water from limestone		480
91	17 SW NW	786		No record. Coal, one foot reported; water from limestone		467
92	17 SW NW	760±		No record. Water from limestone		404
93	21 NE NW	783		No record. Coal, one foot reported; water from limestone		486
94	30	761	1 a.	Loam, and clay, yellow	25	25
			b.	Clay, blue	55	80
			c.	"Sea mud"; clay, silt, and fine sand, white	70	150
			d.	Gravel		150
95	31 NW SW	745±	1.	Clay, yellowish	108	108
96	31 NW SW	745±	1.	Clay, yellow; no water	160	160
97	31 NW SW	745±		Water from gravel pocket		58
98	32 SW NE	770±		Water from gravel pocket		110
	T. 15 N., R. 2 W. (Preemption Twp.)					
99	32 NE SW	636	1.	Alluvium (dug well)	10	10
100	34 NW SW	685	1.	Surface material	58	58
			2B.	"Blue rock" (shaly limestone)	6	64
101	35 SE SW	666	1.	Clay and sand	17	17
			2B.	Sandstone	½	17½
	T. 14 N., R. 2 W. (Greene Twp.)					
102	1 SE NW	742		No record. Reported to pass through coal (Rock Island No. 1)		125
103	4 SW NE	690±	1.	No record to coal	18	18
			2Ba.	Coal (Rock Island No. 1)	3½	21½
			b.	"Fireclay" (thin sandstone)	3½	25
104	5 SW NE	680±		Ends in sandstone		40
105	6 SE SE	720±		Coal, poor, sulfurous, 1-2 feet thick, reported at less than 100 feet; water from limestone		380
106	6 SW SW	680±		No record. Coal 1 foot 2 inches thick, reported at about 10 feet.		27
107	8 SW NW	764	1.	Surface material	14	14
			2Ba.	No record	46	60
			b.	Coal (Rock Island No. 1)	?	60+

Shallow Wells and Wells with Incomplete Records—Continued

Key No. on map	Location by township and quarter section	Altitude		Description and correlation	Thickness Feet	Depth Feet
Key: 1, Recent and Pleistocene systems; 2, Pennsylvanian system—A, Carbondale formation, B, Pottsville formation; 3, Mississippian system—A, Burlington formation, B, Hannibal formation, C, Sweetland Creek formation; 4, Devonian system, Cedar Valley and Wapsipinicon formations, (may include part of 5); 5, Silurian system, Niagaran series.						
108	9 NW SW	780±		No record. Ends a little below top of St. Peter sandstone		1230
109	11 SW NE	758		No record	93	93
			2Ba.	Limestone ("Blue rock" and "cap-rock")	7	100
			b.	Coal (Rock Island No. 1)	?	?
				No record	45	145+
110	18 SE NW	770±		No rock (dug well)		40
111	21 SW SW	760±	1.	Surface material	140	140
			2B.	"Rock"	40	180
112	22 NE NE	785±	1.	Loess and drift; petrified (?) logs reported; ends in gravel		50
113	23 NW SW	777	1.	Surface material	30	30
			2Aa.	Shale, black	9±	39±
			b.	Coal (Colchester)	2½	41½±
			Ba.	Rock, mostly shale; limestone ("cap-rock") at base	95±	136½
			b.	Coal (Rock Island No. 1)	3½	140
				No record	80	220
114	23 SW NE	780+	1.	Surface material	26	26
			2B.	Shale, gray		26
115	25 NW NE	765±		Water from gravel pocket in drift.		23
116	25 NE NW	740±		Water from hard blue clay (Pottsville shale)		9
117	26 SW SW	745±		Probably no rock		20
118	27 NW SE	762±		No rock		40
119	27 NE SW	762±		No rock		55
120	27 SW NE	760±		No rock		52
121	29 NE NE	757	1.	Surface material	65	65
			2Ba.	No record	45	110
			b.	Coal (Rock Island No. 1)	4	114
			c.	No record	11	125
122	31 NW SE	700+		No record. Ends in Galena-Platteville (oil test)		806
123	31 NW SE	705±	1.	No record	40	40
			2Ba.	"Blue rock" (limestone and chert)	?	?
			b.	Coal (Rock Island No. 1)	?	?
			c.	Sandstone ?; water from just below coal		70
124	31 NE SE	705±		Passed through Rock Island (No. 1) coal and bed below it		407
125	34 SE NE	716	1.	Surface material	70	70
			2Ba.	Sandstone	18	88
			b.	Limestone, blue ("cap-rock")	2	90
			c.	Coal (Rock Island No. 1)	4	94
126	35 SE SW	730±		Base of well in sandstone		150
127	36 SE NE	740+		Coal, one foot, at 135 feet; no cap-rock; ends in sandstone		150
128	36 NE SW	725±	1 a.	Clay, blue	100	100
			b.	Sand	25	125

SHALLOW WELLS AND WELLS WITH INCOMPLETE RECORDS—Continued

Key No. on map	Location by township and quarter section	Altitude		Description and correlation	Thickness Feet	Depth Feet
	T 15 N., R. 3 W. (Perryton Twp.)					
129	33 SW SW	680+	1.	Surface material and glacial drift	94	94
			2Ba.	"Soapstone" (shale)	16	110
			b.	Sandstone at base...............		110
130	33 NW SE	725±		Dug well ending in sand, no rock.		33
131	34 NE SE	705±	1.	Glacial drift	44	44
			2Ba.	"Soapstone" (shale)	8	52
			b.	Sandstone		52
132	35 SW SW	697±		No rock		30
133	35 SE SE	690±	1.	Loess and glacial drift...........	70	70
			2B.	Sandstone	30	100
134	36 SE NW	725±		No record. Penetrates rock (Pottsville)		80
135	36 SW SW	700–	1.	Drift	25±	25±
			2B.	Sandstone	5±	30
136	36 SW SW	675±	2B.	Sandstone at top and base........		10
137	36 NE SE	722		No record. Passed through sandstone (Carbondale?) and coal; filled in with rock 50 feet on account of quicksand...........		195
	T 14 N, R. 3 W. (Mercer Twp.)					
138	1 SE SE	647	1.	Surface material	8	8
			2Ba.	Coal (Rock Island No. 1)........	¼	8¼
			b.	Sandstone, shaly	5¾	14
139	3 NW NE	710±	1.	Sand and clay (dug well)........	60	60
140	3 NW SW	699	1.	Glacial drift	16	16
			2Ba.	Sandstone	15	31
			b.	"Slate" (shaly limestone), blue..	4½	35½
			c.	Coal (Rock Island No. 1)........	2½	38
141	3 SW SE	622	1.	Alluvium and drift................		30
142	4 SW NE	700–	1 & 2.	Surface material and a little rock	50	50
			2Ba.	Coal	½	50½
			b.	No record	4½	55
143	8 SE SE	700±		No record		40
144	9 SE SW	720±	1.	Surficial material and glacial drift	34	34
			2B.	Sandstone	2	36
145	9 SW SE	715±		No record		40
146	14 SE SE	759	1.	Loess and glacial drift...........	80	80
			2Ba.	"Soapstone" (shale)	15	95
			b.	"Cap-rock and Blue rock" (limestone and shaly limestone)......	?	?
			c.	Coal (Rock Island No. 1).......	4	?
			d.	Sandstone	?	136
147	14 NE SE	767	1.	Loess and glacial drift...........	90	90
			2Ba.	"Soapstone" (shale), "Blue rock" (shaly limestone), and "cap-rock" (limestone)	22	112
			b.	Coal (Rock Island No. 1).......	5	117
				No record. Well ends in Galena-Platteville limestone	795	912
148	21 SW SE	721		No record. Poor supply of water.		266
149	24 SE SE	740+	1.	Surface material	50	50
			2B.	Sandstone	18	68

SHALLOW WELLS AND WELLS WITH INCOMPLETE RECORDS—Continued

Key No. on map	Location by township and quarter section	Altitude		Description and correlation	Thickness Feet	Depth Feet
Key: 1, Recent and Pleistocene systems; 2, Pennsylvanian system—A, Carbondale formation, B, Pottsville formation; 3, Mississippian system—A, Burlington formation, B, Hannibal formation, C, Sweetland Creek formation; 4, Devonian system, Cedar Valley and Wapsipinicon formations, (may include part of 5); 5, Silurian system, Niagaran series.						
150	25 SW SW	725±		No rock		60
151	26	..	1.	Soil and clay	135	135
			2B?, 3C?	Shale	50	185
			4.	Limestone, fossiliferous, pyritic	95	280
152	27 NE NE	726		No record. Water probably from limestone		425
153	27 NW NW	710±		No record		375
154	28 NE NE	725±		No rock		70
155	32 NE NE	720–		No rock. Water from gravel pocket in drift		30
156	34 NW NE	725±		No record. No coal reported		390
157 & 158	36 NW NW	705±		No records. Two wells, similar depths		490
	T. 13 N., R. 3 W. (Ohio Grove Twp.)					
159	1 NW NW	685±		No record. Water from limestone		400
160	9 SW SE	680–	1 a.	Loam and clay	60	60
			b.	Sand	28	88
161	10 SE NW	679		No record. Water from limestone		336
162	11 SW NE	682		No record. Water from limestone		343
163	12 NW NW	690	1, 2, 3, & 4.	Surface clay and sand, "soapstone" (shale), and limestone		372
164	16 SW NE	655+	1, 2, 3, & 4.	Surface clay and sand, "soapstone" (shale), and limestone		314
165	16 SE NE	654		No record. Water from limestone		425
166	16 NW NW	670±	1 a.	Loess and clay	60	60
			b.	Sand	37	97
167	16 SW SE	641	1, 2?, 3, & 4.	Surface clay and sand, "soapstone" (shale), and limestone		286
168	17 NE NE	672±	1 a.	Loam and clay	74	74
			b.	Sand		74
169	21 NE NW	635±		No rock. Water from sand in drift		40
170	22 SE NW	631		No record. Water from limestone		300
171	27 NW SW	640±	1 a.	Loam and clay	64	64
			b.	Sand	?	64+
172	27 NW SE	640—		No record. Probably no rock		106
173	28 NW NW	620+	1.	Loess and drift	65	65
			3C.	"Soapstone" (shale)	15	80
174	29	..	1.	Loam and clay; sand at base		91
175	33 SW SW	600+	1.	Loam and clay; water in gravel		80
176	34	..	1.	Loam and clay; water from sand.		116
177	34 SE NE	620+	1.	Loess and drift; water from sand.		80
178	36 SE SW	640	1.	Loess and drift; water from sand.		88
179	36 NE SE	640	1.	Surface material	100	100
			2 or 3.	"Soapstone" (shale); no water	60	160
	T. 13 N., R. 2 W. (Suez Twp.)					
180	2 SE SE	750±	1.	Drift	60	60
			2B & 3C.	"Soapstone" (shale)	90	150

Shallow Wells and Wells with Incomplete Records—Continued

Key No. on map	Location by township and quarter section	Altitude		Description and correlation	Thickness Feet	Depth Feet
181	8 NW NW	700+	1.	Drift	85	85
			2B.	Limestone	1	86
182	8 NW NE	705±		No record		115
183	10 SE SW	725±	1.	Drift	100	100
			2B, 3, & 4.	?. Mostly sandstone	235	335
184	10 SE SE	728±	1.	Loess and drift	60	60
			2B.	Rock, mostly sandstone	60	120
185	10 SE SE	730±	1.	Glacial drift	85	85
			2B.	Sandstone	5	90
186	11 SW NW	730±	1.	Glacial drift and sand; water from sand	80	80
187	15 SE NE	720+	1 a.	Clay, blue	140	140
			b.	Sand and gravel at base		140
188	15 SE SW	705±	1 a.	Surface material	60	60
			2B.	"Soapstone" (shale)	30	90
189	16 SW SW	670±		No record. Flowing well		60
190	17 SE NE	680+	1.	Mainly in sand, water rises to 9 feet from top		95
191	17 SE SE	680+		No record. Flowing well		60?
192	17 SE SW	680±		No record. Flowing well, water probably from sandstone beneath shale		100
193	17 SW SW	680±		No record. Water probably from sandstone beneath shale		100
194	18 SE NE	650±		No record. Flowing well		85
195 & 196	18 SE SW	640+		No records. Two flowing wells		60+
197	20 NW NW	663±		Water in sandstone below shale; top of sandstone at 100 feet		109
198	20 SE SW	700+	1.	Surface material	50	50
			2B.	Shale; no water	50	100
199	20 SE SE	705±	1.	Loess and glacial drift	20	20
			2B.	Sandstone	16	36
200	21 SW SE	680+	1 a.	Clay, yellow	20	20
			b.	Clay, blue	40	60
			2B & 3C?	"Soapstone" (shale)	80	140
201	21 SW NE	705±	1.	Surface material	25	25
			2B.	Sandstone	5	30
202	22 SE NW	700+	1.	Loess and glacial drift	60	60
			2Ba.	Shale	28	88
			b.	Sandstone	2	90
203	25 NW SW	710±		Sandstone, with two thin beds of coal under drift, ends in shale		116½
204	28	..	1.	Loam and clay; water from sand	89	89
205	29 SE NW	695±	1.	Loam and clay	45	45
			2B.	Sandstone, red and yellow, soft	47	92
206	30 NE NE	700+	1 a.	Loess and glacial drift	60	60
			b.	Sand	10	70
207	31	..	1.	Loam and clay; water in sand	110	110
208	31	..	1.	Loam and clay; water in sand	102	102
209	31 NE NW	665±		No record. Water from sandstone at base		145
210	31 SW SW	645	1 a.	Loess and glacial drift	74±	74±
			b.	Sand and clay in alternate layers; water from fine sand	40±	114

Shallow Wells and Wells with Incomplete Records—Continued

Key No. on map	Location by township and quarter section	Altitude	Description and correlation		Thickness *Feet*	Depth *Feet*

Key: 1, Recent and Pleistocene systems; 2, Pennsylvanian system—A, Carbondale formation, B, Pottsville formation; 3, Mississippian system—A, Burlington formation, B, Hannibal formation, C, Sweetland Creek formation; 4, Devonian system, Cedar Valley and Wapsipinicon formations, (may include part of 5); 5, Silurian system, Niagaran series.

Key No. on map	Location by township and quarter section	Altitude		Description and correlation	Thickness *Feet*	Depth *Feet*
211	31 NE NE	670±	1.	Clay and glacial drift, sand at base		100
212	32 SE SE	667±	1.	Glacial drift	40	40
			2B or 3C.	"Soapstone" (shale)		40
213	32 SW SE	650±		Well in sand, no rock		180
214	33 SW NW	680±	1.	Loess and glacial drift and much sand	115	115
			2B or 3C.	Shale		115
215	35 SE SW	685±	1 a.	Loam and clay, yellow	35	35
			b.	Clay, blue	60	95
			2Ba.	Shale and sandstone	24	119
			b.	Limestone, gray	26	145
	T. 13 N., R. 1 W. (North Henderson Twp.)					
216	6 NE SE	778	1.	Surface material	60	60
			2A.	"Slate" (shale) and coal	1	61
			2B & 3C.	"Soapstone" (shale)	219	280
217	6 SE SW	760+	1.	Glacial drift	106	106
			2B.	Sandstone	4	110
218	7 NE NE	760+	1.	Loess and glacial drift	123	123
			2B.	Sandstone	5	128
219	9 NW NW	780+	1.	Loess and glacial drift	79	79
			2B.	Sandstone	5	84
220	9 SW NW	760+	1.	Loess and glacial drift	60	60
			2B.	Rock, probably sandstone	1	61
221	9 SW SE	745±		Water from loose sand		85
222	17 SE SE	742±	1.	Loess and glacial drift	103	103
			2B.	Sandstone	10	113
223	19 SE SE	740+		No record		175
224	20 SW SW	740±	1.	Loess and glacial drift	120	120
			2B.	Rock		120
225	20 SW SW	750±	1.	Glacial drift	127	127
			2B.	Sandstone	15	142
226	20 SW SE	760+	1.	Glacial drift	135	135
			2B.	Sandstone	15	150
227	29 SW SE	730+	1.	Loess and glacial drift	125	125
			2B.	Sandstone	5	130
228	30 SW NW	730±		No record		149
229	30 SW SW	720+	1 a.	Loam and clay	?	?
			2B.	Sandstone	?	119
	Warren County T. 12 N., R. 1 W. (Kelly Twp.)					
230	4 SW SW	705±	1.	Surface material	110	110
			2B?	Limestone?	5	115
231	5 NE NE	700+	1 a.	Loam and clay	30	30
			b.	Clay, blue	40	70
			2B?	Limestone	2	72

Shallow Wells and Wells with Incomplete Records—Continued

Key No. on map	Location by township and quarter section	Altitude		Description and correlation	Thickness Feet	Depth Feet
232	5 NE NW	700+	1 a.	Loam and clay, yellow	28	28
			b.	Clay, blue	39	67
			2B.	Sandstone	18	85
233	7 NW SW	690±		No record. Bed of coal 2 feet thick reported		?
234	16	..		No record. Ends in rock, probably Pottsville sandstone		118
235	16 NW NE	705±		No record. Water from sandstone		145
236	16 SE SE	700±	1 a.	Loam and clay, yellow	30	30
			b.	Clay, blue	60	90
			c.	Sand and clay mixed	48	138
			d.	Sand, clean	12	150
237	17 NE SW	715	1.	Surface material	14	14
			2Ba or 2A.	Rock	66	80
			2Bb.	Coal	1	81
			c.	Sandstone	?	81+
			d.	No record	13?	94
			e.	Limestone	12	106
			f.	Coal (Rock Island No. 1)	4	110
			g.	Underclay	½	110½
			h.	Sandstone	9½	120
238	20 SE SW	705	1 & 2B.	Surface material and rock above limestone	?	?
			2Ba.	Limestone and "slate" (shale)	?	139
			b.	Coal (Rock Island No. 1)	2	141
			c.	Sandstone		191
239	30 SE NW	750±		No record. Penetrates No. 2 coal at 30 feet and a coal bed 4 feet thick (probably Rock Island No. 1) at about 95 feet		100
	T. 12 N., R. 2 W. (Spring Grove Twp.)					
240	1 NE NE	704	1.	Loess and glacial drift	60	60
			2B.	Sandstone	20	80
241	6 NW NW	616±	1 a.	Loam and clay, yellow	30	30
			b.	Clay, blue	40	70
			c.	Sand	28	98
242	8 SE SE	670±	1.	Surface clay and sand	97	97
			2Ba.	"Soapstone" (shale), sandy	1	98
			b.	Sandstone		98
243	8 SE SE	660+	1.	Surface clay, sand, and gravel	113	113
244	9 SE SE	685±	1 a.	Dirt and clay	35	35
			b.	Sand and gravel	40	75
			2B & 3C.	"Soapstone" (shale)	135	210
245	9 SE NE	660+	1.	Clay	80	80
			2B & 3C?	Shale and sandstone	50	130
246	11 NW NW	660+		Water in sand, white; no rock		87
247	11 NW NE	660+	1.	Loess, drift, and gravel	72	72
			2Ba.	"Shelly rock" (shale)	73	145
			2Bb or 3B.	Clay (shale), white	25	170
			?.	Rock		170
248	11 SE SW	680+	1.	Surface clay, sand, and gravel; black sticky muck	160	160

Shallow Wells and Wells with Incomplete Records—Continued

Key No. on map	Location by township and quarter section	Altitude	Description and correlation		Thickness Feet	Depth Feet
Key: 1, Recent and Pleistocene systems; 2, Pennsylvanian system—A, Carbondale formation, B, Pottsville formation; 3, Mississippian system—A, Burlington formation, B, Hannibal formation, C, Sweetland Creek formation; 4, Devonian system, Cedar Valley and Wapsipinicon formations, (may include part of 5); 5, Silurian system, Niagaran series.						
249	12 SW SE	700+		No record. Bed of coal (Rock Island No. 1) 3 feet thick reported		90
250	14 SE NW	670±	1.	Clay, sand, and gravel; ends in sand	129	129
251	14 NW NW	680+	1 a.	Loam and clay, yellow	30	30
			b.	Clay, blue	60	90
			c.	Sand	30	120
			d.	Gravel	1	121
252	18 SW SW	685	1.	Surface material	20	20
			2B, 3B, or 3C.	"Soapstone" (shale)		20
253	21 Cen. SW	715	1 a.	Loam and clay	30	30
			b.	Sand	3	33
			c.	Clay, blue	17	50
			2B, 3B, 3C.	"Soapstone" (shale)	120	170
			3Ca.	"Rock" (limy shale)	10	180
			b.	"Soapstone" (shale)	1	181
254	21 NE SE	725		No record. Coal 1½ feet thick at 35 feet; water from sandstone below coal		55
255	22 NW NW	700+	1.	Soil and clay	50	50
			2B.	Limestone, impure, and "soapstone" (shale), (may include 3A or 3B)	90	140
256	23 SW NE	690±		Water from brown gravel and sand, shale at base		63
257	24 SE NE	717	1, 2A?, 2B.	Surface material and rock	63	63
			2Ba.	"Cap-rock" and "slate" (limestone, shaly limestone, and laminated shale)	12	75
			b.	Coal (Rock Island No. 1)	4	79
258	24 SW SW	731		No record. Ends in sand		110
259	25 NW SW	740	1 a.	Loam and clay	30	30
			b.	Clay, blue	41	71
			2B.	Sandstone	12	83
260	26 SE NE	740		No record. Ends in sandstone		120
261	29 SE NE	710		No record. Reported shale and coal and natural gas		67
	T. 12 N., R. 3 W. (Sumner Twp.)					
262	1 NW NW	640+	1 a.	Loam and clay, yellow	30	30
			b.	Clay, blue	40	70
			c.	Sand	15	85
263	2 NW NW	635±	1.	Loam and clay, water from sand.	62⅔	62⅔
264	3 NE NE	635±	1.	Loam and clay, water from sand.	76	76
265	4 NW NW	605±	1 a.	Loam, sand, and clay, alternating	82	82
			b.	Sand	3	85
266	5 NE NE	600+	1.	Loam, clay, and sand	97	97
267	11 NW SW	690	1.	Loess and glacial drift; logs in or below drift	40	40

Shallow Wells and Wells with Incomplete Records—Concluded

Key No. on map	Location by township and quarter section	Altitude		Description and correlation	Thickness Feet	Depth Feet
268	11 NW SE	705±	1.	Loam and clay; water from sand	74½	74½
269	11 SW SE	690±	1.	Loam and clay; water from sand	73	73
270	12 SW SW	702±	1 a.	Surface clay	15	15
			b.	Gravel	3	18
			c.	Sand and loam, sandy	177	195
			3B?	Clay, blue		195
271	12 SE SE	700	1 a.	Surface clay	15	15
			3B & 3C.	"Soapstone" (shale)	170	185
272	15 SE SE	640	1.	Surface material	40	40
			3B, 3C.	"Soapstone" (shale)	50	90
273	15 SW SE	640+	1.	Loess and glacial drift	60	60
			3B, 3C.	Shale	?	?
			4.	Limestone	?	343
274	16 NE SE	620+	1.	Loam and clay; water from sand.	55½	55½
275	16 NW NW	620+	1.	Loam and clay; water from sand; no rock	88	88
276	20 SE SE	620±	1 a.	Loam and clay	126	126
			b.	Sand	6	132
277	20 SE SE	620±	1 a.	Soil and clay, yellow	40	40
			b.	Clay, blue, with pockets of sand.	77	117
			c.	Sand	15	132
278	20 SE SE	620±	1.	Loam and clay; water in sand	78	78
279	20 SE SE	620±	1 a.	Soil, yellow, and clay, blue	73½	73½
			b.	Sand	8	81½
280	20 SE SE	620±	1.	Loam and clay; water in gravel	87	87
281	20 SE SE	620±	1.	Loam and clay; water in sand	75.	75
282	20 SE SE	620±	1 a.	Loam and clay	98	98
			b.	Sand and gravel	6	104
283	21 SW SW	620±	1 a.	Loam and clay	65	65
			b.	Sand	4	69
284	21 SW SW	620±	1 a.	Loam and clay	51	51
			b.	Sand	5	56
285	21 SW SW	620±	1 a.	Loam and clay	55	55
			b.	Sand and gravel	5	60
286	21 SW SW	620±	1 a.	Loam and clay	65	65
			b.	Sand	7	72
287	21 NW NW	620±	1.	Loam and clay; water in sand	84	84
288	22 NW NE	652		No record. Water from limestone		373
289	23 NW NW	655±	1.	Surface material	30	30
			3B, 3C.	"Soapstone" (shale)	40	70
			b.	Sandstone		70
290	24 SW SW	655±	1 a.	Clay, red, peat at bottom	18	18
			b.	Clay, blue	52	70
			c.	Sand	4	74
			d.	Clay, blue	56	130
			e.	Sand	7	137
			3B or 3C.	"Soapstone" (shale)		137
291	24 SW SE	650±	1 a.	Clay, red	20	20
			b.	Clay, blue	96	116
			c.	Sand	8	124
			3B or 3C.	"Soapstone" (shale)		124
292	24 SE SE	625±		No record. Water reported in gravel		125
293	25 NE NW	655±	1.	Surface material	?	?
			3B or 3C.	"Soapstone" (shale), blue		118
294	27 NW SW	640±	1.	Loam and clay; water in sand	104	104

INDEX

A

B

C

D

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J

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R

TABLE 3.—*Mineral analyses of water from wells in the Alexis quadrangle*

	Aledo city well No. 1	Aledo city well No. 2	Alexis village well	Viola village well	Little York village well	Mercer County Farm well	Farm well (W. J. Stephens)	Farm well (C. A. Peterson)	Farm well (W. J. Maloney)
Well number, Appendix C and Plate IV	(20)	(21)	(25)	(19)	(76)	(42)	(64)	(40)	(66)
Depth in feet	3114 closed off at 1450	1172	1200	1281	326	388	303	417	508
Aquifer	St. Peter	St. Peter	St. Peter	St. Peter	Devonian-Silurian	Devonian-Silurian	Devonian-Silurian	Devonian-Silurian	Devonian-Silurian
Depth of casing (feet)	120?	259'9" and between 541'7" and 385'	412	1058					
Gals. per minute yield	200		67	71	33				
Date sample was collected	7-3-18	11-29-26	1-23	7-24-18	7-16-18				
Determinations made									
(Parts per million)									
Potassium[a]	....	23.5	31.5	....	....	....	....	....	....
Sodium	463.5	339.7	219.0	327.5	528.6	272.4	231.1	282.6	187.4
Ammonium	1.4	0.4	1.5	1.5	0.1	0.7	2.3	0.7	1.2
Magnesium	26.9	24.0	29.8	25.7	12.1	3.9	6.3	8.1	11.6
Calcium	95.5	50.3	67.7	48.7	18.1	16.4	9.3	15.7	9.3
Iron	0.2	0.1	0.8	1.1	0.4	0.3	0.2	0.6	0.6
Manganese	0.0	0.0	0.2	0.0	0.0	0.0	0.0	trace	0.0
Alumina	2.5	1.7	0.0	1.4	0.1	1.1	0.7	0.1	1.1
Nitrate	0.9	0.2	2.5	1.4	4.4	0.4	1.1	0.5	3.0
Chloride	439.7	150.0	85.0	273.0	232.6	161.8	51.6	95.0	26.4
Hydrogen sulfide	0.4	....	....	....	....	....	....	....	....
Sulfate	524.0	487.7	410.7	297.3	399.0	112.3	23.5	142.8	0.0
Silica	9.6	8.6	14.2	16.0	2.6	6.0	7.0	8.5	9.5
Non-volatile	3.6	3.0	1.8	1.6	1.6	2.0	1.0	3.0	2.0
Carbon dioxide	4.0	....	....	....	2.0	....	....	....	....
Alkalinity:									
Phenolphthalein	....	....	....	....	....	....	....	....	....
Methyl Orange	237.0	252.0	274.0	237.5	474	306.0	466.0	402.0	442.0
Residue	1755.0	1244.0	1077.0	1128.6	1535	896.0	651.0	835.0	570.0
Hypothetical combinations									
(Parts per million)									
Potassium nitrate	....	0.3	4.0	....	....	....	....	....	....
Potassium chloride	....	44.0	57.2	....	....	....	....	....	....
Sodium nitrate	0.1	....	....	1.9	60.6	0.5	1.4	7.3	4.2
Sodium chloride	725.3	215.7	95.3	450.0	383.3	266.7	85.1	156.6	44.6
Sodium sulfate	638.4	729.5	560.7	439.2	589.4	166.1	34.7	211.0	....
Sodium carbonate	....	34.0	....	16.5	391.1	261.6	435.1	347.1	389.8
Ammonium sulfate	5.2	....	5.7	....	....	....	....	....	....
Ammonium carbonate	....	1.1	....	4.3	0.2	1.9	6.0	1.9	3.3
Magnesium sulfate	110.5	....	34.2	....	....	....	....	....	....
Magnesium carbonate	16.7	83.2	79.2	88.9	41.8	13.6	22.0	28.0	40.1
Calcium carbonate	238.5	124.3	169.0	121.7	45.1	41.0	23.2	39.3	23.2
Iron carbonate	0.4	....	....	2.2	0.8	....	....	....	....
Iron oxide	....	0.1	1.2	....	....	0.4	0.3	0.9	0.9
Alumina	2.5	1.7	0.0	1.4	0.1	1.1	0.7	0.1	1.1
Silica	9.6	8.6	14.2	16.0	2.6	6.0	7.0	8.5	9.5
Non-volatile	3.6	3.0	1.8	1.6	1.6	2.0	1.0	3.0	2.0
Manganese oxide	....	0.0	....	....	....	0.0	0.0	trace	0.0
Total	1750.8	1244.6	1022.5	1143.8	1516.6	760.9	616.5	803.7	518.7
Hypothetical combinations	b								
(Grains per U. S. gallon)									
Potassium nitrate	....	0.2	.23	....	....				
Potassium chloride	....	2.57	3.34	....	....				
Sodium nitrate	.01	....	....	.12	3.51				
Sodium chloride	41.91	12.61	5.53	26.25	22.25				
Sodium sulfate	37.15	42.66	32.70	25.62	34.19				
Sodium carbonate	....	1.99	....	.96	22.69				
Ammonium sulfate	.30	....	.33	....	....				
Ammonium carbonate	....	.06	....	.25	.01				
Magnesium sulfate	6.42	....	2.00	....	....				
Magnesium carbonate	.97	4.81	4.62	5.19	2.42				
Calcium carbonate	13.85	7.26	9.87	7.10	2.61				
Iron carbonate	.02	....	....	.13	.05				
Iron oxide	....	.01	.07	....	....				
Alumina	.15	.10	.00	0.08	.01				
Silica	.55	.50	.83	.93	.15				
Non-volatile	.21	.17	.11	.09	.09				
Manganese oxide	....	.00	....	....	....				
Total	101.54	72.76	59.63	66.72	88.12				

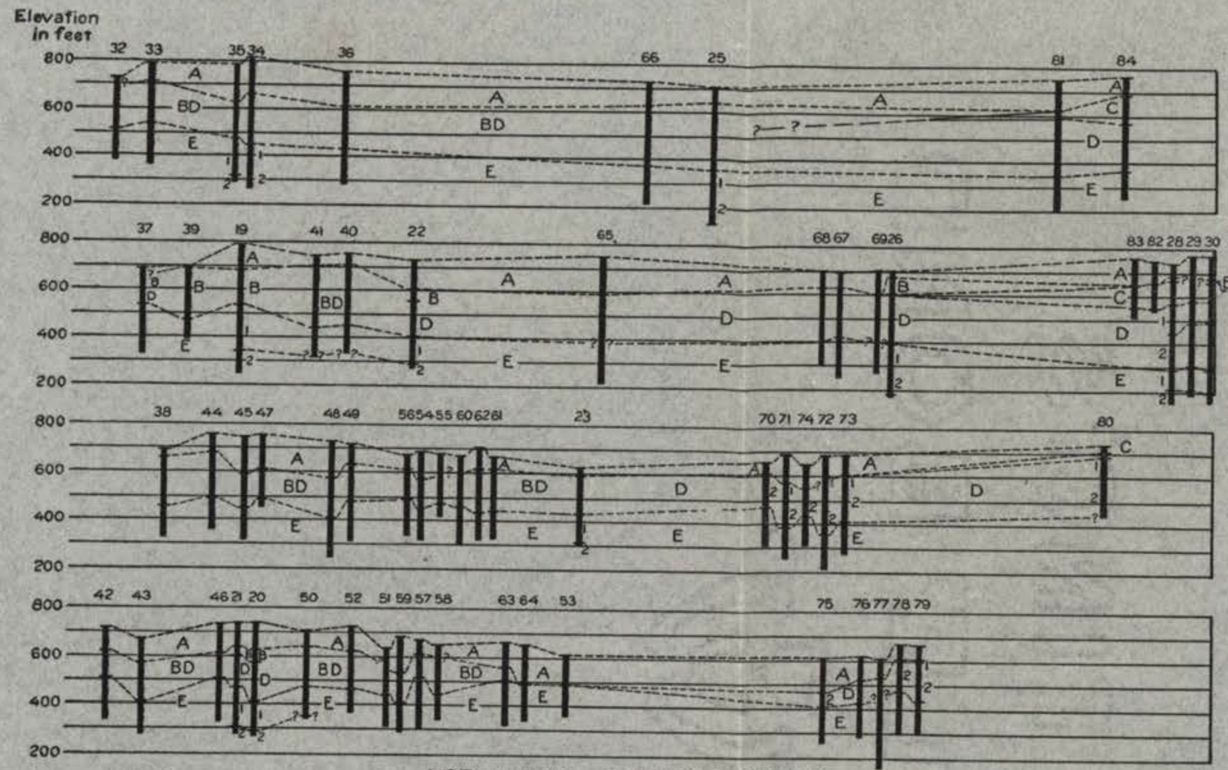
a Where the amount of potassium is not given it is included with the sodium.

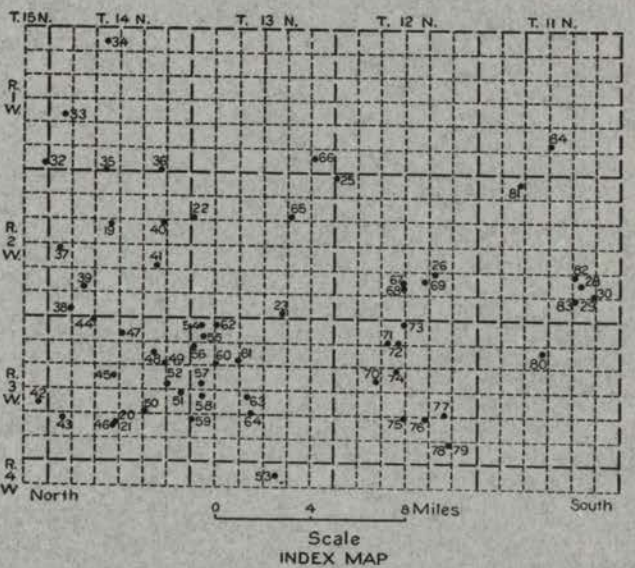
b An analysis of the water taken from this well before it was closed off is as follows: Potassium sulfate, 1.279; sodium chloride, 269.874; sodium sulfate, 47.785; sodium phosphate, traces; sodium bromide, traces; calcium carbonate, 8.307; calcium sulfate, 88.280; magnesium carbonate, 16.648; iron carbonate, .049; silica, .540; alumina, .625; organic compounds of ammonium, .025; total, 432.787. The water also contained 31.91 cubic inches of free and loosely combined carbonic acid gas and traces of sulfuret of hydrogen.

TABLE 1.—*Stratigraphic classification of rocks*

Group		System	Sub-system	Series	Formation	Deposits in Alexis quadrangle
		Recent				Slope wash and alluvium
Cenozoic	Quaternary Sub-group	Pleistocene		*Wisconsin		Glacial drift
				Peorian (Early) and Iowan (Late)		Loess
				Sangamon		Loess-like silt and soil, and gumbotil
				Illinoian		Glacial drift
				Yarmouth		Sands, soil, and gumbotil
				Kansan		Glacial drift
				*Aftonian		
				*Nebraskan		
	Tertiary Sub-group	*Pliocene †Miocene †Oligocene *Eocene				
Mesozoic		*Cretaceous †Comanchean †Jurassic †Triassic				
Paleozoic		†Permian				
		Pennsylvanian			*McLeansboro	
					Carbondale	Conglomerate, sandstone, shale, limestone, coal, fireclay
					Pottsville	Sandstone, shale, limestone, coal, fireclay
		Mississippian	Upper	*Chester		
				*Meramec	*Warsaw	
				Osage	*Keokuk Burlington *Fern Glen	Limestone, chert
			Lower		*Chouteau	
				Kinderhook	Hannibal	Shale
					*Louisiana	
					Sweetland Creek	Shale
		Devonian	Upper	*Chautauquan	Cedar Valley and Wapsipinicon	
				Senecan		Limestone
			Middle	*Erian		
				*Ulsterian		
			Lower	*Oriskanian		
				*Helderbergian		
		Silurian	Upper	†Cayugan		
			Middle	Niagaran (Lockport subseries) (†Clinton subseries)	*Port Byron *Racine *Waukesha Joliet	Dolomite
			Lower	*Alexandrian		
		Ordovician	Upper	Cincinnatian	Maquoketa	Shale, limestone
			Middle	Mohawkian	Galena	Dolomite
					Decorah	Shale
					Platteville	Dolomite
					Glenwood	Shale
					St. Peter	Sandstone
			Lower	Prairie du Chien	Shakopee	Dolomite
					New Richmond	Sandstone
					Oneota	Dolomite
		Cambrian	Upper	Croixan	†Madison	
					†Mendota	
					Jordan	Sandstone
					Trempealeau	Dolomite, shale, sandstone
					Mazomanie-Franconia	Shale, sandstone
					Dresbach	Sandstone
					Eau Claire	Shale
					Mt. Simon	Sandstone

* Occurs in Illinois but not in the Alexis Quadrangle.
† Not known to occur in Illinois.



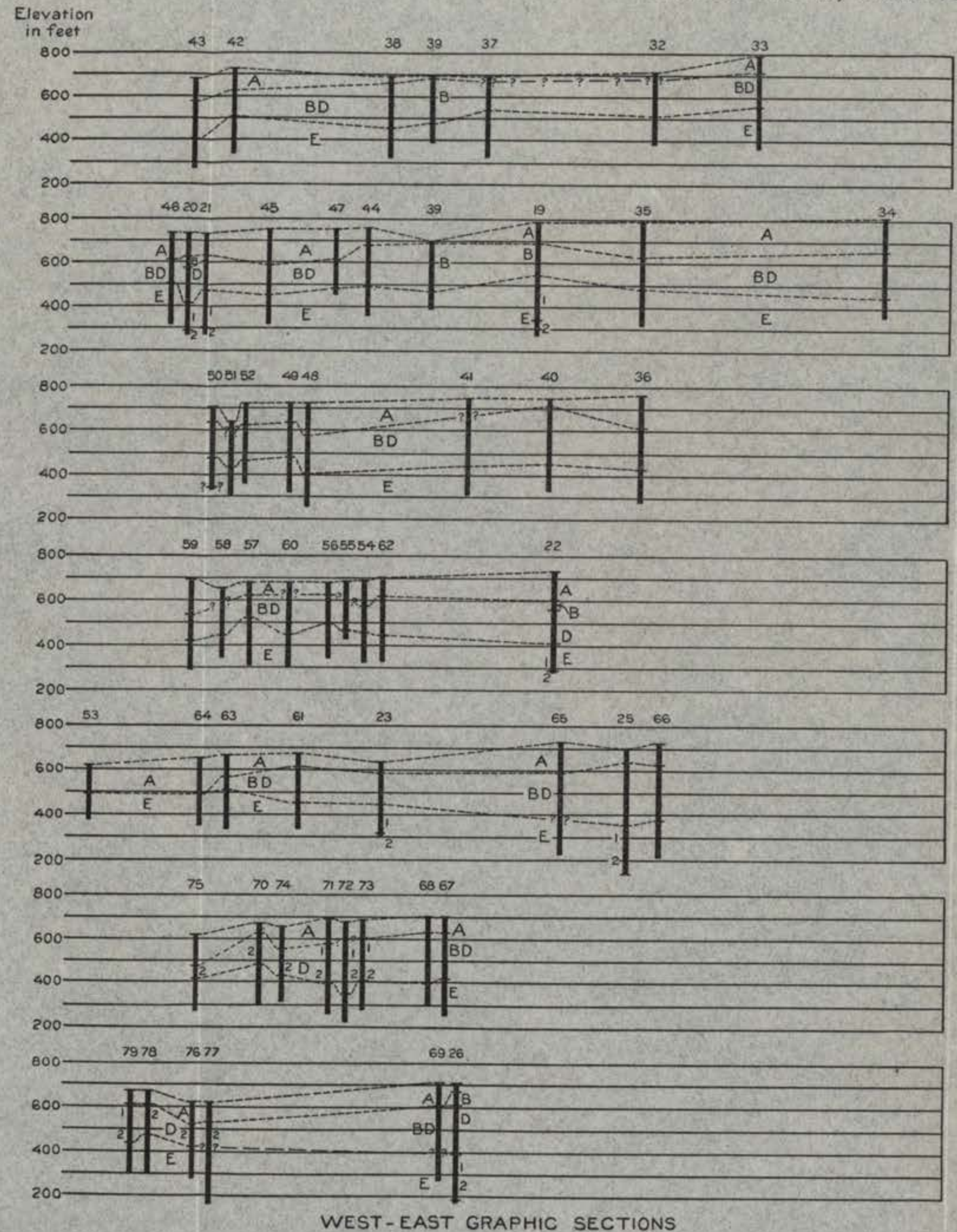


0 2 4 6 8 Miles

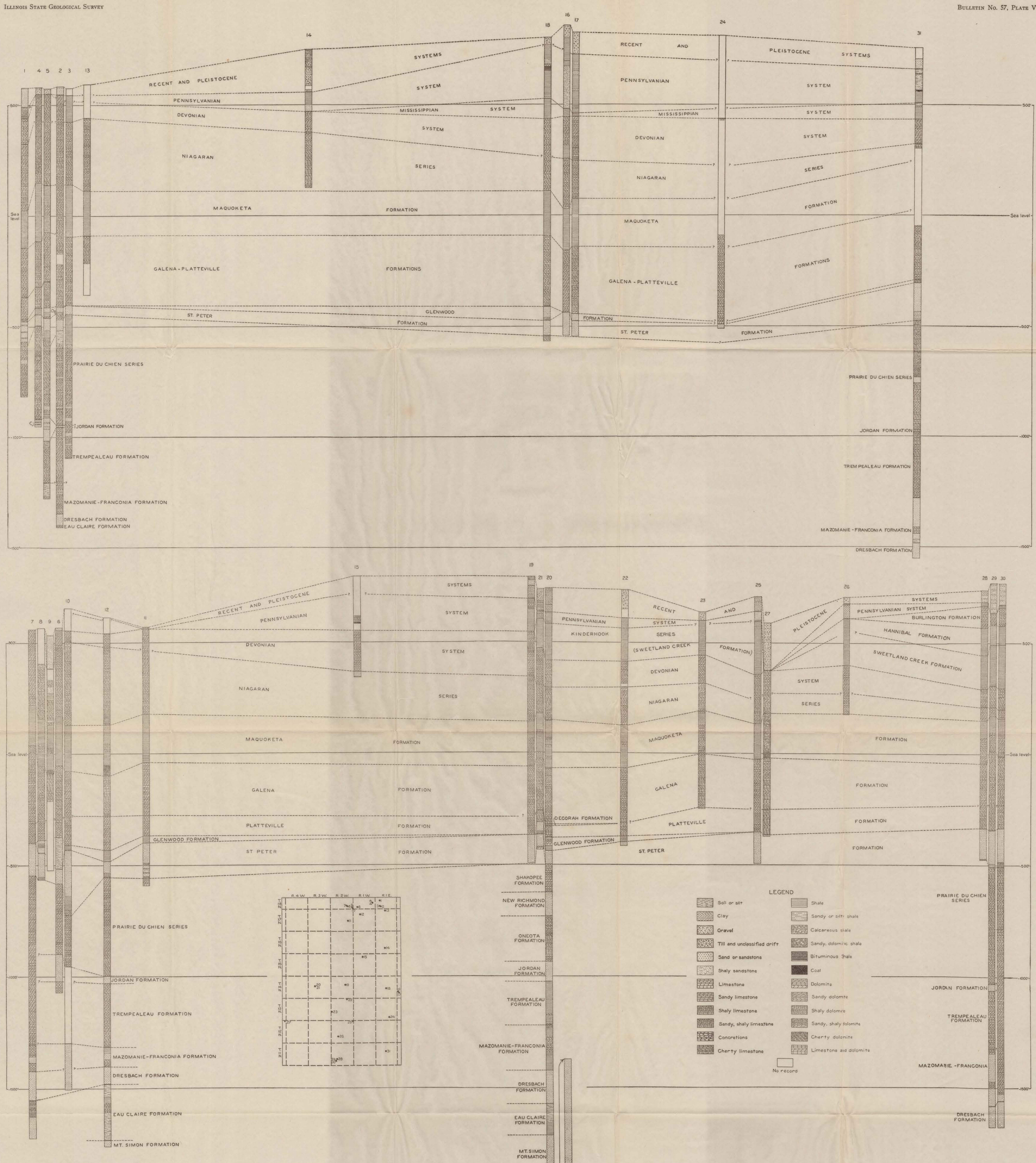
Scale

LEGEND

A-Recent and Pleistocene systems
B-Pennsylvanian system
C-Burlington formation
D { 1 Hannibal formation; 2 Sweetland Creek formation
E { 1 Devonian system; 2 Niagaran series



Graphic representations of well records in and near the Alexis quadrangle. Numbers refer to locations shown on index map and to well records in Appendix C.



Graphic logs of deep wells in and near the Alexis quadrangle. Numbers refer to locations shown on index map and detailed records given in Appendix C.

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION
M. F. WALSH, DIRECTOR
GEOLOGICAL SURVEY DIVISION
M. M. LEIGHTON, CHIEF
URBANA, ILLINOIS

ALEXIS QUADRANGLE
BULLETIN NO. 57, PLATE IV

Topographic base surveyed in cooperation with the U. S. Geological Survey

APPROXIMATE MEAN DECLINATION, 1927

Scale 1/62500

1 ½ 0 1 2 3 4 Miles

5000 0 5000 10000 15000 20000 Feet

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 20 feet

Datum is mean sea level

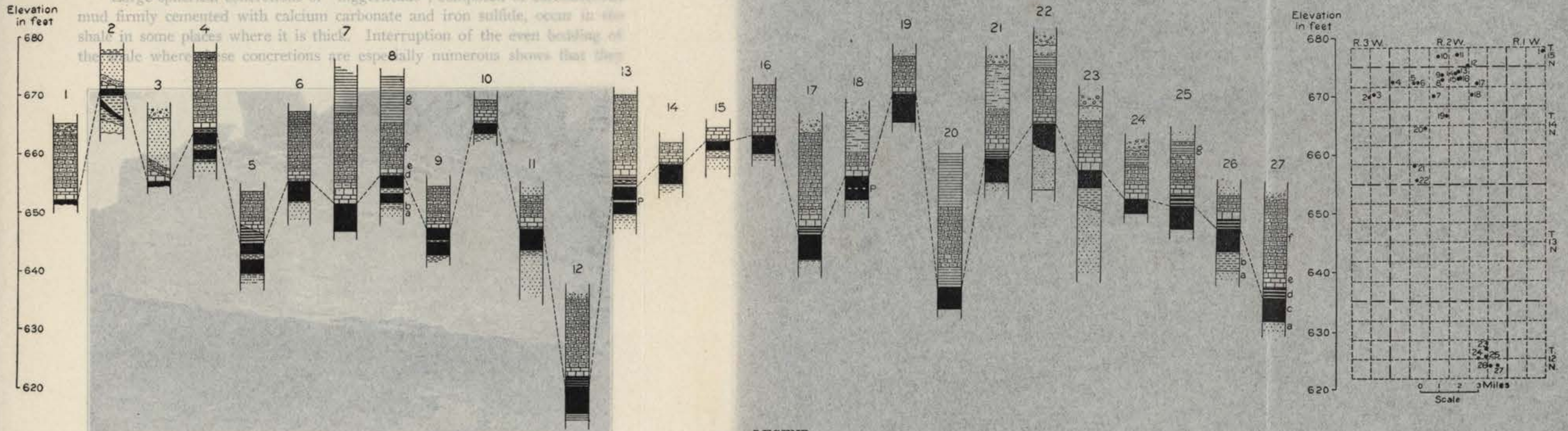
WILLIAMS & HEINTZ CO. WASH. D.C.

BEDROCK SURFACE OF THE ALEXIS QUADRANGLE

INCLUDING WELL LOCATIONS NUMBERED FOR CROSS REFERENCE TO APPENDIX C

Contour interval 20 feet

(Subject to revision according to data revealed by additional drilling, particularly in areas where contours are grossly generalized)

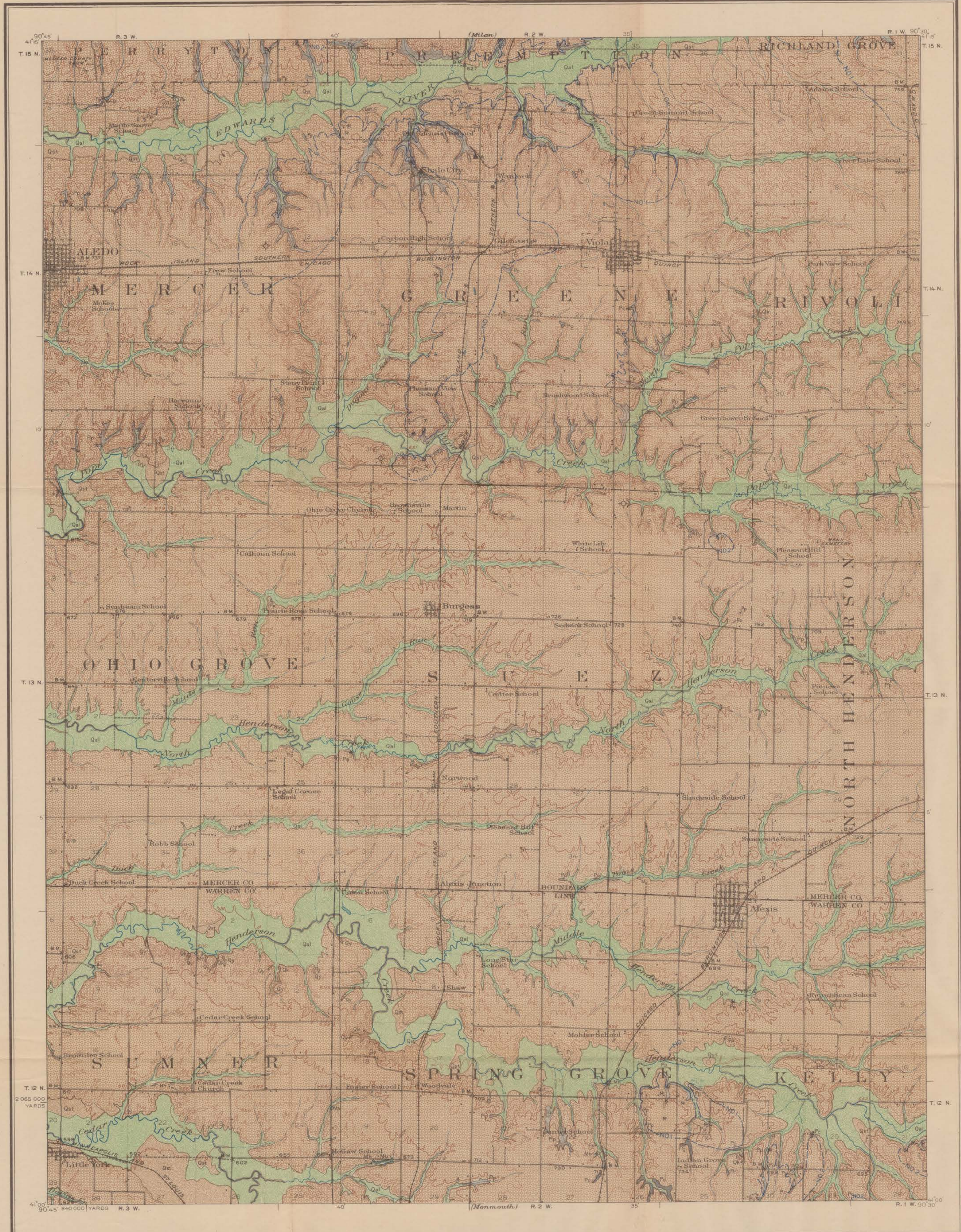


LEGEND

- g Shale
- f Shaly limestone
- e Blue limestone
- d Laminated shale, "clod" at base
- c Rock Island (No. 1) coal
- b Underclay
- a "Stigmarian" sandstone
- P Pyrite

Graphic representations of measured geologic sections of Suite II, Rock Island (No. 1) coal and associated strata. The numbers refer to locations shown on index map and to detailed descriptions given in Appendix B.

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION
M. F. WALSH, DIRECTOR
GEOLOGICAL SURVEY DIVISION
M. M. LEIGHTON, CHIEF
URBANA, ILLINOIS



Topographic base surveyed in cooperation with the U. S. Geological Survey

APPROXIMATE MEAN DECLINATION, 1927

Scale $\frac{1}{62500}$

Contour interval 20 feet

Datum is mean sea level

WILLIAMS & HEINTZ CO. WASH. D.C.

Geology by H. R. Wanless
Geologically surveyed in 1925 and 1926

ECONOMIC AND SURFICIAL GEOLOGY OF THE ALEXIS QUADRANGLE

(Topographic maps without geologic data may be obtained by addressing the Chief, State Geological Survey, Urbana, Illinois)

GENERALIZED SECTION OF STRATA IN THE ALEXIS QUADRANGLE

Vertical scale, 1 inch=200 feet

Group	System	Series	Formation	Thickness in feet: Minimum	Thickness in feet: Maximum	Character of rocks
CENOZOIC	RECENT			0	20+	Alluvial silt, sand, and gravel; slope-wash and soil
CENOZOIC	PLEISTOCENE	Peorian-Sangamon		6	20	Loess; fine silt or sand; gray or buff
				0	4	Soil and silt, noncalcareous; contains plants and other fossils
		Illinoian		0	85?	Till, blue-gray where fresh; gumbotil in upper part
		Yarmouth		0	30?	Soil, silt or sand, with some gravel; sand is noncalcareous, cross-bedded, reddish; contains logs and other fossils
		Kansan		0	50?	Till, bouldery, dark in color; gumbotil in upper part
PALEOZOIC	PENNSYLVANIAN		Carbondale	0	50	Suite V—Pleasantview sandstone, underclay, coal, clay or shale
				13	37	Suite IV—Colchester (No. 2) coal and associated strata: shale, limestone, shale, coal, underclay, and sandstone
			Pottsville	30	145	Suite III—Gilchrist shale and other undifferentiated sandstones, shales, underclays, and coals
				5	47	Suite II—Rock Island (No. 1) coal and associated strata; shale, limestone, shale, coal, underclay, and "Stigmarian" sandstone
				50	80	Suite I—Undifferentiated sandstones, shales, underclays, limestones, and coals
	MISSISSIPPIAN	Osage	Burlington	0	4	Limestone, coarsely crystalline, gray; cherty
		Kinderhook	Hannibal	0	110	Shale, soft, light greenish-gray
			Sweetland Creek	0	140	Shale, brownish-gray; contains Sporangites huronense
	DEVONIAN	Senecan	Wapsipinicon and Cedar Valley	94	165	Limestone; some beds thin, some massive; some horizons shaly, others dolomitic; chert locally abundant
	SILURIAN	Niagaran		125	200	Dolomite and dolomitic limestone, cherty, fine-grained, crystalline, massive, gray
	ORDOVICIAN	Cincinnatian	Maquoketa	192	215	Shale, calcareous, gray or brown, interbedded with dolomitic limestone. A dolomitic limestone member 15-30 feet thick persists near the middle of the formation. Shale is more dolomitic below than above
		Mohawkian	Galena	287	326	Galena—limestone, dolomitic, coarsely crystalline, massive, gray, weathers yellow and sandy; Platteville — limestone, dolomitic, brownish-gray, thin beds with thin shale partings. A thin shale member 50 feet above base may represent Decorah formation
			Platteville			
			Glenwood	10	60	Shale, sandstone, dolomite, and limestone, all interbedded and intermixed; all glauconitic; sand grains angular
			St. Peter	55	156	Sandstone, more or less dolomitic, medium- to fine-grained; light gray, pink, or yellow; grains well-rounded with frosted and pitted surfaces. Greenish shale or red marl may occur at base
		Prairie du Chien	Shakopee	130		Dolomite, or dolomitic limestone, gray or buff with some sand and considerable shale
			"New Richmond"	105		Sandstone, dolomitic, white or reddish
			Oneota	205		Dolomite, sandy, gray, or buff
	CAMBRIAN	Croixan	Jordan	90		Sandstone, gray, with dolomitic cement
			Trempealeau	195		Shale, calcareous, and dolomite; all chocolate-colored; typically includes the St. Lawrence dolomite and Lodi, Norwalk, et cetera, shale and sandstone members
			Mazomanie-Franconia	123		Shale, sandy, dolomitic; sandstone, dolomitic, fine-grained, pink; and dolomite, sandy; all glauconitic
			Dresbach	150		Sandstone, slightly dolomitic, brownish-gray, yellow, or white
			Eau Claire	142		Shale, with beds of sandstone, limestone, and dolomite
			Mt. Simon	657		Sandstone, fine-grained, white, tinted red or brown

LEGEND

QUATERNARY

RECENT
- Qal — Alluvium

PLEISTOCENE
- Sangamon: Qst — Terrace remnants *(covered with loess)*
- Illinoian: Qi — Glacial drift *(covered with loess)*
- Yarmouth: Qy — Sand and silt
- Kansan: Qk — Glacial drift

UNCONFORMITY

PENNSYLVANIAN
- Pc — Carbondale formation
- Pp — Pottsville formation

UNCONFORMITY

MISSISSIPPIAN
- Osage: Mb — Burlington formation
- Kinderhook: Mh — Hannibal formation

ECONOMIC DATA

- NO 1 — Approximate boundary of the Rock Island (No. 1) coal
- NO 2 — Approximate boundary of the Colchester (No. 2 coal)
- Coal mine
- Abandoned coal mine
- Abandoned rock quarry
- Shale pit
- Abandoned shale pit
- Dry hole (oil test)

Note: *The Rock Island (No. 1) coal is the only coal mined commercially, although the Colchester (No. 2) coal and a coal 10-20 feet below the Rock Island (No. 1) coal have been locally exploited. The Gilchrist shale is used in the manufacture of brick and tile. Building stone was formerly quarried from sandstone and shaly limestone in the Pottsville formation. The Yarmouth sands may be suitable for special uses, such as molding sands and filter sands. Water is obtained from the glacial drift, especially the Yarmouth sands, from sandstones of the Pottsville formation, from a porous horizon at the base of the Devonian system, from the St. Peter sandstone, and from the Dresbach sandstone.*