Character and History of the Upper Ohio River Valley

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CONTRIBUTIONS TO GENERAL GEOLOGY

GEOLOGICAL SURVEY BULLETIN 1141-I

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1962

UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C.

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CHARACTER AND HISTORY OF THE UPPER OHIO RIVER VALLEY

By Charles W. Carlston

ABSTRACT

Dismemberment of the preglacial Teays Valley system and development of the present Ohio River valley began in late Tertiary or early Pleistocene. By Illinoian time the present Ohio River was largely established in its present course, except for its headwaters above mile 114, which still flowed northward. The Illinoian glacial advance into northwestern Pennsylvania caused diversion of this portion of the Ohio River into its present course. The bedrock valley was deepened and broadened during the Sangamon interglacial stage, and was filled with fluvioglacial deposits during the Tazewell and Cary ice advances into northwestern Pennsylvania. Post-Cary activity of the river has included downgrading and the cutting of terraces, which are floored with flood-plain deposits.

INTRODUCTION

In 1902, Frank Leverett (p. 88, 89) described features of the upper Ohio River valley that indicate that the uppermost part of the Ohio River once flowed northward and was later diverted to its present course and direction of flow. These features were: (1) The lack of any large tributaries in the upper 130 miles of the streams; (2) an increase in height of the uplands bordering the Ohio from western Pennsylvania to New Martinsville; and (3) the tendency of the tributaries, from western Pennsylvania to New Martinsville, to point up the valley at their junction with the Ohio.

In the present study, certain characteristics of the Ohio River bedrock profile and valley width were found that indicate reversal in direction of flow of the upper Ohio and suggest the location of the divide between the old north-flowing and south-flowing drainage.

In 1956, the writer and G. D. Graeff, Jr., of the Geological Survey, reported on the ground-water resources of the Ohio River valley in West Virginia. The longitudinal profile of the deep bedrock valley of the Ohio River as far as the West Virginia-Pennsylvania boundary was delineated fairly precisely in this report (Carlston and Graeff, 1956, p. 5–6; fig. 2). The present paper is an expansion of the information given in the earlier publication and an extension of its scope upstream to mile 0 at Pittsburgh.

The altitude of the bedrock floor throughout the length of this 318-mile section of the Ohio River valley was determined from 100 test borings made by the U.S. Army Corps of Engineers and the West Virginia Highway Department. It was found early in the study that water-well logs were too inaccurate for use in precise determinations of the bedrock floor. Accordingly, only test-hole borings made by the Corps of Engineers for flood-wall locations, lock sites, and damsites, and foundation borings for State Highway Department bridges were used. All these borings had excellent vertical control. The Corps of Engineers' test borings were made along the river bank and in the river, and the borings in general follow the central axis of the valley.

CHARACTER OF THE BEDROCK VALLEY

TRANSVERSE PROFILES OF THE VALLEY

The bedrock valley has the shape of a trench with a flat bottom and abrupt, steep walls. It contains buried rock benches, and the deepest part of the buried channel may occur anywhere under the present valley, not necessarily beneath the present river channel. The entire valley cross section at Emsworth Lock at mile 6 (measured downstream from Pittsburgh) in Pennsylvania is shown in figure 1*A*. The section illustrates the rock-cut channel of a buried tributary, Lowrie Run, which enters the Ohio from the north. Although about 600 feet of section beneath Neville Island has not been bored, the general character of the cross-valley profile is shown.

A nearly complete cross-valley profile of the Ohio River at lock 19, mile 192, is shown in figure 1*B*. This section illustrates a broad, shallow inner valley and a gently shelving bench on the west, or Ohio, side of the river. The bench may be structural (bench and slope topography).

The east side of the bedrock valley at the Ninth Street bridge at Wheeling, W. Va., is shown in figure 2*A*. A narrow, rather steeply sloping rock bench occurs on the east side of the valley. The general flatness of the bedrock valley floor at lock 15, mile 129, is shown in figure 2*B*.

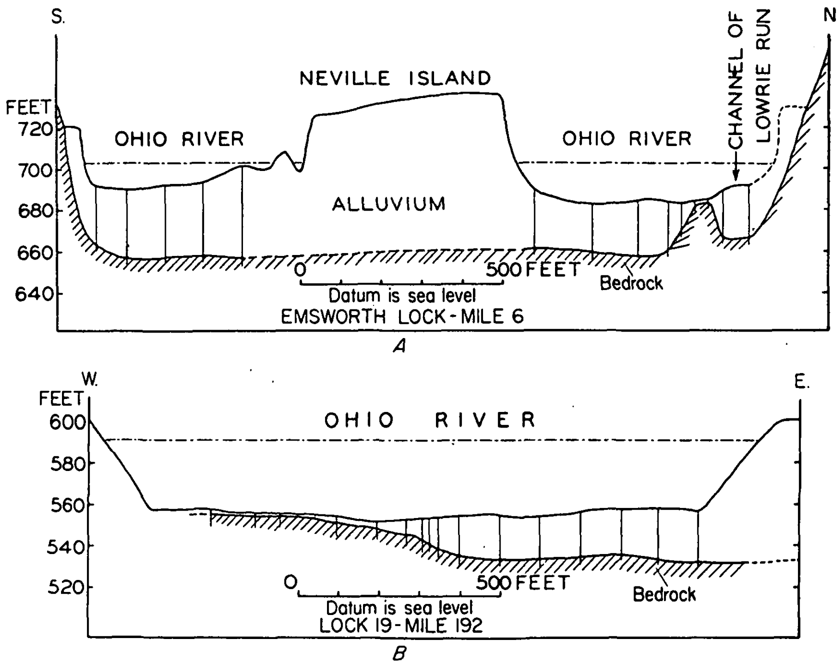

FIGURE 1.—Sections of the Ohio River bedrock valley. Vertical lines in the alluvial section show location of test borings. *A*, At Emsworth lock, mile 6; *B*, at lock 19, mile 192.

VALLEY WIDTH AND PROFILE CHARACTERISTICS

The variations in width of the bedrock valley are shown in figure 3. Measurements of width at 1-mile intervals are plotted from Pittsburgh (mile 0) to the West Virginia-Kentucky State line (mile 318).

As shown in figure 3, there is a long constriction in the width of the Ohio River between miles 108 and 123. Downstream from this constriction there is a progressive increase in valley width to mile 168, where the Little Muskingum River enters the Ohio. Between mile 168 and mile 172, where the Muskingum joins the Ohio, the width increases sharply from about 1 mile to 1.6 miles.

Upstream from mile 108 to Pittsburgh at mile 0, the valley width progressively increases rather than decreases as would be expected. At mile 114, midway in the zone of constriction, there is a well-defined prominence in the longitudinal profile of the bedrock valley. (See fig. 3.) Stratigraphically, the prominence coincides with thick sandstone at the top of the Monongahela group and the base of the Dunkard group.

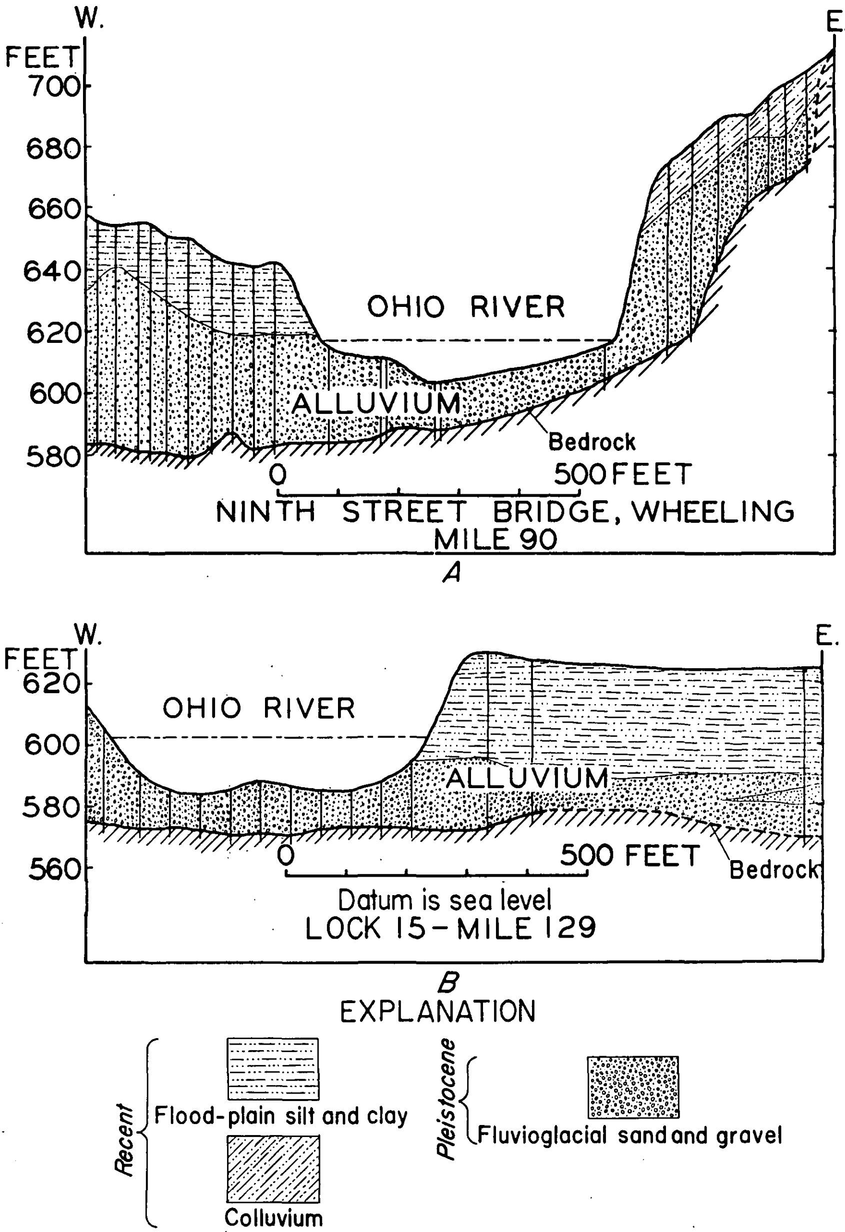

FIGURE 2.—Partial sections of the Ohio River bedrock valley. Vertical lines in the alluvial section show location of test borings. *A*, At Ninth Street bridge, Wheeling, W. Va.; *B*, at lock 15, mile 129.

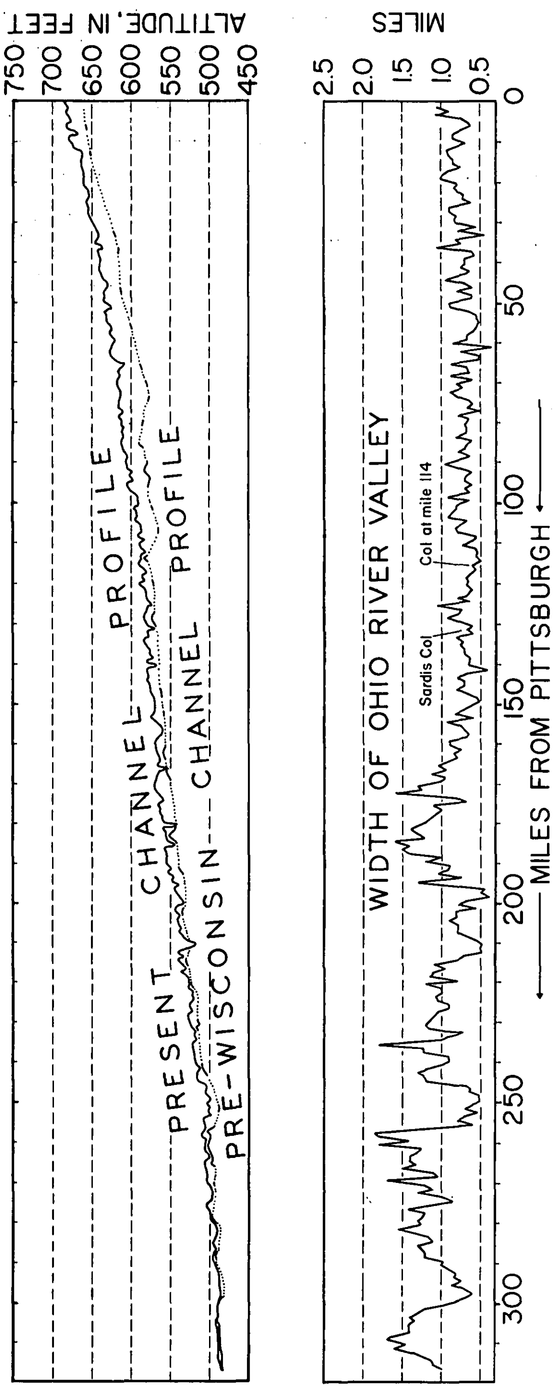

FIGURE 3.—Longitudinal and transverse characteristics of the upper Ohio River valley. At top is the present channel profile, shown by a solid line. The broken line directly beneath outlines the profile of the buried bedrock channel. Solid portions of this line have been established by accurate test-boring data. Below is plotted a graph of the width of the valley measured at 1-mile intervals.

Both Leverett (1902, p. 107) and Tight (1903, p. 29–35) commented on the widening of the valley of the Ohio River downstream from mile 172 at Marietta, Ohio. Leverett placed emphasis on the effect of the character of the bedrock in influencing the width of the valley, although he stated that some points of narrowing may be old cols, or divides, between early stream courses. Tight stated that widening of the valley at Parkersburg, W. Va., and at other places farther downstream was due to the lateral erosion of the river at bends. He stated also that narrows in the valley were cols between segments of pre-Ohio River drainage.

The section of the river upstream from Marietta is characterized by a generally straight channel, as shown on the map of the Ohio River (fig. 4), whereas the first of several strong bends of the river

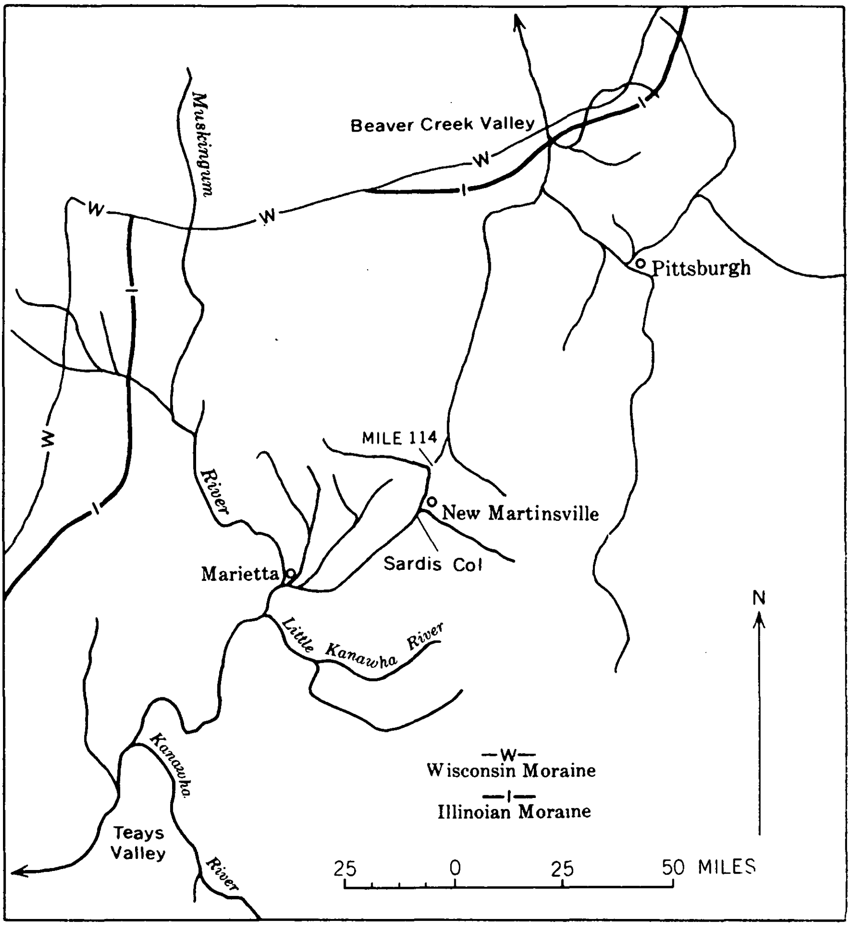

FIGURE 4.—Map of the upper Ohio River at the beginning of the Illinian glaciation.

is at Marietta. There is no significant change in character of the bedrock at Marietta to account for the abrupt widening of the valley. The valley above and below Marietta is cut in the Dunkard group. The Burning Springs anticline cuts across the valley at about mile 160 without discernible effect on the valley width.

The width relation of the upper Ohio River valley described above suggest an older drainage arrangement quite different from the present system. The suggested drainage is as follows: The Ohio River valley between mile 114 and mile 168 was the valley of one of four headwater tributaries of the Ohio, the other three being the Muskingum River, Duck Creek, and the Little Muskingum River. Mile 114 was the location of the head of drainage of the Ohio River. Drainage between mile 114 and mile 0 ran northeastward, as is shown by the progressive increase in the present width of the Ohio Valley in that direction. The sandstones at the top of the Monogahela group and the bottom of the Dunkard group at mile 114 formed the divide between the southwest- and northeast-flowing streams. The sharp increase in the width of the Ohio valley between mile 168 and mile 172 was the result of sharp increase in discharge of the Ohio caused by the confluence with the Ohio of Little Muskingum River, Duck Creek, and Muskingum River.

PRE-WISCONSIN DRAINAGE CHANGES

The width characteristics of the Ohio River valley upstream from Marietta, Ohio, indicate that at some time during the Pleistocene, the head of southwest-flowing drainage in the Ohio valley was at about the present location of lock 14, at mile 114 near Woodlands, W. Va. Above this point drainage flowed northeastward.

As originally described by Leverett (1902, 1939), Tight (1903), and others, somewhere near New Martinsville, W. Va., there was a divide in the Ohio River valley between north- and south-flowing drainage. The north-flowing drainage followed the valley of Beaver Creek in Pennsylvania and was blocked by the advance of a continental glacier from the north. The glacial dam caused the formation of a lake in the valley of the Ohio that rose high enough to overflow the divide. The divide was worn down rapidly by the overflow, and, when the glacial ice had finally melted back, the channel through the divide near New Martinsville was lower than the old north-heading channel at Beaver creek, which had been filled with morainal debris. As a result, the present headwaters of the Ohio River above New Martinsville were diverted to their present course.

The time of this diversion is not clear. According to Shepps and others (1959), the earliest glacial advance in northwestern Pennsylvania for which there is any evidence was during the Illinoian glaciation. Until positive evidence is found for glaciation earlier than Illinoian, the date of the diversion may be set provisionally as during Illinoian glaciation.

According to Tight (1903, pl. 11), the preglacial divide of the upper Ohio River was near the present location of lock 15, or at about mile 130. This divide, the Sardis col, is shown on figure 3 between miles 130 and 132. Leverett (1939 fig. 2) shows an early Quarternary divide just north of New Martinsville, or at about mile 126. Leverett stated (1939, p. 343, 344) that the Ohio did not permanently occupy its present course until Illinoian time. Deepening of the valley to its present width and depth occurred in post-Illinoian, pre-Wisconsin time (Sangamon interglacial stage).

The pre-Illinoian history of the Ohio River valley south of Marietta is not clear. Well-defined narrows in the bedrock valley occur at about miles 200, 210, and 250. The great width of the valley adjacent to these narrows suggests that they represent local changes in the course of the river and that the Ohio was established throughout most of its course by Illinoian time. Studies by Rhodehamel and Carlston (1958, p. 1634) have developed evidence that the preglacial Teays valley in West Virginia, which predated the present Ohio River system, was abandoned in late Tertiary or early Pleistocene time as a result of capture unrelated to glaciation. The first episode of ponding and lacustine deposition in the Teays valley was apparently in Kansan time.

ALLUVIAL SEDIMENTS IN THE BEDROCK VALLEY

The alluvial sediments in the valley consist of a glaciofluvial fill of medium- to coarse-grained sand and gravel of Wisconsin age and postglacial terrace deposits mainly of the "point-bar" type of river sediment.

The glaciofluvial sand and gravel are as much as 125 feet thick and are composed of 45 to 83 percent locally derived pebbles, of Pennsylvanian and Permian rock derivation, and "foreign" pebbles of granite, quartzite, vein quartz, and chert. The foreign constituents of the gravel were brought into the watershed by glacial ice. Increase in the percentage of foreign constituents in the lower part of the valley indicates that very substantial amounts of these materials were brought into the valley by glacial melt waters draining down the Muskingum and Hocking Rivers of Ohio. Two well logs record some clay mixed with the coarser deposits, and a peat bed was recorded in the gravel at one locality north of Parkersburg, W. Va.

Sedimentary structures are of the cut-and-fill type, characteristic of aggrading streams. The individual beds are highly lenticular, and there are abrupt changes in particle size both horizontally and vertically.

The fill has been terraced by downgrading of the Ohio River since the time of the proglacial aggradation. Upstream from Marietta, there appears to be a grouping of terraces on both sides of the river at about 50 and 65 feet above low-water stage. The lack of sufficiently accurate topographic maps has made it impossible to determine definitely that this apparent grouping represented cyclic, prolonged pauses in downcutting. The highest terrace, which represents the top of the alluvial fill, is not covered by later sediments; however, all lower terrace surfaces are covered by 20 to 30 feet of silty clay and clay which contain some channel-fill sand lenses. These are interpreted as normal flood-plain deposits, mainly of the point-bar type.

Flood plains are commonly underlain by thick sections of silt, sand, and clay. Although some of these fine materials are undoubtedly due to overbank flooding, a study by Wolman and Leopold (1957) indicated that the larger part of these beds are point-bar deposits, which are the result of deposition on the inside or convex side of a river bend and represent lateral accretion accompanying erosion on the concave side of the bend. They state (1957, p. 91) that deposition is related to the circulatory or helicoidal flow associated with the channel bend.

The absence of weathering and oxidation of the gravel and sand valley-train fill indicates a Tazewell and, or, Cary age of deposition. According to Shepps and others (1959), there were five Wisconsin ice advances into northwestern Pennsylvania: one during the Tazewell substage and four during the Cary substage. The point-bar types of terrace deposits are post-Cary or Recent in age.

The relation of the point-bar deposits to the Ohio River channel in the present flood plain are shown in figure 2. Figure 2*A*, a cross section at Wheeling, W. Va., shows point-bar silts and clays on the western side of the channel. Fine-grained sediments on the eastern side of the channel are probably colluvial soils. Figure 2*B* shows point-bar flood-plain silts and clays underlying the flood plain to a depth about equal to that of the bottom of the low-water channel of the river.

HISTORY OF THE UPPER OHIO RIVER VALLEY

Studies made by the writer suggest the following tentative history for the upper Ohio River. The history is provisional and will undoubtedly be subject to revision after more detailed studies are made in this part of the Ohio River valley.

The beginning of the Ohio River valley dates back to pre-Kansan time when the preglacial Teays valley in West Virginia was abandoned. During the early Pleistocene, the upper Ohio River became established in virtually its present course, although its head was at the present location of mile 114. During Illinoian glaciatation, blocking of the north-flowing drainage above mile 114 resulted in extension of the Ohio River northward to include its present headwaters. During the Sangamon interglacial stage, deepening and widening of the Ohio developed the present bedrock valley. Glacial advances into Pennsylvania during the Tazewell and Cary substages of the Wisconsin resulted in deposition of fluvioglacial sand and gravel in the valley to a level about 125 feet above the floor of the valley. Since then the river has downgraded its course in the glacial fill and has cut a number of stream terraces, some of which may be of cyclic origin. The lower terraces are covered with fine-grained flood-plain deposits of point-bar origin.

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U.S. GOVERNMENT PRINTING OFFICE: 1962