

AN INTRODUCTION TO THE GEOLOGY OF
PARKE COUNTY, INDIANA

by
CHARLES E. WIER AND WILLIAM J. WAYNE

Indiana Department of Conservation

GEOLOGICAL SURVEY

Circular No. 2

1953

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AN INTRODUCTION TO THE GEOLOGY OF PARKE COUNTY, INDIANA

By Charles E. Wier and William J. Wayne

INTRODUCTION

Landscape features are natural phenomena which long have attracted man's attention. Frequent reference to the permanence of mountains has been made in literature, even though the surface features of the earth actually have been modified continuously by water, ice, and winds. Geologic processes change the face of the earth an insignificant amount during a human lifetime, but if allowed to continue for thousands or millions of years, reduce mountains to nearly level plains.

Because the surface features of the earth have changed so slowly during human history, little thought was given to a possible origin for them until the early part of the nineteenth century. Thus only a little more than a century ago scientists came to realize that the present surface of the earth has been formed by slowly acting agents throughout an immense span of time.

Most of the landscape features of the earth have been sculptured by running water. The water that rushes down a bare hillslope during a heavy rain erodes gullies in the soil. Soil particles that are removed in this way then are carried in suspension by rivers to a lake or an ocean where they are deposited as sediments of sands, muds, and oozes. As new material settles on top of the muds that already have been deposited, the older sediments are compressed and eventually become sandstones, mudstones, shales, and limestones. If the earth's crust had never undergone any deformation, all the sediments which had accumulated beneath ocean waters still would be under water. Large portions of the continents, however, have been intermittently exposed and submerged. Therefore, in places where these former sea floors now are dry land, the rocks that were deposited at a time when the land was covered by water can be studied, and some of the rocks which contain materials of use to man can be quarried or mined.

If the rocks that underlie the earth's crust were exposed everywhere, a geologist could trace rather easily any formation or stratum from one place to another. The rocks are not exposed in all places, however; in fact, in many places outcrops are scarce. Thus the only reliable method by which rocks of a particular age can be identified from place to place is by their organic fossil content. The organisms which live during any geologic period are not like those of any other period because they undergo gradual change. Therefore, fossils furnish a record, even though fragmentary, of the evolution of life.

The study of the earth has advanced far enough that geologists are able to recognize several distinct divisions of geologic time on the basis of events that have taken place throughout the world. These divisions of time are marked by such changes as the uplift of a mountain range or the appearance or disappearance of some form of life. General characteristics of each of the divisions are decidedly different, but the transitions from one time unit to another are so gradual that a geologist sometimes finds it difficult to place a precise boundary on a given unit of time.

Geologists have divided the whole of geologic time into "eras" based upon the kinds of life that were predominant during each era and upon the times during which certain world-wide mountain-building movements of the earth's crust took place. Each of the eras is divided in a similar way into "periods" during which less important, world-wide breaks in the geologic record occurred. Rocks that were deposited during a particular period of geologic time are called a "system." Periods are subdivided into "epochs" of time and systems of rocks into "series" or "groups," each of which in turn is composed of "formations." A formation is a unit of rock strata that can be readily recognized because of its physical characteristics or fossil content¹ and that can be mapped conveniently.

GEOLOGIC SETTING OF INDIANA

Early history

Parke County's long and varied geologic history began in Cambrian time (fig. 1) more than 450,000,000 years ago. Comparatively little is known, however, about the Cambrian rocks of Indiana and virtually nothing about Indiana's pre-Cambrian rocks. Geologists do know that in the periods which followed the Cambrian, a large basin was formed in Indiana, Illinois, and Kentucky, the center of which was in southern Illinois (fig. 2).

This basin, which now is called the Eastern Interior Basin or Illinois Basin, was surrounded by highland areas. On the east the basin was bounded by the low elongate Cincinnati Arch (fig. 2), which extended from south of Cincinnati northward along the Indiana-Ohio state line to Wayne County, Ind. Another large land mass, the Wisconsin uplift, stood above sea level to the northwest, and a low peninsula, called the Kankakee Arm, extended southeastward across north-

¹Prior to the Cambrian, the first period of the Paleozoic era, a few organic remains were preserved in the rocks, but fossils are abundant in rocks of the Cambrian system and younger systems (fig. 1).

MAJOR DIVISIONS (ERAS)	ROCKS EXPOSED IN INDIANA	SUB-DIVISIONS (PERIODS)
CENOZOIC 60	CONTINUOUS EROSION IN INDIANA	QUATERNARY 1
MESOZOIC 140		TERTIARY 59
		CRETACEOUS 80
		JURASSIC 35
		TRIASSIC 25
PALEOZOIC 340	PERMIAN 40	
	PENNSYLVANIAN 40	
	MISSISSIPPIAN 30	
	DEVONIAN 40	
	SILURIAN 30	
	ORDOVICIAN 70	
PRE-CAMBRIAN 1500		CAMBRIAN 90
	EXPLANATION Figures in millions of years Table drawn to scale for Paleozoic and later eras	

Figure 1. *Simplified geologic time scale.*
After Deiss, 1952, pl. 3.

ern Illinois into Indiana and formed the northern boundary of the basin. Other islands in the basin sea were the Nashville dome to the south-east and the Ozark dome to the west.

Clay, sand, chemical precipitates, and plant and animal remains accumulated intermittently in the ocean waters that filled this basin during Silurian, Devonian, and Mississippian time (280,000,000 to 450,000,000 years ago) and formed shale, sandstone, and limestone. Near the end of Mississippian time (fig. 1), the land rose above sea level; and, for thousands of years, rain fell upon the surface and streams eroded the rocks. During this time, nearly all the Mississippian rocks in the northwestern part of Indiana were eroded, but most of those in the southern part were not. That land surface, which looked much as it does today, consisted of hills, deep valleys, and flat uplands.

In the Pennsylvanian (fig. 1), the next geologic period, sediments from mountainous areas in the Appalachians and in northern Arkansas began pouring in upon the old land surface which again had sunk below sea level. The first of these sediments were coarse sands, now called Mansfield sandstone, which filled all the deep valleys and covered the hills, until in some places the deposits were more than 300 feet thick. Such detrital material accumulated intermittently for nearly 40,000,000 years as the land alternately rose above and sank below sea level. Accumulations of clay and coal are found locally within the sandstone.

Most of the sediments were interbedded clay and sand, which, as they were compressed, became shale and sandstone. At irregular intervals the surface rose above the water, and soil began to form. The land surface became swampy after a thin veneer of water had covered the area. Trees grew abundantly, fell down, decomposed, and gradually filled the swamp with peat. The weathered soil was leached of all organic material and became underclay. Moreover, the debris from the trees solidified, carbonized, and became coal.

As the land sank deeper, clay washed in and mixed with the plant remains. This mixture formed black carbonaceous shale, which miners call "slate." Only a small amount of mud was deposited as the water became deeper. Animals with calcareous shells, similar to present-day oysters and clams, died, and their remains accumulated on the sea floor. Calcium carbonate was precipitated from the ocean water and, together with the shells, formed limestone. Furthermore, sand and clay washed in from the surrounding high area and formed more sandstone and shale. This sequence was repeated many times.

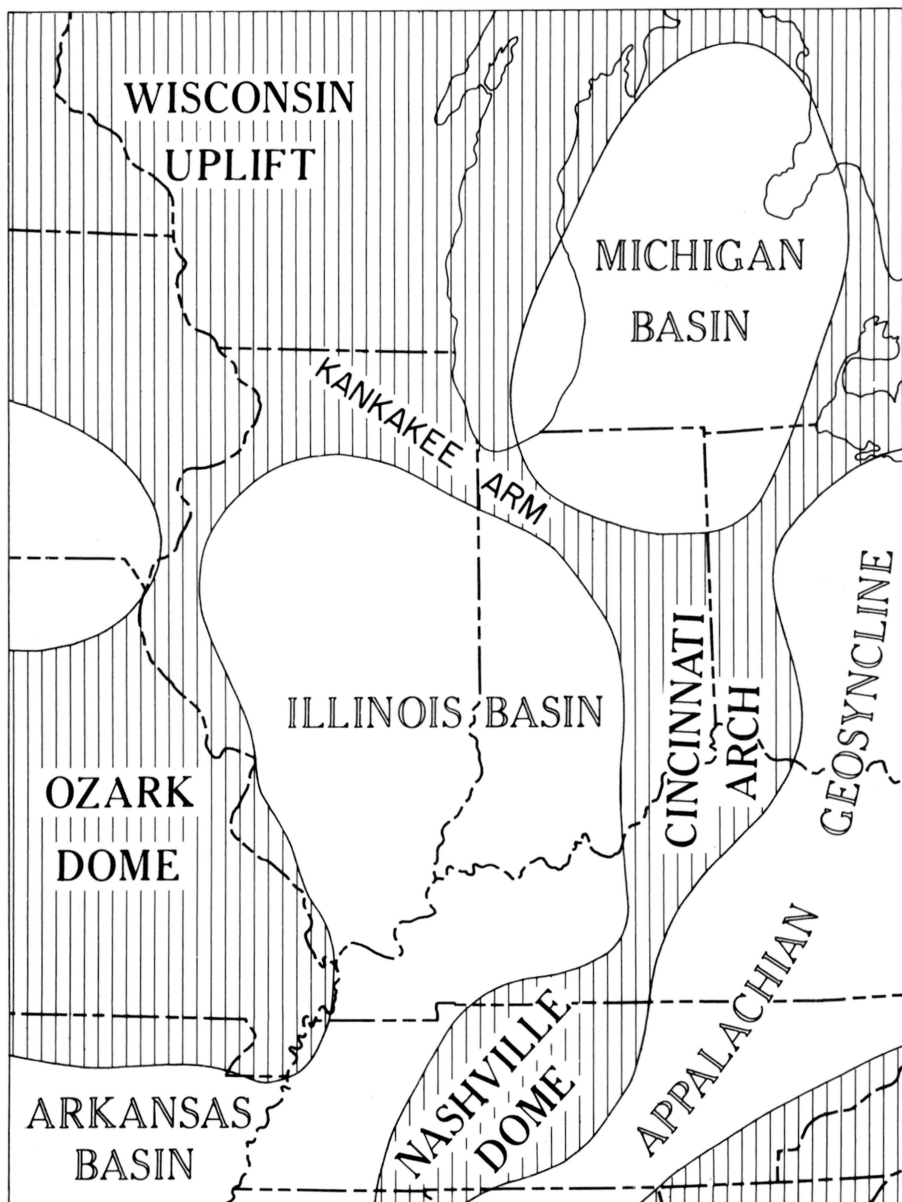


Figure 2. Generalized map of basins and lands in Midwest during early Paleozoic. After Deiss, 1952, pl. 4.

Later history

After the Pennsylvanian rocks (fig. 1) had been deposited over what now is Indiana, the surface rose above sea level and never since has been covered by ocean waters. The period of continuous erosion by streams lasted for nearly 240,000,000 years, or until the earth cooled and glaciers began to form on North America less than 1,000,000 years ago. During Tertiary time (fig. 1) rivers eroded the land to a gently rolling surface with little relief. Such a land form is called a "peneplain." Remnants of this ancient peneplain still can be recognized on ridge tops in southern Indiana, and in a few places, deeply weathered river gravel deposited by the old streams that carved that surface is found.

The last 1,000,000 years of geologic time are called the Quaternary period (fig. 1), of which all but the last 10,000 years are included in the Pleistocene epoch, or "Ice Age." During the Pleistocene epoch ice fields were formed over three great centers in northern Canada, and glaciers spread southward into the United States. As the ice moved, it picked up and carried along fragments of the rocks over which it scraped, and ground many of the softer ones into a rock flour. Later, as the glacier melted, it deposited much of this debris as a layer of bouldery and sandy clay that geologists call "till." Till that was deposited as irregular ridges and hollows along the edge of the glacier is called an "end moraine," and marks a place where, for a long time, the ice melted at the same rate that it moved forward (fig. 3). In other areas, where the glacier melted steadily faster than it moved, it was not able to pile up ridges but left a rather flat "ground moraine."

The floods which were produced during summers by the melting ice carried large quantities of clay, sand, and boulders away from the glacier only to drop the heavier and coarser particles along the valleys a short distance away. Geologists call these deposits of gravel and sand "glacial outwash." It was deposited in outwash plains in front of the ice and in valleys that led away from the glacier (fig. 3). The broad channels down which the meltwater flowed were "sluiceways." During the winters, when the volume of meltwater was small, the wind swept sand on the sluiceway surface into dunes and carried finer particles out of the valleys. This silt deposited by the wind is known as "loess." Gravel and sand that were dropped by streams that flowed across the surface of the glacier or in tunnels beneath the ice while it melted were left as long, sinuous ridges called "eskers" and cone-shaped hills called "kames" (fig. 3). All the deposits laid down by glaciers and their meltwater are called by the general name "drift."

Geologists have identified four distinct glaciations from the deposits in the north-central part of the United States (see table, p. 22).

Each of these glacial ages was followed by an ice-free period during which the climate was at least as warm as it is today. The first two certainly reached Indiana, although no deposits left by either of those ice sheets have been recognized in this state. The oldest ice advance for which geologists have good evidence in Indiana is the third, or Illinoian stage, named for the state of Illinois, where these deposits are excellently preserved. During Illinoian time, more than 200,000 years ago, glacial ice covered all of Indiana except the south-central part (fig. 4). A thick layer of glacial drift covering the entire area that was glaciated when the ice melted was left. For about 135,000 years after the Illinoian glaciation, the climate resembled that of today, and streams carved out valleys in the new land surface.

The last glacial age, the Wisconsin, began about 70,000 years ago, and after several advances and retreats ended about 10,000 years ago. Wisconsin glacial ice, however, did not extend as far south in Indiana as did the earlier Illinoian ice; only the northern two-thirds of the state was covered (fig. 4). Although the Wisconsin glacial age did not end until about 10,000 years ago, the youngest glacial deposits in Indiana are at least 15,000 to 20,000 years old. Erosion by streams since the last ice melted has carved the present valleys, and weathering has produced Indiana's soils.

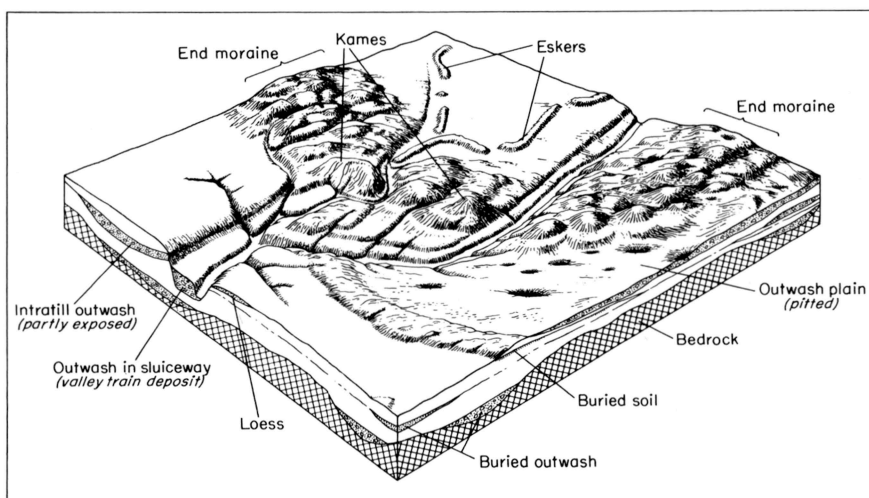


Figure 3. Block diagram illustrating the kinds of glacial deposits found in Indiana. (Diagram prepared for use in W.D. Thornbury's *Principles of Geomorphology*, John Wiley and Sons, Inc.)

PHYSIOGRAPHIC SETTING

Parke County, which is located about 50 miles west of Indianapolis, has an area of 447 square miles. It is bounded on the north by Fountain County, on the northeast by Montgomery County, on the east by Putnam County, on the south by Clay and Vigo Counties, and on the west by Vermillion County.

The Wabash River now controls the drainage in the county as it did before the time of glaciation. The Wabash Valley, which extends along the west side of the county, was a giant sluiceway during Wisconsin time and also probably during earlier glacial ages. The flat bottomlands in the western part of Parke County were eroded in glacial outwash which nearly filled the preglacial valley.

Malott (1922, p. 66) divided Indiana into physiographic divisions, three of which are represented in Parke County. The area in Parke County north of the Wisconsin drift boundary (fig. 4) is part of the Tipton till plain, a flat ground moraine of Wisconsin age on which the only relief consists of relatively low end moraines and postglacial valleys. That part of the county which is south of this boundary and which drains into the Wabash River is included in the Wabash lowland, a region of subdued relief and valleys partly filled with glacial drift. A small upland, a unit which is characterized by trench-like, flat-bottomed valleys, rock benches, and local structural plains. Because glacial till covers the upland areas and glacial outwash the lowland areas, bedrock is found only in isolated areas. These outcrops occur in places where postglacial erosion has stripped away the glacial sediments.

BEDROCK SEQUENCE

Mississippian system

Most of the rocks which crop out in Parke County are included in the Pennsylvanian system. A few inliers of rocks from the underlying Mississippian system, however, are exposed along large stream valleys in the eastern and northeastern parts of the county (figs. 5 and 6). The Mississippian outcrops are nearly all Ste. Genevieve, St. Louis, and Harrodsburg limestone. The oldest exposed rocks are in the extreme northeast corner of the county near Shades State Park, where the underlying Borden siltstone is present in the Sugar Creek Valley bottoms.

Borden group. -- This group of rocks was named from the town of Borden, Clark County, Ind. The Borden (see table, p. 16) has been described as being as much as 700 feet thick, but the group probably is less than 600 feet thick at the places where these rocks occur in

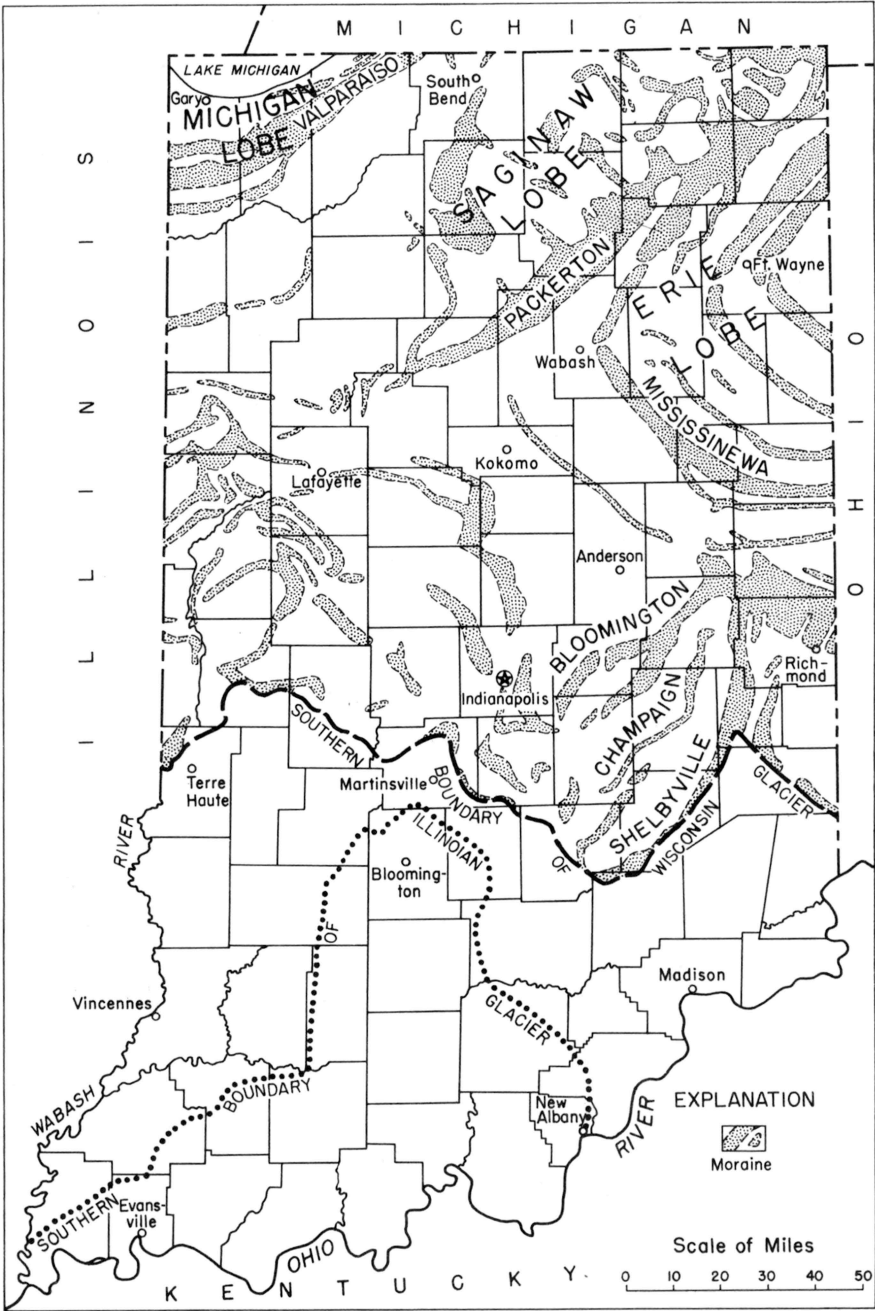


Figure 4. Map of Indiana showing Wisconsin glacial lobes and moraines. After Deiss, 1952, pl. 7.

Bedrock formations exposed in Parke County

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GEOLOGY OF PARKE COUNTY, INDIANA

System	Series	Formation (stage)	Character of sediments	Thickness (feet)
Pennsylvanian		Petersburg	Sandstone, shale, Alum Cave limestone, and Coals IVa and V.	110
		Linton	Sandstone, shale, a thin limestone, and Coals III and IV.	50
		Staunton	Sandstone, shale, and Coal III.	60
	Pottsvillian	Brazil	Alternating sandstone and shale, Block coals, Minshall coal, and Minshall limestone.	35
		Mansfield	Coarse-grained, cross-bedded, massive sandstone; locally contains shale and coal.	80
Mississippian	Meramecian	Ste. Genevieve	Crystalline, partly oolitic, thin-bedded limestone.	80
		St. Louis	Granular lithographic limestone and fine-grained siliceous dolomite.	90
		Salem	Soft, granular fossiliferous limestone and silty argillaceous limestone.	20
	Osagian	Harrodsburg	Crystalline crinoidal limestone and siliceous dolomite.	60
		Borden group	Gray and green siltstone and shale; contains thin beds of limestone near top.	500

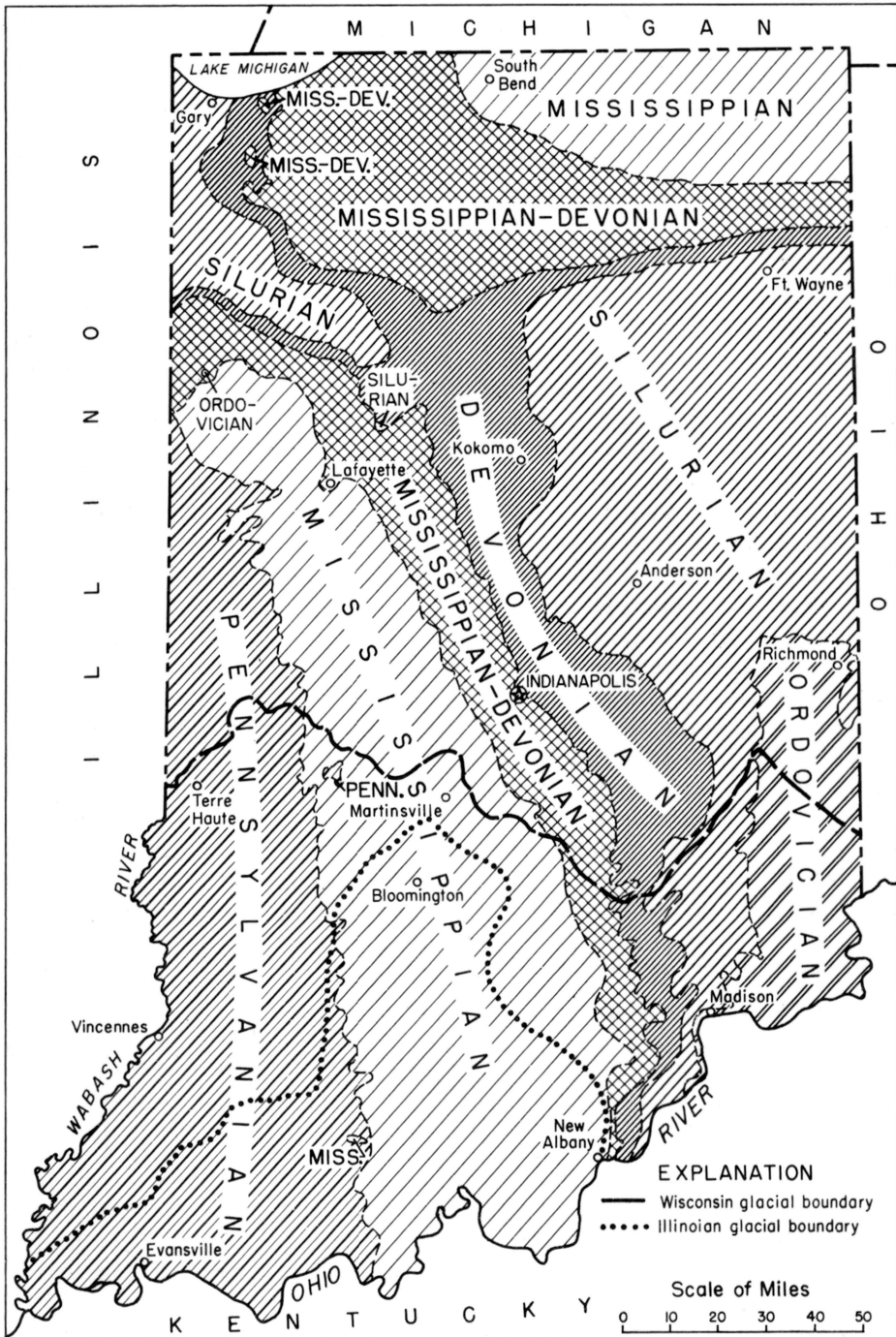


Figure 5. Generalized bedrock map of Indiana.

Compiled by J. B. Patton
1952

Parke County. The lower part is greenish-gray micaceous and glauconitic siltstone. In Parke County, the upper part is soft gray and green shale or siltstone which contains several thin beds of limestone called Floyds Knob.

Harrodsburg limestone. --The Harrodsburg limestone (see table, p. 16) was named from outcrops near Harrodsburg, Monroe County, Ind. The beds are 60 feet thick and are composed of coarsely crystalline crinoidal limestone and fine-grained siliceous dolomite. Geodes and chert are common in the lower part, and, locally shale partings are found throughout the beds.

Salem limestone. --The Salem limestone (see table, p. 16) was named from outcrops near Salem, Washington County, Ind. This limestone is not exposed at the surface but is found in drillings below the surface in the southern two-thirds of Parke County. It ranges in thickness from less than 20 feet at its northern extent to more than 60 feet in the southern part of the county. It is the famous Indiana building stone of Washington, Lawrence, and Monroe Counties, where it is soft, granular, fossiliferous, oolitic, massive, and cross-bedded. Much of the Salem limestone, however, is brown, fine-grained, silty, argillaceous, and dolomitic. This dolomitic limestone, which quarrymen call "bastard stone," may overlie, underlie, or be interbedded with the oolitic limestone.

St. Louis limestone. --The St. Louis limestone (see table, p. 16) was named from exposures near St. Louis, Mo., and consists of tan to gray, granular, lithographic, thin-bedded limestone and gray to brown, fine-grained siliceous dolomite. Thin green, gray, or black shale beds are scattered throughout the formation, and chert and black flint nodules are abundant in the upper two-thirds. This limestone is 90 feet thick in Parke County.

Ste. Genevieve limestone. --The Ste. Genevieve limestone (see table, p. 16) was named from exposures in Ste. Genevieve County, Mo., and is white to buff, crystalline, partly oolitic, and thin-bedded. In Parke County, it is about 80 feet thick.

Pennsylvanian system

Rocks of the Pennsylvanian system, like those of other systems, belong to various formations, and thus this method of classifying rocks is used in the discussion which follows. Within the formations, however, coals and limestones are more persistent and usually of more value than the sandstones and shales. These coals and limestones therefore are given names or numbers independent of formation names.

Ashley (1899, pp. 86-91) named the Indiana coals with roman numerals. The lowest coal was Coal I and the highest, Coal IX.

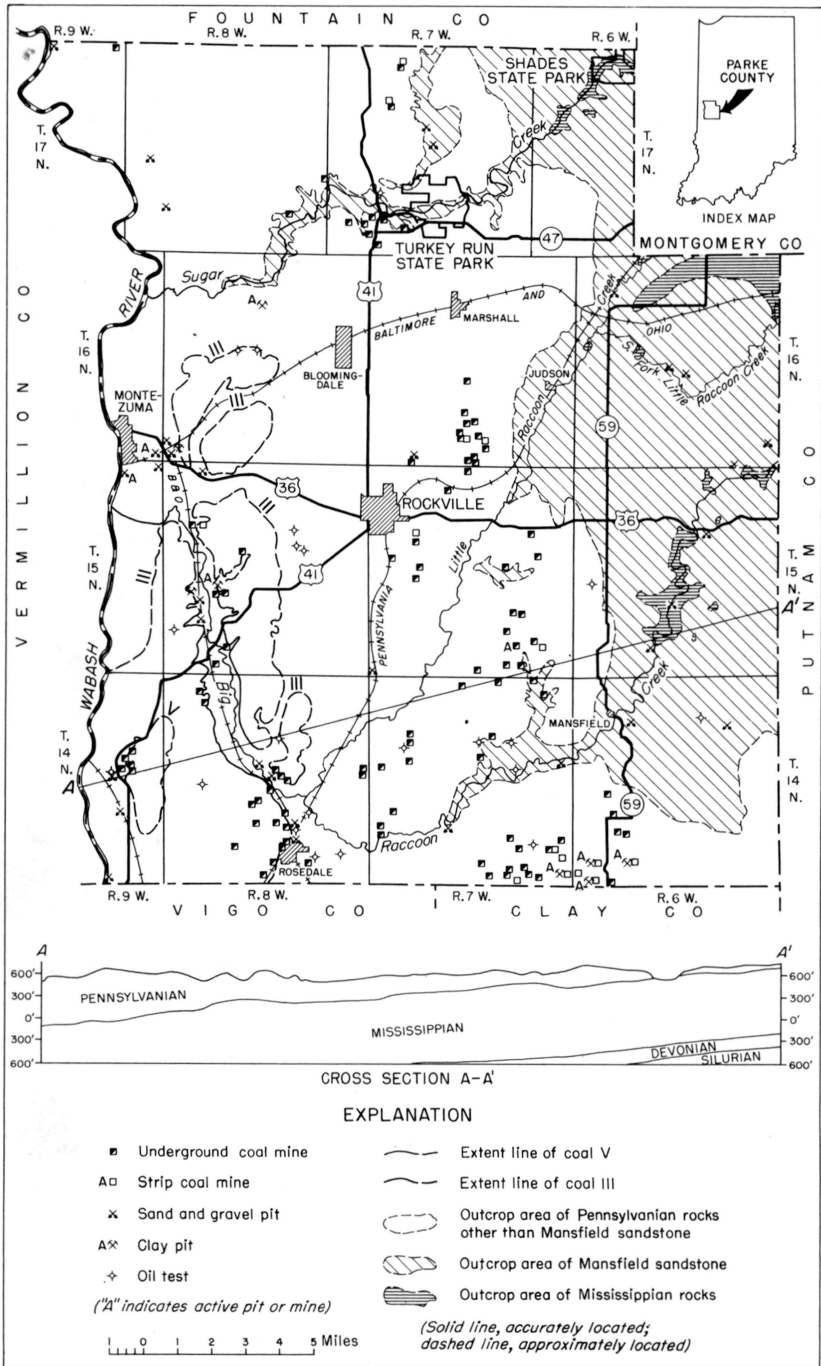


Figure 6. Map of Parke County showing areal extent of bedrock formations, coal mines, and clay and gravel pits.

This system, although slightly revised, still is used in Indiana. Coals are designated from the base upward as Mansfield coals, Lower Block, Upper Block, Minshall, and Coals II, III, IIIa, IV, IVa, V, Va, Vb, VI, and VII.

Mansfield formation. --The Mansfield sandstone (see table, p. 16), which was named from exposures in the quarry at Mansfield, Parke County (Hopkins, 1896, p. 199), is massive, coarse-grained, cross-bedded, and variegated. This sandstone fills the valleys which were eroded at the end of Mississippian time.

Contrary to popular opinion, however, the Mansfield formation is not in all places a massive sandstone. In Parke County, it contains a few thin lenticular coals and, locally, as much as 20 to 30 feet of shale. In other areas, the formation is almost entirely shale or may contain shale, several coals, and at least two thin limestones.

Outcrops of the massive sandstone facies of the Mansfield formation are abundant along Raccoon Creek northeast of Mansfield, along Little Raccoon Creek northeast of Rockville, and along Sugar Creek east of U. S. Highway 41.

Brazil formation. --The Brazil formation (see table, p. 16), which is best developed near Brazil, Clay County, overlies the Mansfield formation. This formation ranges from 75 to 90 feet in thickness and is composed of alternating sandstone and shale and the well-known Block and Minshall coals. The Brazil formation, however, is not well exposed in Parke County. The Block coals can be seen mostly in the southern part of the county near Carbon and in the northern part in the area 3 or 4 miles north of Turkey Run Park. The Minshall coal and limestone are exposed near the abandoned town of Minshall, at Nyesville, and in the northwest corner of the county near Lodi.

Staunton formation. --The Staunton formation (see table, p. 16), which overlies the Brazil formation, ranges from 50 to 70 feet in thickness and is composed of sandstone, shale, and Coal III. Coal III averages about 6 feet thick in the vicinity of Rosedale and has been mined extensively in the vicinity of Rosedale and Coxville. This coal crops out along Raccoon Creek between Coxville and Mecca and can be seen along U. S. Highway 36 east of Montezuma, where it is much thinner.

Linton formation. --The Linton formation (see table, p. 16) overlies the Staunton formation and ranges from 40 to 60 feet in thickness. It contains sandstone, shale, Coals IIIa and IV, and a thin limestone above Coal IIIa. Coal IIIa, overlain by a thin black fissile shale and a thin limestone, crops out about 20 feet above Coal III in the vicinity of Mecca and Montezuma. Coal IV is not known to crop out in the southern part of the county but may be present just below the hill-tops west of Bloomingdale.

Petersburg formation. --The uppermost Paleozoic (fig. 1) rocks

exposed in Parke County are part of the Petersburg formation. (See table, p. 16.) This formation ranges from 90 to 120 feet in thickness and contains sandstone, shale, Coals IVa and V, a thin limestone above Coal IVa, and the Alum Cave limestone above Coal V.

Coal IVa occurs only in the southwest corner of the county and crops out in a few places northwest of Coxville. Coal V can be seen in the bluff just east of Lyford, where the coal was mined in many small drift mines.

Other Pennsylvanian sediments were deposited on top of the rocks in the Petersburg formation, but they were removed during the long period of erosion which followed the Pennsylvanian period.

YOUNGER DEPOSITS

Tertiary

The complete withdrawal of the seas shortly after the deposition of the youngest Pennsylvanian sediments accompanied a general uplift of central North America. During the time between the Pennsylvanian period and the onset of glaciation, this part of the continent underwent erosion by streams, and thus the land was reduced to a gently rolling surface called a peneplain. Although several successive peneplains probably were formed, uplifted, and dissected by streams, evidence of only the last one, developed during the latter part of the Tertiary period (fig. 1), can be recognized in Indiana. In the unglaciated part of Indiana, deeply weathered, cherty gravel deposits are present on some of the upland peneplain remnants and probably were laid down by streams that meandered over the old land surface (Malott, 1922, pp. 132-136).

Early Pleistocene

Geologists believe that the Pleistocene (glacial) epoch began about 1,000,000 years ago (see table, p. 22). It consisted of four major advances of ice which reached as far south as central and southern Indiana. Each glaciation was followed by a long period during which the climate was as warm as it is now. Differentiation of the deposits of one glacial stage from those of another is done largely by the recognition of soils that were developed during the long intervals of weathering and that now are buried beneath unweathered deposits of a younger glaciation.

The presence in Indiana of the first two ice sheets, Nebraskan and Kansan, can be inferred both from drainage changes and from deposits found in Indiana and in adjacent states. An exposure of

Pleistocene chronology for the upper Mississippi Valley

Geologic Time Units			Age in years (estimated)
RECENT			8, 000
PLEISTOCENE EPOCH	Wisconsin (fourth glacial) age	Mankato subage ¹	11, 000
		Cary subage	25, 000
		Brady (intergla- cial) subage	45, 000
		Tazewell subage	60, 000
		Iowan subage	70, 000
	Sangamon (third interglacial) age		200, 000
	Illinoian (third glacial) age		300, 000
	Yarmouth (second interglacial) age		600, 000
	Kansan (second glacial) age ²		700, 000
	Aftonian (first interglacial) age ²		900, 000
Nebraskan (first glacial) age ²		1, 000, 000	
PLIOCENE EPOCH			

¹Did not extend into Indiana. Dated by radiocarbon.²Deposits not definitely recognized in Indiana.

probable pre-Illinoian drift in Parke County can be found along Green Creek about 2 1/2 miles south of the north county line. Both Nebraskan and Kansan ice sheets undoubtedly dammed the Teays River, a major preglacial stream which crossed north-central Indiana from east to west and which left Indiana at the Warren-Benton county line. The water that escaped from this temporary glacial lake into the Wabash Valley probably was largely responsible for eroding the deep bedrock floor beneath the Wabash upstream from Terre Haute.

Illinoian stage

Ice covered all of Parke County during the Illinoian age. Illinoian drift underlies younger deposits in the northern part of the county, and it is at the surface in the southern third (fig. 7). Post-Illinoian streams have cut deep valleys into this drift and have reached the underlying bedrock in many places. Considerable flat upland area, however, still remains. Unweathered till, or ice-laid drift, of the Illinoian stage is a hard, gray to drab, sandy and silty clay that is studded with pebbles and boulders. The till has been leached of carbonates to a depth of 13 or 14 feet (Thornbury, 1937, p. 33), and gumbotil, a sticky, clay-rich product of weathering, has developed in the subsoil where drainage is imperfect. The Illinoian drift includes glacial outwash gravels and lake clays, but none of these are found at the surface in Parke County. Some of the buried sand and gravel beds which yield ground water are undoubtedly of Illinoian age.

Sangamon interglacial stage

After the Illinoian ice sheet had melted, a long period of warm weather prevailed during which streams excavated valleys in the glacial deposits and soils were formed on the new surface. During this ice-free interval, the glacial materials were leached of lime to a depth of about 6 feet. Exposures in many bluffs show part of this old soil buried beneath younger, unweathered glacial drift (Thornbury, 1937, pp. 117-118). Forests covered Indiana during the Sangamon interval, and in a few places peat and pieces of wood have been found buried at the base of the younger drift.

Wisconsin stage

Deposits of the last glacial ice that covered North America are so well preserved that a more detailed study has been made of them than of older deposits. Recent work with radioactive carbon has shown

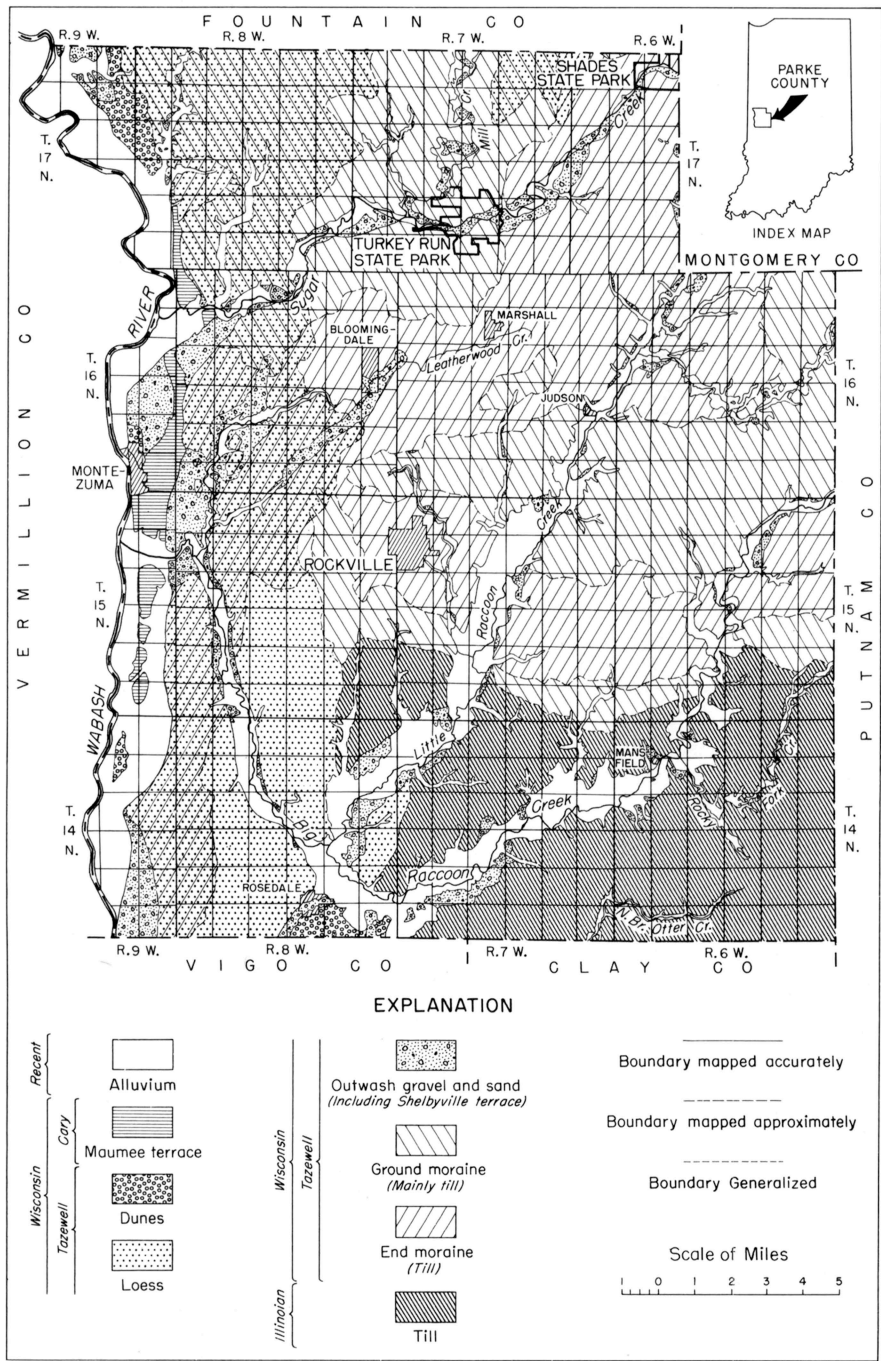


Figure 7. Map of Parke County showing glacial geology.

that the last, or Mankato, ice advance of the Wisconsin reached its maximum extent 11,000 years ago. However, deposits of only two of the Wisconsin substages, Tazewell and Cary, both of which are older than the Mankato, now are recognized in Indiana. The age of the Tazewell drift in Parke County has been estimated as about 45,000 years.

Tazewell substage. -- Tazewell drift comprises the southernmost Wisconsin deposits in Indiana. Till of the Tazewell substage is a compact, sandy and silty clay which is blue gray to olive gray when it is fresh but which weathers to tan. It is leached of carbonates to a depth of 4 to 5 feet.

Leverett (1899, p. 197) described the Shelbyville moraine, the terminal ridge left by the Wisconsin ice, as crossing central Parke County. This moraine is generally 3 to 4 miles wide and consists mostly of irregularly deposited till. The shallow, closed depressions characteristic of morainal topography now are nearly all drained by streams. A narrow plain of till and outwash silts and sands lies south of the Shelbyville moraine across much of Parke County (fig. 7) and fills the re-entrant in the moraine west of Rockville (Thornbury, 1937, p. 37). In the western part of the county thick loess covers this feature.

The Champaign moraine, which marks a pause in the general ice retreat, trends northeastward between Sugar and Little Raccoon Creeks. Postglacial streams have eroded it less than the Shelbyville moraine, and the original hummocky topography left by the ice is much better preserved.

The terraces along the Wabash River and along Sugar and Raccoon Creeks are underlain by Tazewell outwash. This outwash is predominately cross-bedded gravel and sand, although in some places a veneer of weathered gravel a few feet thick covers a bedrock terrace.

The upper terrace along the Wabash River has been called the Shelbyville terrace because it marks the highest level of valley filling when the ice stood at the Shelbyville moraine (Fidlar, 1948, p. 21). It stands about 75 feet above the river bottomland or floodplain. As the ice retreated northward from the Shelbyville moraine, outwash gravels and sands continued to be deposited along the Wabash Valley. Thus the upper level of valley filling is represented now by a terrace that becomes progressively younger upriver from the Shelbyville moraine. Low dunes give the terrace surface a hummocky appearance between Lodi and Howard and northeast of Montezuma. These dunes were blown against the east side of the valley by strong westerly winds during the Pleistocene winters, when melting was at a minimum and the valley was a broad expanse of bare sand and gravel. Silt picked up by the winds at the same time was carried out of the valley and fell upon the upland. This layer of silt, called loess, is more than 20 feet thick at the edge of the valley but tapers eastward and becomes so thin a few miles away that it cannot be recognized. The loess

"boundary" shown in figure 7 is drawn where the loess still is approximately 1 foot thick, but where it is patchy and no longer gives a distinct texture to the soil and drainage pattern. Thin, discontinuous loess probably covers the upland throughout Parke County. Loess is a massive, compact, tan silt which stands in nearly vertical bluffs and which may contain lime nodules and shells of land snails. The top 6 to 8 feet re-leached of carbonates.

Cary substage. --No ice-laid deposits of Cary age are found in Parke County. During the Cary deglaciation of northeastern Indiana, however, glacial Lake Maumee, an ancestral phase of Lake Erie, was formed. Its outlet was at the place where Fort Wayne now stands. Overflow water from this lake cut a new valley floor which can be traced along the Wabash from Allen County to the Ohio River. The extensive terrace that stands about 20 feet above the present floodplain in Parke County is the remains of this old river floor and is called the Maumee terrace (Fidlar, 1948, p. 71).

Recent deposits

The Recent (postglacial) age began when the last Wisconsin ice melted. Because the glaciers retreated gradually, the Recent age began in an area as soon as the ice no longer directly influenced erosional and depositional processes there. Outwash was laid down along the Wabash Valley and loess collected on the bluffs at the same time that alluvium was being deposited by the non-ice-fed streams that drained Parke County. Thus some of the Recent deposits were formed at the time glacial ice still existed a few miles away.

Along most of the streams of Parke County, alluvial sand, silt, and clay have been deposited on the floodplains. The most extensive deposits of this kind are found on the bottomland along the Wabash River and Big Raccoon Creek, where they generally form a veneer a few feet thick over previously deposited glacial drift. Alluvium lies directly on Mississippian or Pennsylvanian bedrock along some parts of Sugar Creek.

Muck and peat have collected in a few shallow depressions in the Champaign moraine which crosses northeastern Parke County. If these deposits were to be studied, the changes in the predominant pollen grains found at different levels undoubtedly would indicate the changes in climate that have taken place since the ice melted.

COAL

History of mining

Coal has been mined for nearly 100 years in Parke County. In 1859 (Lesquereux, 1862, pp. 331-333), mines were reported to have been opened in Coal V near Lyford and in the Minshall coal 3 miles east of Catlin. By 1869, many small mines were producing coal in the southern and western parts of the county.

In 1898, Parke County produced 612,000 tons of coal from 13 mines and ranked fourth among the coal-producing counties in Indiana. Most of the coal that was mined came from Coal III near Rosedale, Coxville, and Lyford. In addition, smaller amounts came from the Block and Minshall coals near Diamond and Mecca. By 1918, the peak year for coal production in Indiana, production in Parke County had declined to 295,000 tons, and the county ranked eleventh among coal-producing counties in Indiana. Since 1918, coal production in Parke County has continued to decline gradually.

Most of the coal that has been produced has come from underground mines, which, by a conservative estimate, would number more than 200 (fig. 6). In recent years, however, most of the coal has been mined by stripping. Block coals have been stripped in the southern part of the county east of Diamond and about 3 miles north of Turkey Run State Park. The Minshall coal was stripped near Diamond, east of Rockville, west of Nyesville, and 4 miles north of Turkey Run near the county line. Coal II was stripped 3 miles northwest of Mansfield, half a mile southeast of Nyesville, and 2 miles east of Lodi.

Present mining

During the past few years, the Minshall coal has been mined underground by the Big Four, the Jones, and the Wimmer No. 2 mines. All the underground mines are small, and only the Wimmer No. 2 now is known to be producing coal on a commercial basis. The Frazier strip mine also mined Minshall coal. The Maple Grove and the Blackburn strip mines produced Coal II. Several small strip mines now are producing the Upper Block coal in localities south of Mansfield and near the Parke-Clay county line.

Possible future mining

In general, the cream of the coal in Parke County, as in the other coal areas of the state, already has been mined. Many small areas which are suitable for strip mining could be outlined by drilling

a few coal tests. Likely areas, such as the Mill Creek Valley in the northwest corner of the county, could be exploited easily.

The Block coals and the Minshall coal are present at depth under much of the western one-third of the county, and they are thick enough in some places for underground mining. A comprehensive drilling program would soon locate and limit such areas. Coal mining probably will never again be a large industry in Parke County, but sufficient coal still is available to ensure a continuance of small mines for a few hundred years.

CLAY

Clay is an important raw mineral product in the county. The clays are found west of the Mansfield formation and are stratigraphically younger than this formation. Mecca was the center of the ceramic industry in the county before 1900. The Indiana Sewer Pipe Company and the two plants of the William E. Dee Company made drain tile, sewer pipe, wall coping, flue lining, and other products from local shales and clays. Most of the clay was obtained from the underclay below Coals III and IIIa. Later, the William E. Dee Company operated a tile plant 1 1/2 miles east of Montezuma. This plant used the shale which overlay Coal II and which was obtained from the north-south trending bluff adjacent to the plant.

Present ceramic plants in the county are The Clay City Pipe Company at Mecca and Dee Clay Products at Bloomingdale. Most of the raw materials used in these plants come from the underclays below Coals III and IIIa and from the shale below Coal III. Moreover, underclay from below the Upper Block coal now is being mined in the southeastern part of the county and just north of Carbon, Clay County. This clay is used in ceramic plants in the Brazil area. The future for these ceramic plants looks bright because adequate amounts of raw material will be available in Parke County for many years.

SAND AND GRAVEL

Large amounts of sand and gravel are available in the Wabash River Valley. Locally, more than 100 feet of gravel is present north and south of Montezuma. This gravel, as mentioned previously (see p. 25), is cross-bedded and was deposited as outwash during glaciation. Smaller amounts of sand and gravel which also owe their origin to glacial sand and gravel have been recovered from pits in about 40 localities scattered across the county (fig. 6). Only four or five pits, however, now produce gravel. Parke County has an abundance of sand and gravel, the production of which is limited only by the economic

factors that influence production and shipping to the point of utilization.

PETROLEUM

Oil and gas have not been produced commercially from rocks in Parke County. Only approximately 30 test wells have been drilled in the entire county (fig. 6). The Devonian (fig. 1) limestones from which oil is produced in Vigo and Sullivan Counties to the south are present at a depth of 1,000 to 1,600 feet in Parke County. Therefore, possibly some oil will be found in these beds by future drilling. The deeper Trenton (fig. 1) horizon also offers possibilities.

In order for oil and gas to occur in a rock, however, proper conditions of structure and lithology must be present. In addition to a source material for petroleum and a porous and permeable rock which will hold oil, a trap must be present to retain the oil in the rock. None of these traps are known to exist in Parke County. Geologic knowledge indicates, however, that possibly some small traps may be present in the county. On the basis of these facts, geologists believe that the production of petroleum will never be a large industry in Parke County, but small amounts of oil and gas may be produced.

TURKEY RUN STATE PARK

Turkey Run State Park, which is 2 miles north of Marshall, extends along Sugar Creek for 2 1/2 miles and comprises more than 1,500 acres of rugged topography.

The park owes its deep canyons, winding gorges, and vertical bluffs to forces which have been at work for several thousands of years. When the postglacial Wabash River cut its valley below the level of the glacial floodwaters, Sugar Creek likewise had to cut down to a lower level. If the rocks had been soft, Sugar Creek could have cut a wide valley with fairly steep slopes. The Mansfield sandstone, however, was hard and resisted easy erosion. Sugar Creek therefore eroded a deep, narrow valley, and all its tributaries cut steep ravines in the sandstone. Rocky Hollow is an excellent example of a deeply incised tributary. The stream has nearly vertical walls which in places have been undercut by the water. If one walks along trail no. 3, which leads through Rocky Hollow, one can see evidence of this water cutting through the sandstone as it reaches the lower level of Sugar Creek. Spectacular features, such as the Devil's Ice Box and the Punch Bowl, also are the results of erosion. Sunset Point is a good example of an upland area that resisted erosion while the rocks all around it were cut away.

Not all the Mansfield formation, however, is massive. If one

follows trail no. 4 to the covered bridge on the east side of the park, one sees the massive sandstone abutments at the bridge. Just west of the bridge, however, on the north side of Sugar Creek, the sandstone is thin-bedded. There members of the Civilian Conservation Corps quarried the sandstone for use in the construction of trails and buildings. The stone that was used in the service building and the saddle barn came from this quarry.

A few hundred yards east of the bridge, the massive sandstone changes to shale and platy sandstone and contains a few thin coals and underclays. Sugar Creek cuts through the softer material more easily, and for 3 miles between Turkey Run and the Shades State Park, that stream cuts a valley about half a mile wide. Coal is present in a few localities in the massive sandstone in Turkey Run Park. The coals, in general, are less than 2 feet thick and extend only a few hundred yards from the outcrop. One can see an example of this coal near the junction of trails nos. 4 and 8 about 800 feet east of the suspension bridge.

Not all the steep bluffs in the Turkey Run vicinity were formed in Mansfield sandstone. About 1 mile north of the hotel, on the bank of Mill Creek, steep, deeply serriate bluffs were cut out in Wisconsin till. These bluffs are nearly 100 feet high and look like miniature badlands. This area, which can be reached by horse trail, is called the Camel's Back Area.

SHADES STATE PARK

The Shades State Park is 4 miles north of Waveland and contains 1,952 acres which extend along Sugar Creek. About one-third of the area is in Parke County, a few acres are in Fountain County, and the remainder of the park, which includes all the area open to the public, is in Montgomery County.

Like Turkey Run, the Shades Park has deeply incised valleys and many vertical bluffs. Likewise, these valleys and bluffs were formed by the rapid cutting down of Sugar Creek and its tributaries. Massive Mansfield sandstone forms the top of the upland areas and is underlain by shale and siltstone of the Borden group. After the streams had cut down through the hard sandstone, they quickly cut through the softer shale and siltstone. A good example of this can be seen at Silver Cascade. There the small stream, which still is cutting through the Mansfield sandstone, is perched high above Sugar Creek, which already has cut deeply into the sediments of the Borden group. Just below the base of the sandstone and in the stream at the top of the falls, the Floyds Knob limestone is present near the top of the Borden group. It is composed of several thin hard ledges and forms a series of miniature waterfalls.

CONCLUSIONS

From a geologist's viewpoint, Parke County will never have more than a small amount of coal mining and probably will have only a small amount of oil and gas production. The county does have, however, a great wealth of sand and gravel, ceramic clay and shale, and spectacular scenery.

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GLOSSARY

- age - a major subdivision of the Pleistocene (glacial) epoch of geologic time; also, a general term used to refer to any unit of geologic time, regardless of length.
- alluvium - undifferentiated clays, silts, sands, and gravels deposited by a stream.
- argillaceous - shaly; containing clay.
- bedding - layered structure of sedimentary rocks, generally caused by changing conditions during deposition.
- bedrock - rock (in Indiana, limestone, sandstone, shale, coal) which lies beneath a mantle of unconsolidated or loose material, such as alluvium or glacial drift.
- calcareous - containing a recognizable amount of calcium carbonate (CaCO_3).

carbonaceous - containing a recognizable amount of partly oxidized organic remains, generally of plants, which have a black or brown color.

chert - white, tan, or gray masses of non-crystalline or microscopically crystalline silica.

crinoidal - containing abundant fragments and columnal segments of crinoids, marine animals commonly known as "sea lilies."

cross-bedded - beds which exhibit an oblique original stratification.

detrital material - particles derived from pre-existing rocks.

dolomite - a mineral composed of (Ca, Mg) CO_3 ; a sedimentary rock similar to limestone and composed essentially of the mineral dolomite.

drift - undifferentiated sediments of glacial origin.

end moraine - a ridge or belt of hummocky topography and the glacial drift of which it is composed that marks a position occupied by the edge of a glacier while the ice advanced at the same rate that it melted and dropped the load of debris which it carried.

epoch - a major subdivision of a period of geologic time.

era - a major subdivision of geologic time.

esker - an elongate, steep-sided, commonly segmented ridge of sand and gravel deposited by streams of meltwater flowing beneath stagnated ice of a disappearing glacier.

facies - variations in composition and thickness of a rock formation which have resulted from changes in the environment of deposition.

fissile - tending to be separated easily into thin layers or laminae.

flint - dark-gray or black masses of non-crystalline or microscopically crystalline silica.

formation - a unit of rocks which has readily recognizable boundaries and which can be mapped.

fossiliferous - containing fossils, or the remains of formerly living

organisms.

geode - a cavity in a rock, filled with crystals.

glauconitic - containing the green mineral glauconite, a hydrous potassium iron silicate.

ground moraine - a flat to gently rolling, glacially constructed plain underlain dominantly by till.

group - a local or provincial subdivision of the rocks which constitute a system; contains two or more formations.

gumbotil - a dark-colored, completely leached clay, which is sticky and plastic when wet and hard when dry, and which is chiefly the result of weathering of till under conditions of poor drainage.

inlier - an area of outcrop of rocks completely surrounded by younger rocks.

kame - a hill composed of sand and gravel, which was deposited beneath, or at the edge of, a glacier, and which slumped when the supporting ice walls melted.

lacustrine - pertaining to the environment and sediments of a lake.

leach - to remove some components of a material by solution.

lenticular - lens-shaped.

limestone - a sedimentary rock composed mainly of consolidated lime (calcium carbonate) mud, or shells, or both.

lithographic - descriptive of uniform, fine-grained limestone similar to that once extensively used for printing by the lithograph process.

lithology - the study of rocks; physical composition and character of any rock.

loess - wind-blown and wind-deposited silt.

meltwater - water derived from melting glacial ice.

micaceous - containing flakes of minerals of the mica group.

nodule - a rounded to irregular mass of earthy or mineral material.

oolitic - pertaining to small granular particles of calcium carbonate which resemble fish eggs.

outwash - glacial drift that has been sorted and deposited by moving water; consists mainly of gravel and sand.

peneplain - a widespread, nearly flat or gently rolling land surface produced during a long period of stream erosion without uplift or other interruption.

period - a major subdivision of an era of geologic time which has standard boundaries recognizable throughout the world.

re-entrant - an inward-pointing opening, as in the face of an excarpment or ice margin.

sandstone - a rock composed mainly of sand grains cemented or compacted together.

series - sediments or rocks deposited during an epoch.

shale - a rock composed predominantly of clay particles.

siliceous - containing silica (quartz).

siltstone - a rock composed mainly of silt particles.

sluiceway - a wide, trough-like valley which carried meltwater away from a glacier.

stage - sediments or rocks deposited during an age; a major subdivision of the sediments which comprise the Pleistocene series.

system - rocks deposited during a period of geologic time.

till - heterogeneous, nearly non-bedded, unsorted drift deposited directly by glacial ice and consisting of boulders and pebbles set in a matrix of sand, silt, clay, and rock flour: "boulder clay."

topography - the surface of the earth or of a region.

underclay - the clay which generally underlies a coal bed; considered to be the remains of an ancient soil.

valley train - glacial outwash deposits concentrated in valleys or sluiceways, and generally well-sorted and rounded.

