DRAINAGE HISTORY OF NORTH CENTRAL OHIO

GEORGE W. WHITE,
University of New Hampshire

INTRODUCTION

Incident to a study of the glacial geology of the region in and around the re-entrant angle in the glacial boundary in northeast central Ohio, observations on present and past drainage lines were made in Crawford, Richland, Ashland, Wayne, Morrow, Knox, Holmes, and Coshocton counties. Examination shows, as noted by earlier workers, that many of the present streams flow from low land through higher land; that some large streams flow in small valleys; that some large valleys have no streams; and that, in fact, the present drainage system is a "patch-work" system of streams and valleys of very different sizes and characteristics. As an outgrowth of recent studies of glacial boundaries in the region, the present writer will attempt to show that the position of some of the narrow gorge-like valleys is obviously related to the position of the last Wisconsin ice edge, that some valleys, gorge-like but wider than those referred to the Wisconsin ice margin, are clearly related to the position of the Illinoian ice border, and that still other valleys which are very much wider than those of Illinoian age, but whose streams cross divides through cols and are therefore deranged, have had their courses governed by an early, pre-Illinoian, ice sheet. It is the belief of the present writer that most abandoned valleys, commonly referred to as "preglacial" are only "pre-last glacial" or "pre-Illinoian," rather than "pre-Pleistocene." In fact, the pre-Pleistocene valleys are now so modified that in most cases their location can be only inferred from the pre-Preistocene divides, still well preserved, which indicate ancient drainage basins and which afford clues to approximate locations of the Pliocene streams.

RELIEF AND PHYSIOGRAPHIC DIVISIONS[1]

The region varies from an almost flat plain 950 to 1,100

[1]This brief summary of the physiographic features is given here to aid in making more clear the discussion of drainage history. Detailed study of the geomorphology of the area here discussed and of territory to the north and south is now in progress and the results will be reported in another paper.

feet in elevation in the western part to a maturely dissected plateau 1,200 to 1,500 feet in elevation with a relief of 400 feet in the central and eastern part. A small part of the region, the lower, western part, falls within the Till Plains section of the Central Lowland province as arranged by Fenneman.[2] Most of the area, the central and eastern part, which

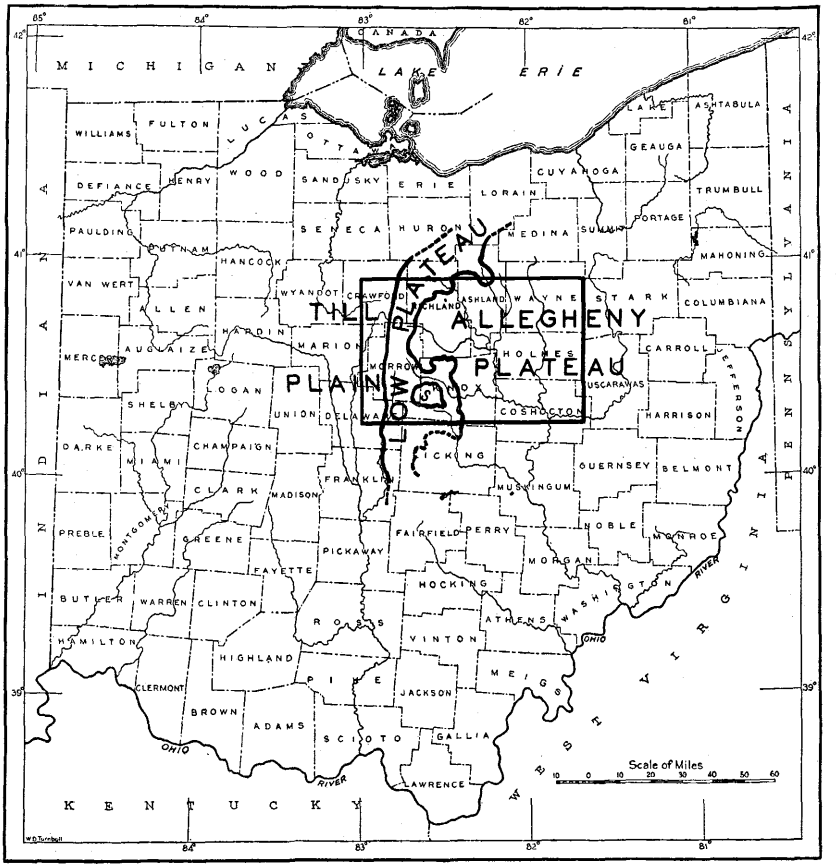


FIG. 1. Index map showing position in Ohio of area discussed, and physiographic provinces present. S.—Sparta Outlier.

is also the higher and more rugged, falls in the Allegheny Plateau section of the Appalachian Plateau province. However, study by the present writer indicates that an "inter-

[2]Fenneman, N. M. Physiographic Divisions of the United States, *Annals Assoc. Am. Geographers*, Vol. 6, 1916, pp. 19–98 and Pl. 1.

mediate plateau" intervenes between the Till Plain and the Allegheny Plateau. This lower plateau will be referred to here as the "Low Plateau." The location of the three physiographic divisions within the area and the position of the area in the state are shown on Fig. 1.

The Allegheny Plateau.—The eastern two-thirds of the area lies in the Allegheny Plateau and is the portion with which this study on drainage history is most concerned. This is in the western part of the Allegheny Plateau section of the Appalachian Plateau province which includes western Pennsylvania, the eastern half of Ohio, West Virginia, and eastern Kentucky. In the area under discussion the Allegheny Plateau is dissected to a stage of early to middle maturity, with an average relief of about 200 feet, but locally of as much as 400 feet. It varies in elevation from 1,200 to 1,500 feet, the greater elevation being due to resistant Logan sandstone of Mississippian age and to sandstones of Pennsylvanian age, which here formed a pre-Pleistocene major divide region. The concordant ridge tops of the plateau are remnants of a peneplain developed in Early Tertiary time. In eastern Ohio the peneplain has been correlated by Stout and Lamborn[3] and in this region by Ver Steeg[4] with the Harrisburg peneplain of Pennsylvania, and by Cole[5] with the Allegheny[6] peneplain of West Virginia. The northern and western parts of the Allegheny Plateau in this area have suffered glaciation, but the southeastern part is unglaciated. An outlier of the Allegheny Plateau is present in southeastern Morrow and southwestern Knox counties (see Fig. 1). The name "Sparta Outlier" is here suggested for this feature, from the village of Sparta, which is on the western end of the outlier.

The Low Plateau.—The Low Plateau is the name applied to an area having an elevation of 1,100 to 1,200 feet, lying between the Allegheny Plateau on the east and the Till Plain on the west. It is entirely covered by Wisconsin drift. In elevation, in relief, and in prominence of glacial features, this region is intermediate between its bordering regions.

[3]Stout, Wilber, and Lamborn, R. E. Geology of Columbiana County. *Geol. Surv. Ohio Bull. 28*, 1924, pp. 38–40.

[4]Ver Steeg, Karl. Some Features of Appalachian Peneplanes. *Pan. Am. Geol.*, Vol. 54, 1930, pp. 22–24.

[5]Cole, W. S. Personal Communication; and, Identification of Erosion Surfaces in Eastern and Southern Ohio. *Jour. Geol.*, Vol. 42, 1934, pp. 285-294.

[6]Fridley, H. M., and Nölting, J. P., Jr. Peneplains of the Appalachian Plateau. *Jour. Geol.*, Vol. 39, 1931, pp. 749–755.

This physiographic division forms a gently curving belt from 5 to 16 miles in width which lies in Richland, Crawford, Morrow, Knox, and Delaware counties.

Its eastern boundary is marked by the generally abrupt rise of the Allegheny Plateau. Its western boundary is along a scarp that follows the outcrop of the resistant Berea sandstone, which rises from 50 to 100 feet above the Till Plain. The scarp is still further accentuated at places by end-moraines which lie along its top. The Low Plateau extends from this area southward across eastern Delaware and western Licking counties, and although it was not recognized by Fenneman[7] as a physiographic entity, it appears to continue to southern Ohio where it becomes a part of the Lexington plain section of the Interior Low Plateau province. The Low Plateau is part of an erosion surface cut in Late Tertiary time on the weak Cuyahoga shale and shaly sandstones of Mississippian age and is correlated with the Lexington (Worthington) peneplain. The relief of the Low Plateau varies from only a few feet to as much as 100 feet, but averages less than 50 feet. It is covered by a thick blanket of drift so that its topography is glacially controlled.

The Till Plain.—The Till Plain, which covers large parts of western Ohio, Indiana, and Illinois, extends into the western part of the area under discussion, where it forms a north-south belt varying from 8 to 15 miles in width. Its eastern boundary is the edge of the Low Plateau. The Till Plain is featureless except for the low broad swells of end-moraines and for a few large stream valleys cut 10 to 50 feet below the general level. It is a bedrock plain cut on the weak Ohio shale and the soluble Devonian limestone, and covered by a blanket of drift of rather even thickness.

PRE-PLEISTOCENE DRAINAGE

The mapping of the course of the pre-Pleistocene streams in this region is largely hypothetical. The fact that a valley is now mature, or is too wide or too deep for the stream it carries, or is abandoned entirely, does not necessarily indicate that it is preglacial in age. It may have been formed during an interglacial stage and be only earlier than the glacial advance that caused the diversion. The basic postulate in reconstructing

[7]Fenneman, N. M., op. cit.

the pre-Pleistocene drainage is that the streams had become adjusted during the long erosion interval of Mesozoic and Tertiary times and that at the end of the Pliocene the direction of the flow of the streams was the same as that of the slope of the land or, in other words, that the streams were flowing from high land to low land. Therefore, to reconstruct the ancient stream systems, it is necessary to determine the location of the major and branch divides. It may be inferred that streams drained the basins bounded by these divides. If these drainage basins slope from the plateau to the Till Plain, it may be assumed that such systems developed over a long period of time, and that they are the systems which were present at the beginning of the Pleistocene, before the first ice sheet to reach this area disrupted these ancient, adjusted, drainage lines.

The major pre-Pleistocene divide, as shown in Fig. 2, extends eastward from central Morrow County, across southern Richland County, and along the north line of Knox County to Holmes County, and thence in a general east-southeast direction to northern Mechanic Township of Holmes County, where it turns southeast and enters Tuscarawas County. This tracing in the eastern part of the region agrees with that suggested by Coffey.[8] From the major east-west divide other divides extended north and south, thus delimiting the headwaters of drainage basins. One branch divide ran north to southeastern Wayne County. Another had a north-south course in Ashland County east of the present Black Fork, but its connection with the major divide to the south is now obscure because of severe dissection by later streams. A third ran from the high land, in south central Richland County west of Mansfield, southeastward to the major divide, but its connection with the main divide has also been obscured by glacially diverted streams.

A very important divide, still well preserved, extended south from the major divide, across southwestern Holmes County and western Coshocton County, about two miles east of the Knox County line. Another extended south across Monroe and Pleasant townships in Knox County southeast of Mt. Vernon, probably reaching northern Morgan Township. From this divide a divide extended west from southwestern

[8]Coffey, G. N. Preglacial, Interglacial and Post Glacial Changes of Drainage in Northeastern Ohio with Special Reference to the Upper Muskingum Drainage Basin. *Ohio Jour. Sci.*, Vol. 30, 1930, pp. 373-384.

Monroe Township, across the long axis of the Sparta Outlier, into southeastern Morrow County. This latter divide was cut

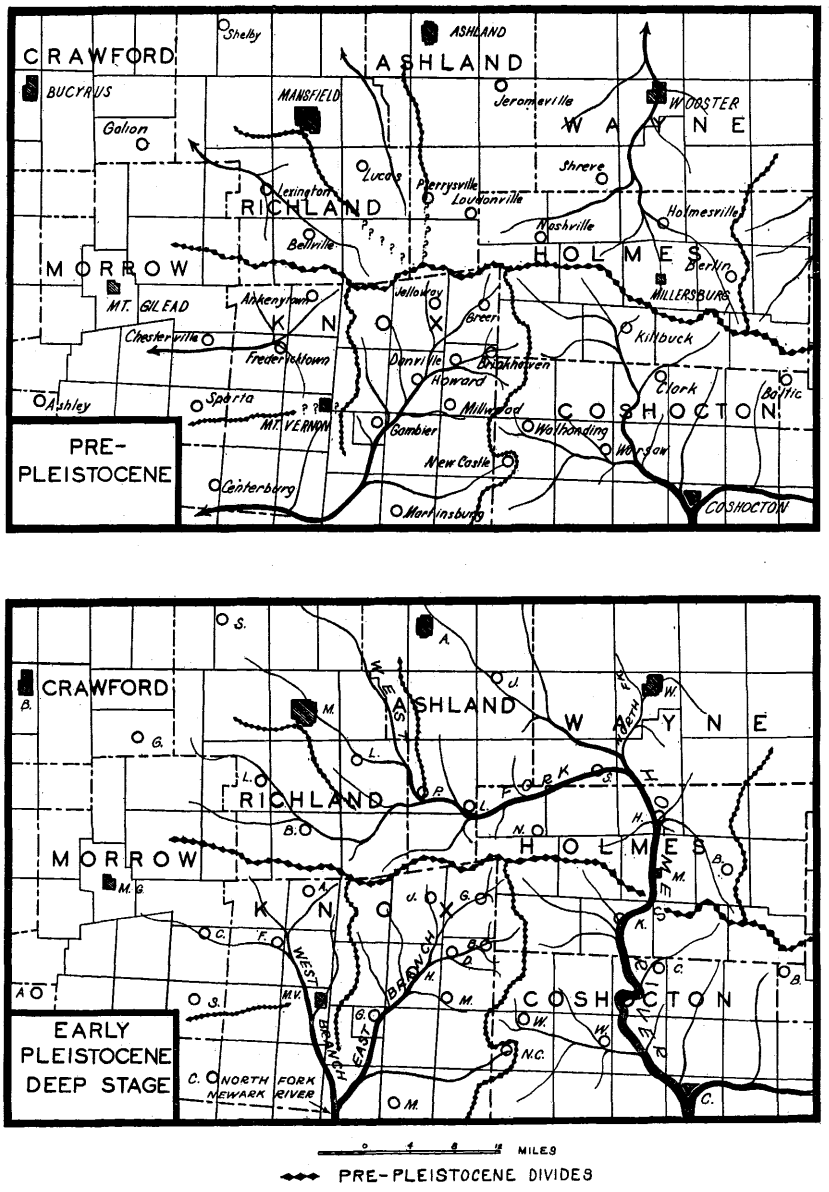
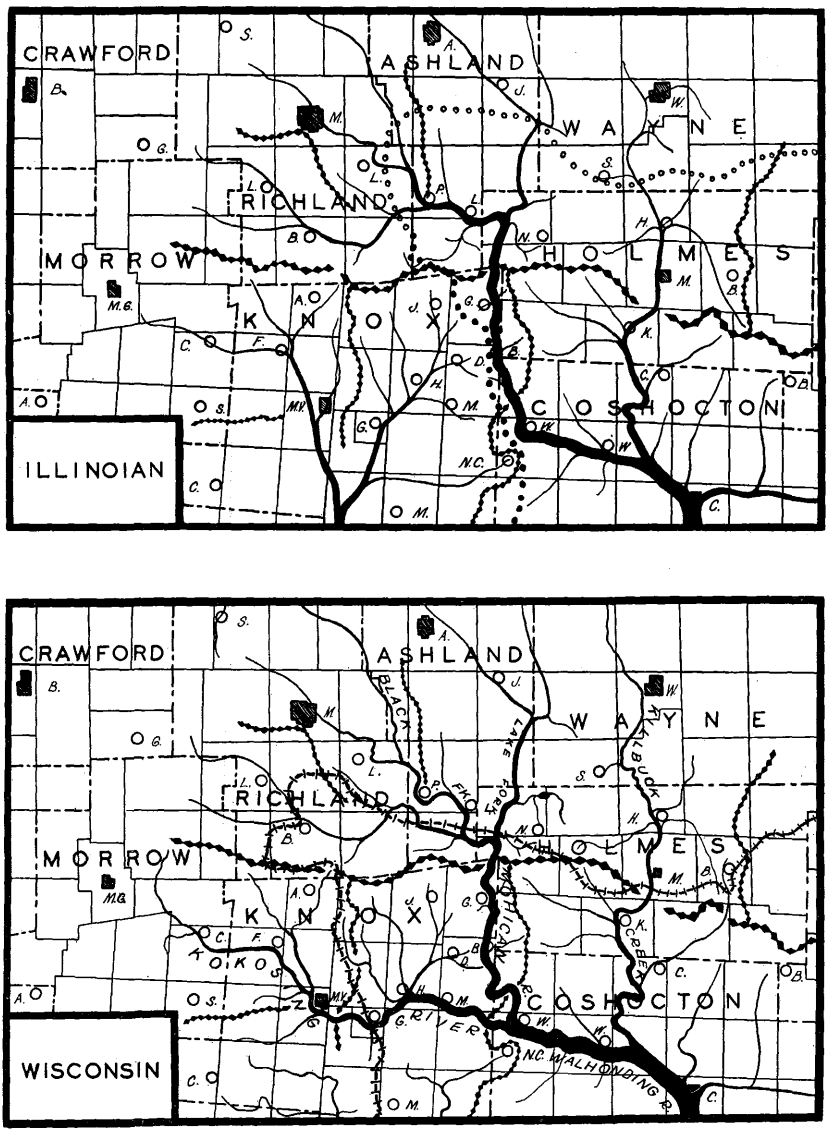


FIG 2. Maps showing Pre-Pleistocene (upper map) and Early Pleistocene (lower map) streams and divides.

through by a wide Deep Stage valley in early Pleistocene time. The Deep Stage valley is now abandoned south of Mt. Vernon.



• • • KNOWN ILLINOIAN BOUNDARY ○○○ POSTULATED ILLINOIAN BOUNDARY -I-I WISCONSIN BOUNDARY

FIG. 3. Maps showing Illinoian (upper map) and Wisconsin (lower map) streams.

These divides mark out the boundaries of the headwaters of certain basins and, on this basis, hypothetical pre-Pleistocene streams are drawn as shown in Fig. 2. This region, then, had a somewhat radial system of drainage, with streams flowing outward from the highest parts of the Allegheny Plateau.[9]

This system of drainage is probably correlative with the Parker strath system in southern Ohio which was tributary to the Teays River. It is believed that the valley bottom of the Teays was above the present drainage and that the streams in its tributary valleys flowed at levels well above the present streams. As the preglacial streams in northeast central Ohio were all near main divides, their positions were probably still farther above the present water courses. On this basis, the deep valleys in northeast central Ohio are not preglacial. These shallow ancient preglacial valleys have been so cut down, or transected, and so modified by drift in the glaciated portion that they cannot commonly be identified. It must be emphasized that the streams indicated on the map, Fig. 2, are largely hypothetical, especially in the glaciated part of the area and are so mapped because each basin, marked by divides still preserved, must have been drained by a stream flowing from that basin. In the unglaciated part of the region, streams of later age may have had their courses fixed by preglacial valleys, but because of later stream work it has not been possible to identify the preglacial valleys except by inference.

EARLY PLEISTOCENE DIVERSIONS

The preglacial streams which flowed north or west from the region were partly or wholly blocked in early Pleistocene time. New systems of streams were developed which flowed from the Low Plateau southeast into the Allegheny Plateau and across divides to join streams which flowed south, eventually emptying into the newly formed Ohio River. The collected waters broke through the main divide at one place, and the col at Killbuck village is the only early Pleistocene col across the main divide in the area here discussed. Such diversions took place long before the Illinoian glacial stage. In order to explain

[9]Ver Steeg rightly concluded (Drainage Changes in the Vicinity of Wooster, Ohio. *Ohio Jour. Sci.*, Vol. 30, 1930, pp. 309–314) that no *deep* valley leads northward through Wayne county, but the present writer believes that a *high level* (Parker strath) valley must have drained northward since the divides west and south of Wayne county and in the eastern part of the county enclose a basin whose only natural outlet is northward.

them, it is necessary to postulate that an early Pleistocene ice sheet, of which so far no other evidence has been discovered, advanced to the north and west borders of the Allegheny Plateau (Fig. 1). This ice sheet may have been either the Nebraskan or the Kansan of the Mississippi valley succession.

Northward and westward flowing streams were ponded, water broke over the lowest places in divides, and stream courses were established which persisted after the ice withdrew. A long interval of time elapsed between the retreat of this early Pleistocene ice sheet and the oncoming of the Illinoian ice sheet, during which the new streams widened and deepened their valleys. Sufficient time was available for some of the large streams to partially integrate their attendant systems. Valleys were widened to a state of maturity and deepened 150 to 300 feet below the present stream levels.[10]

The pre-Illinoian valleys of this age have been called Deep Stage valleys by Mr. Wilber Stout, State Geologist of Ohio, because of the great depths of their valleys as revealed by well drilling. The name seems appropriate and definitive, and will be used in this report for early Pleistocene, pre-Illinoian valleys. The Deep Stage stream systems of northeast central Ohio are shown in Fig. 2 and will be briefly discussed.

Deep Stage Holmes River.—A Deep Stage stream which drained almost all the northern part of this area is here called the "Deep Stage Holmes River," because its ancient valley cuts across northwestern and central Holmes County. It was brought into existence by pre-Illinoian ice at the north border of the Allegheny Plateau. The dammed up waters escaped southward through the lowest place in the main divide, a col between Millersburg and Killbuck. A wide valley, which may be regarded as the West Fork of the Holmes River, now occupied in part by Black Fork, was cut by a stream which entered the Allegheny Plateau in northeastern Richland County and flowed southeast along the Richland-Ashland county line. Here it entered another valley, now occupied in part by Rocky Fork, which entered the Allegheny Plateau at Mansfield in central Richland County. The West Fork valley continued southeast into Ashland County as far as Perrysville in Green Township, where it received Deep Stage Clear Fork from the

[10] *Cf.* Ver Steeg, Karl. The Thickness of the Glacial Deposits in Ohio. *Science*, Vol. 78, 1933, p. 459; and, The Buried Topography of North-Central Ohio and its Origin. *Jour. Geol.*, Vol. 42, 1934, pp. 602–620.

west, then extended eastward past Loudonville to northern Holmes County and thence east-northeast across southern Wayne County to its junction with another large valley now occupied by Killbuck Creek, which may be referred to as the North Fork of the Holmes River. Black Fork now follows the old West Fork valley from Perrysville to Loudonville, but from Loudonville eastward past Shreve this Deep Stage valley is now abandoned. Just north of the junction of the West Fork and North Fork, the latter stream was joined by a large confluent flowing from the northwest, the West Branch of the North Fork. This branch was formed by the union of two streams flowing in the valleys occupied by the present Jerome and Muddy forks, which united just east of the Ashland-Wayne county line and flowed east, through a valley now drift blocked, past Millbrook.[11] The Deep Stage Holmes River thence flowed southward[12] across Holmes County in the valley now occupied by Killbuck Creek through a col, now almost two miles wide, in the pre-Pleistocene divide between Millersburg and the village of Killbuck. Fig. 4-A is a cross-section of this col, and shows its width and depth to be much greater than the Illinoian and Wisconsin cols (Fig. 4-B and C). South of the col the Holmes River entered a pre-Pleistocene drainage system unaffected by glaciation and the Holmes flowed south to Coshocton, where it joined tha ancient (Deep Stage) Newark River.

Deep Stage Clear Fork.—The northwestward drainage from eastern Morrow and southern Richland counties, between the major east-west divide and a branch divide, was blocked. The water found a passage eastward across the high land in Worthington Township, Richland County, and thence flowed northeast across southeastern Monroe Township, joining West Fork of Holmes River at Perrysville. In the main, present Clear Fork occupies this Deep Stage valley. For a distance of three miles near the mouth the old valley is choked with Wisconsin drift, and here the present stream has taken a new course to the south, as discussed below. At Newville, and

[11] *Cf.* Conrey, G. W. Geology of Wayne County. *Geol. Surv. Ohio, Bull. 24*, 1921, p. 18.

[12] Ver Steeg shows (op. cit.) that there is no Deep Stage valley running northward to Orrville as Todd (Some Observations on the Preglacial Drainage of Wayne and Adjacent Counties. *Ohio Acad. Sci., Spec. Pap. No. 3*, 1900) postulated. In any event, the dammed waters had to escape to the south and the Killbuck col is unquestionably Deep Stage, indicating a large southward flowing stream crossing the divide at this place.

for two miles upstream, the present Clear Fork has been forced slightly north of the Deep Stage valley by Illinoian drift filling.

The Deep Stage North Fork of Newark River.—Before the early Pleistocene ice advance, the drainage from northwestern Knox County, and that from southern Knox and southwestern Coshocton counties, was westward. Water dammed up between the east-west divide (Sparta Outlier) near Mt. Vernon and the Allegheny Plateau to the north was forced to break across the east-west divide at Mt. Vernon. The water flowed into a lake dammed up south of the east-west divide. The outlet was

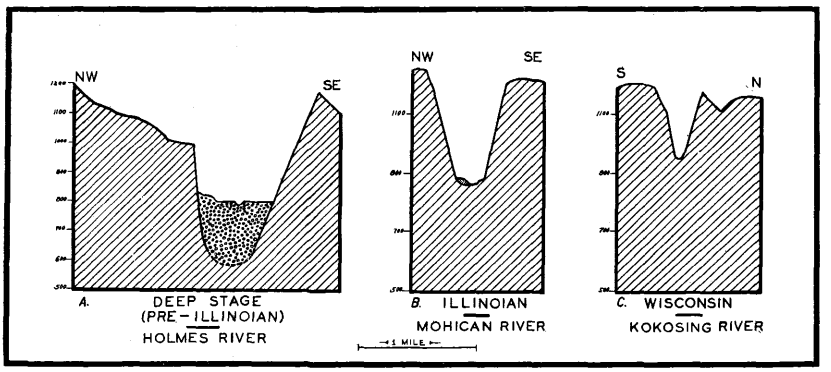


FIG. 4. Sections of cols cut across pre-Pleistocene divides by streams diverted by different ice sheets, showing relation of gorge width to age.

A. Col of Deep Stage Holmes River (now occupied by Killbuck Creek) across main divide between Millersburg and Killbuck. From NE Sec. 9, Mechanic Twp. to NW Sec 3, Killbuck Twp., Holmes County.

B. Col of Illinoian Mohican River between Brinkhaven and Greer. From NW Sec. 15, Richland Twp., Holmes County to S Sec. 10, Jefferson Twp., Knox County.

C. Col of Wisconsin portion of Kokosing River between Mt. Vernon and Gambier. From one-half mile W of Bedell School to one-half mile E of Oak Grove School, Pleasant Twp., Knox County.

established southward to Newark. This stream has been called the North Fork of the Newark River by Lamborn,[13] who has studied its Deep Stage valley in detail. He shows that the valley was formed by streams rising in northern Knox County on the southern slope of the major east-west divide and in western Coshocton County on the western slope of the subsidiary north-south divide. The present writer believes that a tributary which flowed eastward past Chesterville in Morrow

[13]Lamborn, R. E. The Newark Drainage System in Knox, Licking, and Northern Fairfield Counties. *Ohio Jour. Sci.*, Vol. 32, 1932, pp. 449–466.

County, outside the area studied by Lamborn, must have been of considerable size, and must have headed some distance west of the Allegheny Plateau border.

The tributaries to the Deep Stage East Branch of the North Fork that headed at the north-south divide in western Coshocton County can be traced eastward across the present Mohican, therefore this whole Deep Stage system is older than that stream. As the Mohican will be shown to have been forced into its present course by the Illinoian ice sheet, the Deep Stage system must be pre-Illinoian.

ILLINOIAN DIVERSIONS

The position of the ice front of the Illinoian Scioto lobe across this area has been traced in detail and will be described in another paper. Its general location is shown in Fig. 3. One very outstanding and positive drainage diversion caused by the Illinoian ice will be taken up, and then certain other diversions that are less positively attributable to this glacier will be considered.

The Mohican River.—The Illinoian ice front lay from one to five miles west of the present Mohican River in northeastern Knox County and continued just east of south across Newcastle and Perry townships of Coshocton County, from one to eight miles west of a pre-glacial north-south divide. The ice dammed the headwaters of the westward and southwestward flowing tributaries to the Deep Stage East Branch of the North Fork of the Newark River and caused the water to flow south across westward extending spurs of the north-south divide, from one headwater basin to the next, as far as southwestern Tiverton Township, Coshocton County. Here a low place in the north-south divide allowed the water to break over to the southeast and enter the valley of the Walhonding River, which then, as now, flowed east-southeast to Coshocton where it united with the Tuscarawas River.

The present Mohican valley southward across Knox and Coshocton counties (Loudonville and Brinkhaven quadrangles) varies from one-fourth mile in width, where it has cut across spurs, to one mile in width, where it crosses Deep Stage valleys. Because of its obvious association with the Illinoian ice front, this valley is regarded as Illinoian in age. Since the stream flows on bedrock where it has cut across spurs and since it cuts across headwater streams of a Deep Stage system, it is not

Deep Stage. The fact, that the Wisconsin diverted streams have narrower gorges (lower Clear Fork, Kokosing between Mt. Vernon and Gambier, and other valleys discussed below), indicates that the Mohican must be pre-Wisconsin. The greater width of one of the typical cols in the Mohican as compared with the width of a Wisconsin col, and the lesser width as compared with that of a Deep Stage col is illustrated in Fig. 4.

The age of the present Kokosing valley in eastern Knox County is as yet undetermined. The valley crosses the old north-south divide area between the villages of Millwood and Walhonding in a wider valley than that of the Mohican. Mr. R. E. Lamborn suggests[14] that a Deep Stage stream which originally headed at the village of Walhonding had, before Illinoian time, worked westward by headward erosion almost to Millwood. If this be the case, a stream may have flowed from the upper part of the East Branch drainage system to the Walhonding River just before, as well as after, Illinoian time. The present writer is of the opinion, however, that only a small stream passed through this col between Millwood and Walhonding until Wisconsin time.

Lake Fork.—Lake Fork now flows from the junction of Jerome and Muddy forks southward across southeastern Ashland County, crosses the Deep Stage valley of the West Fork of the Holmes River in northwestern Holmes County, and thence flows southwest across the south line of Washington Township to the Mohican River (West Salem and Loudonville quadrangles). The valleys of its tributaries, Jerome and Muddy forks, are two to three miles wide and are certainly pre-Illinoian (Deep Stage), but the valley of Lake Fork is only one-fourth to one-half mile wide, except where it crosses the ancient Holmes valley. On this basis it is believed not to be a Deep Stage valley. Its width is, however, greater than that of the valley of Clear Fork in Ashland County, which is canyon-like and which is quite definitely Wisconsin in age. On these bases the Lake Fork valley is believed to have come into existence with the Illinoian ice stage. To block the mouth of the Deep Stage Holmes River in southern Wayne County, and to divert the Deep Stage streams of Jerome Fork and Muddy Fork valleys from their southeastern courses to the Deep Stage

[14]Lamborn, R. E. Personal communication.

Holmes, an obstruction was necessary. It is therefore postulated that a lobe of the Illinoian glacier east of the Scioto lobe extended as far south as Shreve, but not as far as did the later Wisconsin ice, since no Illinoian drift has been discovered in this region south of the Wisconsin boundary. The location of this postulated portion of the Illinoian boundary is shown in Fig. 3.

WISCONSIN DIVERSIONS

The Wisconsin glacier advanced to the limits shown on Fig. 3.[15] Its presence caused several major diversions and many minor changes. When the Wisconsin ice had finally disappeared the streams now present, shown in Fig. 3, were established. The Wisconsin diversions will be taken up from east to west across the area.

Doughty Creek.—The headwaters of Martins Creek in southern Berlin Township, Holmes County (Millersburg and Coshocton quadrangles), ponded by the Wisconsin glacier, broke through the main east-west divide in northeastern Mechanic Township, entered Doughty Creek, and flowed southwest to join Killbuck Creek in northern Coshocton County. The course of the stream through the divide is a narrow gorge two miles in length called "Troyers Hollow." Doughty Creek and Martins Creek now rise in an area of terminal moraine topography in central and northern Berlin Township; Martins Creek flowing north from the southeastern part of the township and Doughty Creek flowing south from the northern part, their courses being only from one to two miles apart for a distance of four miles.

Sigafoos Run.—Sigafoos Run, in the western part of Holmes County (Loudonville quadrangle), suffered diversion of its lower course, which in pre-Wisconsin time was north from Knox Township to the ancient West Branch of the Holmes River in central Washington Township. The Wisconsin ice advanced as far as the south line of Washington Township, blocking the northward flowing stream and forcing it to flow westward, where it cut a narrow gorge for a mile along the front of the ice to the present Mohican River.

Black Fork.—After the Illinoian diversion of the West

[15]For details of boundary in Holmes County see White, G. W., Glaciation of Northwestern Holmes County, Ohio. *Ohio Jour. Sci.*, Vol. 31, 1931, pp. 429–453; and, An Area of Glacier Stagnation in Ohio. *Jour. Geol.*, Vol. 40, 1932, pp. 238–258.

Branch of the Holmes River, Black Fork followed the Deep Stage valley eastward from Perrysville past Loudonville to northern Washington Township, Holmes County, where it joined Lake Fork and flowed southward (Perrysville and Loudonville quadrangles). A tributary, Pine Run, flowed northeast from southwestern Hanover Township, Ashland County, and entered Black Fork at Loudonville. The Wisconsin glacier front dammed this ancient Pine Run valley two miles southwest of Loudonville. The ponded water broke over a divide eastward to the Mohican River[16] and established the present drainage course during the waning of the ice. The lower end of the old Pine Run valley was freed of ice while the old Holmes valley from Loudonville to Lake Fork was still blocked by dead ice masses. The present course of Black Fork was therefore established southwestward for two miles up the old Pine Run valley and thence eastward through the new gorge to the Mohican River.

Clear Fork.—After the early Pleistocene glaciation, Deep Stage Clear Fork flowed eastward through a wide valley from Richland County to join Deep Stage West Fork at Perrysville in Ashland County (Perrysville quadrangle). The Wisconsin ice of the Killbuck[17] lobe at the time of maximum advance covered the lower course of Clear Fork to a point about one-half mile north of Newville in northeastern Worthington Township, Richland County. However, the present Clear Fork does not leave its old valley at this place, but follows the old valley eastward along the line between Worthington and Monroe townships and into Section 31, Green Township, Ashland County, to a point only one mile from the Black Fork valley. Here Clear Fork turns southward at right angles, leaving its old valley and entering a canyon-like gorge which it follows southward into northwestern Hanover Township for two miles and thence eastward for three miles to join Black Fork. Its course in the old valley along the Worthington-Monroe township line is almost two miles north of the Wisconsin boundary, but its course in the Clear Fork gorge across northern Hanover

[16]Ver Steeg, who has called attention to this diversion (Drainage Changes in the Vicinity of Loudonville, Ohio. *Ohio Jour. Sci.*, Vol. 31, 1931, pp. 368–377) suggested it might be Illinoian. However, the position of this col, immediately south of the Wisconsin glacial boundary, and its extreme narrowness point to Wisconsin age.

[17]Name proposed for the lobe of Wisconsin ice between the "main" Scioto lobe and the Grand River lobe.

Township is just south of the glacial boundary. Such a diversion of the stream along the ice front in northern Hanover Township is to be expected, but the absence of diversion in northeastern Worthington Township is not so easily explained. The following hypothesis is offered:

The Killbuck lobe advanced into northeastern Worthington Township and dammed Clear Fork. At first the ponded waters found an outlet through a spillway in the divide at the head of the valley of Smoky Run southwest of Butler in the southeast corner of Jefferson Township, Richland County[18] and escaped into the valley of East Branch of the Kokosing River near Ankenytown. This spillway was not used very long for the Scioto lobe of the glacier advanced a little to the east of Ankenytown to a position just east of the spillway, closing the outlet. By this time, the ice of the border of the Killbuck lobe had melted away from the old valley in northeastern Worthington Township or was fissured and crevassed so that the waters again followed the old course to the southwestern corner of Green Township. However, the ice edge, or more solid ice blocks, kept the water from entering the Black Fork valley, and ponded it to a sufficient height so that it could flow south over the divide into the headwaters of a tributary of Pine Run, and thence eastward along the ice front to the point where Pine Run and Black Fork meet. From here the waters continued eastward, flowing through the new outlet established by Pine Run and Black Fork.

Kokosing River.—The course of the Kokosing River was considerably altered by the Wisconsin ice sheet. The pre-Wisconsin course of the Kokosing was southward from Mt. Vernon to the south line of Knox County, where it joined the East Branch of the North Fork of the Newark River. The Wisconsin ice blocked this valley at its mouth in southern Knox County and ponded waters found egress to the eastward across a low place in the divide at Millwood in southwestern Union Township and joined the Mohican River just east of the Knox-Coshocton county line.

The gorge by which the Kokosing crosses the divide in northwestern Pleasant Township (Gambier quadrangle) is just west of the position attained by the Wisconsin ice front. A cross-section of this Wisconsin gorge is shown in Fig. 4-C.

[18]This spillway appears to be pre-Wisconsin, although the Wisconsin boundary crosses it. It may have been the course of a minor Illinoian stream.

This gorge is explained by supposing that the marginal ice, quite thin on the divide, rapidly disappeared, while ice remained to the south in southern Morgan Township, blocking any outlet to south or east. Water had to escape over the divide between Mt. Vernon and Gambier. There is evidence of a temporary channel immediately to the north of the present gorge (see topographic map and Fig. 4-C). Finally, one channel, probably because it received more water than the other, was cut down faster, and the other was abandoned. The down-cutting was rapid, and by the time the ice disappeared from the region, drainage was established through the new gorge.

Schenk Creek.—Schenk Creek, a former tributary to the Kokosing River at Mt. Vernon, was also diverted by the Wisconsin ice sheet. This stream rises in eastern Berlin Township, Knox County, and flows southward along the Wisconsin boundary to northwestern Monroe Township, four miles north of Mt. Vernon (Gambier quadrangle). The Wisconsin ice filled the valley south to Mt. Vernon, and the ponded waters escaped eastward across a divide, along a course now marked by a narrow gorge, into the valley of Little Schenk Creek in northeastern Monroe Township. The water thence flows southeastward to the Kokosing River.

SUMMARY

It has been shown that in the Allegheny Plateau of north central Ohio there are three valley systems which cross ancient divides. The cols are of different widths (Fig. 4) and of different ages.

Narrow gorges closely related to the Wisconsin glacial boundary exist where the Kokosing, Clear Fork, Black Fork, and other streams cross divides. These gorges are believed to date from the Wisconsin glacial stage.

The Mohican River crosses divides in wider gorges, related to the Illinoian glacial boundary, and is believed to have been diverted to its present channel by the Illinoian ice.

Other valleys, where they cross divides, are deep, wide, and mature, and are manifestly pre-Illinoian. Since they cross divides, however, they were cut by diverted streams. An early, pre-Illinoian, ice sheet is believed to have caused the diversion. Valleys of this age are called Deep Stage, the two important systems in the area being the Holmes River (with North and

West forks), and the North Fork (with East and West branches) of the Newark River.

The ancient divides, here mapped (Fig. 2), are believed to mark out basins drained by pre-Pleistocene streams. The actual valleys of these streams were well above present drainage, and have therefore been so cut down, modified, and concealed by glacial drift that their exact location is very uncertain. Based on a study of the pre-Pleistocene divides and drainage basins, which slope northward, westward, southwestward, and southward, the drainage of the plateau in north central Ohio before the Pleistocene was somewhat radial.[19]

[19]ACKNOWLEDGMENTS.—The writer gratefully acknowledges his indebtedness to Professor J. Ernest Carman for many valuable suggestions made during the progress of the field work and during the preparation of most of the manuscript; to Mr. Wilber Stout for many stimulating discussions on the problems of drainage changes in Ohio; to Mr. Raymond E. Lamborn and to Dr. W. Storrs Cole for suggestions on certain points; and to Mr. John H. Edgerly for drafting the figures.