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## THE GEOMORPHIC HISTORY OF THE UPPER WABASH VALLEY\*

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**ABSTRACT.** Most of the area now drained by the upper Wabash Valley was in Tertiary time part of the Teays Valley drainage. Burial of the Teays Valley and its associated Tertiary topography and diversion of part of its drainage to the Wabash were initiated by the Kansan glaciation and completed by the Illinoian.

The upper Wabash River is superposed across a buried Tertiary topography that the river has hardly more than begun to exhume. Headward, from about Terre Haute, Indiana, the Wabash Valley consists of alternating wide and narrow stretches depending largely upon whether its course crosses a preglacial valley or a buried preglacial bedrock upland. The courses of the Wabash and Teays in Indiana roughly parallel each other but actually intersect at only two places.

The most conspicuous topographic features along the Wabash Valley are largely a consequence of its having been a major Wisconsin sluiceway. Most striking are: (1) minor scabland tracts, where the sluiceway cuts through buried bedrock uplands, (2) partially exhumed bioherms (klintar), where the valley crosses the belt of Silurian rocks, (3) numerous abandoned valley braids above the present valley floor, (4) gravel and bedrock terraces, and (5) dune and loess deposits in or adjacent to the sluiceway.

The surficial loess adjacent to the Wabash Valley is of Tazewell age, but buried loess that has been interpreted as of Farmdale age indicates that during this Wisconsin subage ice extended far enough into Indiana to send outwash down the Wabash Valley. It is questionable whether Iowan loess is present along the Wabash Valley. What has been previously called Iowan loess may be pro-Tazewell loess. No Cary loess has been mapped, but till and outwash of this stadial are present in the uppermost part of the Wabash drainage basin.

### INTRODUCTION

The Wabash River is commonly thought of as a Hoosier stream, although its source is in Ohio about 12 miles east of the Indiana-Ohio boundary. Its lower course forms the boundary between Indiana and Illinois. Nearly three-fourths of the drainage basin of the Wabash and its tributaries is in Indiana. The portion here designated as the upper Wabash Valley is that part of the river from near Terre Haute, Indiana, headward to its source. There are two reasons for logically limiting the present discussion to this part of the Wabash Valley. The first is that the portion of the valley from Terre Haute southward to its junction with the Ohio has been previously studied and discussed (Fidlar, 1948), and the second is that the boundary here chosen essentially coincides with the southernmost extension of the Wisconsin ice sheet in Indiana.

The Wabash River, according to Fidlar, has a drainage basin of some 33,000 square miles, 300 of which are in Ohio, 8,600 in Illinois, and 24,000 in Indiana. The source of the Wabash is at an altitude of 870 feet, and its junction with the Ohio is at an altitude of about 320 feet. The gradient of the river ranges from about 3 feet per mile in the upper 100 miles to approximately 8 inches per mile in its lower course.

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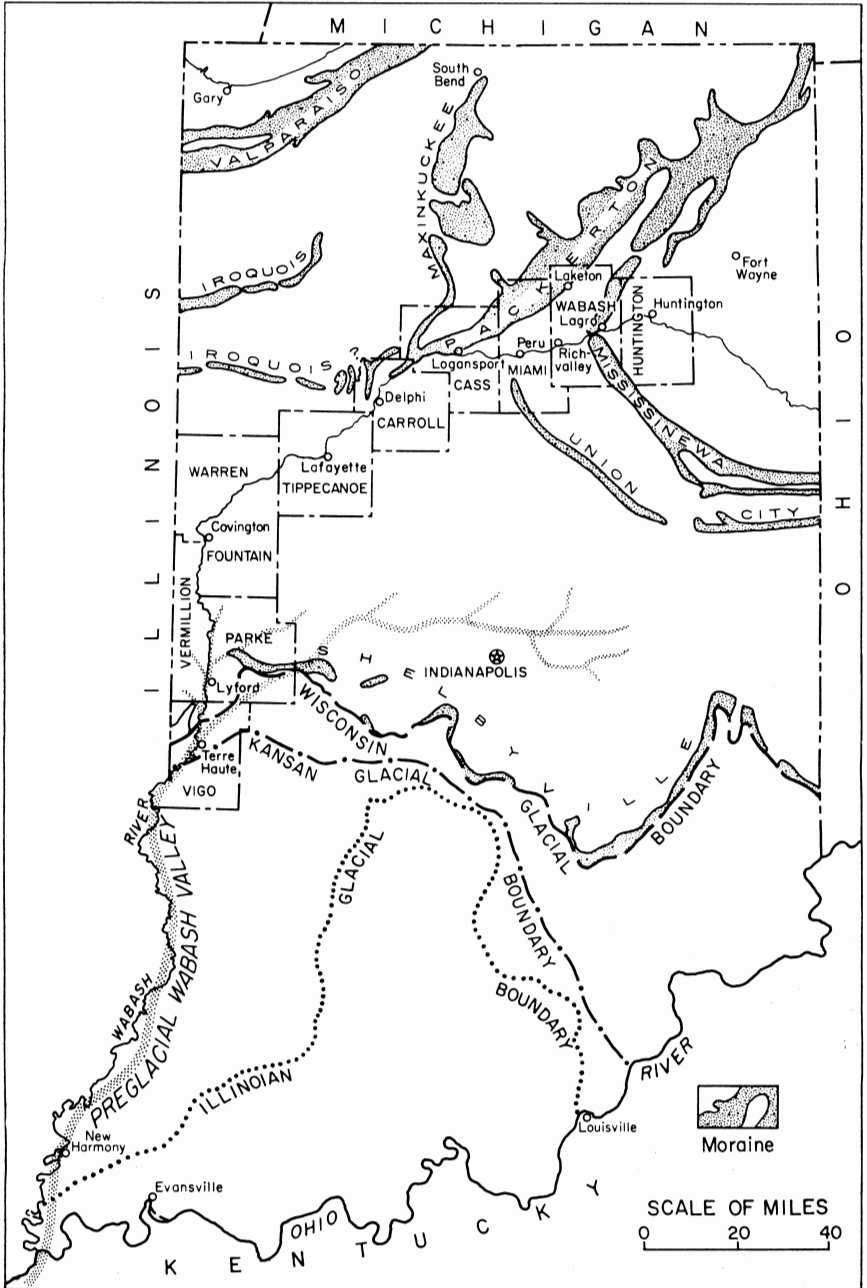


Fig. 1. Index map of Indiana showing towns, counties, glacial boundaries, and moraines to which reference is made in the text. Present and preglacial courses of Wabash River are also shown.

The Wabash River today is a considerably larger stream than it was in Tertiary time. Extensive drainage has been added to it as the result of filling of preglacial drainageways by Pleistocene glaciers. An explanation of the genesis of the present Wabash River is a primary aim of this paper. A second objective is a discussion of the topographic features along the Wabash Valley that are a result of the role played by the Wabash Valley as a major glacial sluiceway during the Wisconsin glacial age. To do this we must start back in the Tertiary.

#### TERTIARY DRAINAGE OF EAST-CENTRAL UNITED STATES

Probably as much work has been done on the preglacial drainage of Ohio, Indiana, and Illinois as on the preglacial drainage of any other comparable area in the United States, but differences of opinion as to its details still exist. The preglacial drainage of Illinois has been worked out more completely (Horberg, 1950) than has that of Indiana and Ohio, but, as the salient facts for the latter two states are reasonably well known, it is now possible to present the general picture fairly accurately.

There seems to be little question that what Tight (1903) designated as the Teays Valley in West Virginia and its continuation across Ohio (Ver Steeg, 1936), Indiana (Wayne, 1952), and Illinois (Horberg, 1945, 1950) was the major drainage line of east-central United States during Tertiary time. The Teays River headed in the Blue Ridge or possibly Piedmont of North Carolina and flowed northwestward across West Virginia and Ohio and then southwestward across Indiana into Illinois, where it joined the Mississippi River in Tazewell County, in west-central Illinois. It is probably more nearly correct to state that the preglacial Mississippi joined the Teays in central Illinois. The route of the Teays was rather remarkable in that its source was unusually near the Atlantic coast for a stream that had its terminus in the Gulf Embayment.

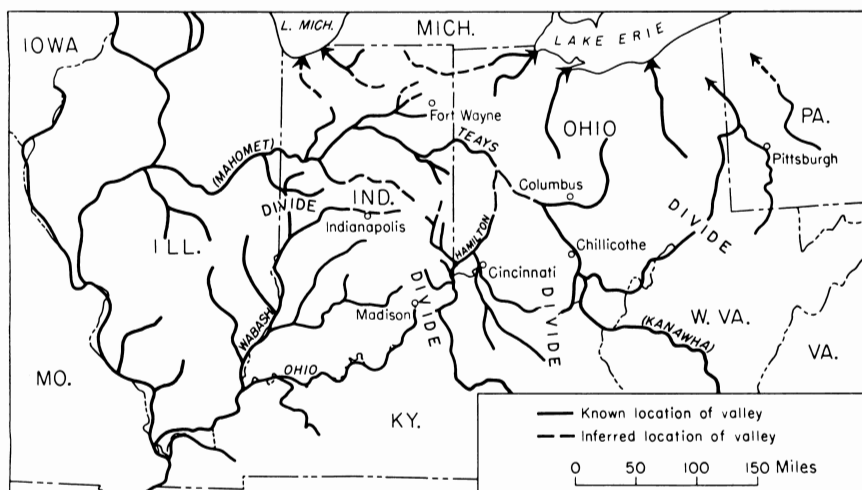


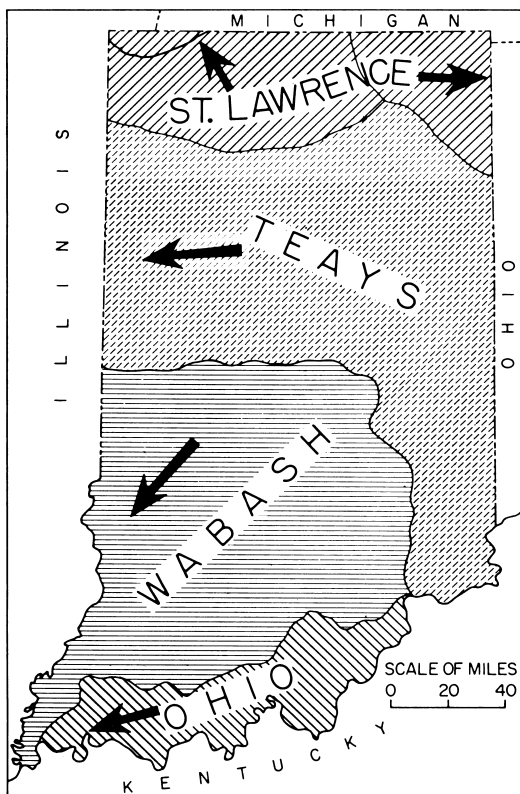
Fig. 2. Postulated preglacial valleys and divides in midwestern United States during late Tertiary time. (From Wayne, 1950 and based upon the ideas of numerous individuals).

The time of origin of this river system is uncertain. It may have been the major river of eastern United States throughout the Mesozoic as well as Cenozoic time. The part of its history which is decipherable is limited mainly to late Tertiary and early Pleistocene time. In considering the history of the Teays River we are concerned primarily with the obliteration of this drainage system by continental glaciation and the resulting diversion of part of the Teays drainage to the Wabash and Ohio Rivers.

The writer's ideas regarding the major drainage lines of east-central United States during Tertiary time are essentially similar to those shown in figure 2. The regional picture is fairly clear, but there are questions as to where some of the major stream divides were located. The position of the divide in northeastern Illinois between the drainage to the Gulf of Mexico and to the Gulf of St. Lawrence probably is essentially correct. There is difference of opinion as to whether the divide between the preglacial Ohio and Teays drainage was above or below Cincinnati.

#### PREGLACIAL DRAINAGE OF INDIANA

Studies in recent years have made possible a generalized reconstruction of the preglacial topography of Indiana. Wayne (1952) has presented a pic-



PREGLACIAL DRAINAGE BASINS OF INDIANA

Fig. 3. Preglacial drainage basins of Indiana.

ture of the topography and drainage of that part of Indiana (approximately five-sixths) in which the preglacial topography is largely obscured beneath glacial drift. Figure 3 represents the writer's interpretation (based largely upon Wayne's work) of the major preglacial drainage basins of Indiana. The divide between the preglacial Wabash and Teays has been variously located by workers upon this problem. Fidler (1948, fig. 1) placed it near Covington in Fountain County, Indiana. Thornbury (1948) thought that the divide might have been near the crest of the Knobstone escarpment where it extends across southern Tippecanoe County, northern Fountain County, and northern Warren County. Wayne's (1952) early studies of the bedrock topography seemed to indicate that the head of the preglacial Wabash was farther south in northern Parke County and southern Fountain County. More detailed work by Wayne (1956) later led him to conclude that the main branch of the preglacial Wabash was not the one that headed near the western boundary of Indiana but rather was a valley, named by him Montclair Valley, that headed in east-central Indiana, in Hancock County, on the black slope of the Laughery escarpment, an escarpment formed on resistant Silurian limestone (Niagaran series).

From such knowledge as we now have it appears that the preglacial drainage of Indiana can be described in terms of five major drainage areas: drainage to the Ohio in southern Indiana, the Wabash drainage of southwest-central Indiana, the Teays drainage of southeastern and central Indiana, the drainage of northwestern Indiana into a lowland now occupied by Lake Michigan, and a small area in extreme northeastern Indiana that drained into a lowland now occupied by Lake Erie. Thus, in Tertiary time, distribution of runoff from Indiana was not significantly different from what it is today. The major difference was that the Teays River was the largest river in Indiana, whereas the Ohio and Wabash were much shorter and smaller streams than today.

#### TERTIARY GEOMORPHIC HISTORY OF INDIANA AND ADJACENT STATES

Little can be said about the geomorphic history of Indiana in pre-Tertiary time. Presumably Indiana has been above sea level since the close of the Paleozoic, but all evidence of Mesozoic erosion surfaces has been obliterated and even the early Tertiary history of the state is obscure.

The geomorphic histories of such unglaciated areas as south-central Indiana, Kentucky, Tennessee, the Appalachian plateau area of Ohio and West Virginia, and the Driftless Area of Wisconsin, Minnesota, and Iowa, all areas that may be presumed to have had geomorphic histories similar to that of central and northern Indiana, are fairly well known. Opinions as to how many cyclical erosion surfaces should be recognized in the Mississippi-Ohio Valley region vary from none (Martin, 1916) to as many as five (Hershey, 1896). Most workers have recognized evidence of one or two major cycles that attained the peneplain or near peneplain stage and some have seen what they considered evidence for one or more subcycles now represented by strath terraces.

In the Driftless Area of Wisconsin two peneplains have been described (Trowbridge, 1921), the higher and older Dodgeville and the lower and younger Lancaster. Trowbridge (1954), however, recently concluded that there is

really only one peneplain, the Lancaster, present. This peneplain surface lies 300 to 600 feet above present valley flats and 625 to 725 feet above buried bedrock valley floors. Presumably, the cycle during which the Lancaster peneplain was formed corresponds with that during which the Highland Rim peneplain of Tennessee (Hayes, 1899) and the Lexington peneplain of Kentucky (Campbell, 1898) were formed. This cycle of peneplanation in the eastern interior United States apparently corresponds in a general way with the Harrisburg cycle of the Appalachians. The Dodgeville peneplain of the Driftless Area, if it is really a higher and older surface than the Lancaster, would thus seem to correspond to the Schooley cycle farther east. Little evidence has been found in the area south of the glaciated region of an erosion surface older than that produced during the Highland Rim-Lexington cycle. Some workers have considered the tops of hills that project above the level of the Highland Rim surface to be remnants of a higher and older erosion surface, but evidence for a pre-Highland Rim-Lexington peneplain in Indiana, Kentucky, and Tennessee is rather meager.

Malott (1922) recognized in southern Indiana an early Tertiary peneplain that he correlated with the Highland Rim and Lexington peneplains. Remnants of this erosion surface are found at altitudes of 900 to 1,000 feet in southeastern Indiana. Malott considered this peneplain to be of probable Eocene age, but it is now more commonly considered to be of Miocene or Pliocene age. Malott also described in southern Indiana an erosion surface below the Lexington-Highland Rim peneplain that he called a late Tertiary peneplain. The cycle that produced this erosion surface destroyed much of the so-called early Tertiary peneplain in western Indiana. The late Tertiary peneplain of Malott is probably better described as a strath terrace than as a peneplain.

Horberg (1946, 1950), from his studies of the bedrock topography of Illinois, thought that four buried erosional surfaces are recognizable beneath the glacial deposits of Illinois. These he designated as the Dodgeville, Lancaster, and Central Illinois peneplains and the Havana strath. The Lancaster peneplain was correlated with the Calhoun peneplain (Rubey, 1952) of southwestern Illinois and the Ozark peneplain of Missouri (Marbut, 1896; Hershey, 1901). Remnants of the Dodgeville peneplain are found only in a small area in northwestern Illinois and are at altitudes between 1,000 and 1,150 feet above sea level. The more extensive Lancaster surface lies about 150 feet below the Dodgeville surface. The most extensive erosion surface in Illinois is the Central Illinois peneplain. It is found consistently at altitudes between 600 and 650 feet. It is most widespread on upland tracts to the south and north of the Mahomet (Teays) valley of central Illinois. Horberg (1946, 1950) thought that there is evidence of strath terraces along the preglacial Mahomet, Mississippi, Kaskaskia, and Wabash valleys. These terrace tracts are found at altitudes ranging from 550 feet at the north to 450 feet or less in southern Illinois and were interpreted as remnants of a planation surface developed before the period of valley entrenchment that resulted in the so-called Deep Stage. Horberg named this erosion surface the Havana strath. Entrenched bedrock valleys 100 feet or more below the Havana strath represent the last period of valley erosion prior to burial of the preglacial topography beneath glacial deposits.

There has been difference of opinion as to when the Deep Stage was cut but Horberg believed that the valley deepening in Illinois took place prior to Nebraskan glaciation. Ver Steeg (1936) suggested that cutting of the Deep Stage started after disruption of the Mahomet-Teays drainage and continued until the advent of Illinoian glaciation. Ireland (1946) considered the valley trenching to have been additive and thought that degradation occurred during the early stages of each glacial age as a result of lowering of sea level and consequent increase in stream gradients. He thought that degradation occurred during early phases of the Nebraskan, Kansan, and Illinoian glaciations and was terminated when the extensive Illinoian glaciation disrupted many major drainage systems. Evidence cited below for extensive Kansan glaciation east of the Mississippi River makes it seem unlikely that major Tertiary drainage lines persisted in the glaciated area as late as Illinoian time.

#### PLEISTOCENE HISTORY OF AREA

*Nebraskan Glaciation.*—Whether the Nebraskan glaciation affected Indiana is still questionable. No unequivocal evidence of Nebraskan deposits has been recognized in Indiana. Thwaites (1946, pl. 3), largely upon the basis of glacial erratics described by Leverett (1929) in northeastern Kentucky, postulated a Nebraskan ice lobe that extended across southeastern Indiana and southwestern Ohio into Kentucky. There is no convincing evidence of the Nebraskan age of these boulders. It can only be said with assurance that they are probably pre-Illinoian in age, and, as will be shown later, there is a greater probability that they are Kansan than Nebraskan.

Eveland (1952) assigned a Nebraskan age to a large block of gumbotil embedded in Kansan till in a strip mine near Danville, Illinois, but personal examination of the exposure left the writer uncertain as to the correctness of this interpretation. Horberg (1953) described what he considered to be buried Nebraskan drift in northeastern Illinois and also in central-western Illinois (1956) and suggested the possible presence of Nebraskan deposits in the bedrock Mahomet and Danvers Valleys of central Illinois. If these interpretations are correct, the Nebraskan ice sheet may well have extended into northern Indiana and may have crossed the Teays Valley, but as yet no uncontrovertible evidence of this ice invasion has been recognized in Indiana.

*Kansan Glaciation.*—The evidence for Kansan glaciation in Indiana is much stronger than that for Nebraskan. MacClintock (1929) described several exposures of pre-Illinoian till that are in Illinois and slightly southwest of Terre Haute, Indiana. He was uncertain as to whether the tills are Nebraskan or Kansan in age, but in view of our present knowledge of the extent of those two glaciations in the Midwest, a Kansan age seems more likely. Wayne (1954, 1955, 1958) has described several exposures of what he considered to be Kansan till beneath calcareous Illinoian till in Indiana. There are several exposures of Kansan till in the area east and northeast of Terre Haute. These fit in very nicely with the occurrences of Kansan till in Illinois. Beneath till at one exposure is a calcareous and fossiliferous loess that contains several species of gastropods suggestive of a Kansan age. The loess is calcareous throughout and is probably a pro-Kansan deposit closely related in age to the till above it. Ex-

posures of Kansan till in southeastern Indiana are so situated as to suggest that a lobe of Kansan ice extended into southeastern Indiana as far as, if not beyond, the Ohio River (see fig. 1). The rapidly accumulating evidence for extensive Kansan glaciation in Indiana, particularly in southeastern Indiana, suggests the probability that the erratics in Kentucky that Leverett (1929) described and Thwaites (1946) interpreted as Nebraskan in age are more likely of Kansan age.

*Illinoian Glaciation.*—The extent of Illinoian glaciation in Indiana is rather well known, (see fig. 1) as a result of the mapping of the glacial boundary in Indiana by numerous workers. Until recently it was assumed that the Illinoian ice extended farther into Indiana than did any other ice sheet, but the recognition of Kansan drift in southern Indiana makes this assumption one of uncertain validity. It has already been established that at one locality in south-central Indiana the Kansan ice reached slightly farther south than did the Illinoian and this may be true in other parts of the state. This is particularly likely in southeastern Indiana where, as stated above, it appears probable that the Kansan glaciation reached into Kentucky.

*Wisconsin Glaciation.*—The boundary of Wisconsin glaciation in Indiana is readily recognizable. Presumably the surficial Wisconsin tills of Indiana

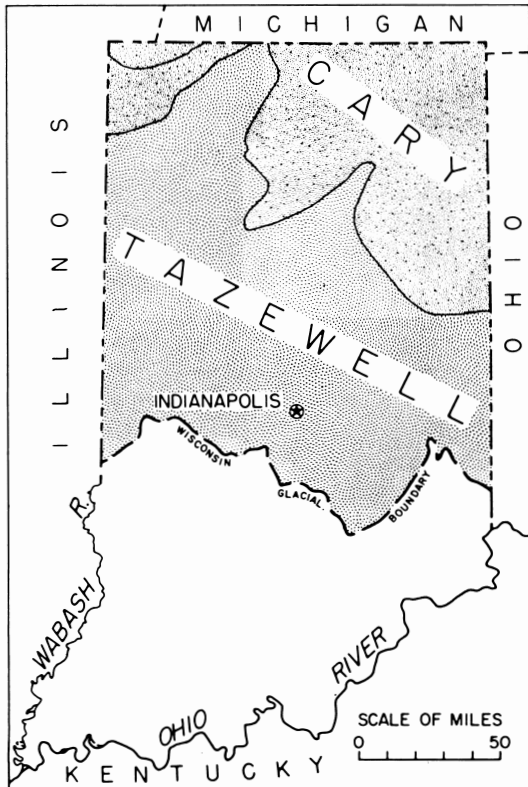


Fig. 4. Areas of Tazewell and Cary tills in Indiana according to the writer's concept.

belong to the Tazewell and Cary substages (fig. 4). The possibility exists, however, that some of the till that has been considered Tazewell in age may actually be of Farmdale or Iowan age. Farmdale loess has been recognized at several localities in the Wabash Valley area and loess that was interpreted as Iowan loess has been described (Thornbury, 1937) north of the outer Wisconsin border. The writer now believes that at least some of the loess that he earlier interpreted as Iowan is more logically considered to be pro-Tazewell loess, although there may be relatively little difference in age between an Iowan loess and a pro-Tazewell loess in Indiana. There seems to be no question about the presence of Farmdale loess in the lower Wabash Valley and this must mean that the Farmdale glaciation reached far enough into Indiana to send outwash down the Wabash Valley. Ray (1957) has recently described what he considered to be Farmdale loess in the vicinity of Louisville, Kentucky, and if this interpretation is correct, the possibility should be recognized that Farmdale ice somewhere sent outwash down the Ohio Valley, for the Farmdale loess at Louisville seems to be too far away to have been derived from outwash in the Wabash Valley. Furthermore, the Farmdale loess in the Louisville area seems too thick to have been derived from the Wabash Valley. It is  $5 \pm$  feet thick, according to Ray, whereas the greatest known thickness of Farmdale loess in the Wabash Valley is only 4 feet.

On the glacial map of North America (Flint and others, 1945), except for the area back of the Valparaiso moraine in northwestern Indiana, which is mapped as Cary in age, the Wisconsin glacial deposits of Indiana are shown as undifferentiated. Wayne and Thornbury (1951) concluded that the Mississinewa moraine marked the outer limit of Cary glaciation by the Erie lobe. The writer now believes that the Union City moraine (see fig. 1) more likely is the outer moraine of the Cary glaciation in the area covered by the Erie lobe. This moraine marks a definite change in till petrology, the till back of it having a higher clay content than does the Tazewell till beyond it. Radiocarbon dating (Suess, 1954) of some gyttja from a marl pit at the southeast edge of the Packerton moraine, near the village of Laketon, in Wabash County (see fig. 1) gave an age of  $13,140 \pm 400$  years. This indicates that the Packerton moraine of the Saginaw lobe is early Cary in age. The writer, at present, considers the Packerton and Maxinkuckee moraines to be the outer Cary moraines of the Saginaw lobe, but this conclusion is very tentative and is based primarily upon the topographic change which takes place at these moraines rather than upon any careful study of till petrologies. Lakes and closed basins are common within these two moraines but are scarce outside them. Actually the Cary drift of the Saginaw lobe has been so little studied in Indiana that the location of the outer Cary deposits is questionable. Horberg (1955) mapped Cary drift of the Saginaw lobe across Indiana a short ways into Illinois and considered the Iroquois moraine (see fig. 1) to be the end moraine of this substage. Other Illinois geologists share this viewpoint. Only by detailed field study and radiocarbon dating of the deposits in this part of Indiana can we ultimately determine where the boundary for the Cary substage is in the area of the Saginaw lobe.

## EFFECTS OF GLACIATION UPON PREGLACIAL DRAINAGE

The major effect of the several glaciations of Indiana was obliteration to a large degree of preglacial drainage lines in northern and central Indiana and superposition of new stream courses across the buried bedrock topography. The Teays Valley was completely buried and the Wabash Valley became the major drainageway of central Indiana. Most likely it was the Kansan glaciation that largely caused the obliteration of the Teays as a major through drainageway. Nebraskan ice may have extended across the Teays Valley in Indiana and Illinois, but it seems probable that even if it did the effect was not a closing of the Teays as a regional drainageway.

Horberg (1945, 1953) attempted a reconstruction of the topography of central and northeastern Illinois during Sangamon time, and he concluded that by then the Mahomet (Teays) Valley had been largely obliterated as a drainage line in Illinois. Sufficient data are lacking at present to make possible a reconstruction of the Sangamon surface in Indiana, but in view of the newly discovered evidence that Kansan ice extended far south of the Teays Valley in Indiana, it seems most likely that it was this ice invasion that initiated burial of the Teays Valley. It is therefore postulated that as a result of Kansan

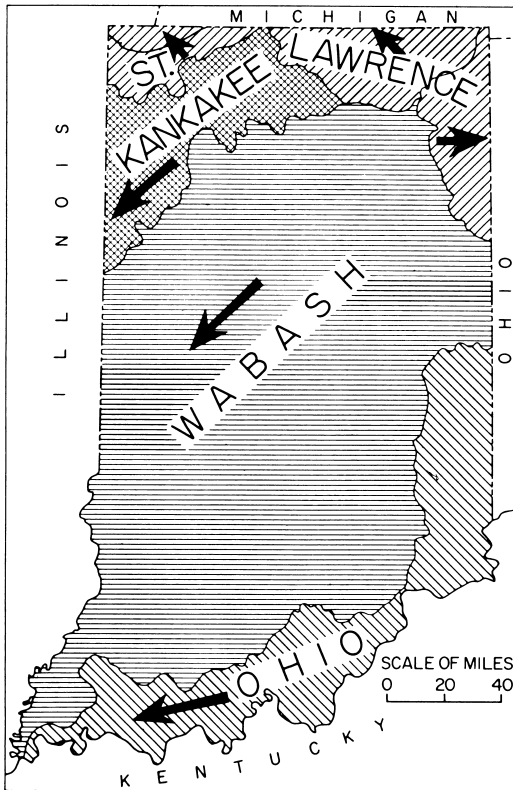


Fig. 5. Present drainage basins of Indiana.

glaciation the following modifications of preglacial drainage were effected: (1) upper Teays drainage as far north as southern Ohio and southeastern Indiana was diverted to the south and joined with the preglacial Ohio whose headwaters were in southeastern Indiana or southwestern Ohio, and (2) most of the Teays drainage area in central Indiana was added to the preglacial Wabash (fig. 5). This interpretation is not meant to imply that the Teays Valley in Indiana was completely buried by Kansan glaciation and abandoned, for it is probable that stretches of the Teays Valley continued to function as local drainage lines. Illinoian glaciation further obscured and closed portions of the Teays Valley, but discontinuous segments still served as drainage lines as late as Wisconsin time, as is indicated by the extensive outwash gravels beneath Wisconsin till in portions of the Teays Valley in Wabash, Miami and Tippecanoe Counties.

GEOMORPHIC FEATURES OF WABASH VALLEY

*Relation of Courses of Teays and Wabash*

The present route of the upper Wabash came into existence largely following deglaciation during the Tazewell and Cary subages of the Wisconsin age. Although the upper Wabash follows in a rough way the same general course as did the preglacial Teays, at only two localities (fig. 6) do the two river courses



Fig. 6. Comparison of courses of Teays and Wabash Valleys across Indiana.

coincide. One of these is just east of the hamlet of Rich Valley in western Wabash County and the other is near Lafayette in Tippecanoe County. At both places, there is notable widening where the Wabash Valley intersects the buried Teays because the drift-filled Teays Valley is more erosible than the stretches to either side where the present course of the river extends through preglacial bedrock uplands.

*Partial Exhumation of Tertiary Topography.*—As a result of the superposition of the Wabash Valley on glacial drift and its lack of coincidence with the course of the Teays, the Wabash Valley consists of more or less alternating stretches of wide and narrow valley as it crosses preglacial valleys and divides. At the intersection of the Wabash and Teays Valleys east of the village of Rich Valley, referred to above, (fig. 7) there is an expansion of valley width

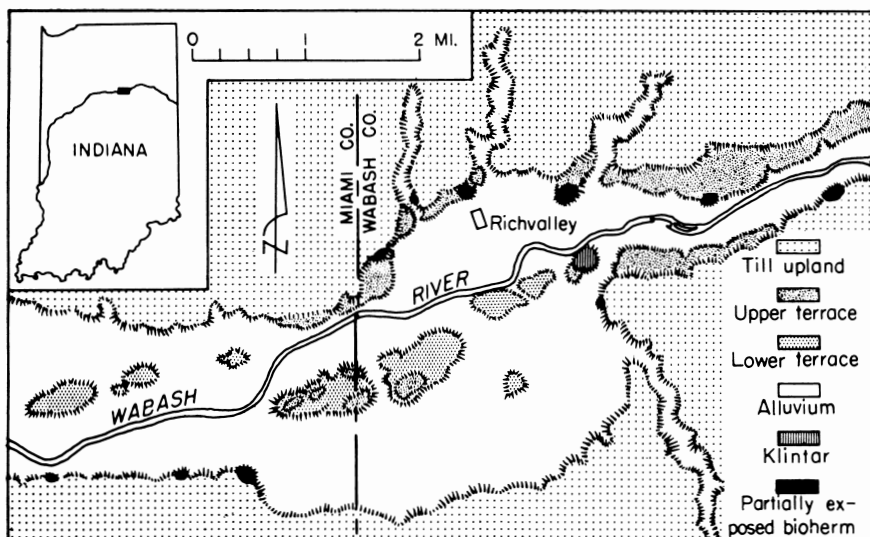


Fig. 7. Widening of Wabash Valley at its intersection with Teays Valley.

from about half a mile where the valley is cut through Silurian limestone and bioherms to nearly 3 miles where it intersects the Teays Valley. An almost equally striking expansion in valley width related to partial exhumation of the Teays Valley takes place in the Lafayette area. The great width of the Wabash Valley here is in part a result of a major tributary valley, Anderson Valley (Wayne, 1956), joining the Teays at this point. These preglacial valleys were filled with Wisconsin outwash, and thus the widest gravel terrace tract to be found along the entire length of the upper Wabash was formed. The filled valley is nearly 5 miles wide, but the present alluvial strip is hardly 1 mile wide.

The width of the Wabash Valley in those stretches where it is cut into bedrock reflects to a large degree the ease with which the rocks into which it is being cut are eroded. Where the valley crosses Silurian rocks, it is notably narrower through the outcrop area of the cherty Liston Creek limestone than

across the Mississinewa shale. In the belt of Devonian rocks the valley is much narrower where it crosses limestones than across the New Albany shale. The Pennsylvanian sandstone in the Pottsville series causes a marked narrowing of the valley near the west margin of Tippecanoe County.

### Bioherms and Klintar

Possibly the most interesting bedrock features to be seen along the Wabash Valley are the many Silurian bioherms that have been partially resurected. These features, often referred to as reefs, have cores of massive dolomite that are more resistant to erosion than the associated interreef shales and limestones. The bioherms consequently have topographic expression as bold bluffs along the valley sides or occur along the valley floor as hills or low mounds known as *klintar* (singular, *klint*) (Shrock, 1928). A klint located just south of the Wabash River 1 mile southeast of the village or Rich Valley

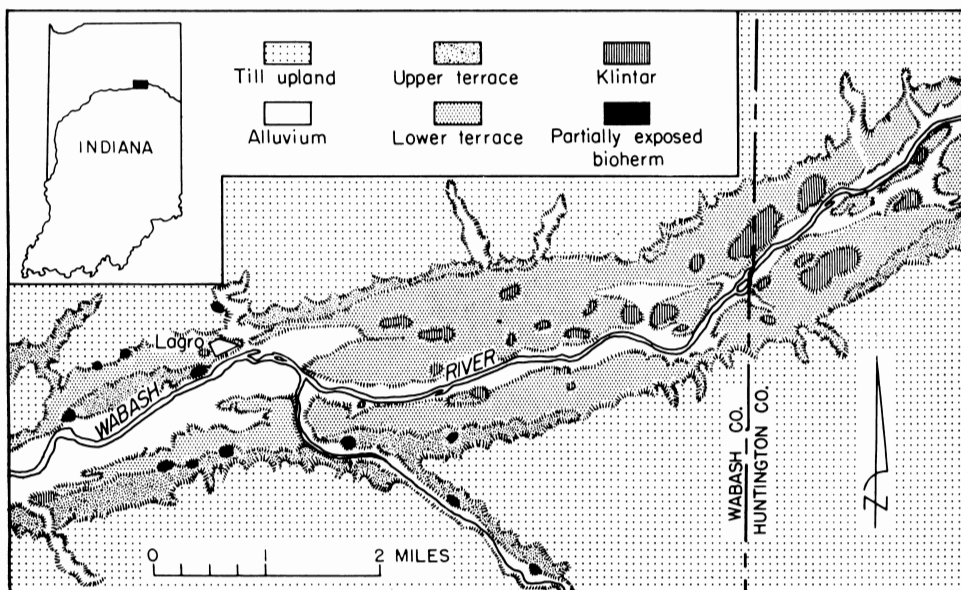


Fig. 8. Bioherms and klintar in Wabash Valley east of Lagro, Indiana.

and about 2 miles east of the west county line of Wabash County rises abruptly about 80 to 90 feet above the valley floor. Probably the most famous klint is Hanging Rock on the south bank of the Wabash River about 1 mile southeast of Lagro in Wabash County (fig. 9). During its exhumation by the Wabash River about half of the bioherm has been eroded, and the remainder stands about 75 feet above the river level. About 90 bioherms have been mapped in the area of outcrop of Silurian rocks in Miami, Wabash, and Huntington Counties. These bioherms commonly are reflected in the topography as klintar, by steepening of the valley wall where they crop out, or as water falls or rapids in tributaries of the Wabash.

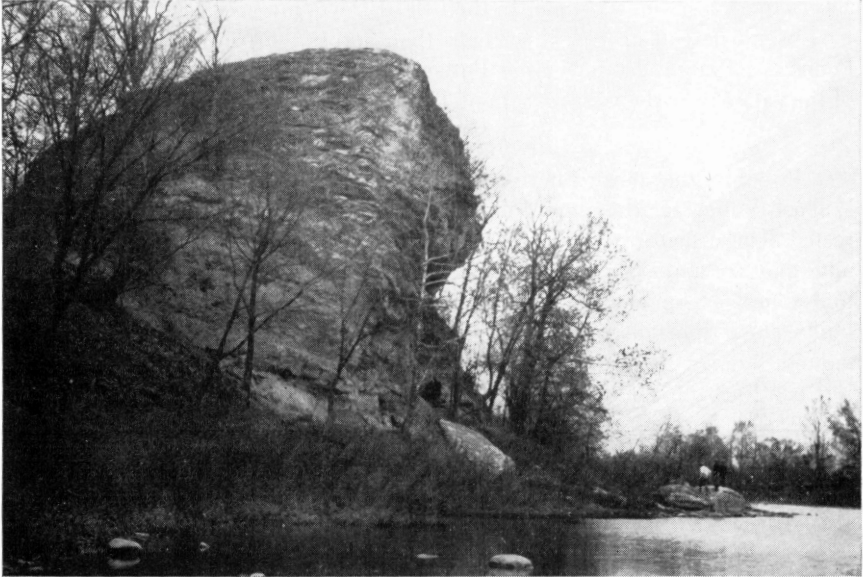


Fig. 9. Hanging Rock, east of Lagro, Indiana, an exhumed Silurian bioherm. The bioherm has been cut into by the Wabash River. (Photo by C. A. Malott).

#### *Miniature Scabland Topography*

Many topographic features along the Wabash Valley attest to the fact that this valley served as a major sluiceway for glacial melt waters. Several tracts of miniature scabland topography, similar in many respects to the famous scabland area in eastern Washington but on a much reduced and less spectacular scale, are present along the valley. The scabland consists of water-swept bedrock tracts with little or no glacial outwash on them, anastomosing valley braids, and small islandlike bedrock remnants that project above the torrent-swept valley floors. The four main scabland areas are found at Delphi, east of Logansport, east of Lagro, and at Huntington. Klintars are numerous in the scabland tract near Lagro (fig. 8). In the scabland area east of Logansport glacial floodwaters flowed across Silurian and Devonian limestones in numerous braided channels. In the abandoned valley braids many small patches of bedrock crop out through a thin veneer of outwash, and numerous small mounds of Devonian limestone not quite reduced by the glacial floodwaters stand a few feet above the floor of the sluiceway. Pulpit Rock, on the south side of the Wabash Valley about 5 miles east of Logansport, is one of the better-known examples of these small rock nubbins. It consists of a mass of Kenneth (Devonian) limestone resting upon Kokomo limestone of Silurian age.

#### VALLEY TRAIN DEPOSITS

The importance of the Wabash Valley as a glacial sluiceway is shown by the amount of glacial outwash found along it. Gravel fill is found chiefly in those areas where the valley crosses or follows preglacial or interglacial val-

leys. The thickness of the fill varies greatly and exceeds 200 feet in many places. A well in the valley near Peru, in Miami County, penetrated 237 feet of gravel and mud, and several wells in the gravel terrace upon which Purdue University is located at West Lafayette, in Tippecanoe County, go through 200 to 210 feet of sand and gravel before reaching bedrock.

#### *Abandoned Valley Braids*

Many large abandoned valley braids that no longer carry water except at times of extremely high floods, such as those of 1913 and 1937, further attest to the great volume of glacial melt water than once flowed down the Wabash sluiceway. These abandoned valley braids enclose numerous island-like tracts of both bedrock and outwash gravels that stand as terraces in the sluiceway.

#### TERRACES

Terraces are probably the most conspicuous features found along the Wabash sluiceway. Bedrock terraces characterize the scabland areas but elsewhere the terraces are alluvial. They may occur as narrow strips abutting against the valley walls, as expansive areas several miles wide, or as detached tracts between valley braids in the sluiceway. Two terrace levels persist throughout the upper Wabash Valley, although at places there are suggestions of additional terraces, but it appears that these represent portions of one or the other of the two persistent terrace levels that have been reduced somewhat below their representative altitudes. Wier and Friedman (1955) described what they considered to be three terraces along a 25-mile stretch of the Wabash Valley extending above and below Terre Haute, Indiana. The topographic maps of the area suggest the presence of three terrace levels in this area but there is some question as to whether these three terrace levels persist throughout the upper Wabash Valley. Wier and Friedman's interpretation of the three terraces was that the highest terrace represents the upper limit of valley fill with Wisconsin outwash; the middle terrace they considered an erosion level developed along the valley prior to the discharge of overflow waters from Lake Maumee down the Wabash Valley; the lowest terrace was considered to represent a planation surface cut by the overflow waters from Lake Maumee or the so-called Maumee torrent.

Fidlar (1948) described two terraces in the lower Wabash sluiceway that he designated as the Shelbyville and Maumee terraces. The Shelbyville terrace is about 75 feet above the present floodplain in the area immediately south of the Wisconsin glacial border, and the Maumee terrace lies about 35 feet below it and 20 feet above the floodplain. The interval between the two terraces gradually decreases downstream, and near the junction of the Wabash with the Ohio the two terraces are only 20 feet apart. Fidlar interpreted the Shelbyville level as representing the upper level of valley filling with Wisconsin outwash and the Maumee level as a planation surface cut by overflow waters from Lake Maumee (the Maumee torrent) during the time that this ice-marginal lake drained through the Fort Wayne outlet to the Wabash Valley.

Terraces comparable in position to those in the lower Wabash Valley continue up the valley roughly to the neighborhood of Huntington (figs. 7

and 8) where the spillway of the Fort Wayne outlet joins the present Wabash Valley. Wayne and Thornbury (1951) described two terraces in Wabash County, the upper of which they called the Mississinewa terrace and the lower the Maumee. Both were considered to be of Cary age. The Mississinewa terrace was thought to be comparable in origin to the Shelbyville terrace of Fidler but to be younger in age. They concurred with Fidler's explanation of the Maumee terrace.

Part of the gravel fill in the upper Wabash Valley may be pre-Wisconsin in age, but thus far such outwash has not been identified. Deposition of Wisconsin outwash probably began as early as Farmdale time, for, as stated above, Farmdale loess has been identified in the lower Wabash Valley as well as at several places within the outer Wisconsin drift area. Whether the Iowan glaciation extended into Indiana is uncertain.

The tendency in recent years to divide the Wisconsin into numerous substages has greatly stimulated study of Wisconsin stratigraphy, but may have led to overemphasis of the idea of prolonged breaks between the substages. It seems to the writer that the field evidence indicates that there were no long intervals between deposition of the successive till sheets. There appear to have been, in Indiana, three main stadials during the subage that has commonly been designated as Tazewell. Numerous well records commonly show three tills separated by outwash, and at several places within the area of Tazewell drift there are exposures of three Wisconsin tills. At no place is there a suggestion of a soil or weathered zone on any of the tills except the surficial one. Which particular advances of the Wisconsin ice sheet deposited these tills is as yet uncertain. Probably they are to be correlated with the ice advances that built the Shelbyville, Champaign and Bloomington moraines, but an earlier glaciation, such as the Iowan or Farmdale, is not to be ruled out.

At numerous localities in central Indiana a thin fossiliferous loess is found between what is conventionally thought to be the Shelbyville and Champaign tills. Radiocarbon dates, as yet unpublished, indicate that there may be as much as 800 to 1000 years difference in the time of deposition of the two tills. Ages around 20,000 years suggest that the tills are of Tazewell age rather than older.

There may be some question, however, as to whether what have been considered the Shelbyville and Champaign stadials in Illinois and Indiana are exactly comparable. The possibility exists that what Leverett mapped as the Champaign moraine in Indiana is not exactly the same thing as the Champaign moraine in Illinois. Three lines of evidence suggest that this stadal may actually be as significant as some of the advances that elsewhere in the midwest have been given subage rank. The radiocarbon dates indicate at least a moderate withdrawal of the ice as does the presence of a fossiliferous loess at numerous places. Probably the strongest reason for suggesting that the so-called Champaign stadal in Indiana was just as significant as the earlier Shelbyville and later Cary advances is the soil pattern on the Wisconsin tills in the area covered by the Erie lobe. A glacial geologist can hardly look at the new *Map of Indiana Soils* published in 1957 by the Agronomy Department

of Purdue University without seeing that there are three distinct soil belts in the area glaciated by the Erie lobe. The soils of the Fincastle-Russell catena occur in the area from the Shelbyville moraine to the edge of the so-called Champaign moraine; the soils of the Miami-Russell catena lie in the region between the Champaign moraine and the Union City moraine; and the soils of the St. Clair-Nappanee catena occur in the area commonly believed to be the area of Cary drift.

There was more or less continuous outwash going down the Wabash Valley during the Tazewell subage, but there is reason to believe that during the Tazewell-Cary (Brady) interval<sup>1</sup> the ice withdrew a considerable distance to the northward so that for a time no outwash went down the Wabash sluiceway. The basis for this conclusion lies more in the difference in the Tazewell and Cary till lithologies than in the presence of a widespread soil profile upon buried Tazewell drift. Cary till in northeastern Indiana is notably higher in clay content than is the Tazewell till. A logical explanation for the larger amount of clay in the Cary till is that the clay was obtained from lacustrine deposits laid down in ice-marginal lakes in northeastern Indiana and northwestern Ohio while the ice front was many miles to the north.

Outwash was again carried down the Wabash sluiceway during the Cary readvance. After the Cary ice had retreated to the northeast of the Fort Wayne moraine, Lake Maumee came into existence and for a time it poured its waters, the Maumee torrent, through the Fort Wayne outlet down a broad spillway to the Wabash River at Huntington, Indiana.

Here, perhaps, a distinction should be drawn between the Wabash Valley and the Wabash sluiceway. The Wabash Valley heads in Ohio about 12 miles east of the Ohio-Indiana state boundary, whereas the Wabash sluiceway heads in Indiana at the Fort Wayne outlet of Lake Maumee. The two are one and same from Huntington downstream but the 25-mile trench from Fort Wayne to Huntington, followed through most of its length by U. S. Highway 24, is not a part of the Wabash Valley but was the spillway for Lake Maumee (fig. 10) in its earliest phase. It was not cut by the underfit Little River or Little Wabash that now flows through part of it, but rather by a great torrent of glacial melt water overflowing from Lake Maumee. This water was relatively clear water because Lake Maumee had acted as a settling basin for any outwash that came into it. Hence, this torrent was able to trench the fill that had been deposited in the Wabash Valley during Tazewell and early Cary time and thereby develop an erosional surface about 25 to 30 feet below the top of this fill. In this way the terrace was formed that Fidler (1948) called Shelbyville and Wayne and Thornbury (1951) called the Mississinewa. Later opening of a lower outlet for Lake Maumee than that at Fort Wayne caused the Maumee torrent to run dry. Development in late glacial and Recent time of a floodplain below the Maumee erosion surface has left portions of it as terrace remnants

<sup>1</sup> There may be some doubt as to whether the term Brady commonly applied to this interval is entirely appropriate in Indiana, as there remains some question as to where the Brady soil belongs in the Wisconsin stratigraphic sequence. Detailed search for Brady soil horizons in northeastern Indiana has not been particularly fruitful. At a few places infant soil profiles have been found, mainly on gravels, but they are not very convincing that in Indiana there was a long break between Tazewell and Cary glaciations.

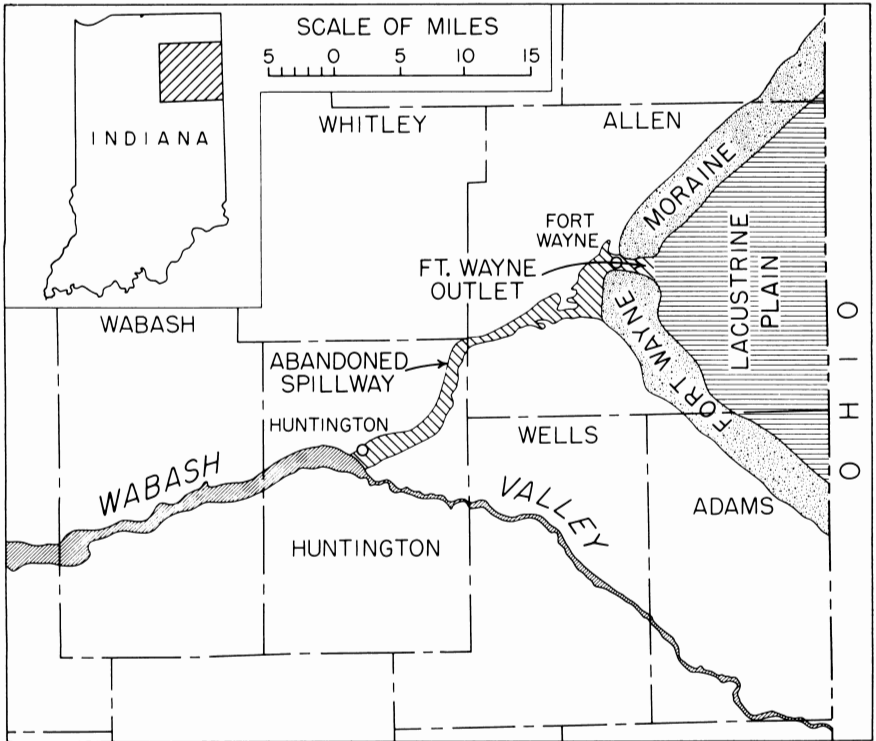


Fig. 10. Map showing relations of Lake Maume and Fort Wayne outlet to Wabash sluiceway.

about 20 to 25 feet below the Mississinewa terrace and 15 to 20 feet above the floodplain of the river. It was largely the Maume torrent that produced the scabland areas described above.

A different interpretation of the terraces would be to consider them climatic terraces. According to this viewpoint, glacial time was marked by valley aggradation and interglacial (or in this case intraglacial or interstadial) time by valley trenching. The upper terrace would represent the level of valley filling during the Tazewell subage. Presumably during the Brady interval this fill was trenched and partially removed. During the Cary glaciation, outwash again was deposited down the sluiceway, but this fill did not reach as high as the previous Tazewell fill. Dissection of the Cary valley train has left part of it as the Maume terrace. No Mankato outwash is present because the outer limits of the Mankato ice sheet lay considerably north of the Wabash Valley.

It is difficult to say which of these interpretations is correct. The first one was advocated by Malott (1922), Fidler (1948), and Wayne and Thornbury (1951). At the present time the writer is not completely convinced that it is the correct one, but he has been unable to find convincing evidence for the latter interpretation. Examination of many exposures of outwash sands and

gravels along the Wabash sluiceway has failed to produce evidence that there are two gravel fills in the valley.

If there has been trenching of the Tazewell fill during the Brady interval and later deposition of Cary outwash within the trenched gravels, it would appear that somewhere there should be evidence of unconformable relationships of the two gravel deposits. Such evidence has not been found. The fact that there is only one terrace along Eel River, an important tributary that enters the Wabash from the northeast at Logansport, lends support to the idea that the Maumee terrace is genetically related to the Maumee torrent. No terrace corresponding to the Maumee terrace exists in Eel Valley because Eel Valley had no episode in its history comparable to the Maumee torrent in the Wabash sluiceway.

### *Dunes*

Windblown deposits are characteristic features along most glacial sluiceways, and the Wabash sluiceway is no exception. Extensive dune and loess deposits characterize the lower Wabash Valley (Fidlar, 1948); and, although not as extensive in the upper Wabash Valley, they are present. Dunal areas particularly are local in extent, but small dune areas exist in Parke, Fountain, Tiptecanoe, Carroll, Cass, and Miami Counties. Small dunal tracts are found in most places where the sluiceway is wider than normal, but as the width of the upper Wabash sluiceway is not as great as that of the lower Wabash, sand dunes are not particularly conspicuous in size or extent.

The loess belt which lies to the east of the lower Wabash Valley continues northward into the area of Wisconsin drift; and, although the belt of thick loess becomes narrower, loess forms a more or less continuous blanket over the uplands on both sides of the sluiceway as far north as Warren and Fountain Counties.

### CONCLUSIONS

1. The Wabash River was a much smaller stream in preglacial time than at present, but its drainage area has been notably increased as a result of the acquisition of part of the Tertiary Teays drainage after burial of the Teays Valley by the Kansan and Illinoian ice sheets.
2. Located as it is in an area of multiple continental glaciation, the Wabash Valley has served repeatedly as an important glacial sluiceway, being equaled or exceeded in importance only by the Illinois, Mississippi, Ohio, and Missouri Valleys.
3. The Wabash Valley is superposed across a buried Tertiary topography with little regard to the position of the preglacial valleys and uplands and the stream in the valley is now engaged in exhuming portions of the preglacial topography.
4. The striking topographic features along the Wabash Valley, such as abandoned valley braids, gravel terraces, scabland tracts, klintar, and sand dunes and associated upland loess deposits, are largely a consequence of the role that the valley played during Wisconsin time as a major glacial sluiceway.

5. Because of the importance of the Wabash Valley in the glacial history of central United States, its valley and adjacent till uplands provide an excellent area in which to study the effects of multiple continental glaciation and to work out the glacial stratigraphy of the Pleistocene.

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