

# MAJOR GLACIAL DRAINAGE CHANGES IN OHIO<sup>1</sup>

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During the Pleistocene epoch, glaciers, probably several thousand feet thick, advanced at least four times over much of the northern part of the United States. These are usually referred to as the Nebraskan, Kansan, Illinoian and Wisconsin glaciations. It has been estimated that the Nebraskan, or first advance, was probably one million years ago and that thousands of years intervened between each advance. There is positive evidence that the Illinoian and Wisconsin glaciations spread southward until all of the northern and western parts of Ohio were covered by the ice. Evidence that the Nebraskan and Kansan glaciations invaded northern Ohio, although indirect, has been accepted as sufficient by many geologists.

The advance of the glaciers into Ohio seems to have brought about as great, or greater, drainage changes in Ohio than in any other part of the United States. The most important changes were due to the earlier ones. This paper will, therefore, give most consideration to those changes, which the evidence indicates, were the result of these earlier glaciations, particularly those in the present Scioto and Miami valleys.

Perhaps not enough emphasis has been given to the changes that may have taken place during the advance of the same glacier, which Goldthwait estimates "at fastest known speed took 5,000 years to cross the state the first time," nor to the different changes which resulted from the advance of *each* of the earlier glaciations and during the thousands of years that intervened between them. While the evidence of such changes may not be conclusive, it seems sufficient to justify giving it careful consideration.

Perhaps, the most important factors in determining the changes are the elevation and slope of the present surface, and also of the rock surface where available, and the location of the main divides, valleys and streams. The advance of the different glaciations brought about so many reversals and other changes in the streams and the formation of new channels, or the deepening of the old ones, that it is often difficult, or even impossible, to determine the exact location of the preglacial divides and streams. There is some positive evidence that in preglacial time the drainage of all streams in Ohio, including those in the present Scioto and Miami valleys, discharged northward into the present Lake Erie Basin.

## *Preglacial Divides and Drainage*

Based upon the best evidence obtainable, Ohio has been divided into four main preglacial drainage basins: the Northeastern, the North-Central, the Central-Southeastern and the Western Basins. A map of these Drainage Basins, with the principal divides and preglacial streams, is shown as figure 1. This should be compared with the Teays Stage Drainage map by Stout, Ver Steeg and Lamb (1943), shown on page 50 of a report on the Geology of Water in Ohio, which also has several other maps of the drainage systems resulting from the different glaciations, and on page 48 on a "Relief on Rock Surface" map by Stout, which has very much helpful information.

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### Northeastern Drainage Basin

The Northeastern Drainage Basin lies east of the divide, extending from the preglacial divide across the present Ohio River Valley in Monroe County northward by Barnesville, Cadiz and Ravenna to Geauga County and Lake Erie. The drainage included that of the present Ohio River Valley north from the old divide to Beaver Falls, Pennsylvania, where it joined the Pittsburgh drainage, flowed

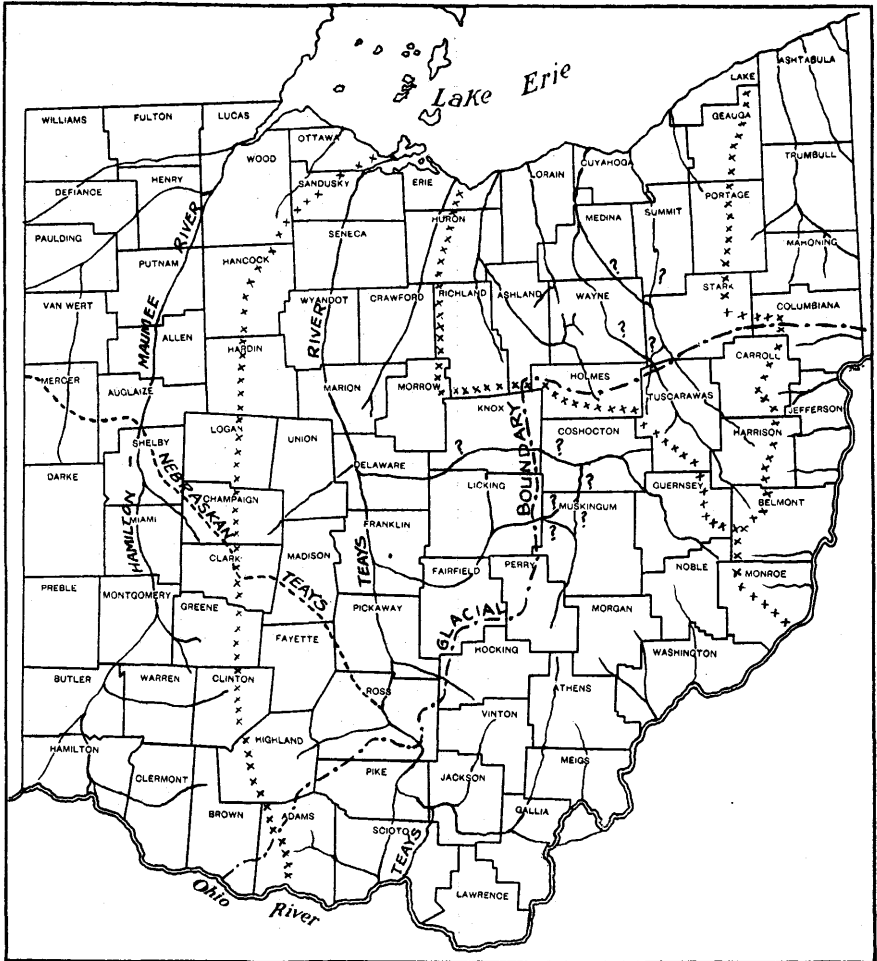


FIGURE 1. Major preglacial drainage basins, divides and streams. The location, especially of the streams, is necessarily approximate, and where particularly so, is indicated by a question mark ?. Divides are indicated by xxx and streams by ———. The glacial boundary is also shown by - - - - and the interglacial Nebraskan-Teays River by . . . . .

northward through the present Mahoning and Grand River valleys to the Lake Erie Basin. The elevation in most of these two valleys is less than 1,000 feet and the surface is more like the Plains than the Plateau.

### The North Central Drainage Basin

The North-Central Drainage Basin is situated west of the divide just described and north and east of the divide, which extends northwest from Belmont County

across the present Tuscarawas River Valley near Port Washington and on into Holmes County, thence west to Morrow County, where it turned North through the Plains to the Lake Erie Basin, probably in Erie County.

The drainage changes in this Basin are probably more complicated than in any other part of Ohio. In the November, 1930, issue of *The Ohio Journal of Science* is an article by the writer with a map on which is indicated the possible preglacial, interglacial and postglacial drainage in most of this Basin. The evidence seems to indicate that in preglacial time there was a number of streams, including the present Stillwater, Conotton, Killbuck, Jerome and Black Fork creeks, as well as the Cuyahoga and Chagrin rivers, which flowed northward into the Lake Erie Basin. At that time the streams in the Plateau, except perhaps near the escarpment, had not cut out deep valleys, the elevation of the valley floors probably being more than 1,000 or even 1,100 feet above sea level.

#### *Central-Southeastern Drainage Basin*

The Central-Southeastern Drainage Basin is bounded on the east and Northeast by the divide, extending from Monroe County northwest and west to Morrow County, and then north to Erie County on the lake; on the southeast and south approximately by the present Ohio River; and on the west by a line running north from the present Ohio River in Adams County along the divide between the present Scioto and Miami valleys to Hardin County, and then probably northeast to the Lake Erie Basin west of Sandusky Bay. The southeastern and southern parts are a part of the Plateau, of which very little if any was covered by the earlier glaciations, but the later ones, especially the Illinoian, advanced onto the western portion particularly from Fairfield County northward to Richland County.

In preglacial time the elevation of the northern portion of the Plateau in this basin was probably more than 1,000 feet above sea level and some of it as much as 1,200 to 1,400 feet, but in the southern portion is now less than 1,000 feet and much is below 800 feet. An outlier of the Plateau along the western border of this basin in Logan and Champaign counties includes east of Bellefontaine the highest elevation in Ohio, which is 1,533 feet.

In the Plains section the elevation of the rock surface, as shown on page 48 of "Relief on Rock Surface" map by Stout already referred to, rises gently from less than 600 feet along Lake Erie southward to the upper Scioto Valley, where, for a width of 30 miles or more it is less than 1,000 feet and much of the upper and lower portions are less than 900 feet, while that of the divide, along its western border from the outlier of the Plateau in Logan County south almost to the Ohio River, is more than 1,000 feet, except in the narrow abandoned valley where the Nebraskan-Teays River broke over and in Champaign County cut a channel through an area where the rock surface on each side is more than 1,100 feet. The width of this broad valley, which extends northward from Columbus between two of the highest points in Ohio, and the lower elevation of the rock surface in this valley, as compared with that of the divide along its western border, furnish positive evidence 1) that the preglacial Teays River flowed northward from Chillicothe and was primarily responsible for the formation of this broad valley and 2) that the abandoned channel northwestward from Chillicothe to Indiana must have resulted from the later blocking of this northward flow of the old Teays River by the advance of the Nebraskan glaciation, causing it to break over the divide on the west and, during the thousands of years before the coming of the Kansan glaciation, to cut out this deep, narrow valley, making it interglacial rather than preglacial in origin. This offers a logical explanation of the origin of this broad upper Scioto Valley which it is difficult to explain satisfactorily otherwise.

#### *Western Drainage Basin*

The Western Drainage Basin includes all of Ohio west of the divide just described and now occupied principally by the Maumee and Miami valleys. The

rock surface rises gradually from less than 600 feet along Lake Erie, and much of the Northern portion of the Maumee Valley, to more than 900 or 1,000 feet in the Miami Valley, except in the middle and southern portions, where it gradually lowers to less than 800 or even 700 feet.

Most geologists agree that the preglacial drainage in the Maumee Valley was northeastward into the Lake Erie Basin and that the drainage of the central part, which includes the present divide between the Maumee and Miami valleys, was northwestward by means of the Teays River into Indiana, as indicated on the Teays drainage map already referred to. However, they do not agree as to the preglacial drainage in the southern part. Some think it was southwestward into what is now the Ohio River Valley while others believe it was northward and joined the Teays River.

On page 53 of a recent publication Wayne (1956) states, "I believe that preglacial Hamilton River probably flowed northeastward"; and on page 35 he states, "the data used to prepare the maps showing drift thickness and bedrock topography of northeastern Indiana indicate the slope of the bedrock surface must be eastward toward Ohio and the Lake Erie basin rather than to the southwest," which apparently agrees with the slope on "Relief on Rock Surface" map of Ohio already referred to. This and other evidence lead to the conclusion that all of the preglacial drainage in the Western Drainage Basin was north and eastward into the Lake Erie Basin, that the Teays River across the central portion was formed during the Nebraskan glaciation, and that the lower elevation in the present Miami Valley has taken place since the advance of the Kansan glaciation. It does not seem logical that a large stream like the old Teays River would have naturally developed on a divide like that between Lake Erie and the Ohio River.

#### *Nebraskan Glaciation*

Evidence strongly indicates that the first advance of the ice into Ohio was the Nebraskan glaciation. The advance was from the northeast along the Lake Erie Basin, from where it spread southward, the tendency being to flow around the higher parts of the country and spread out like a fan from the lower valleys. The ice blocked the northeastern preglacial drainage of the old Lake Erie Basin and formed a lake, the level of which continued to rise until it overflowed westward into Indiana. All of the Ohio drainage would then have been into this glacial lake until the southern border of the ice successively blocked the northward flow of the streams and forced many of them to seek new lines of discharge, probably at first across the divides between them and later resulting in the reversal of many streams and cutting out of new, or the deepening of old, channels southward. As the glacier came from the northeast it may have taken a thousand or more years for it to move westward to the Indiana line.

When the glacier advanced far enough south to encounter the northern boundary of the divide, forming the western boundary of the northeastern Drainage Basin, it blocked the old Pittsburgh drainage and formed a lake, which rose until it reached the lowest elevation in the divide along its western border, apparently south of Ravenna, as previously suggested (Coffey, 1914, 1930). As the Grand River glacial lobe advanced south of Ravenna, as it apparently did, the lake continued to rise until it broke over the divide in Monroe County and joined the old Marietta River which united with the Teays River in Jackson County.

As the glacier moved westward around the highlands in Geauga County it successively blocked the streams in the North-Central Drainage Basin, resulting in such a complexity of changes in the drainage as to make it impossible to determine definitely the preglacial, or post Nebraskan, location of the streams. The Pittsburgh drainage, which apparently broke over the divide near Ravenna, may have flowed northwestward for many years along the old valley described by

Scranton and Lamb (1932) as extending from southeast of Alliance northwestward across the divide near Ravenna.

The blocking of the drainage in the old Cuyahoga Valley resulted in the formation of a lake. It rose and probably found successive temporary outlets northwestward along the present Chippewa and other valleys leading northwestward from it until the ice moved far enough south to block these outlets and to cause the lake to break over the divides near Justus and Port Washington and form a stream, which flowed southwestward and joined the Nebraskan-Teays River in Madison County. This might help to explain the complexity of the deep valleys now occupied by Chippewa Creek and other streams in this section. They are shown in detail on map by Ver Steeg (1934).

In the Plains section the Nebraskan glacier extended far enough south to block the northward flow of the old Teays River and also that of the old Hamilton-Maumee River. The blocking of the Teays drainage resulted in the formation of a lake in the present Scioto Valley. The lake continued to rise until it broke over the western divide in Clark County, joined the old Hamilton drainage, and continued on northwestward into Indiana, thus forming a new or Nebraskan-Teays River from the old Teays at Chillicothe. As this Nebraskan-Teays River included not only all of the Ohio drainage but also the West Virginia and Kentucky and the Pittsburgh drainage; it must have been a large stream. During the thousands of years that intervened before the coming of the Kansan glaciation, the stream cut out the deep valley extending from Chillicothe northwestward across the divide into Indiana.

After the retreat of the Nebraskan glaciation, the drainage in the northern part of the state again discharged into the Lake Erie Basin. The upper Tuscarawas drainage, which had broken over the divide near Port Washington, apparently reversed its course and discharged northward along the old Tuscarawas and Cuyahoga valleys and contributed to the rapid lowering of the stream channels in these valleys, where, according to White (1953), "well records in Cuyahoga River valley indicate the valley floor to be 100 feet or more below sea level near Gordon Park at the lake shore."

The Pittsburgh, Hamilton, and Teays drainage remained very much the same until the coming of the Kansan glaciation. The much shorter distance from the Flusing escarpment in eastern Ohio to the Lake basin, as compared with that from east of this escarpment along the old Pittsburgh and Teays drainage to Indiana, may offer at least a partial explanation of the apparently more rapid and deeper erosion, which resulted in the differences in the physiographic features east and west of this escarpment.

#### *Kansan Glaciation*

The Kansan glaciation apparently advanced farther south than the Nebraskan, especially in the Plains section, and blocked all northward drainage into the Lake Erie basin and also that of the Nebraskan-Teays and Hamilton drainage northwestward into Indiana. The Hamilton drainage was reversed and as the ice advanced farther south the Teays River apparently broke over its southwestern bank in Clark County and joined the reversed Hamilton River at Dayton and continued southwestward to become eventually a part of the Ohio River west of Cincinnati. Further advance of the ice forced the Teays River drainage to flow southward to Portsmouth, where it turned westward, broke over the divide in Adams County, and continued to near Cincinnati. From here it followed the old Licking River northward and joined the reversed Hamilton River. Together they flowed southwestward and broke over the divide near Madison, Indiana, thus forming the present Ohio River, except the section south of Cincinnati, which probably was formed at the later advance of the Illinoian glaciation.

The long interglacial period before the coming of the Illinoian glaciation would

have resulted in degrading the surface, thereby forming the present broad Scioto and Miami valleys, as well as lowering the surface in other valleys in the state. Perhaps "Deep Stage" drainage really consisted of two stages, Nebraskan and Kansan.

While the evidence indicates that the Kansan glaciation extended farther south in western Ohio than the Nebraskan, it is not possible in the northeastern part of the state to determine definitely to which glaciation certain changes were due. However, the Kansan glaciation doubtless produced some changes in the drainage as well as in the deepening of many stream channels.

#### *Illinoian and Wisconsin Glaciations*

The Illinoian and Wisconsin glaciations advanced much farther south than the earlier ones and produced important changes in the drainage but there are differences of opinion as to when some of these changes took place.

It is generally agreed that the Illinoian glaciation advanced across the Ohio River at Cincinnati and east as far as Brown County. The border then extended northeastward to Muskingum County and then north to Ashland County. From there a map in Bulletin 44 by Stout, Ver Steeg, and Lamb (1943) extends it northward to the Lake in Erie County. They believe that the ice barrier on the Ohio River at Ripley completely obstructed the drainage to the west, resulting in the reversal of the Ohio River and the discharge of all the drainage east of the ice border northward into the Lake Erie Basin. White (1951), however, is positive that the "fringe" east from Canton to Pennsylvania is of Illinoian age.

In discussing the glaciation south of the Ohio River Wright (1890) states, "the amount of drift transported is trivial. The fact, therefore, that the ice bridged the chasm of the Ohio does not necessarily carry with it the view that it blocked that chasm to the exclusion of the river." The rather large streams that flow under some of the present glaciers, the ice of which is several times harder than normal ice, as well as other evidence, support Wright's statement.

As the Illinoian glaciation advanced southward it blocked the streams flowing westward into the present Scioto Valley. This resulted in their breaking over the divide on the east and in the formation of the present Muskingum and Hocking rivers. There were probably also changes in the Walhonding and Mohican rivers although the latter is east of the Illinoian border and may have been due to the Wisconsin glaciation, as the eastern border of the Illinoian glaciation on map by White (1934) is west of the present stream and the post-Illinoian drainage may have continued east along the broad valley to the Killbuck near Shreve, until the coming of the Wisconsin glaciation.

As the Wisconsin glaciation did not extend as far south as the Illinoian, except from Ashland County east to Canton, it apparently did not cause important changes in the drainage, except in the northern Plains, where the location of the present streams was much influenced by the moraines. Another example is in the Tuscarawas Valley, where it blocked Conotton Creek, causing it to break over the high divide on the west and to cut out a narrow channel through which the Tuscarawas River now flows to the broad valley at Dover.

Many other less important drainage changes could be cited. It is hoped the suggestions in this paper may prove of some assistance in solving the many puzzling drainage changes in Ohio that resulted from the different advances of the ice.

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