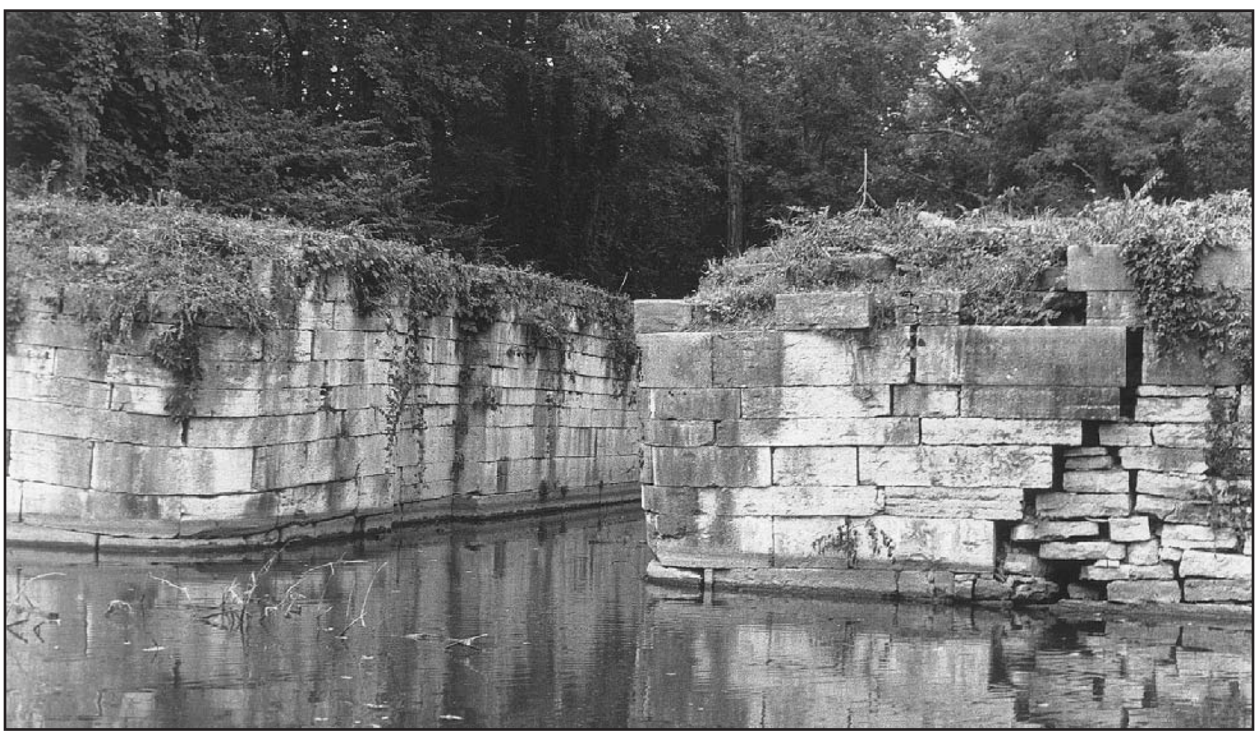
GUIDEBOOK NO. 14

GEOLOGY ALONG THE TOWPATH: STONES OF THE OHIO & ERIE AND MIAMI & ERIE CANALS

by

Joseph T. Hannibal

The Cleveland Museum of Natural History



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DIVISION OF GEOLOGICAL SURVEY

OHIO DEPARTMENT OF NATURAL RESOURCES

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Cover illustration: Lock 8, Piqua Historical Area. See Stop 13.

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GEOLOGY ALONG THE TOWPATH: STONES OF THE OHIO & ERIE AND MIAMI & ERIE CANALS

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INTRODUCTION

The experience of this country during the past 30 years, has shown how necessary it is to make a proper selection of building materials for public edifices, and more particularly, for the Canal locks and aqueducts, where, by successive changes of wet and dry, and the action of frost, the stone is subjected to the most severe tests of durability.

William W. Mather (1838a, p. 10)

Stimulated by the success of New York's Erie Canal, constructed between 1817 and 1825, two great systems of canals extending from Lake Erie to the Ohio River were constructed in Ohio between 1825 and 1850 (fig. 1). The Ohio & Erie Canal, between Cleveland and Portsmouth, was completed in 1834. The Miami & Erie Canal, between Toledo and Cincinnati, was completed in 1845.

Most of the 260 or so locks used for the canals were made of stone (see table 1). Stone also was used for **culverts**, **aqueducts**, and other structures. Today, locks and other stone structures along the canal routes provide excellent examples of classic Ohio **building stones**. The stones used for these structures are interesting geologically as they vary in their **mineralogy**, **sedimentary** structures, and **body-fossil** and **trace-fossil** content. These structures have held up to exceedingly severe conditions (freeze and thaw; bumps by canal boats, etc.). However, these structures do show classic signs of physical and chemical **weathering**. Most locks and other stone canal structures in western Ohio are made of **carbonate** rocks, chiefly **limestone**, whereas locks in eastern Ohio are constructed of the **clastic** rocks **siltstone**, **sandstone**, and **conglomerate** (table 1). Physical weathering has affected both the carbonates and the clastics, but chemical weathering has affected the carbonates to a greater extent.

The nineteenth-century canals in the United States ushered in new technology and stimulated the use of stone where wood had been the primary building material (Sheriff, 1996, p. 30). The canals played a crucial early role in the development of the building-stone trade in Ohio. Because of the need for stone for locks and culverts, construction of the canals stimulated the existing stone industry and spurred the opening of new quarries. The completed canal system facilitated the movement of local stone through the state and beyond. However, the Ohio canals, in conjunction with shipping along Lake Erie and the Erie Canal system in New York State, also facilitated the transport of imported **dimension stone** from Vermont and Italy throughout Ohio. The Ohio canals were part of a great national system, in many ways similar to today's interstate highway system. Material could be shipped from quarries in Vermont down the Champlain Canal to the Erie Canal through New York, along Lake Erie and then down one of the two main Ohio canals to other points.

Canals are noted in many early geological reports. The first Ohio Geological Survey (1837-1838) was made during the construction of the canal system. Thus it is not surprising that the first published report of the Survey (Mather, 1838a) made note of the canals a number of times. Later Ohio Geological Survey reports and maps, for instance, Newberry's (1870) geologic map of Ohio, show the canal routes. So do many subsequent topographic and geologic maps, including the maps accompanying Stauffer, Hubbard, and Bownocker's *Geology of the Columbus quadrangle* (1911). Stone used for or shipped along the canals is noted in a number of geological reports, including those of Hawes (1884a, 1884b) and Bownocker (1915). In addition, memoirs of some of those who quarried and shipped stone along the canals have been reprinted in Towpaths, a periodical published by the Canal Society of Ohio (see, for example, Weisenburger, 1992).

This guidebook is intended to serve as an introduction to those who wish to explore geological aspects of the canals, especially the stone used in canal construction. Most of the sites were chosen because of their accessibility. Some of the sites include canal boat rides and canal exhibits, and these are noted in this guidebook. Because this guidebook is likely to be used by a diverse audience, a glossary that lists selected canal, geological, and masonry terms that may not be familiar to all readers is included at the end. Such terms are printed in **boldface** the first time that they are used in the guidebook.

VISITING THE CANALS

Great old canal systems have been maintained and remain popular in France and England as tourist destinations, and the canals of the eastern United States have become popular sites for outdoor recreation in recent decades. Canal segments, locks, and towpaths have been or are being preserved and reconstructed in many parts of Ohio, including those in smaller towns such as Lockbourne (Crumbley, 1993b) and those in densely populated urban locales such as Akron (Keifer, 1995). However, in other areas, canal structures have been left to fall apart. This is especially true for aqueduct piers, which are most exposed to flooding. A number of canal locks are missing or buried. Some canal stone was sold early on (Mould, 1994, p. 48), and canal stone has been "mined" from old locks and other structures and reused for other structures, including bridges (a possible example is noted in Canal Society of Ohio, 1993, p. 9) and even seats for a baseball field (Mould, 1994, p. 234). Stone blocks from the Minthorn Lock of the Ohio & Erie Canal were reused for seating in an outdoor amphitheater at the Ohio Historical Society in Columbus (R. C. Glotzhober, personal commun., 1995).

This guidebook includes sites that are generally open to the public for at least part of the year. Because canal boat rides and many canal museums and exhibits have seasonal hours, it is always best to contact these sites for current schedules before visiting. A few sites that are on private land also are noted; permission of the landowner is necessary to visit these and other privately owned canal sites.

Canal areas are apt to be wet, at least seasonally. Vegetation, if not controlled, may include spiny brambles. The

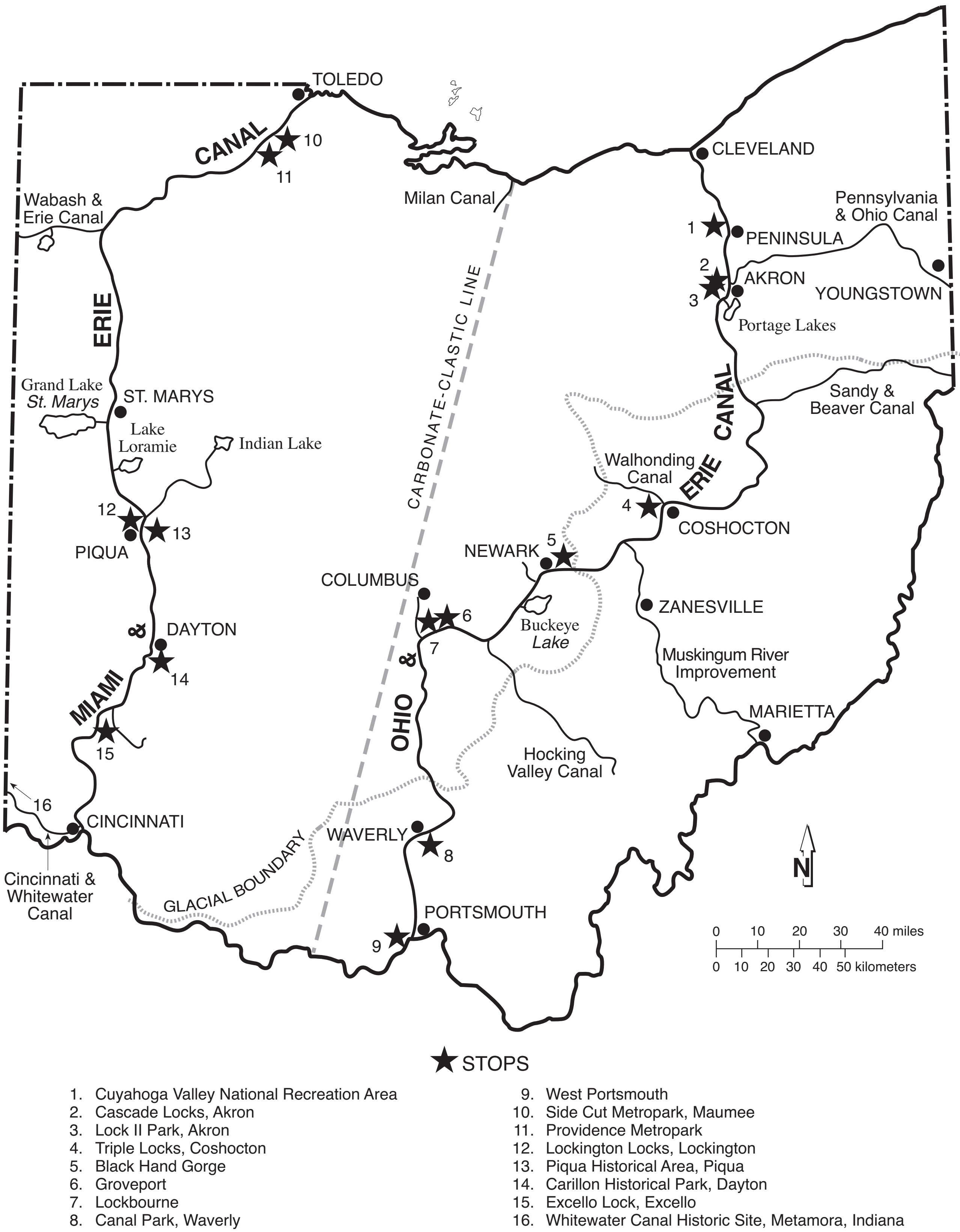


FIGURE 1.—Map of Ohio canals showing Stops 1-15; Stop 16 is outside the area of the map. The two main Ohio canals, the Ohio & Erie and the Miami & Erie, are indicated, as are the major branch canals. Lakes used to supply water to the canal also are shown. Modified from Canal Society of Ohio (1989) by Roberta Hannibal.

pestiferous poison ivy also thrives in the moist areas along the canals and commonly can be found growing alongside of, on top of, and even between the blocks of canal locks, as well as along the towpath. One last warning: if you really take a close look at the stone used for a particular canal, you might be considered a **gongoozler**!

CANAL ROUTES, ENGINEERING GEOLOGY, AND HYDROLOGY

The routes that the canals took were dictated by both politics and nature. The original locations for Ohio's canals depended upon political pressure from towns and regions vying for positions along the canal routes and the availability of water sources. One of the early designs for a diagonal canal across Ohio had to be abandoned because of insufficient water (Scheiber, 1987, p. 19). Engineers calculated the amount of water necessary to maintain adequate supplies for operation of the canals. The amount needed was about 100 cubic feet per minute (Neuhardt, 1985, p. 14). **Summits** of the canals were of special concern. Sufficient water was obtained for these by means of a system of **feeder canals** and reservoirs. The latter were innovations, especially notable for their large size (Fatout, 1972, p. 55). Several of these reservoirs are now recreational lakes. One example is the Licking Reservoir of the Ohio & Erie Canal, now known as Buckeye Lake. These reservoirs are shown on figure 1.

Because canals were built along major streams, most canal segments cut into floodplain or **fluvial** deposits or into buried valleys (ancient valleys that had been filled in by glacial material), not **bedrock**. Much of the area traversed by the canals is in glaciated parts of the state, covered in most places with **till**. The Ohio & Erie Canal had more complex topography to cross than the Miami & Erie Canal. The Ohio & Erie traversed the more hilly, eastern part of the state, and large sections of the canal passed through topographically rougher, unglaciated areas. Its route necessitated crossing the boundary between glaciated and unglaciated areas three times. More information on the geology of portions of the route of the Ohio & Erie Canal can be found in Hansen (1989, 1993).

The Miami & Erie Canal passed over generally flatter terrain, blanketed by glacial sediments, including old glacial-lake deposits in the northwestern part of the state and **till plains** in west-central and south-central Ohio. This canal did, however, have to pass through major **end moraines**. In Auglaize County, a deep cut had to be made through the St. Marys Moraine. This end moraine, named for the town of St. Marys on its crest, is composed of glacial deposits laid down at the edge of a continental glacier during the part of **Pleistocene** time known as the Late Wisconsinan, between 18,000 and 14,000 years ago (Forsyth, Pavey, and Goldthwait, 1993). Digging the cut through this moraine was a great undertaking for the time, requiring between 400 and 500 men and taking almost four years (Robinson, 1979). More information on the geology of the area traversed by the Miami & Erie Canal can be found in Hull (1993).

Generally speaking, both canals were constructed through **unconsolidated** material of **Recent** and Pleistocene age. Construction necessitated wood foundations for locks, aqueducts, and other structures, which "floated" in the unconsolidated sediment. However, some canal locks, especially those in high areas, were built upon bedrock (see, for example Stop 2, Cascade Locks). Canals through bedrock were more difficult to cut.

Maintenance of the canal system was always a problem. As Orth (1910, p. 697) wrote, "Freshets and storms have constantly played mischief with its banks, its feeders and its overflows." However, lack of sufficient water was also a problem, particularly at the summits. When rainfall was low, fully loaded canal boats could not pass through these high areas of the Ohio & Erie Canal (Scheiber, 1987, p. 175). The Licking Summit, southwest of Newark in Licking County, was a particular problem (Scheiber, 1960, p. 255).

Canal boats had a great advantage over boats moving through bodies of fast-flowing water. Canals were safer, as the water level of the canal was at a constant level, at least theoretically. The canal boats floated in slowly moving water, so that the **laminar flow** of the water created low drag (Gieck, 1992, p. 35). Speed limits were set at 4 miles per hour in order to minimize damage to canal banks.

CANAL AND LOCK DIMENSIONS AND LOCK OPERATION

Specifications for the construction of the canals can be found in various places, including Ohio Senate documents and old newspaper advertisements and notices. Many of these have been reprinted in county histories (for example, Bareis, 1902, p. 65-68), issues of Towpaths (for example, Golding, 1991), and elsewhere. Trevorrow (1978b) and Trevorrow and Golding (1992) have compiled a great deal of information on the canals and canal locks, including canal distances and lock dimensions.

The main Ohio canal ditches (fig. 2) were a minimum of 40 feet (12 meters) wide at the water line and 26 feet (8 meters) at the bottom. Water depth was a minimum of 4 feet (1.2 meters). Banks extended a minimum of 2 feet (0.6 meter) above water level. Thus, when filled with water, the canal ditches took on a prismatic shape. The banks were lined with clay, or, in some cases, were paved with stone (Kilbourne, 1828, p. 28). Some feeder canals exceeded these dimensions.

The inner area of the locks (fig. 3), known as the lock chamber, was 15 feet by 90 feet (4.6 by 27 meters). Where there was no base of stone, the locks were built with a wood foundation. These foundations were stabilized by wooden sheet pilings. Locks basically consisted of two walls, a floor, and gates. The gates were attached to **heel posts** that set into **hollow quoins** (fig. 4) and were held in place by a pin set into their base and a **goose neck** at their top. The gates came to a stop at a **mitre sill**. A **spillway** was built parallel to the lock to regulate the flow of water, allowing excess water to flow around the lock. More information on early lock construction can be found in Trevorrow (1978b).

The stone walls of the canal locks were 5 feet (1.5 meters) thick at their base, tapering to 4 feet (1.2 meters) at the water line. Specifications indicate the stone for the walls of the locks was to be laid in **courses**. Joints were to be square. Perpendicular joints were to be made by sawing. The size of the blocks placed parallel to the length of the lock walls, known as stretchers, and the blocks placed perpendicular to the walls to serve as anchors, known as headers, were specified. **Coping** stone was to be at least 3 feet (0.9 meter) wide and uniformly thick. The thickness was less than that of the courses below. Stone was ordered by the perch (16.5 cubic feet). Finished sizes of blocks varied, some blocks, especially stretchers, were up to 8 feet (2.4 meters) long. The stone was laid in and grouted with water **cement** (see p. 8). There was generally a wooden floor.

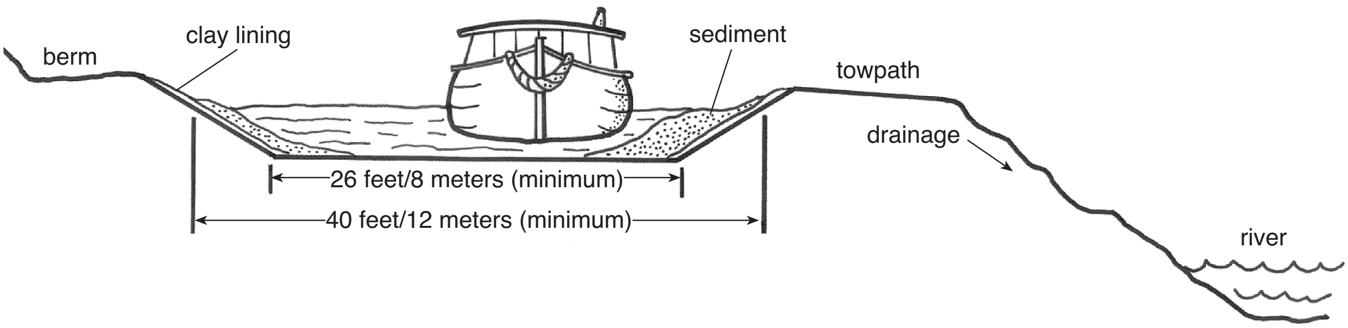
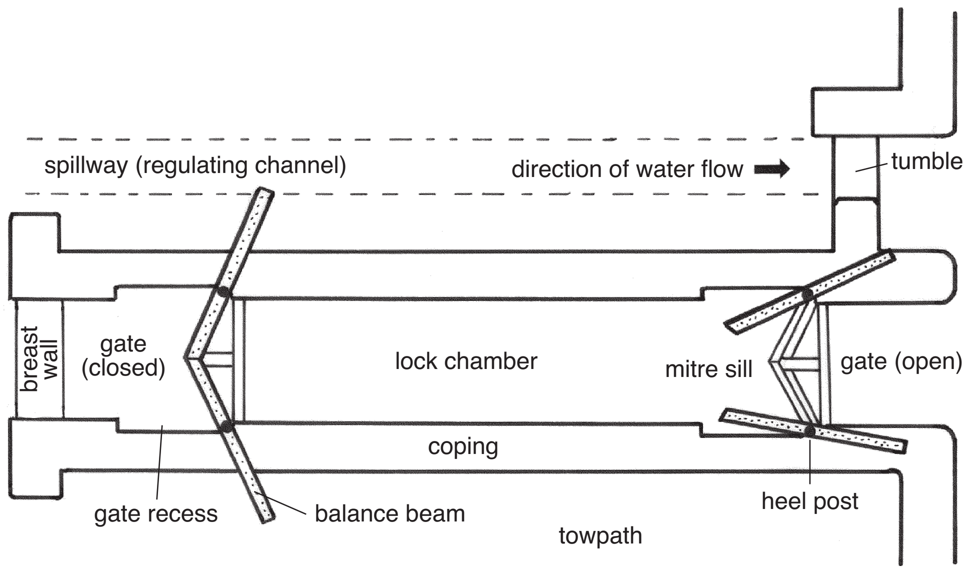


FIGURE 2.—Cross section of a typical canal. Original configuration is shown, along with infilling sediment. The walls of the canal were either lined with clay or protected by a rock lining. The bottom also was lined with clay. Water depth in the canal was a minimum of 4 feet (1.2 meters). The canals had to be dredged constantly in order to keep them passable. Aquatic vegetation (not shown here) was an additional problem. Towpaths were slightly inclined so that they would drain away from the canal.

FIGURE 3.—Plan view of a typical lock and spillway. Exact configurations differ from lock to lock.



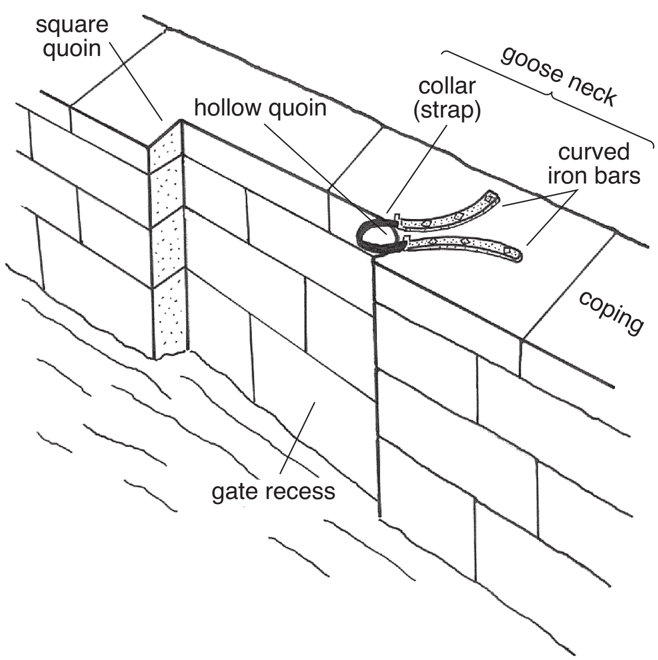


FIGURE 4.—Detail of a lock showing parts visible in many existing locks. The gate recess (see also fig. 36) has one square quoin and one semicircular quoin known as a hollow quoin. The goose neck served to keep the upper part of the heel post in position. The curved iron bars of the goose neck were bolted to the coping. If the goose neck is no longer visible, grooves showing the position of the curved iron bars commonly remain.

Although some wooden locks, most temporary, were used in Ohio, stone was used for almost all of the Ohio canal locks (Dial, 1904, p. 476). Such stone structures were known to stand up well to floods, unlike wooden structures (Fatout, 1972, p. 154). And it was expected that certain Ohio stone would be useful and plentiful, for instance, stone from Dayton (Kilbourne, 1828, p. 125). The stone used for canals has been discussed in many publications over the years. Trevorrow (1986a) compiled a good deal of information from a variety of sources, including Board of Public Works reports for 1837, 1839, 1844, and 1904, and various Ohio Division of Geological Survey reports.

Locks used to move boats from one level to another typically were made of stone. Guard locks, which only needed to protect the entryways into or out of bodies of water where there was no difference in elevation, were constructed with stone only at the ends to hold the gates.

The architecture of the locks of the two major canals differs somewhat; those of the Miami & Erie Canal typically have distinctively rounded corners (Gieck, 1992, p. 171), whereas those of the Ohio & Erie Canal are angular and squared off. One is tempted to ascribe some of this difference to the hardness of the stone; it is much easier to carve limestone, such as that used for the Miami & Erie Canal, than sandstone, such as that used for the Ohio & Erie Canal. However, some Ohio & Erie locks also had rounded corners (see fig. 45). Another difference between the two canals is the prevalence of stone and brick culverts on the Miami & Erie Canal and of aqueducts, typically made of wood but having stone bases, on the Ohio & Erie Canal.

In cases where the wooden substructure of locks has been partially buried, the substructure has remained moist and has kept its integrity. This is not true for structures that have been left high and dry or which have been subjected to alternating moist and dry conditions.

Canal locks served to lift canal boats from a lower level along a canal to a higher level, or to lower boats from a higher to a lower level. Most locks had two sets of gates, one at the higher level end that served as the inlet, and one at the lower level end that served as the outlet. The gates were opened and closed by means of massive wooden balance beams. Water level in the locks was controlled by means of wickets, small openings built into the gates. When closed, the gates formed a V shape (fig. 3), with the V's pointing upstream, toward the higher level of the canal, to better resist the pressure of the water coming at them. When a boat approached the lock, the water in the lock was adjusted to the height of that of the boat about to enter. The gates on that end of the lock were then opened and the boat entered the lock. The wickets in the lock gates, or in some cases openings for channels in the lock walls, were then opened so that the water in the lock could reach the level of that on the other side of the lock. Once the levels were equal, the gates on that side of the lock were opened and the boat exited.

STONE USED FOR THE CANALS

Stone used for locks and other canal structures in Ohio included rock from most of the major geological systems exposed in the state, from **Ordovician** through **Pennsylvanian** age. Many of these occurrences are listed on table 1; there are undoubtedly more. Western Ohio has always been known for its abundant limestone deposits, whereas eastern Ohio has been known for its abundant sandstone. Hawes (1884a, p. 639) described the quarrying activity in these two spheres as follows:

> *The line drawn nearly through the center of the state from Erie county on the north through Adams county on the south will form the boundary between the area to the east, in which the chief quarrying industry is devoted to the extraction of sandstones, and the western area, in which the only quarrying industry is devoted to the extraction of limestones.*

This carbonate/clastic quarry line is shown on figure 1.

Although this pattern no longer holds true today, it did hold true for the most part for stone used for canal structures. The main trunk of the Ohio & Erie Canal was entirely on the eastern side of this line; the Miami & Erie Canal was on the west. Thus stone used for the Ohio & Erie was siltstone, sandstone, and conglomerate; stone used for the Miami & Erie was primarily limestone. There was one major exception, noted by Trevorrow (1986a): *Buena Vista sandstone* was used for locks along the Miami & Erie Canal in the Cincinnati area. The general localities where most of the canal stone was quarried is known (table 1), and several quarry sites that may have yielded stone for the canals have been identified (Loomis, 1994, p. 92, 99; Stewart, 1991). However, much work is yet needed to verify these locations.

Most canal-era stonework was done by hand, but in later years steam power came to dominate the stone business. Bownocker (1915, p. 108-111) and others have described quarrying techniques. Stone was split from the quarry by various means, including wedges, **plug and feathers**, and drill holes combined with wedges. Remnants of vertical drill holes are visible in some places on stone used for the canals. Later, stone was quarried with the help of steam-operated channeling machines. Blocks of stone were typically lifted for transport and installed into their final position by **derricks** and movable cranes. Some of these can be seen in illustrations in old county atlases, such as the illustration of the Kitchen quarry in Piqua (fig. 5), which shows a derrick being used to load a canal freighter. The blocks were grasped by means of a set of **tongs** (fig. 6). The two prongs of the tongs were placed into rough, cone-shaped holes cut into opposite sides of the stone blocks (Rockwell, 1993, p. 174). Typically, these holes would have been cut into the middle of the long sides of the blocks, several inches from their tops, for stability. The holes used for lifting can be seen in some canal blocks (see figs. 16, 17). The use of tongs was especially efficient. Pulling upward on the tongs caused the two prongs to close in tightly on the stone block; once the stone was lowered into position, the prongs released automatically when the stone was in its final position (Knight, 1876, p. 2588). This method was precarious, however, as an imbalance could cause the block to slip (Bowles, 1924, p. 210). Another drawback was that the holes used for the tongs remained. Thus, these markings are not found on more refined stonework that used alternative methods to put the stone blocks into place.

FINISH OF THE STONE BLOCKS

Original plans to use rough stone for locks were changed during the planning stages (Scheiber, 1987, p. 53). A notice (May 17, 1827) for bidders for the Miami Canal (which later became the southern part of the Miami & Erie Canal) between Dayton and Middletown already indicated that the stone must be laid in regular courses or ranges of well-**dressed** or cut stone. The finish of the stone blocks used

TABLE 1.—*Stone used for locks and other stone structures of the Ohio canals*[1]

System	Stone	Quarries	Places used
Pennsylvanian	Cow Run sandstone	southern Muskingum and northern Morgan Cos.	southeastern Ohio (?Muskingum Improvement)
	Clarion sandstone	Zanesville, Muskingum Co.	southeastern Ohio (Muskingum Improvement and/or Ohio & Erie Canal)
	Pennsylvanian sandstone ("Lower Coal Measures"; in part Homewood sandstone)	Zoar area, Tuscarawas Co. Coshocton Co. Lancaster, Fairfield Co. Elkton and Lisbon areas, Furnace Hollow, Columbiana Co.	Zoar (Ohio & Erie Canal) Coshocton Co. (Ohio & Erie Canal and/or Walhonding Canal) Hocking Valley Canal Sandy & Beaver Canal
	Massillon sandstone	Coshocton Co.	Akron (Ohio & Erie Canal 1980's reconstruction)
	Sharon conglomerate	Kent, Portage Co. Akron, Summit Co.	Kent (Pennsylvania & Ohio Canal) Akron (Ohio & Erie Canal)
Mississippian	Black Hand Sandstone Member of Cuyahoga Formation ("Waverly conglomerate"; "Waverly sandstone")	Licking Valley, Licking Co.; Lancaster, Fairfield Co.	Hanover area (Ohio & Erie Canal) between Logan and Lancaster (Hocking Valley Canal) southeast of Columbus (Ohio & Erie Canal 1845-46 reconstruction)
	Buena Vista Member of Cuyahoga Formation ("Waverly")	Rockville area, southeastern Adams Co., and probably adjacent areas of Scioto Co.	Cincinnati area (Miami & Erie Canal and/or Cincinnati & Whitewater Canal) Portsmouth area (Ohio & Erie Canal)
	Cuyahoga Formation ("Waverly")	Lithopolis, Fairfield Co.	?Waverly, Chillicothe, Columbus (Ohio & Erie Canal)
Devonian	Berea Sandstone[2] ("Berea grit"; "Waverly sandstone")	Peninsula, Summit Co. Waverly, Pike Co.	Cleveland, Akron, Peninsula (Ohio & Erie Canal) Waverly (Ohio & Erie Canal)
	Sylvania Sandstone	northwestern Ohio	northern part of the Miami & Erie Canal
	Columbus Limestone	Marblehead, Ottawa Co.	northern part of Miami & Erie Canal
	?Middle Devonian limestone	Charloe area, eastern Paulding Co.	northern part of Miami & Erie Canal
Silurian	Dayton Formation (*Dayton limestone*)	Dayton area, Centerville, Montgomery Co.; probably Piqua area, Miami Co.	between Cincinnati & Toledo (Miami & Erie Canal)
	Brassfield Formation ("Clinton limestone")	Piqua, Miami Co.; ?Centerville, Montgomery Co.	between Piqua and Cincinnati (Miami & Erie Canal)
	Silurian limestone	Providence, Lucas Co.	Junction (Miami & Erie Canal and/or Wabash & Erie Canal)
Ordovician	?Fairview Formation ("Hill Quarry Beds")	Cincinnati, Hamilton Co.	Cincinnati area (Miami & Erie Canal)
	?Point Pleasant Formation ("River Quarry Beds")	Cincinnati, Hamilton Co.	Cincinnati area (Miami & Erie Canal)

[1]Sources include: Bownocker (1915), Hawes (1884a, 1884b), Loomis (1994), Norling (1958), Orton (1884), Runkel (1949), Stout (1918, 1944), Trevorrow (1986a, 1986b), personal communications (D. L. Crowell, R. A. Davis, M. R. Sandy, 1997-98), and personal observations. Not all occurrences have been field checked.

[2]The Berea Sandstone may be Devonian-Mississippian or Mississippian in age.

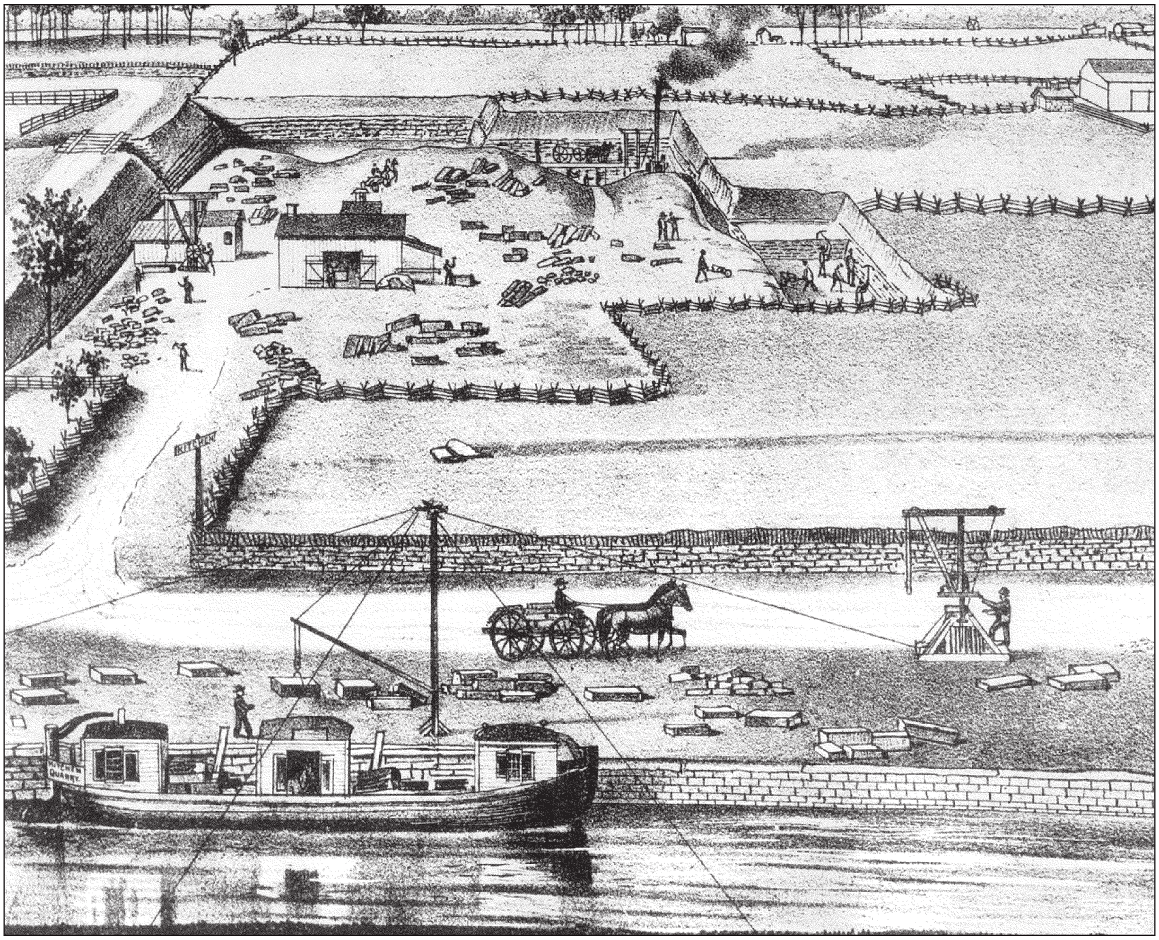


FIGURE 5.—Kitchen quarry in Piqua. A derrick is being used to load a canal boat with stone in the foreground. From L. H. Everts & Co. (1875, p. 30).

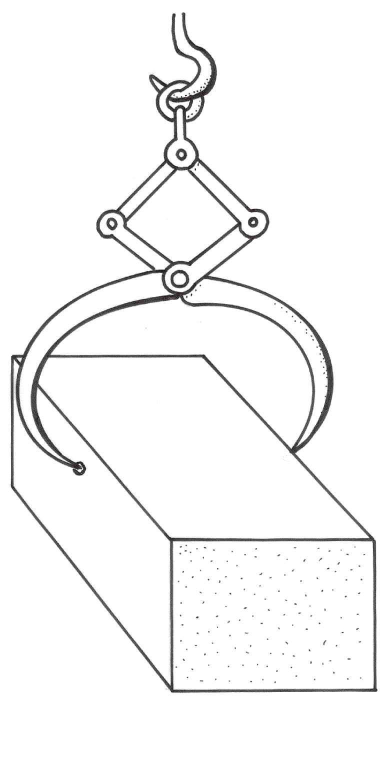


FIGURE 6.—One type of tongs used to hoist stone blocks in the nineteenth century. After Knight (1876, fig. 6509d). Tips of the two prongs of the tongs fit into holes cut into the sides of the stone block.

for the locks is variable. Portions of the stones not intended to be exposed were only roughly finished. The portions of the stone blocks that were intended to be exposed in the final lock structure were typically dressed and given a flat, decorative finish. The finish of blocks generally consists of **bush-hammered** surfaces having **drafted margins** (see figs. 17, 51). A bush-hammered surface has a pleasing stippled appearance. Ohio specifications called for hammer-dressed stone or rough-cut stone (Trevorrow, 1978b, p. 39). Specifications issued in 1838 for masonry of stone locks of the Whitewater Canal called for the face of the front stone of the lock to be "neatly dressed with the bush hammer" (J. L. Williams, 1838, *in* Neuhardt, 1989, p. 5). Merrill (1891, p. 47- 48) noted that the bush hammer was invented between 1831 and 1840, but it may have been invented earlier. Donnelly (1994, p. 38) noted that the bush hammer originated in the United States and was brought to Aberdeen, Scotland, in 1832. It is possible that a toothed chisel was used instead in some cases. Regardless, the use of a bush hammer for the Ohio canals must rank as one of the earlier uses of this tool. The bush hammer was known for being used more easily with limestone, as it could cause sandstone to scale (Knight, 1884, p. 148).

A wide and thin-bladed chisel was used to draft the margins; the width of the drafting is roughly the width of the chisel's blade. Some blocks of stone used for the canals also show evidence of cruder techniques. Some of this rougher finish was due to economics in the later stages of lock construction (Gard and Vodrey, 1952, p. 54).

Early descriptions of the locks at Cincinnati note that the faces of the masonry walls are "rusticated" or "chamfered" (Stapleton, 1972), meaning the stone blocks have beveled edges. Such stonework does not appear to have been common, however, and is restricted mostly to locks in southwestern Ohio (see Stop 15) and masonry of aqueducts.

CEMENT AND CONCRETE

Cement was used as mortar for the stone blocks of the canal. This cement, known as water or hydraulic cement, had to be especially durable. The building of the canals prompted exploration for suitable raw materials for cement, and cement works grew up at various points along the nineteenth-century canal systems of the United States (Eno, 1904, p. 21). Limestones used for production of water cement were known as water limes. Indeed, some of the Upper **Silurian** rocks of Ohio were once known as the Waterlime. Mather (1838b, p. 6) asked, "Who shall pretend to calculate the future wealth to be produced by the *lime* made on the banks of the Ohio, and of the canal . . ."? Water limestone was quarried for use in this cement as close to the canal route as possible. Along the Ohio & Erie it was quarried in the Cuyahoga Valley (Kilbourne, 1828, p. 196), probably from limy layers of the Meadville **Shale Member** of the Cuyahoga **Formation**, of **Mississippian** age. Whittlesey (1838, p. 57) noted that an 8-inch bed of hydraulic lime could be found in the formation below the conglomerate at Cuyahoga Falls; this unit would have been the Meadville Member. Briggs (1838, p. 148) noted use of a lime bed southwest of Dover (Tuscarawas County) for the canal. Along the Sandy & Beaver Canal (see fig. 1), a lime bed was quarried just above New Lisbon (Columbiana County) near Logtown (Gard and Vodrey, 1952, p. 54-55). Stone from New Lisbon was used in the manufacture of hydraulic lime for an especially durable cement used for all the locks of the Sandy & Beaver Canal (Newberry, 1871). Unfortunately, the cement held up better than the stone in some cases.

Concrete became very popular around 1900. Ohioans were proud of the streets paved with concrete in Bellefontaine (Logan County), some of the first in the country. There was an attempt to rejuvenate the canals between 1904 and 1911. This effort included repair and replacement of many of the old stone locks with concrete (see fig. 12). By this time, the large-scale use of concrete for lock construction in the United States had been pioneered by Illinois' Hennepin Canal, whose construction began in 1890. In Ohio, concrete was used especially on the higher and the upper level parts of locks. Because they bore the brunt of oncoming water, the upper levels were exposed to more wear and tear. In addition, because of pressure from their lateral sides, the higher portions of the lock walls were under greater stress. The concrete also must have helped to reduce the porosity of the lock walls, particularly those constructed of sandstone. Despite all of the reconstruction efforts, extensive flooding in 1913 caused immense damage to the canals and adjacent areas, thus ending the canal era in Ohio.

WEATHERING OF THE STONE LOCKS

Physical weathering has affected the sandstones and limestones used for canal structures. Chemical weathering has had its greatest effect on limestone, a rock type that is soluble in weak acids (McGee, 1995). Generally speaking, the sandstone used for the locks has held up better than the limestone, but there are exceptions. Unraveling the history of any particular canal stone is complex, as various stone was replaced over time with similar, or in some cases, different stone.

Limestone commonly exhibits differential weathering along bedding planes and **stylolitic** surfaces, and in some cases it tends to develop a series of vertical cracks. Rope markings also are much more prominent in the limestone blocks (see figs. 60, 66, 67). The **calcite** grains of limestone are much softer than the **quartz** grains and quartz cement of the sandstone used for locks. However, these markings also can be found in sandstone blocks. Most of these markings were probably the result of abrasion by the ropes used by the men and women who worked on the canal boats. Three-inch hemp rope was the standard of the time (Fatout, 1972, p. 133).

CANAL BOATS

Several types of canal boats were used in Ohio: packets, state boats, line boats, and three-cabin freighters (Woods, 1995). Packets carried passengers, state boats were used for canal maintenance, and line boats were fully enclosed cargo carriers. Three-cabin freighters (figs. 7, 8) typically were used to haul stone and other bulk cargo. The central cabin of three-cabin freighters housed mules or other animals used to tow the boats, the bow cabin held the crew, and the stern cabin was reserved for the captain and his wife and children. The three cabins were connected by removable walkways, or catwalks, allowing the crew to pass above the cargo. Three-cabin freighters can be seen in illustrations in the elegant drawings found in old county atlases (see fig. 5), as well as in photographs taken at the end of the nineteenth century (Gieck, 1992, p. 170). The same type of canal boats were used to haul coal (see Crowell, 1995, figs. 169, 170).

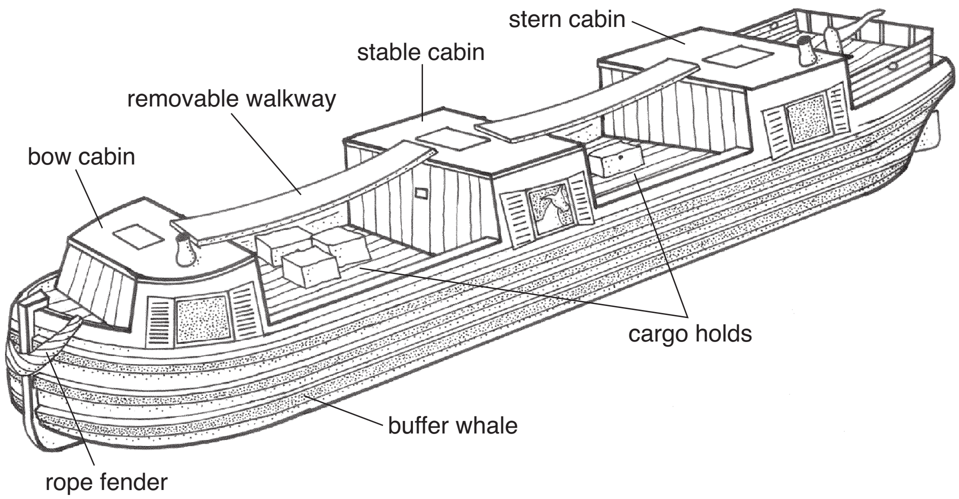


FIGURE 7.— Typical three-cabin canal freight boat. Adapted from diagrams in Woods (1995, p. 15) as well as other sources. Illustration drawn by Roberta Hannibal.

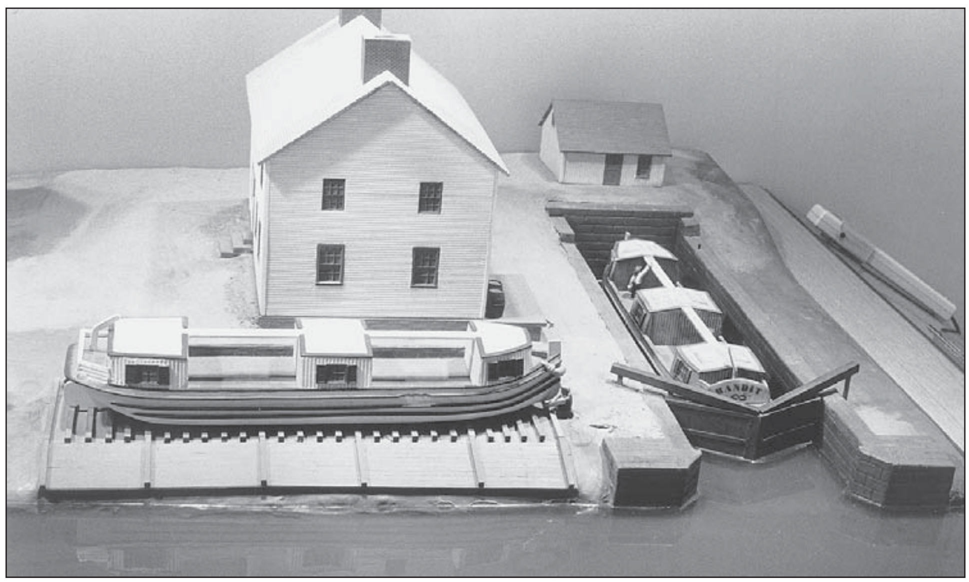


FIGURE 8.—Diorama showing a canal freight boat under construction along a canal (left) and another canal freighter being repaired in dry dock (right). Boston Store, Cuyahoga Valley National Recreational Area.

Canal boats were made of wood and were between 14 and 15 feet (4.3 and 4.6 meters) wide and 60 to 80 feet (18 to 24 meters) long (Scheiber, 1987, p. 40, and other references). They were constructed along the side of the canal and repaired in **dry docks** built adjacent to the canals (fig. 8). The boats had **buffer whales**, which served as bumpers, built into their sides. These bumpers helped to absorb the shock when the boats hit the sides of locks and other stone structures; they also served to soften the blow to the structures from the impacts. That the canal boats hit the locks is well known. The battering of the boats upon the locks was perhaps best described by the great American politician, sixth president of the United States (1825-1829), and inveterate diarist John Quincy Adams (1767-1848) during his 1843 trip from Cleveland to Columbus on the canal packet Rob Roy (Adams, 1876, p. 420):

The most uncomfortable part of our navigation is caused by the careless and unskillful steering of the boat into and through the locks, which seem to be numberless, upwards of two hundred of them on the canal. The boat scarcely escapes a heavy thump on entering every one of them. She strikes and grazes against their sides, and staggers along like a stumbling nag.

STONE NAMES AND PROBLEMS IN IDENTIFYING STONE

In this guidebook, stones are identified using standard geologic terminology. Rocks are classified as sandstones, limestones, and so on. Whenever possible, formal **rock-unit names** are given. These names consist of two parts: a geographic name and either a rock type or the word member, formation, or **group**. The first letter of each part of a formal rock-unit name is capitalized. The Berea Sandstone, for example, is a rock unit that was named for the city of Berea, in western Cuyahoga County, one of the places in which this rock is exposed at the surface. In some cases, **trade names** used in the building-stone industry are given. These terms are *italicized* in order to distinguish them from formal rock-unit terminology.

Identification of stone originally used for canal structures is not straightforward. The reconstructed concrete portions of the locks are commonly the most accessible, upper parts, and original stone remains in lower, less accessible parts of the locks. In some cases, stone used for the canals has been destroyed or moved far from its original site and lost over the years. Some of the stone blocks discarded during reconstruction can be seen along the canal (Loomis, 1991, p. 13), in some cases next to locks rebuilt with concrete (see fig. 12).

Once there is an adequate view of the stone, determining the general rock type (sandstone, limestone, etc.) is relatively straightforward, but determining the rock unit to which it belongs is more difficult. Rock constituents, such as fossils, and grain size can be used to help with these determinations. Fossils are fairly common in some of the limestones (see fig. 59), but, with the exception of the *Buena Vista sandstone*, which has trace fossils (Hannibal, 1995), the sandstones used for building stone are not **fossiliferous**. The sandstones have similar sedimentary structures, mainly **cross-bedding**, and grain sizes overlap. The pebble content of sandstones and conglomerates can help in distinguishing them (see fig. 31). However, even the Berea Sandstone, which is not known for being conglomeratic, has some quartz pebbles at Deep Lock quarry (see fig. 19). Reports of the Ohio Geological Survey are helpful in identifying the stone. Orton (1884, p. 604), for instance, noted that stone from a quarry about half a mile ($^3/_4$ km) east of Zanesville was used extensively for canal locks. Stout (1918, p. 140-142) later noted that this stone was the Clarion sandstone, of Pennsylvanian age. Color also can be useful and commonly is noted in this guidebook. However, because only nondestructive techniques were used in this study, most color determinations were made on stone that has been at least partially weathered. Colors were taken on stone that appeared to be the least weathered unless noted. Most colors were determined using the Geological Society of America Rock Color Chart (Rock-Color Chart Committee, 1991).

SHIPPING STONE BY CANAL

Because of the weight of stone and other geologic products, transportation by water has long been preferred. Quarries located near bodies of water had great advantages compared to those that were not. Canals were important modes of transportation for stone in both Europe and the United States during the nineteenth century. In Scotland, the opening of the Inverurie Canal (1805) benefited the Aberdeen **granite** industry (Donnelly, 1994, p. 12). Granite was used extensively in Boston only after the 27-mile (43-km)-long Middlesex Canal, completed in 1803, allowed the stone to be easily shipped from Chelmsford, Massachusetts (Merrill, 1891, p. 2). New York's Erie Canal, whose main portion was completed in 1825, when combined with its Champlain Canal extension, allowed access to the Vermont **marble** deposits. Stone use also was stimulated by Maryland's Chesapeake & Ohio Canal, completed in 1828 (National Park Service, 1991, p. 68), and Ontario's Rideau and Welland Canals, built between 1824 and 1831 (Fouts and others, 1991, p. 3). The Ohio canals were a boon for the state's building-stone industry. Early on, the principal items for which tolls were collected in Ohio were wheat, stone, coal, wool, and cloths (Bogart, 1924, p. 27). Examples of types of stone shipped down the Ohio canals are given in table 2.

Ohio geologists were well aware of the importance of canals for the stone industry. Mather (1838b, p. 6) noted that "a good quarry on the banks of the Ohio, or of the canal, ought to be as valuable as a coal bed." Newberry (1873, p. 210) predicted that the canal, as well as the then as yet proposed railroad, would serve as a stimulus to an active quarry industry in the Cuyahoga Valley. Orton (1874, p. 618-619) noted that the distribution of *Waverly stone* (Berea Sandstone) along the canal in the Scioto Valley was one of the factors that brought this stone to prominent notice.

The Ohio & Erie Canal provided a great stimulus to the stone industry of the Cuyahoga Valley region in the Independence (Miller and others, 1979), Peninsula, and Akron areas, as well as in the Waverly and Buena Vista areas in southern Ohio, and other areas. At the Peninsula stone quarries (see Stop 1, Cuyahoga Valley National Recreation Area), the quarrying and shipping of Berea Sandstone was facilitated by the location of suitable exposures of sandstone just above the canal (Tillson, 1903, p. 32). The sandstone was shipped from Peninsula to Cleveland (tables 2, 3) by canal. From Cleveland it was shipped to other lake ports, notably Buffalo (Orton, 1884, p. 588). Stone from Peninsula also was shipped to Akron (Orth, 1910; Orton, 1884, p. 588). At Waverly (see Stop 8, Canal Park, Waverly), quarrying of the Berea Sandstone began soon after the canal opened; the canal provided both a means of shipping and a source of power for cutting stone (Bownocker, 1915, p. 103, 105). According to Andrews (1871, p. 73), "Stone from the town of Waverly and vicinity is extensively used for building purposes in all the cities and towns on the Ohio Canal." The Coshocton Stone Company also was located on the Ohio & Erie Canal (Hunt, 1876, p. 107). Although use of the *Buena Vista sandstone* at Buena Vista predated the canals (see Stop 9, West Portsmouth), the demand for the stone for use in the canals prompted the first really large-scale quarrying activity (Bownocker, 1915, p. 123). The Lang Stone Company in Columbus, a company that is still in business, used *Buena Vista sandstone* shipped via canal from southern Ohio (Campen, 1978, p. 85).

Three quarries were located on or very near the Miami & Erie Canal at the south end of Piqua's Main Street in the 1870's: the Hamilton, Statler, and Kitchen (fig. 5) quarries. The illustrations in the Miami Atlas (L. H. Everts & Co., 1875) show canal freight boats at both the Statler and Kitchen quarries. Hawes (1884a, p. 613) noted that stone from these quarries, the *Dayton limestone*, was very strong and that it was shipped by rail, canal, and horse or mule team to Ohio towns and to Indiana. At Piqua and Dayton, much stone was shipped by canal to Toledo (Bownocker, 1915, p. 37; Camp, 1994).

In some cases, stone could be shipped both ways along the canals. Cist (1846, p. 109) relates the story of a Dayton man who wanted to get **freestone** (in this case, Buena Vista sandstone) shipped from Cincinnati via canal. The captain of the canal boat told him that he had taken a load of *Dayton marble* (limestone) to Cincinnati for the Humble Stone Co. Of course, he was agreeable to take the freestone from Cincinnati, as he could get a load going both ways. Such backhaul of material made canal transportation more lucrative for the boat owner.

The importance of building stone as a trade item can be seen in toll lists and in lists of products shipped by canal (table 4). Other geologic products were also of great importance. Crowell (1995, p. 123-129) has provided a nicely illustrated discussion of the effects of the canals on Ohio's coal industry. Kilbourne (1828, p. 24) noted the then-recent discovery of gypsum along Sandusky Bay, predicting correctly that it would prove to be an important item. Stone

TABLE 2.—*Examples of stone shipped along Ohio canals*

Stone	Quarry location	Shipped via	Used for	Used at
Berea Sandstone	Independence, Cuyahoga Co.; Peninsula, Summit Co.	Ohio & Erie Canal	grindstones, building stone	Cleveland, Akron
Buena Vista Member of Cuyahoga Formation	Adams and Scioto Cos.	Ohio & Erie Canal, Ohio River, Miami & Erie Canal	tombstones, building stone	Columbus, Dayton, Cincinnati
Dayton Formation	Dayton, Montgomery Co.	Miami & Erie Canal	building stone	Dayton, Cincinnati
Vermont marble	Dorset Mountain, Vermont	Champlain Canal, Erie Canal, most or all Ohio canals	tombstones	throughout Ohio
Italian marble	Carrara, Italy	Mediterranean, Atlantic Ocean, Erie Canal, most or all Ohio canals	tombstones	throughout Ohio

TABLE 3.—*Examples of Ohio quarries shipping stone by canal*[1]

Name	Location	Year opened	Stone type	Mode of transportation	Principal market
E. Schmidlin	Independence Township, Cuyahoga Co.	1840	sandstone	wagon and canal	Cleveland
J. Kinzer	Independence Township, Cuyahoga Co.	1848	sandstone	wagon and canal	Cleveland
H. Merkle Township,	Independence Cuyahoga Co.	1875	sandstone	wagon and canal	Cleveland
Peninsula Stone Company	Boston Township, Summit Co.	1837	sandstone	canal	Cleveland and Akron
Suter & Everhart	Perry Township, Stark Co.	1880	sandstone	rail and canal	U.S. and Canada
J. Inskeep	Rush Township, Scioto Co.	1874	freestone (sandstone)	barge (canal)	Columbus
J. S. Bookes	Wayne Township, Montgomery Co.	1869	limestone	canal and rail	Sidney, Ohio, and others

[1]From 1880 products of industry reports of the census (U.S. Census, 1850-1880).

movement by canal can be traced using census data (U.S. Census, 1850-1880). For instance, the Peninsula Stone Co., in Summit County, shipped sandstone by canal to Cleveland and Akron (see table 3).

Ohio stone also has been used for canals outside Ohio. The Sault Ste. Marie Canal used Columbus Limestone from Marblehead and Kelleys Island (Hawes, 1884a, p. 636; Bownocker, 1915, p. 63; but, strangely, this stone is not mentioned in Dickinson, 1981).The sandstones of the Portsmouth area were used for locks and dams along the Licking River in Kentucky (Mather, 1838b, p. 6).

Stone yards and manufacturing companies tended to locate along or near the canal. Most of the 14 stone yards listed in the 1858 Cincinnati City Directory, for instance, were located within one block of the Miami & Erie Canal (Baird [1977], p. 6). The situation was similar in other towns. In Piqua, Hummel and Cardoni's Ohio Marble Works, importers of granite and marble, were located only a block from the canal.

The Ohio canals did more than stimulate the local stone trade, however. The canals also facilitated the importation of stone, including both Italian and Vermont marbles, into

TABLE 4.—*Geological products shipped by canal arriving or clearing Cleveland*[1]

1850

Articles	Arrived	Cleared
salt	3 barrels	61,468 barrels
coal	2,347,844 bushels	2,514 bushels
burr stone (used for grinding stones)		41,046 pounds
cut stone	6,835 pounds	
grindstone		332,510 pounds
gypsum		3,275,562 pounds
marble, unwrought (rough)		1,653,758 pounds
marble, wrought (finished)	740 pounds	45,100 pounds
dressed and rough stone	4,877 perches[2]	26 perches

1900

Articles	Arrived	Cleared
coal	20,683,958 pounds	
stone	605,000 pounds	605,000 pounds

[1]Adapted from Orth, (1910, p. 700, 701).
[2]A perch is a volumetric measure of stone. During the canal days, 1 perch = 16.5 cubic feet.

Ohio. A number of advertisements from the 1840's and later note that particular facilities are located for ease in transport by canal, as well as railroad. For example, an advertisement in the Cleveland Leader for September 26, 1855 (p. 3) notes that:

Messrs. Whitman & Myers, who have a marble shop on Prospect st, have lately erected a manufactory on the canal below Pittsburg st, where they saw and polish by steam power large quantities of marble and freestone. Messrs. Whitman & Myers have most convenient facilities for obtaining marble from the east, manufacturing, and shipping it to the interior both by canal and railroad.

An advertisement (fig. 9) in the 1856 Cleveland City Directory (Spear, Denison & Co., 1856) promoted the steam marble works of Myers, Uhl & Co., "wholesale and retail dealers in foreign and American marble." Marble was a major item in the canal trade; canal toll schedules noted rates for both manufactured marble and marble in blocks.

Cleveland was an important transshipment place. Chillicothe, for instance, obtained its marble, most of which originated in Italy, from Cleveland (Williams Bros., 1880, p. 206). Some imported stone was sent from Cleveland via both major Ohio canals: south down the Ohio & Erie Canal to Portsmouth on the Ohio River, then west down the Ohio River to Cincinnati, and then north to the Dayton area. Examples of stone transport to and from Cleveland are given in table 4. In 1850, 4,877 perches of dressed and rough stone arrived in Cleveland via canal, but only 26 left.

The railroads soon took a toll on the canals, however, and the number of types of items shipped declined. The canals remained important for coal and stone, however (table 4). By 1905, only coal, hay, stone, and lumber were being shipped by canal. In 1905, 4,973,950 pounds of coal and 2,308,050 pounds of stone were transported by canal (Orth, 1910, p. 701). Coal, salt, iron, and building stone were the main items transported along the Hocking Valley Canal after its first years of operation (Droege and Goldring, 1985, p. 52). Thus, some of the last remaining, and oft photographed, canal boats were stone haulers. The *Primrose*, the *St. Marie*, and the *Mohawk* transported stone from the Dayton-area quarries to Cincinnati (Baird, [1977], p. 8), and the *Statler* took stone from the Statler quarry in Piqua. The *Statler* was one of the last canal boats operating at Piqua and environs (Gieck, 1992, p. 170). The Statler quarry at Piqua was very well known and was cited in various works, including Newberry (1880, p. 129).

THE INFLUENCE OF CANALS ON GEOLOGISTS

Canals have long been associated with geologists. The famed early British geologist William "Strata" Smith (1769-1839) honed his geological concepts while working on a canal project in Britain in the 1790's (Geikie, 1897, p. 225-226). Benjamin Latrobe (1764-1820), an emigrant from Britain and one of the most famous early American architects and engineers, applied his own observations of geology to the engineering of the Chesapeake & Delaware Canal and the Washington Canal. He also used his geological knowledge to search for stone for canal structures as well as other purposes (Lintner and Stapleton, 1979).

The most prominent American geologist in the 1820's was Amos Eaton (1776-1842). One of Eaton's best known and largest works was his geological and agricultural survey of the area adjacent to New York's Erie Canal (Merrill, 1923, p. 98). The Erie Canal, especially the section which cut through fossiliferous strata at Lockport, New York, played an important role in influencing Othniel C. Marsh and other paleontologists (Schuchert and LeVene, 1940, p. 17). James Hall (1811-1898), a student of Amos Eaton and one of the most productive paleontologists of all time, formed a company to quarry trilobites along the banks of the Erie Canal at Lockport (Clarke, 1921, p. 87). A young Ohioan, John Strong Newberry (1822-1892), was one of the stockholders in Hall's company. Newberry would later serve as the head of the Ohio Geological Survey and would become Ohio's most prominent geologist.

It is also worth noting that President James A. Garfield (1831-1881), who had worked as a mule driver and a deck hand on a canal boat carrying copper ore and coal along the Pennsylvania & Ohio Canal as a youth (Ridpath, 1882, p. 37-43), had an enormous and underappreciated influence on the field of geology, both in Ohio and nationally (Hannibal, 1996).

KEY REFERENCES

This guidebook builds upon the large body of literature on the nineteenth-century canals of Ohio and other areas. Many of these publications are listed in the references at the end of this guide. However, there are a few key works. One of the most comprehensive works on the Ohio canals, and certainly the best illustrated, is Gieck's (1992) *Photo album of Ohio's canal era, 1825-1913*. Trevorrow's article, "What kind of stone?" (1986a), published in the Canal Society of Ohio's Towpaths, established the broad outlines of stone use for locks and other masonry structures of the Ohio canals. All of the publications of the Canal Society, including its guidebooks, are recommended. The address of the Canal Society of Ohio is: 550 Copley Road, Akron, OH 44320. Woods' (1995) *The Ohio & Erie Canal: a glossary of terms*, is a handy guide to terminology. The Ohio Historical Society published a brochure and map (Hood, 1971) on Ohio's canal system. A similar brochure by the Roscoe Village Foundation (1990) has a large map on one side and information on many aspects of the canals on the other side. Davies' (1989) *Highlights of the geology and engineering of the Chesapeake and Ohio Canal* was the stimulus for this guidebook to Ohio's canals.

More information on the geology of the area traversed by the canals can be found in the publications of the Ohio Division of Geological Survey. Several are particularly helpful: Hansen's (1989) *Guide to the geology along U.S. Route 23 between Columbus and Portsmouth*, Hansen's (1993) *Guide to the geology along Interstate 77 between Marietta and Cleveland*, and Hull's (1993) *Guide to the geology along Interstate 75 between Toledo and Cincinnati*.

ORGANIZATION OF THE STOPS

The stops in this guidebook are organized north to south along the Ohio & Erie Canal and its tributary canals, then along the Miami & Erie Canal and its tributaries. Portions of the appropriate U.S. Geological Survey topographic maps are provided for each site. Additional maps commonly are provided in literature of the Canal Society of Ohio. Please note that most measurements are given in English units, but metric equivalents are listed in parentheses.

Lock numbers can be confusing. The locks were numbered in each direction from the summit points of both major canals. Numbers proceeded in descending order in both directions from the summits. For example, the locks north from the summit in Akron to Cleveland were numbered 1 through 44, and the locks south from the summit in Akron to Adams Mills in Muskingum County were numbered 1 through 30. To make things even more complicated, there were additional systems of numbering and changes in numbers as canals were extended or locks were added (for example, see Stop 15, Excello Lock).

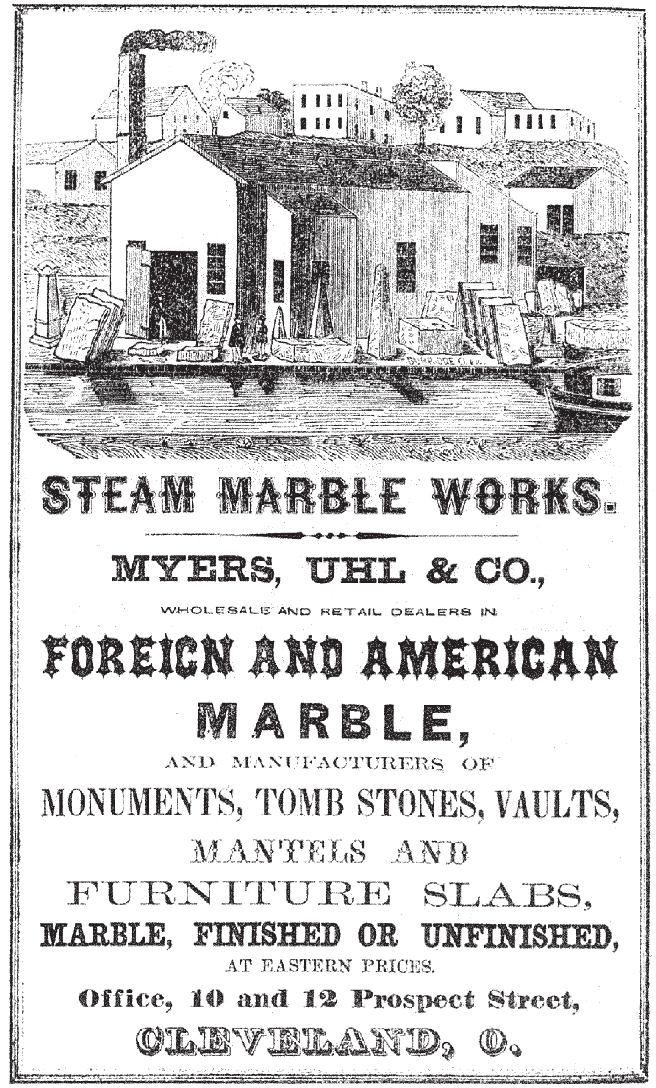


FIGURE 9.—Advertisement for steam marble works of Myers, Uhl & Co., located along the Ohio & Erie Canal in Cleveland, in the area now known as the Flats. The prow of a canal boat is seen to the right. The final monuments fashioned from marble slabs and obelisks like those seen in front of the factory can be found in older cemeteries. From Spear, Denison & Co. (1856).

THE OHIO & ERIE CANAL AND ITS TRIBUTARIES

The Ohio & Erie Canal, known simply as the Ohio Canal in older literature, ran from Cleveland at its northern end to Portsmouth at its southern end. The canal was constructed along the valleys of the Cuyahoga River, the Tuscarawas River, the Muskingum River, the Licking River, Little and Big Walnut Creeks, and the Scioto River. There are two summits, the Portage Summit at Akron (for which Summit County is named), and the Licking Summit, southwest of Newark. Construction of the main part of the canal began in 1825 and was completed in 1834. This 309-mile (497-km)-long canal was the first of Ohio's two great systems. Various side canals, including feeders, were added; these include the Columbus Feeder Canal (completed in 1831), the Pennsylvania & Ohio or Cross Cut Canal (completed in 1848), the Walhonding Canal (completed in 1841), and the Hocking Valley or Side Cut Canal (completed in 1843).

STOP 1. CUYAHOGA VALLEY NATIONAL RECREATION AREA, LOCKS 39 TO 24 OF THE OHIO & ERIE CANAL

Because of their proximity to Cleveland and Akron, the canal-related features of the Cuyahoga Valley National Recreation Area (CVNRA) are some of the most visited in Ohio. These features include Locks 39 to 24 of the Ohio & Erie Canal; the Canal Visitors Center; the canal-boat-building exhibit at the Boston Store; and Deep Lock quarry. The park is located between Rockside Road in Independence and the vicinity of Bath Road in Cuyahoga Falls (see U.S. Geological Survey Cleveland South, Shaker Heights, Northfield, and Peninsula 7.5-minute quadrangle maps).

The Ohio & Erie Canal towpath trail passes through the length of this park, which includes many nicely preserved locks (most redone in concrete), well-marked trails, and excellent interpretive signage. There are re-enactments of "locking through" given at Lock 38 (fig. 10). Call the park at 216-524-1497 for days and times. The CVNRA, which incorporates several Cleveland and Akron metropolitan parks within its boundaries, also is well known for its natural geological features, including **Devonian**, Mississippian, and Pennsylvanian clastic rocks (Hannibal and Feldmann, 1987).

Most or all of the stone originally used for the locks here is probably Berea Sandstone, a fine- to medium-grained quartz sandstone. (See the discussion of Deep Lock quarry below for more information on the Berea Sandstone.) However many of the locks were redone in concrete. The concrete was used to replace, or cover, much of the original stone.

Lock 39, the northernmost lock in the CVNRA, is located alongside Canal Road just south of Rockside Road. The lock is a short walk from a parking area off Rockside Road. Most of the lock is concrete, but portions of four or five lower courses of sandstone usually can be seen. The concrete was added around 1906. The sandstone is fine to medium grained, and the least weathered stone of the sandstone blocks is very pale orange in color. It is probably the Berea Sandstone.

Lock 38, also known as 12-Mile Lock, is next to the Canal Visitors Center (fig. 10), which is at the intersection of Hillside and Canal Roads. Lock 38 was repaired with concrete around 1906. The 1913 flood damaged the canals in this area so much that canal traffic essentially ended. The National Park Service restored Lock 38 to its 1907 appearance in 1991-1992 (Bobel, 1993). The only stone normally visible is on the east side of the north end of the lock. The Visitors Center has excellent exhibits on the canal and other aspects of the park. Canal-related materials are available for sale here.

Sandstone blocks can be seen at the bottom of Lock 32, a short walk along the towpath trail, just north of the Boston Store, which is located at the intersection of the canal and Boston Mills Road, just to the east of Riverview Road. Most of Lock 32 is covered or replaced with concrete. The sandstone blocks at the bottom are a fine- to medium-grained light-olive-gray quartz sandstone. There are also indications of small iron-rich areas and holes where **concretion**like bodies may have been. This stone is probably the Berea Sandstone. The canal-boat exhibit at the Boston Store includes tools used in building canal boats, a partial canal boat showing how the boats were constructed, and a model of a boatyard and dry dock (see fig. 8). The towpath trail leads south from the Boston Store to Stumpy Basin, an old turning basin that includes a diverse plant assemblage. Lock 31, a short walk south of Stumpy Basin, is known as Lonesome Lock or Lost Lock and is made of sandstone and concrete.

Lock 30 (figs. 11, 12), known as the Peninsula Feeder, has been redone with concrete. This lock is reached most easily via the towpath trail from Lock 29 (see below). Some discarded stone on the west side of the canal can be examined. These blocks of Berea Sandstone include concretionlike bodies (fig. 13) whose centers have weathered out. This area is in the narrows, a constricted area bounded by cliffs of the Chagrin Shale Member of the Ohio Shale, of Late Devonian age. Most of the shale is covered by vegetation.

Lock 29 (figs. 11, 14-17) is one of the best preserved locks in the Cuyahoga Valley National Recreation Area. The parking area for this lock is off Akron-Peninsula Road north of its intersection with Ohio Rte. 303 (follow the signs). Visitors can enter the lock and examine the tooling of the stone, which is fine-grained Berea Sandstone. This lock is also one of the best places to see what are presumed mason's marks, symbols or letters carved into stone blocks by stonemasons. Such markings are known from at least the twelfth century in Europe. Although exceptions are known, mason's marks (fig. 16) were typically applied to the top surfaces of stones, not to exposed surfaces (Clifton-Taylor and Ireson, 1983, p. 92). Here the markings are Roman numerals, about 2.8 inches (7 cm) tall. Although other examples of mason's marks are known (see Gieck, 1992, p. 256; Bobel, 1993, p. 47), such markings are not prominent, or easy to see, at most locks along Ohio canals. Most blocks in the walls have drafted margins and dressed interiors; holes for tongs are common (figs. 16, 17). The coping also has some bush-hammered marks and a number of holes for tongs. Although they are mostly filled in with concrete, grooves in which the curved iron bars of goose necks were once inset are visible in the coping. There are slight indications of nicks in the stone that may have been made by rope on the northeast part of the top of the lock. This lock was reconstructed in 1882 with stone supplied by the Peninsula Stone Company (Canal Society of Ohio, 1996, p. 45). There is a tall outcrop of the gray Chagrin Shale Member of the Ohio Shale across the Cuyahoga River from this site.

The best known of the canal-era quarries in Ohio is Deep Lock quarry (figs. 11, 18, 19), where the Berea Sandstone was quarried over a long period of time. This quarry is in Deep Lock Quarry Metropark in Peninsula, an Akron metropolitan park within the Cuyahoga Valley National Recreation Area. The parking lot for the park is off Riverview Road about 0.8 mile (1.3 km) south of the intersection of Riverview Road and Ohio Rte. 303. The quarry is accessible via a marked trail from the parking lot of Deep Lock Quarry Park.

The Berea Sandstone is Ohio's most famous sandstone. Some of this fame is due to its popularity as material for grindstones and building stone. In the subsurface, the Berea has produced hydrocarbons. The Berea Sandstone has been intensively studied by geologists; its depositional environment has been interpreted as a **deltaic** sequence. The complexities of this deposit have been described by Pashin and Ettensohn (1995). The Berea Sandstone has been considered to be Late Devonian, Devonian-Mississippian, or Mississippian in age, but some more recent interpretations (for example, Pashin and Ettensohn, 1995) consider it to be Late Devonian in age.

The stone at Deep Lock quarry is a fine- to medium-grained, yellowish-gray quartz sandstone containing some small pebbles (up to 0.8 inch/2 cm in length) and larger reddish concretionlike bodies and clasts (fig. 19). Reddish-brown spots denoting iron-rich areas can be seen in less weathered areas, but are best seen under magnification by a hand lens. The color of the weathered stone varies from moderately reddish orange to brownish black. The sand grains are typically subrounded. Pebbles are unusual in the Berea Sandstone; Bownocker (1915, p. 75) noted that they were found only at Peninsula. The Berea Sandstone of central and southern Ohio is much finer grained than that found in northern Ohio (see Stop 8, Canal Park, Waverly).

This quarry operated over an extended period of time; thus, it is not likely that any canal-era quarry walls still exist. Markings left by quarrying activity change from one area to another of this quarry, indicating changes in tools used to cut the stone. The present floor of the east part of the quarry is crossed by grooves that are parallel to the quarry walls. These grooves were made by channeling machines, which were probably steam operated.

Much of the sandstone used for the northern locks of the Ohio & Erie Canal is said to have come from this quarry (Gieck, 1992, p. 17), but it may not have been open at the time the locks were constructed. It is certain that the Peninsula Stone Company opened a quarry in 1837, shipping stone to Cleveland and Akron via the canal (table 3). Stone from this quarry was used for reconstruction of canal locks. According to Orton (1884, p. 588), the principal market in the early 1880's was Akron. However, much of the stone quarried at Deep Lock and other area quarries was shipped to Cleveland via the canal, and then transshipped via lake carrier to other cities, especially Buffalo, New York.

Deep Lock quarry takes its name from Deep Lock (figs. 11, 20, 21), Lock 28 of the Ohio & Erie Canal, located about 800 feet (244 meters) south of Deep Lock quarry. The lock is located below the quarry and is accessible via trails from the quarry. It is also along the towpath trail. Deep Lock was so named because of its 17-foot (5.2-meter) lift, the highest of any lock on the Ohio & Erie Canal. In 1909, the stone at the lower end of the lock was taken apart and rebuilt; the upper end was redone in concrete, reinforced with iron rods (Canal Society of Ohio, 1996, p. 55). Thus, today, most of the lock is covered with concrete, but stone blocks can be seen at the lower end of the lock.

Deep Lock is made of fine- to medium-grained, beige to reddish Berea Sandstone. The color of the weathered stone varies from light brown to brownish black. This stone can confidently be identified as Berea Sandstone because of the reddish-brown spots in the stone like those seen in Deep Lock quarry. Bedding of the sandstone is mostly horizontal. Some of the stone toward the north side is **spalling**. The stone blocks are tooled, commonly in a coarse fashion, and holes for tongs can be seen in a number of blocks. The concrete used here has fragments and particles derived from the region's bedrock, including worn pieces of sandstone and siltstone, dark shale, and white quartz pebbles, as well as pebbles and cobbles transported by Pleistocene glaciers. Some of the rocks in the concrete are very large, more than 1 foot (0.3 meter) in diameter. The concrete is badly **exfoliating** in places. Indeed, early reports criticized the use of Cuyahoga River gravels for use in concrete (Canal Society of Ohio, 1996, p. 59).

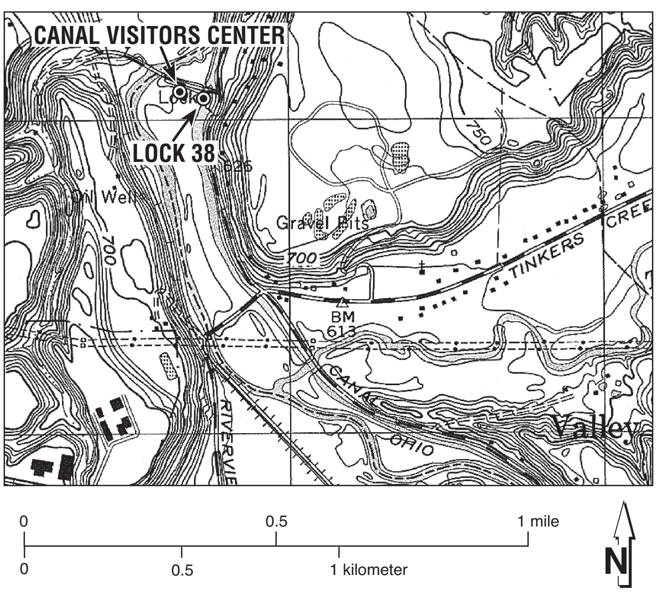


FIGURE 10.—Portion of U.S. Geological Survey Northfield, Ohio, 7.5-minute quadrangle showing location of Lock 38 of the Ohio & Erie Canal and the adjacent Canal Visitors Center. Lock 39 of the Ohio & Erie Canal is to the northwest (on the Cleveland South 7.5-minute quadrangle). Contour interval is 10 feet (3 meters).

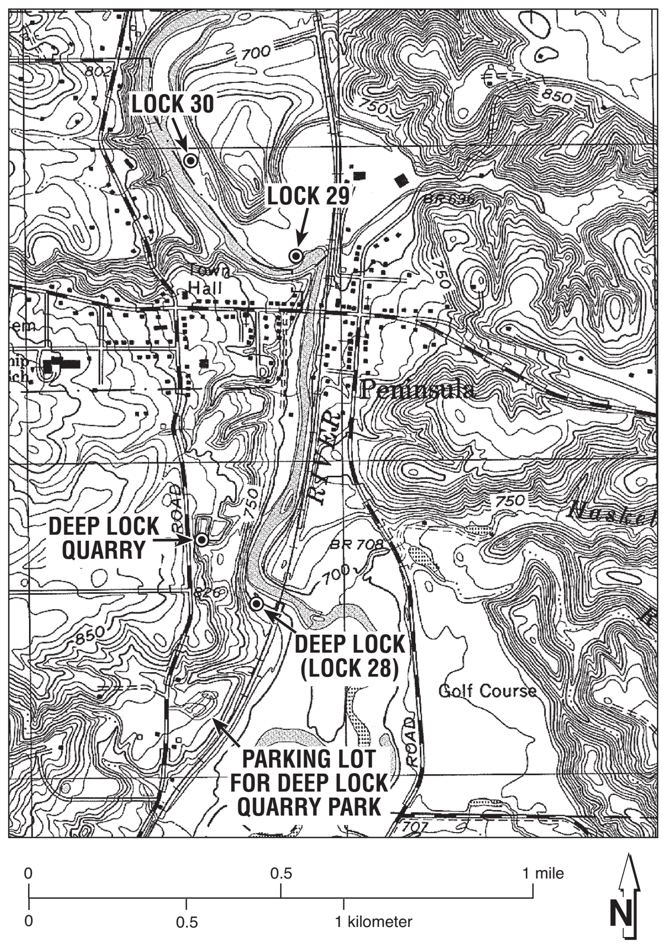


FIGURE 11.—Portion of U.S. Geological Survey Peninsula, Ohio, 7.5-minute quadrangle showing location of Locks 28 (Deep Lock), 29, and 30 of the Ohio & Erie Canal and Deep Lock quarry. Contour interval is 10 feet (3 meters).

FIGURE 12.—Lock 30 of the Ohio & Erie Canal, Cuyahoga Valley National Recreation Area. This lock is composed mostly of concrete, which is exfoliating. Discarded stone from the original structure can be seen beyond the lock. November 1997 photo.

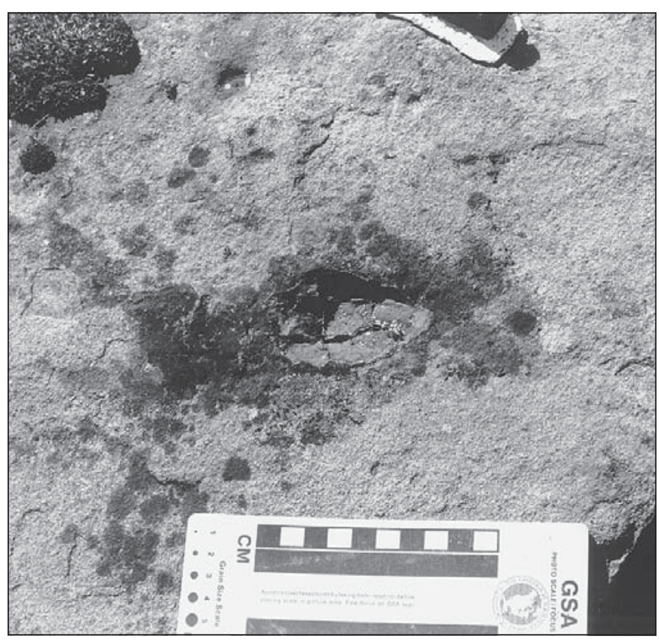


FIGURE 13.—Detail of discarded stone left next to Lock 30. Note concretionlike body just above the scale. Much of the block is covered by moss and lichen. This block was probably used for the coping of a quoin block. November 1997 photo.

FIGURE 14.—Lock 29, Cuyahoga Valley National Recreation Area, one of the best preserved locks along the Ohio & Erie Canal. This lock provided the lift for an aqueduct. The Cuyahoga River is in the foreground. November 1997 photo.

FIGURE 15.—Top portion of Lock 29. Note the angular quoins of the lock recess and the rough, unfinished outer edges of the stone across the center of the photo. November 1997 photo.

FIGURE 16.—Mason's mark (VI) and hole for tongs in sandstone block used for Lock 29. November 1997 photo.

FIGURE 17. —Stone of Lock 29 showing roughly bush hammered interior, drafted margins, and cement mortar. November 1997 photo.

FIGURE 18.—Deep Lock quarry in the Berea Sandstone, Cuyahoga Valley National Recreation Area. Several benches of the quarry, probably cut with channeling machines, are visible. December 1997 photo.

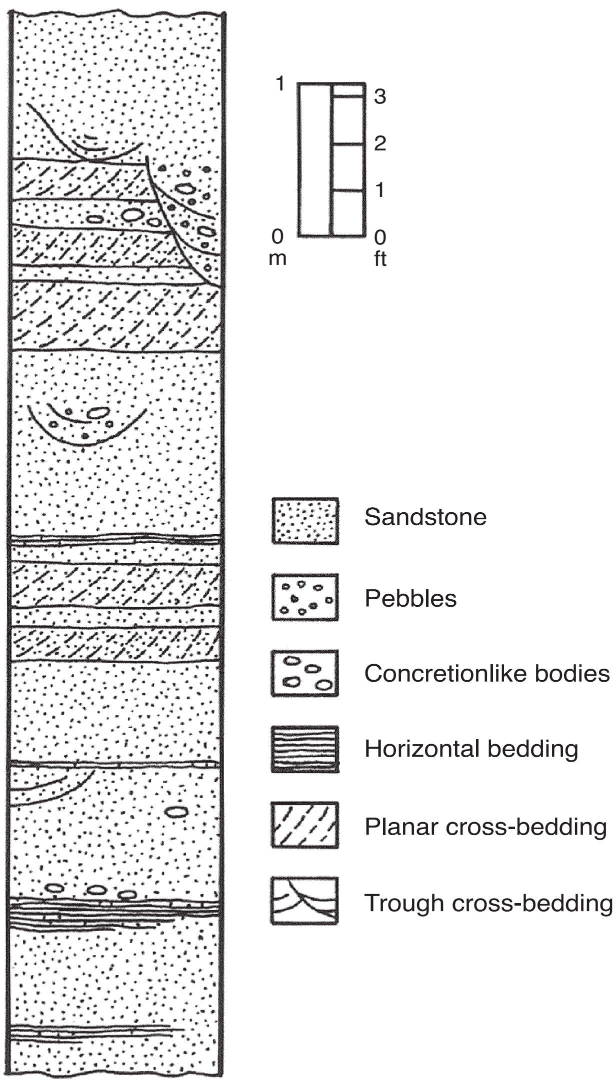


FIGURE 19.—Measured section of Berea Sandstone at Deep Lock quarry. Modified from Hannibal and Feldmann (1987).

FIGURE 20.—Deep Lock (Lock 28), Cuyahoga Valley National Recreation Area. The lower level (front end) of the lock (foreground) is sandstone block. The back portion of the lock is concrete. The iciclelike streaks on the concrete are encrustations of salts that have dissolved from the concrete. December 1997 photo.

FIGURE 21. —Lower level end of Deep Lock, which is heavily encrusted by lichen and moss. Note towpath trail at top of photo. December 1997 photo.

STOP 2. CASCADE LOCKS, CASCADE VALLEY METROPARK, AKRON, LOCKS 15-10 OF THE OHIO & ERIE CANAL

Cascade Locks Park is part of the Cascade Valley Metropark in Akron. The park extends both north and south from W. North Street, just west of its intersection with Howard Street. Locks 14 through 10 are south of W. North Street; Lock 15 is north of W. North Street (see fig. 22 and U.S. Geological Survey Akron West 7.5-minute quadrangle map). This series of closely spaced locks, often described as a **staircase** section, represents part of the steepest section of the Ohio & Erie Canal.

The park includes the historic Mustill Store and a towpath hiking path. There are scenic overlooks and boardwalks along a park trail. The locks here were originally made of conglomerate or sandstone, but most of the stone was replaced or covered by concrete in 1907. This date can be found cast in the concrete of several of the locks. The following directions start at W. North Street.

Lock 15 is a short walk north of W. North Street, adjacent to the Mustill Store. The lock is mostly concrete, but has some sandstone visible along the lower parts of the lock.

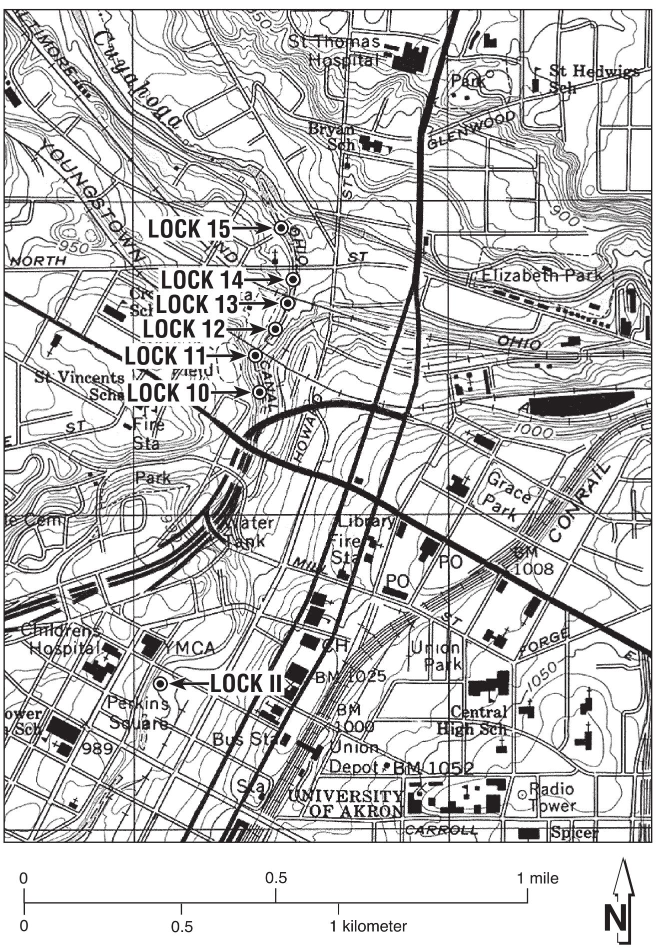


FIGURE 22.—Portion of U.S. Geological Survey Akron West, Ohio, 7.5-minute quadrangle showing location of Locks 10-15 of the Ohio & Erie Canal in Cascade Valley Metropark. Contour interval is 10 feet (3 meters). The location of Stop 3, Lock II Park, also is shown.

Just south of W. North Street is Lock 14, also known as Cascade Mills Lock. Several mills were once located along this and the other locks of this series. The flowing water here provided the power for the mills. Lock 14 is mainly concrete, but some stone can be seen on its lower parts. Just to the east of the lock, and just below street level of W. North Street, is an old sandstone masonry structure (fig. 23) that was part of a spillway. This structure is composed of a fine- to medium-grained quartz sandstone containing a few pebbles. This description fits most of the stone used for the locks at this locality. It is likely that these structures are made of Sharon conglomerate, a Pennsylvanian-age rock unit that typically consists of pebbly sandstone. This unit generally is considered to be a braided stream deposit. It was formerly quarried in Akron and vicinity (Newberry, 1873, p. 212) and was used as a building stone for several classic Akron structures. However, the Berea Sandstone at nearby Deep Lock quarry in Peninsula also contains some pebbles (see Stop 1, fig. 19).

Lock 13 is located beneath the Cuyahoga Valley Line Railroad overpass. Stone blocks can be seen toward the base of this lock. Strong cross-bedding and some pebbles can be seen in the sandstone blocks of the lock from the overlook.

A rock exposure is visible in the canal just north of Lock 12. A thick (4 inches/10 cm) bed of siltstone is sandwiched between layers of gray shale. This rock unit is the Meadville Member of the Cuyahoga Formation of Mississippian age.

Lock 12, located alongside the large Ace Rubber Company building, is mostly concrete, like the other locks in this series. The foundation of Lock 12, and probably most of the other locks here, is set into bedrock. The concrete walls along the canal that stretch between the locks in this area were constructed to stem erosion in the 1930's. A mill race, which flows under Ace Rubber, is located to the east of this lock.

Lock 11, just south of the Wheeling & Lake Erie Railroad bridge, is composed of a fine- to medium-grained conglomeratic sandstone. The stone used for Lock 11 can be seen on the lower parts and lower end of the lock; it has an interesting combination of coarse finishes. The date 1907 is imprinted into the concrete. Lock 10 is mostly destroyed.

FIGURE 23.—Spillway, constructed of conglomeratic sandstone, probably the Sharon conglomerate, adjacent to Lock 14, Cascade Mills Lock, part of Cascade Valley Metropark. December 1997 photo.

STOP 3. LOCK II PARK, AKRON, OHIO & ERIE CANAL

Lock II Park (figs. 22, 24-26) is located along the canal just southeast of the intersection of State and Water Streets, below the level of State Street (which is a bridge at this point), in downtown Akron (see U.S. Geological Survey Akron West 7.5-minute quadrangle map). The park is directly west of the Canal Park Stadium. The park can be reached via stairways and paths from several directions, including State Street. The lock, spillway, and filled-in dry dock here were rebuilt in the early 1980's (Jackson, 1984). There is also a skeletal representation of a three-cabin freighter at the site. Interpretive information about this site can be found along one of the railings of the boat skeleton.

The first canal boat passed here on July 3, 1827. A ceremony the next day marked the official opening of the Cleveland-to-Akron segment of the canal. This park commemorates the boatyard and dry dock of William Payne, who began working at this site in 1873. The canal in this area was abandoned after the disastrous 1913 flood.

Berea Sandstone or Sharon conglomerate was probably used for the original lock structures at this location, but the reconstruction uses Massillon sandstone, a Pennsylvanian-age Ohio stone. The Massillon sandstone used here was quarried by the Briar Hill Stone Company in one of its quarries in northwestern Coshocton County (quarry no. 3, map symbol 5 in Weisgarber, 1996; Jerry Parsons, Briar Hill Stone Company, personal commun., 1998). The Massillon is a fine- to medium-grained quartz sandstone. The quartz grains are angular to subangular in shape. The stone contains **mica** flakes in places. Its original color is very light gray with dark, yellowish-orange streaks, but it weathers darker.

The Massillon sandstone formed as a shallow-water deposit. Schmidley (1987) determined that it was deposited in a fluvial environment. The Briar Hill Stone Company has been quarrying the stone since 1917, but the stone was quarried even earlier by others. More information on the stone and its quarrying history can be found in works by Bownocker (1915, p. 118-129) and the Briar Hill Stone Company staff (1991).

The stone used for the reconstruction has a simpler, **split-faced** finish (fig. 26) than the stone for the original lock would have had. Such a difference in finish is appropriate, as it distinguishes the reconstructed lock from the original. The top of the coping has a slightly roughened finish composed of subparallel grooves, giving it an antique appearance. The square **pavers** around the skeletal boat frame include blocks of *Charcoal Black granite* quarried near St. Cloud, Minnesota, by the Cold Spring Granite Company (Jan Ellering, Cold Spring Granite Company, personal commun., 1998). There are also some lighter colored granite pavers.

The availability of water at the summits was critical for the great canal systems. A ready source of water was one of the reasons that the Ohio & Erie Canal passed through Akron. The Portage Lakes, which supplied this water, are located just south of this area (Jackson, 1984; Gieck, 1992, p. xiv).

FIGURE 24.—Lock II Park, Akron, showing reconstructed lock, filled-in dry dock, and spillway. December 1997 photo.

FIGURE 25.—Detail of Lock II Park. Stone used for reconstructed lock and as armoring for canal is Massillon sandstone. December 1997 photo.

FIGURE 26.—Close-up view of stone used for reconstructed Lock II. Note that the finish of the stone does not attempt to replicate that of the original canal structures. It is split faced instead of bush hammered, as were most original canal stones. This difference in finish helps to identify the lock as a replica. December 1997 photo.

STOP 4. TRIPLE LOCKS OF THE WALHONDING CANAL, COSHOCTON, AND ROSCOE VILLAGE

The famous Triple Locks (figs. 27, 28) of the Walhonding Canal, a branch of the Ohio & Erie Canal, are located in a park just north of Roscoe Village, on the western outskirts of Coshocton (see U.S. Geological Survey Randle 7.5-minute quadrangle map). The parking lot for the park is on Whitewoman Street (County Road 495) 0.2 mile (0.3 km) northwest of Ohio Rtes. 16/83. Going west on Whitewoman Street, you will pass the Visitor Center for Roscoe Village on your right.

The Walhonding Canal ran west from Roscoe along the Walhonding River. Construction for the canal began in 1836 and it was completed in 1841. The triple locks are notable for their unusual, triple configuration, their good state of preservation, and their beautifully colored stone. The bottom few courses of the lock here are distinctly beveled inward. The beveling helps to butress the lower part of the lock and causes the width of the lock chamber to be less at the bottom of the lock than at the top. The styles of stone dressing vary somewhat at this lock.

Where it is relatively unweathered, the color of the stone used for the locks ranges from a very pale orange to moderate reddish orange to moderate red. Grain size ranges from medium to very coarse. The lower courses are generally coarser grained than the upper courses. The rock has distinct cross-bedding. Orton (1884, p. 604) noted that the canal locks in Coshocton County were made of sandstone from the Lower Coal Measures (lower Pennsylvanian) located stratigraphically a few feet above the level of the Zoar limestone. He noted that this sandstone was typically light colored and in some cases was reddish colored. According to the exhibits at Roscoe Village, the stone used here was quarried from atop Roscoe Hill. This stone may be the Homewood sandstone. It is similar to the Massillon sandstone (see Stop 3, Lock II Park, for more on the Massillon sandstone).

Just east of the Triple Locks, and extending from the main parking area for Roscoe Village, is a towpath walking trail extending northward to the canal-boat ride area in the Coshocton City/County Park. This trail passes Locks 26 and 27 (known as double locks) of the Ohio & Erie Canal and crosses a replica aqueduct over the Walhonding River. Visitors can seasonally take a ride on the *Monticello III* canal boat, which travels down the Walhonding Canal. The park entrance is off Ohio Rte. 83, about $3/8$ mile ($1/2$ km) north of its intersection with U.S. Rte. 36 (see U.S. Geological Survey Coshocton 7.5-minute quadrangle map). The Coshocton Park District headquarters is located at 23253 Ohio Rte. 83, Coshocton, OH 43812, telephone 740-622-7528.

Nearby Roscoe Village extends along Whitewoman Street, from the Visitor Center almost to Ohio Rte. 541. (There is an entrance fee; call 740-622-9310 for more information.) Roscoe Village maintains many old canal-era buildings, including a tollkeeper's house, as well as exhibits of canal materials and stone carving. It is best to begin a tour of the village at the Visitor Center, where there are canal exhibits and a scale-model replica of a canal boat and lock. Canal literature is available for sale in the gift shop. Today's Roscoe Basin (fig. 27) is an 1870's feeder basin for the canal. (It is labeled "Lower Basin" on the U.S. Geological Survey Coshocton 15-minute topographic map.)

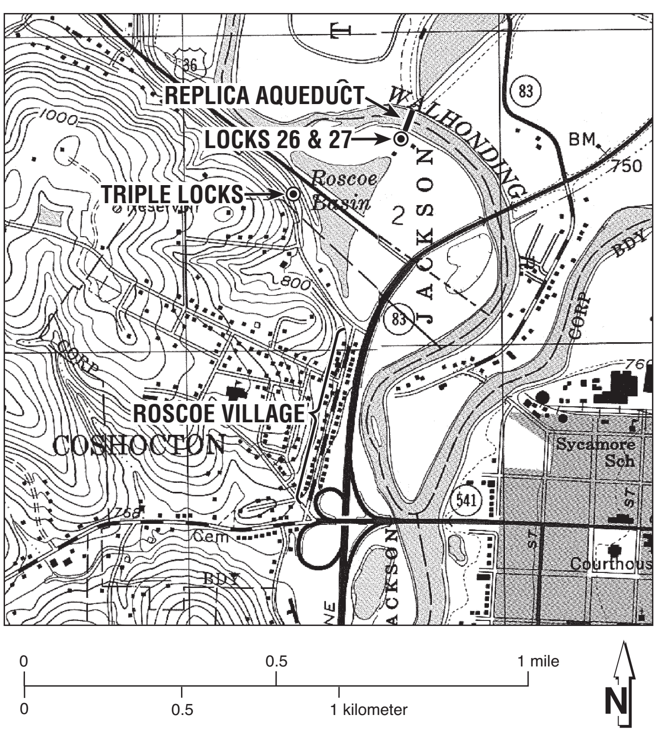


FIGURE 27.—Portion of U.S. Geological Survey Randle and Coshocton, Ohio, 7.5-minute quadrangles showing location of the Triple Locks of the Walhonding Canal, Locks 26 and 27 (known as double locks) of the Ohio & Erie Canal, a replica aqueduct, and Roscoe Village. Contour interval is 20 feet (6 meters); some intermediate 10-foot (3-meter) contours are shown as dotted lines.

FIGURE 28.—Triple Locks, Coshocton. January 1998 photo.

STOP 5. BLACK HAND GORGE, FEEDER LOCK AND TOWPATH OF THE OHIO & ERIE CANAL

Black Hand Gorge State Nature Preserve contains a feeder (outlet) lock of the Ohio & Erie Canal (figs. 29-31). A canal towpath cut into a bedrock cliff also is visible here (fig. 32). The preserve is located about 9 miles (15 km) east of Newark in Licking County (see U.S. Geological Survey Toboso 7.5-minute quadrangle map). From Ohio Rte. 16 turn south on Toboso Road and enter the Black Hand Gorge parking lot. From the gorge parking lot, walk across the bridge over the Licking River and proceed to your left (west) down the trail. A lock is located a short distance down the trail. Work began on the canal here in 1826.

The stone used for the lock is made of a distinctly cross-bedded conglomeratic sandstone, the Black Hand Sandstone Member of the Cuyahoga Formation (fig. 31). The gorge here is the type area for which this Mississippian-age rock unit was named. The name Black Hand comes from a large, dark, hand-shaped petroglyph that had been carved into the sandstone of the cliff wall by Native Americans. The hand was accidentally blasted away while making way for the canal towpath in 1828.

The Black Hand Sandstone Member was deposited as part of a series of deltas (Malcuit and Bork, 1987, p. 413). The stone is typically medium to coarse grained but contains pebbles that range from 0.2 to 1 inch (0.5-2.5 cm) in length. Most pebbles are a light-colored quartz. Less weathered stone is grayish orange or pale yellow orange; more weathered stone is olive gray to dark greenish gray. The lock here is covered with much moss and liverworts.

Black Hand sandstone was quarried over a 2- to 3-mile (3.2- to 4.8-km) distance in the Licking Valley (Foster, 1838, p. 100) and was used for canal locks, culverts along the National Road (U.S. Rte. 40), and railway stone (Foster, 1838, p. 100; Bownocker, 1915, p. 141). The Black Hand sandstone also was quarried along the Licking River and shipped to Newark and Columbus along the canal (Orton, 1884, p. 596). Hyde (1912, p. 210) noted the durability of Black Hand sandstone used for the canal.

If you continue westward on the trail past the lock on the north side of the river, you will pass an outcrop of the Black Hand Sandstone Member. The stone exposed here is a cross-bedded conglomeratic sandstone containing abundant pebbles of quartz and chert. The public trail continues until just before a very large outcrop of the Black Hand containing a tunnel. This gothic-arch-shaped tunnel was cut into the rock to allow interurban cars to pass through the outcrop. Farther along, on private property (permission is needed to pass onto it), is the famous Black Hand Rock that once contained the famous petroglyph. The towpath trail, cut into the cliff and built up with blocks of quarried Black Hand sandstone (fig. 32), extends along the base of Black Hand Rock. To see the trail as well as remains of old quarries, return to the parking area and take the paved Black Hand Gorge trail on the south side of the river. Turn off the paved trail at the sign for Black Hand Rock. The view of the old towpath and the remains of Black Hand Rock towering above it is quite dramatic. During canal days a dam blocked the river in this area, creating a **slackwater** run, and the towpath would have been closer to the water level at that time.

These are some of the best rock exposures along the Ohio canals. Maximilian, Prince of Wied (1782-1867), passed through this area in 1834 on a canal boat, finding it to be a very romantic, picturesque valley, and noting that the rocks here had what he termed "a singular stratification" (Wied-Neuwied, 1906, v. 24, p. 152). The formation of the gorge at this point has an interesting history, involving the reversal in flow of the river during the Pleistocence (Frolking and Szabo, 1998, p. 36).

A historical marker and the partial remains of Lock 1, located along Ohio Rte. 79 in nearby Heath, about 4 miles (6.5 km) south of downtown Newark, commemorate the site of the July 4, 1825, ground breaking for the Ohio & Erie Canal. The marker and lock are opposite Coffman Boulevard. Only the east wall of Lock 1 is preserved. The lock is made of a fine- to medium-grained, grayish-orange-pink to pale-brown sandstone composed mostly of quartz but containing some mica. The sandstone is cross-bedded and has concretionlike structures. This stone may be the Black Hand sandstone, but the only pebbles to be seen are those in the sandstone used for the base of the stone monument erected at the site in 1925.

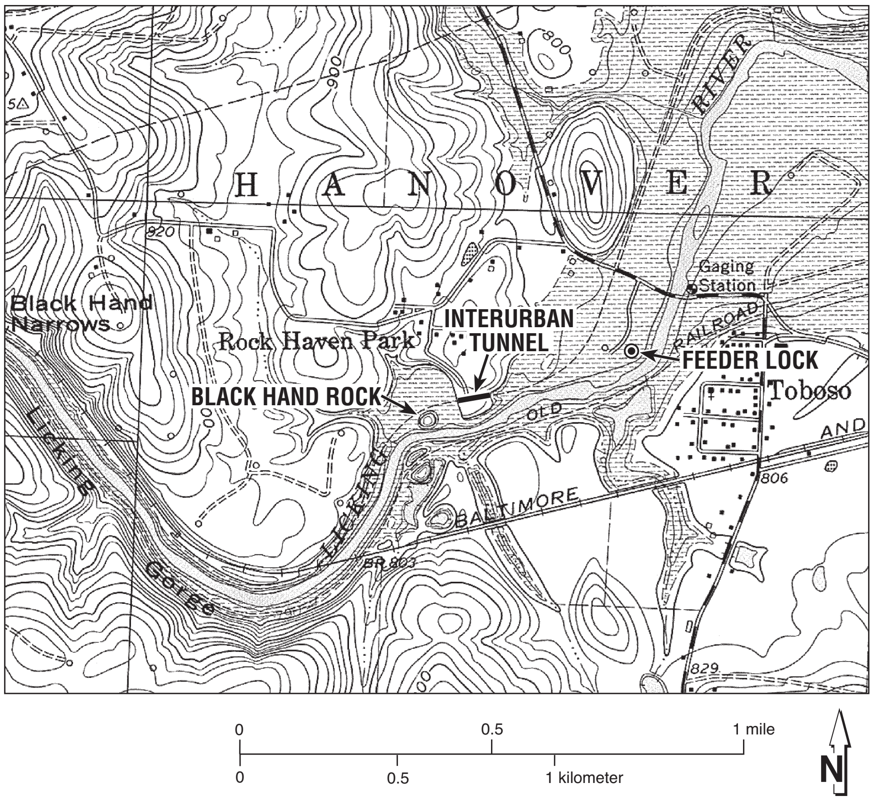


FIGURE 29.—Portion of U.S. Geological Survey Toboso, Ohio, 7.5-minute quadrangle showing location of feeder lock of the Ohio & Erie Canal, interurban tunnel, and Black Hand Rock. Contour interval is 20 feet (6 meters).

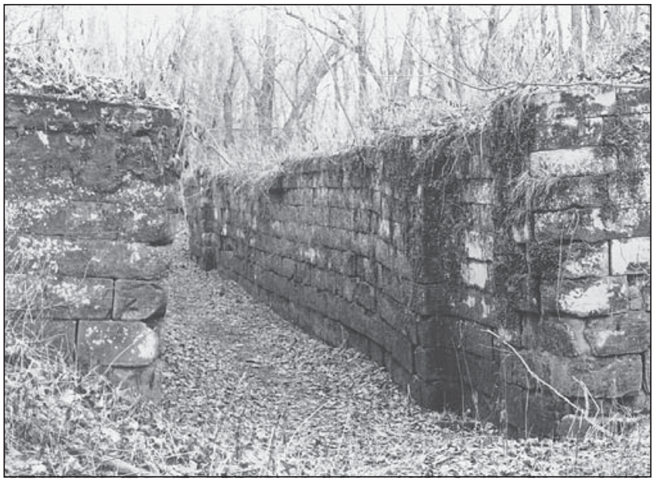


FIGURE 30.—Outlet lock at Black Hand Gorge State Nature Preserve. January 1998 photo.

FIGURE 31.—Block of Black Hand Sandstone Member of the Cuyahoga Formation used for outlet lock at Black Hand Gorge. Note abundant quartz pebbles. January 1998 photo.

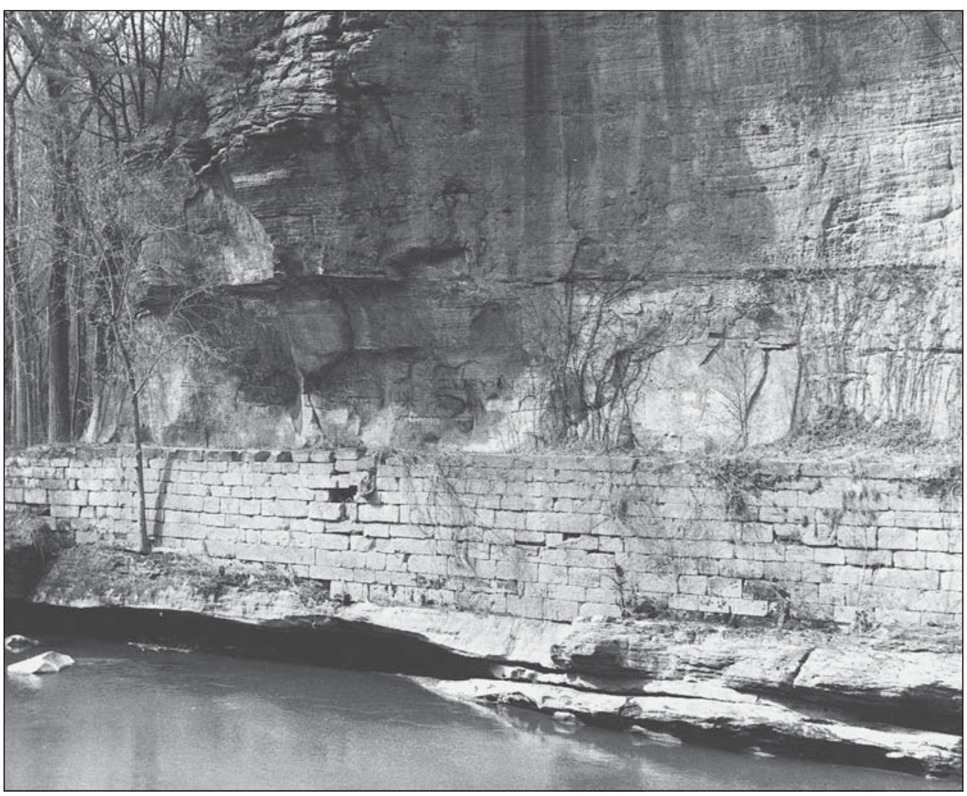


FIGURE 32.—Built-up towpath at Black Hand Gorge and towering remains of Black Hand Rock above. Visible portion of towpath is composed of courses of sandstone blocks. During canal days, the water level here would have been higher, covering the lower courses of stone. March 1998 photo.

STOP 6. GROVEPORT, LOCK 22 OF THE OHIO & ERIE CANAL

Lock 22 is in Blacklick Park, which is at the east end of Blacklick Street in Groveport (fig. 33), just southeast of Columbus (see U.S. Geological Survey Lockbourne and Canal Winchester 7.5-minute quadrangle maps). The lock is just west of where the power line crosses the canal and is a short (0.2 mile/0.3 km) hike down a trail that leads east from the parking area. The stone used for the original lock at this site came from Lithopolis, about 5 miles (8 km) southeast of Groveport. Lithopolis takes its name from the stone quarried there, "litho-polis" being derived from the Greek for "stone city." More information on stone from Lithopolis is given under Stop 7, Lockbourne.

Lock 22 was rebuilt in 1845-46 (Bareis, 1902, p. 64-65) but is not in good condition (Droege and others, 1981, p. 20). Many blocks on the lower end of the lock have been displaced. The stone used for the present structure is a medium-grained to very coarse grained pale-yellowish-brown sandstone containing some very small (about 2 mm long) pebbles. The stone weathers darker and has distinct cross-bedding. This replacement stone was likely from the Black Hand Sandstone Member of the Cuyahoga Formation, quarried in the Hocking County area. The site may be overgrown with vegetation.

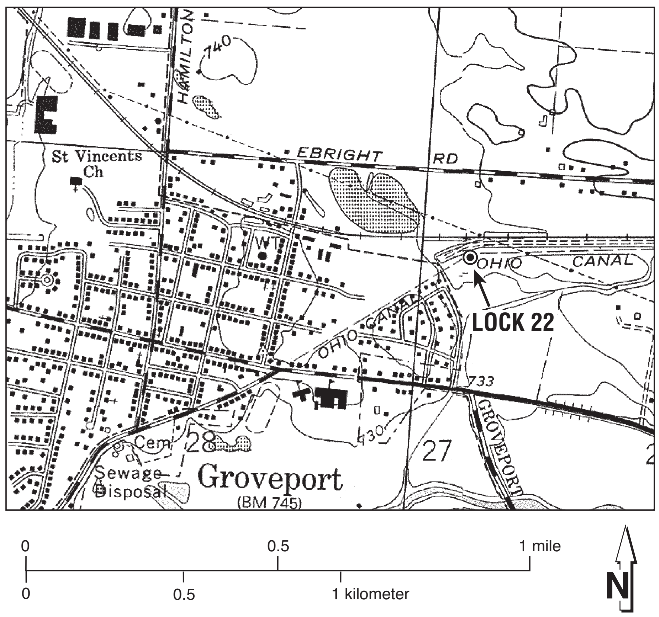


FIGURE 33.—Portions of U.S. Geological Survey Lockbourne and Canal Winchester, Ohio, 7.5-minute quadrangles showing location of Lock 22 of the Ohio & Erie Canal in Groveport. Contour interval is 10 feet (3 meters).

STOP 7. LOCKBOURNE, LOCKS 26, 27, AND 30 OF THE OHIO & ERIE CANAL AND LOCKS OF THE COLUMBUS FEEDER CANAL

Several locks are preserved in the vicinity of Lockbourne (fig. 34), which is just south of Columbus on Lockbourne Road (see U.S. Geological Survey Lockbourne 7.5-minute quadrangle map). The name Lockbourne is in honor of the locks and James Kilbourne, who founded the town in 1831. The citizens of the town of Lockbourne have recently worked on the preservation and refurbishing of the town's canal structures (Crumbley, 1993a, 1993b). The most centrally located lock, Lock 30 of the Ohio & Erie Canal, is in Locke Meadow Park, which is just below the intersection of Denny and Commerce Streets in Lockbourne. Locks 26 and 27 of the Ohio & Erie Canal are located northeast of town along Canal Road, and the remains of canal aqueducts for the Columbus Feeder Canal are located on both sides of Big Walnut Creek just west of Lockbourne along Rowe Road.

Lock 30 (figs. 35-38) in Locke Meadow Park has a classic 90-foot (27-meter)-long chamber and is 15 feet (4.6 meters) wide. It is made of a fine- to coarse-grained quartzose sandstone that has subangular to subrounded grains. The stone is light gray to mottled brown and gray. The original color must have been very light. The stone is in fairly good shape, except for some stone along the ends of the lock that has weathered along bedding planes. Blocks that are more weathered show horizontal bedding and cross-bedding. The blocks used for this lock have, or once had, bush-hammered interiors and drafted margins (figs. 37, 38). Lock 30 also has an unusual wall (fig. 37) extending from its spillway that has been interpreted as possibly being an abutment for a **change bridge** (Droege and others, 1981, p. 12). It appears to have been added onto the spillway.

Lock 27 (fig. 39), along Canal Road, is made of a fine- to medium-grained sandstone. Some of this stone has a reddish coloration, but the original coloration was very pale orange or a lighter color. The stone used here has weathered more than that of Lock 30. There are also signs of grooves, probably made by rope, on the east side of the lower (south) end of the lock. Because of the greater amount of weathering, the detail of the dressed stone is not as well preserved as that of Lock 30.

Lock 26 (fig. 40), 0.4 mile (0.6 km) north of Lock 27, is made of a pale-yellow-brown sandstone that is moderate red in some places. The red coloration may be the result of weathering. The stone is fine to coarse grained; a few small (3 mm) subangular pebbles are visible. **Cramps** have been used to hold some of the blocks together (fig. 40).

The Columbus Feeder Canal, also known as a **side cut**, crossed Big Walnut Creek west of Lockbourne along Rowe Road. A floating towpath allowed mules to cross the stream. A guard lock on the east side of the creek and a lift lock on the west side can be seen from the road. These locks are more

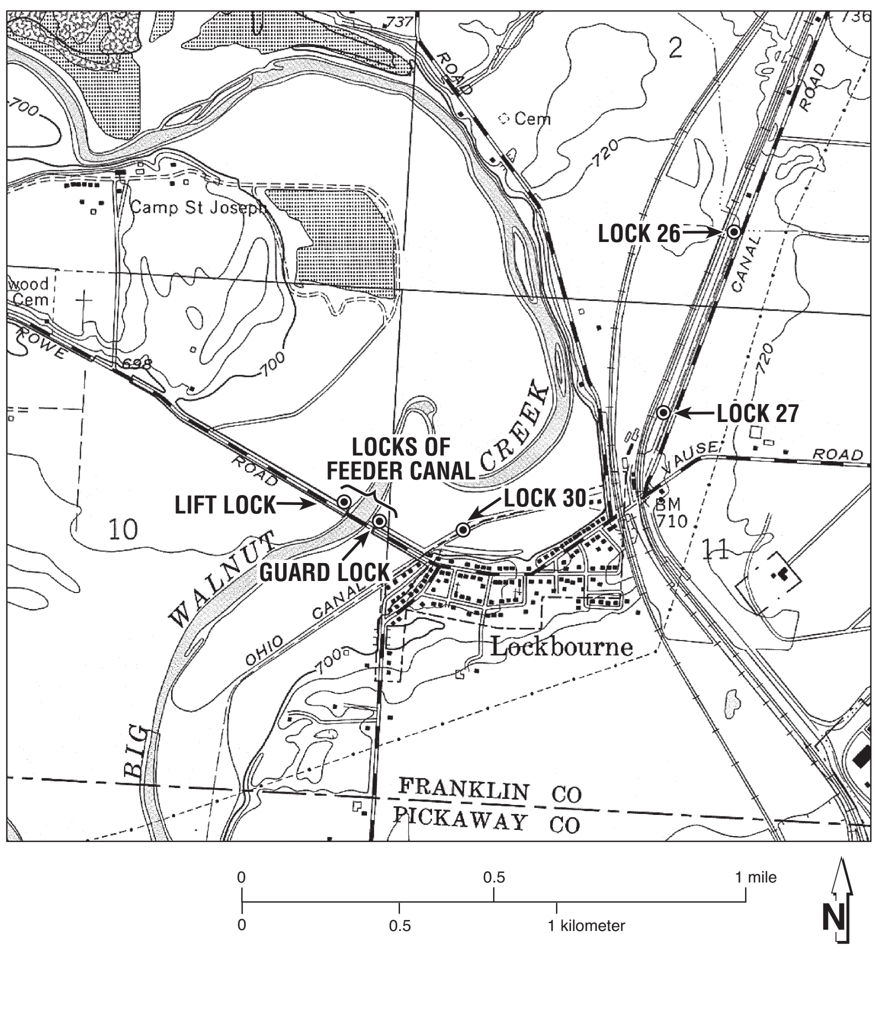


FIGURE 34.—Portion of U.S. Geological Survey Lockbourne, Ohio, 7.5-minute quadrangle showing locations of Locks 26, 27, and 30 of the Ohio & Erie Canal and locks of the feeder canal on the sides of Big Walnut Creek. Contour interval is 10 feet (3 meters).

weathered and not in as good shape as Locks 26, 27, and 30.

Some of the stone used for these locks may have been sandstone from the Cuyahoga Formation or possibly Berea Sandstone quarried in Lithopolis, about 8 miles (13 km) to the east. Lithopolis stone, also called “Waverly sandstone,” was once well known and was used for sills, gravestones, and other purposes (Goslin, 1976). Other quarries in the region also produced building stone from the “Waverly” (Orton, 1878, p. 639-642). However, most of the stone used for this lock may well be replacement stone from other areas. Trevorrow (1986a, p. 2) noted that an 1884 Canal Report mentioned problems with the stone of nearby Lock 13 in Lockville, east of Lithopolis. The stone used for the Lockbourne locks is similar to that used for Lock 22 in Groveport (see Stop 6). It is likely that it is the Black Hand Sandstone Member of the Cuyahoga Formation.

The main cemetery in Lockbourne, located on Landis Street, one block south of Commerce Street, preserves good examples of typical nineteenth-century Ohio tombstones. The oldest, from the 1830’s, are made of very fine to fine grained sandstone. These old stones have classic weeping willows and urns carved into them. Marble tombstones seem to have begun to appear in the late 1840’s (fig. 41). It is likely that these marble tombstones were transported via canals (table 2), for tombstones are frequently noted as being carried by canal boats, and tombstones are listed on lists of tolls (see fig. 9). More information on the canals in the Lockbourne area can be found in Droege and others (1981).

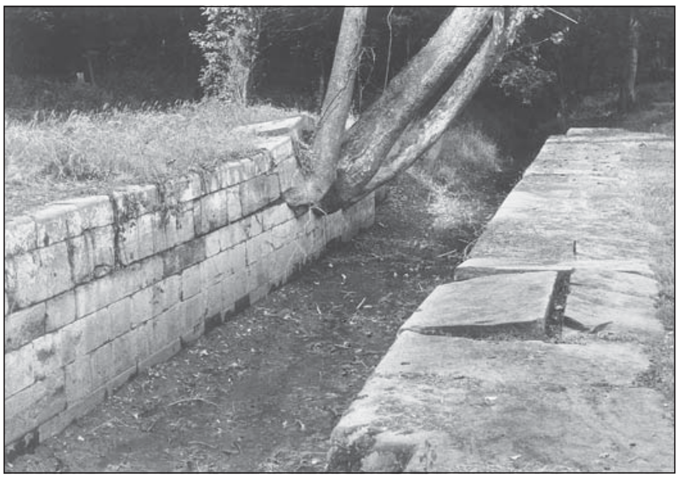


FIGURE 35.—Lock 30, Lockbourne. Sycamore trees growing from side of lock to the left are dislodging blocks. June 1997 photo.

FIGURE 36.—Gate recess of Lock 30, Lockbourne. June 1997 photo.

FIGURE 37.—Lock 30, Lockbourne, showing angular corners typical of Ohio & Erie Canal locks. Upper courses show original dressed faces. Lower courses have been weathered, exposing natural bedding of the stone. In the background is an unusual wall that extends from the spillway. June 1997 photo.

FIGURE 38.—Close-up view of the higher, east end of Lock 30, Lockbourne, showing state of stone blocks, weathered areas, drafted margins, etc. June 1997 photo.

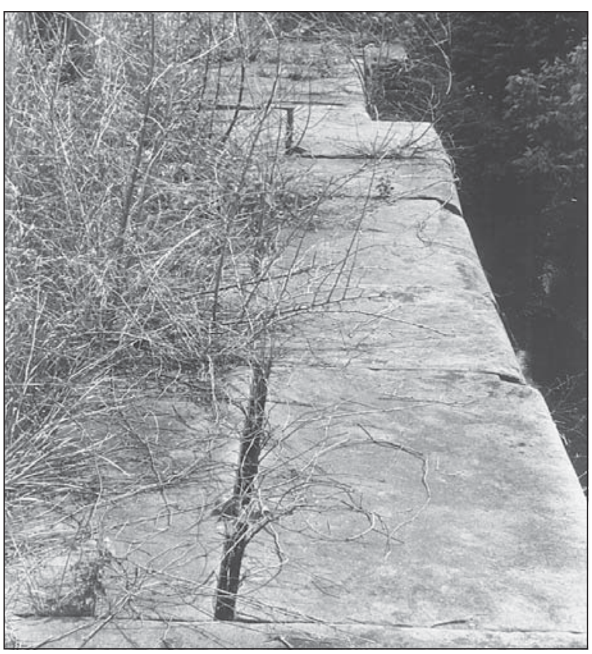


FIGURE 39.—Lock 27, off Canal Road just northeast of Lockbourne. Vegetation here is helping to dislodge blocks. June 1997 photo.

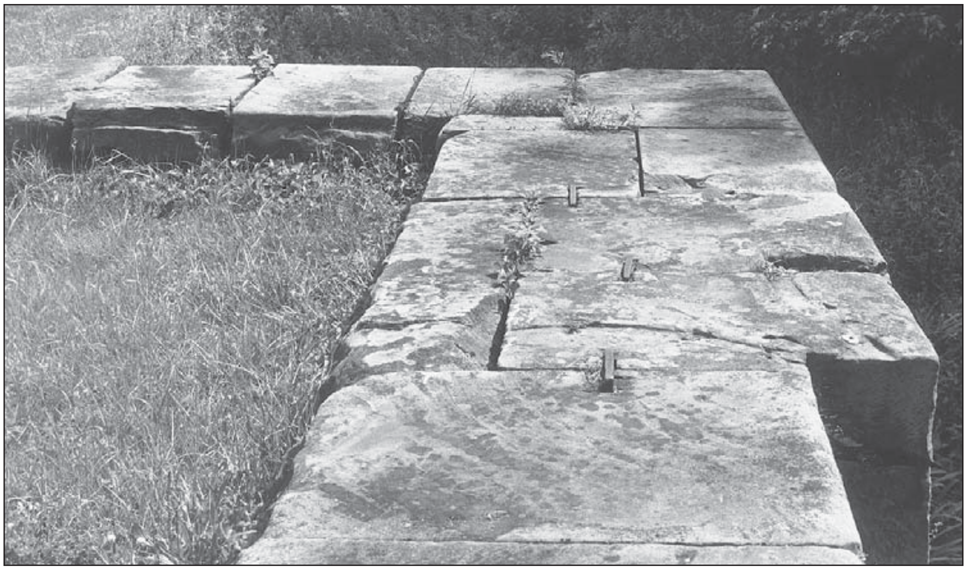


FIGURE 40.—Coping of Lock 26, off Canal Road just northeast of Lockbourne, showing typical squared-off ends of Ohio & Erie Canal locks. Note grooves for the goose necks (center right of photo) and three iron cramps used to tie blocks together. Cramps were used for various purposes along the canals, especially to strengthen coping near the heel posts. June 1997 photo.

FIGURE 41.—Marble tombstone, dated 1853, in Lockbourne cemetery. Note Masonic emblems at top. The tombstone has been broken and repaired. Marble slabs for tombstones like these were commonly shipped down the Ohio canals beginning in the late 1840's. June 1997 photo.

STOP 8. CANAL PARK, WAVERLY, LOCK 44 OF THE OHIO & ERIE CANAL

Lock 44 (figs. 42, 43), also known as Waverly Lock, is in Canal Park, which is located along U.S. Rte. 23 immediately southwest of Crooked Creek, near Lock Street in downtown Waverly, Pike County (see U.S. Geological Survey Waverly North 7.5-minute quadrangle). Waverly was once known as Uniontown. A canal engineer suggested that the town be called Waverly, after the once-popular Waverley [sic] novels (Golding and Neuhardt, 1992, p. 9-10). That series of novels, written by Sir Walter Scott (1771-1832), was very popular at the time the canals were being constructed. The first book in the series was *Waverley* (1814); other books in the series included *Rob Roy* (1818) and the famous *Ivanhoe* (1820). The influence of Scott's works was far reaching. As noted on page 9, John Quincy Adams (1767-1848) traveled on the canal packet *Rob Roy* during his 1843 trip from Cleveland to Columbus.

Waverly was the type area for the Waverly Group, a now-abandoned term for rocks encompassing a broad range of rock layers of Devonian and Mississippian age. The name Waverly Group has been replaced by other, more specific rock-unit names.

According to Golding and Neuhardt (1992, p. 11-12), the structure exposed in this park is the wall of the spillway of Lock 44. The stone used for this structure is siltstone and very fine grained sandstone that has cross-bedding, fine horizontal bedding, and a few red, concretionlike bodies. Less weathered stone is very pale orange; the color of more weathered stone varies from moderate reddish brown to dark gray. This stone is probably locally quarried Berea Sandstone, which was known in this area as *Waverly stone*. The grain size of the Berea in central and southern Ohio is much finer that that of northern Ohio (Pashin and Ettensohn, 1995, fig. 2). An outcrop of Berea Sandstone containing silt-size grains similar to those of the stone used for the Lock 44 structure can be seen along U.S. Rte. 23 near the top of the hill just north of Waverly (fig. 42). The canal helped this area become a production center for this stone, but by 1884 the stone around Waverly became uneconomical to produce, as the easily accessible outcrops had been depleted (Orton, 1884, p. 598). The sandstone at Waverly had a good reputation (Orton, 1874, p. 621), but it was known to be of a lesser quality than that quarried in northern Ohio. Golding and Neuhardt have noted (1992, p. 5) that the stone used for the locks in the lower Scioto River valley has not held up well. Indeed, some of the blocks of stone used for this structure in Waverly have weathered badly. Natural bedding has been accentuated in places by weathering and some of the stone has badly spalled. Tooling of the stone varies, but is typically coarse; some blocks have drafted margins. Many holes for tongs can be seen in the blocks.

A stone sawmill powered by water from the canal was located near this lock (Golding and Neuhardt, 1992, p. 11). It was undoubtedly used to cut the local sandstone for the building-stone market.

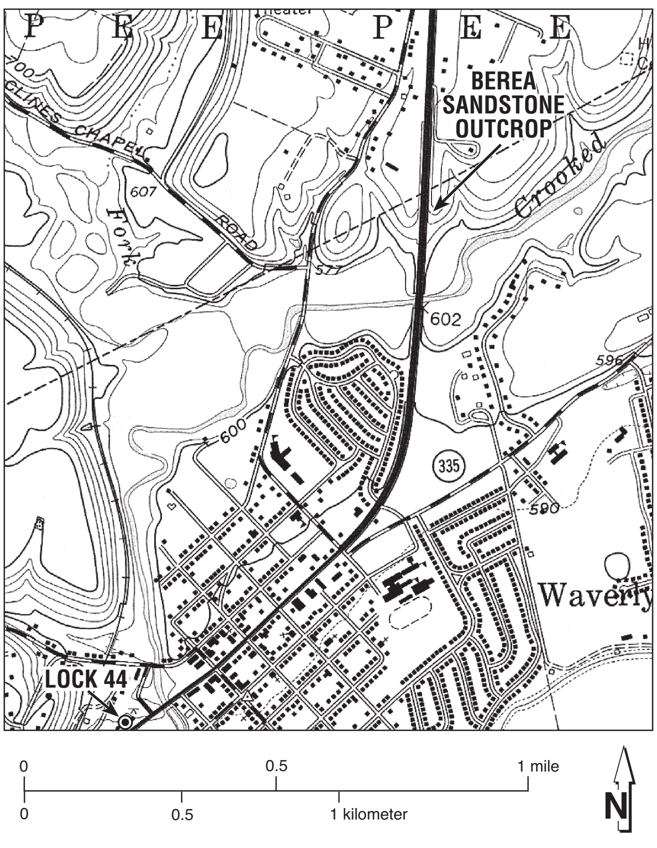


FIGURE 42.—Portion of U.S. Geological Survey Waverly North, Ohio, 7.5-minute quadrangle showing location of the remains of a structure associated with Lock 44 of the Ohio & Erie Canal. An outcrop of the Berea Sandstone north of Waverly also is indicated. Contour interval is 20 feet (6 meters); some intermediate 10-foot (3-meter) contours are shown as dotted lines.

FIGURE 43.—Structure associated with Lock 44, Canal Park, Waverly. Several blocks have severely deteriorated. June 1995 photo.

STOP 9. WEST PORTSMOUTH, SOUTHERNMOST LOCKS OF THE OHIO & ERIE CANAL

The locks in the West Portsmouth area (figs. 44-46) extend from West Portsmouth (formerly called Bertha) to the Ohio River, just west of Portsmouth (see U.S. Geological Survey Friendship, Kentucky–Ohio 7.5-minute quadrangle map). Most of the locks in this area are either on private property or safe access is via private property. These structures are included in this guide because they are made of one of the most interesting types of stone used for the canals, the Buena Vista Member of the Cuyahoga Formation. This stone is also the only type used to any major extent on the main routes of both the Ohio & Erie and the Miami & Erie Canals. The Buena Vista Member is a very fine grained sandstone or siltstone of Mississippian age. The color of the least weathered stone is very pale orange; weathered stone may be pale yellowish brown and other dark shades. This stone formed as sand bodies laid down in a marine shelf environment (Hannibal and Davis, 1992, p. 15). The Buena Vista Member was known by various trade names in the past, including *Buena Vista sandstone* and *Buena Vista freestone*. It is likely that the stone used for the locks in the West Portsmouth area was quarried near Buena Vista, which is located near the Adams-Scioto County line, southwest of West Portsmouth. Buena Vista is the locality for which the stone is named. Stone from this area had an excellent reputation and was transported down the Ohio River and used for Cincinnati-area locks (Stivers, 1900, p. 426; Bownocker, 1915, p. 123, 124) and culverts (Neuhardt, 1989, p. 17). The stone was probably quarried from tracts of land owned by John Loughry (also spelled Loughery) in Rockville, which is just west of Buena Vista. Use of the stone for canal structures greatly stimulated its use. Howe (1888, v. 2, p. 564) described how this came to be:

In the earlier days of the State an engineer of reputation, employed upon the construction of canals, became conversant with the then known building-stones of the State, and recognizing the great value and accessibility of the ledge, commonly known as the Buena Vista Freestone Ledge, bought a large territory here, and began the development of the quarries in a large way.

The engineer was John Loughry, who quarried stone for locks from hillside ledges at Rockville beginning in 1831

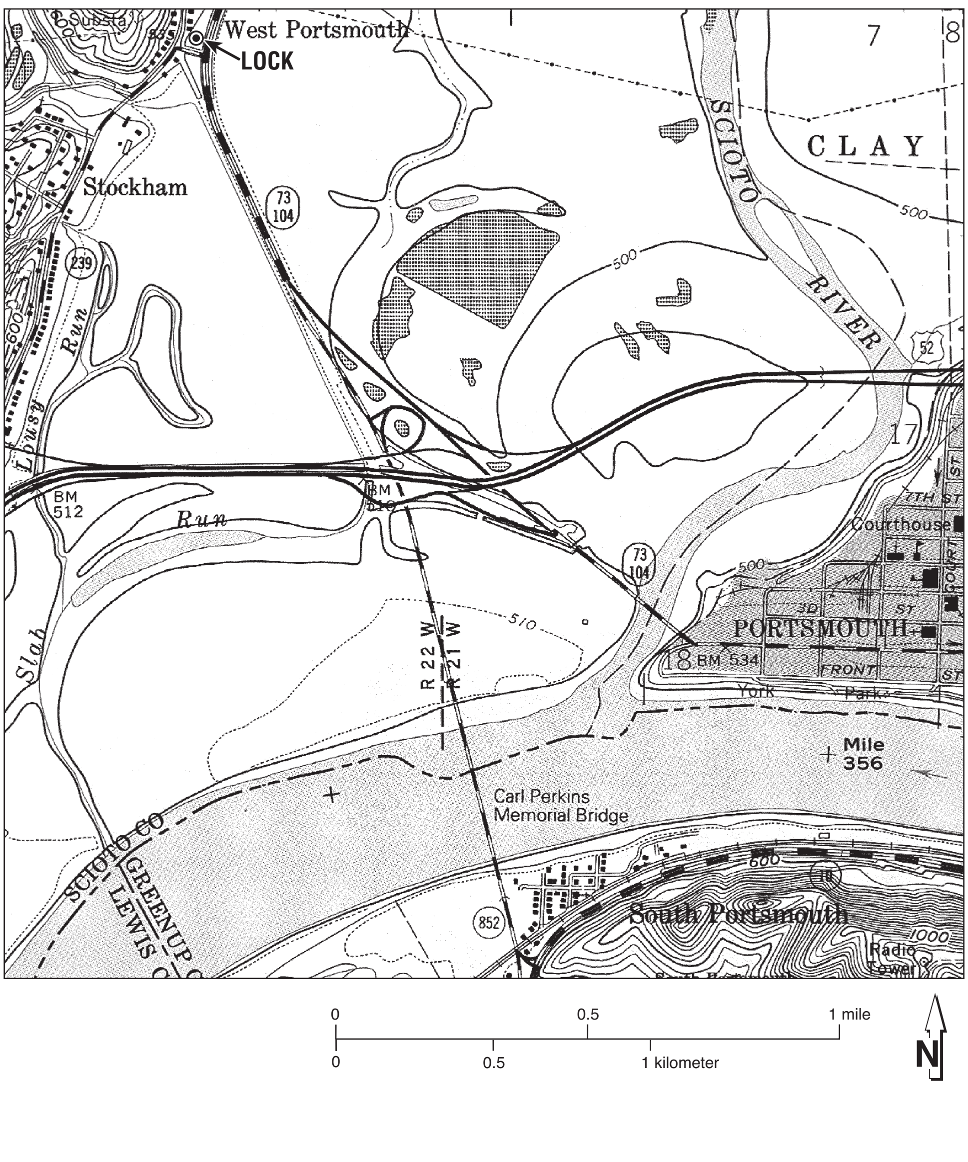


FIGURE 44.—Portion of U.S. Geological Survey Friendship, Ohio–Kentucky, 7.5-minute quadrangle showing location of a lock of the Ohio & Erie Canal at West Portsmouth and present-day configuration of the Scioto River at its mouth (compare to Whittlesey's 1838 map, fig. 48). Contour interval is 20 feet (6 meters); some intermediate 10-foot (3-meter) contours are shown as dotted lines.

(Bownocker, 1915, p. 123). One of Ohio's early geologists, Dr. John Locke (1792-1856), stayed with Loughry during the first geological survey of Ohio and described the quarries in Rockville (Locke, 1838, p. 263-266).

Unfortunately, most locks in the Cincinnati area have been covered or destroyed. Although many sources have described most of the stone used for locks in Cincinnati as being quarried in the Buena Vista area (some Cincinnati area limestone also was used), the use of this stone for locks in the West Portsmouth area seems to have been neglected.

The tops of the beds of the Buena Vista Member commonly are marked by trace fossils (Hannibal, 1995), which can be seen in the coping of one of the locks at West Portsmouth (figs. 45, 46). The most prominent of these trace fossils is *Zoophycos* (fig. 46), a trace made by wormlike animals. Well-preserved, three-dimensional specimens from modern quarries in the McDermott area, north of West Portsmouth (see Hannibal, 1995, for details), show that these specimens consist of coils of curved markings surrounded by a tube (fig. 47). More information on the quarrying and use of the Buena Vista Member can be found in King (1976), Kelley (1982), Hannibal and Davis (1992), and Hannibal (1995). The Buena Vista Member used for the West Portsmouth locks has weathered differentially. Some blocks are in good shape, others have weathered badly.

Portsmouth, being at the termination of the Ohio & Erie Canal, had an advantageous position, at least theoretically. Whittlesey (1838) discussed the engineering geology of the Portsmouth canal area, noting that the mouth of the Scioto River had been changed in order to accommodate canal boats. A new mouth was cut into the Ohio River (fig. 48), eliminating a meander loop of the Scioto and, according to Whittlesey, increasing the abrasive power of the river. Portsmouth's location along the Ohio River also made it prone to flooding and thus unable to take full advantage of its position at the terminus of the Ohio & Erie Canal, as did Cleveland, along Lake Erie on the north end of the canal.

FIGURE 45.—Coping of West Portsmouth lock, made of sandstone from the Buena Vista Member of the Cuyahoga Formation. Lock is west of Ohio Rtes. 73/104 and north of turn-off to Ohio Rte. 239. Note rounded edge of lock and poison ivy. June 1995 photo.

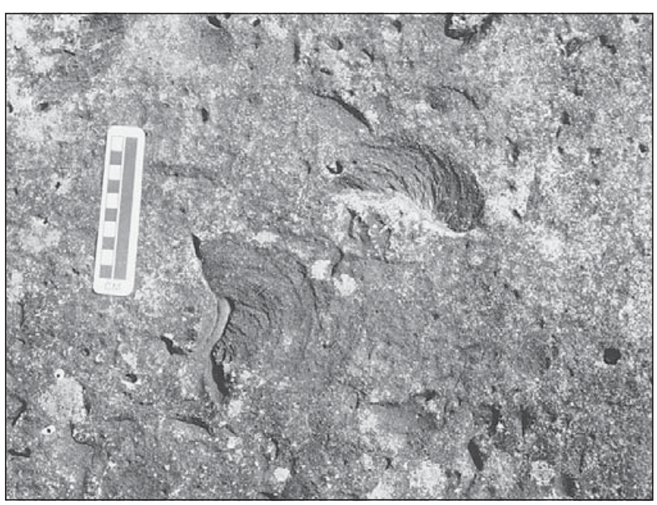


FIGURE 46.—Close-up view of coping of West Portsmouth lock. The arcuate markings in the Buena Vista Member are the trace fossil *Zoophycos* seen in top view. Scale bar = 10 cm. June 1995 photo.

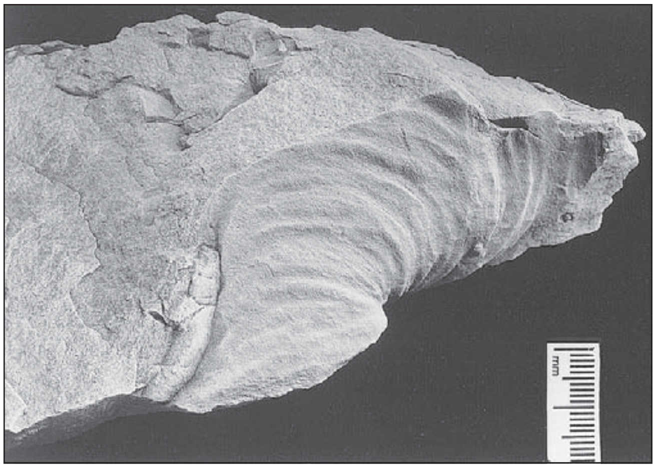


FIGURE 47.—Three-dimensional specimen of trace fossil *Zoophycos* seen in side view. Cleveland Museum of Natural History specimen no. 8944, from the Buena Vista Member in the Crabtree quarry, about 3½ miles (6 km) northwest of McDermott, Scioto County. See Hannibal (1995) for additional information. The specimen has well-developed spreiten (arcuate zones representing disturbed sediment) and a distinct marginal tube characteristic of the genus. Scale = 2 cm.

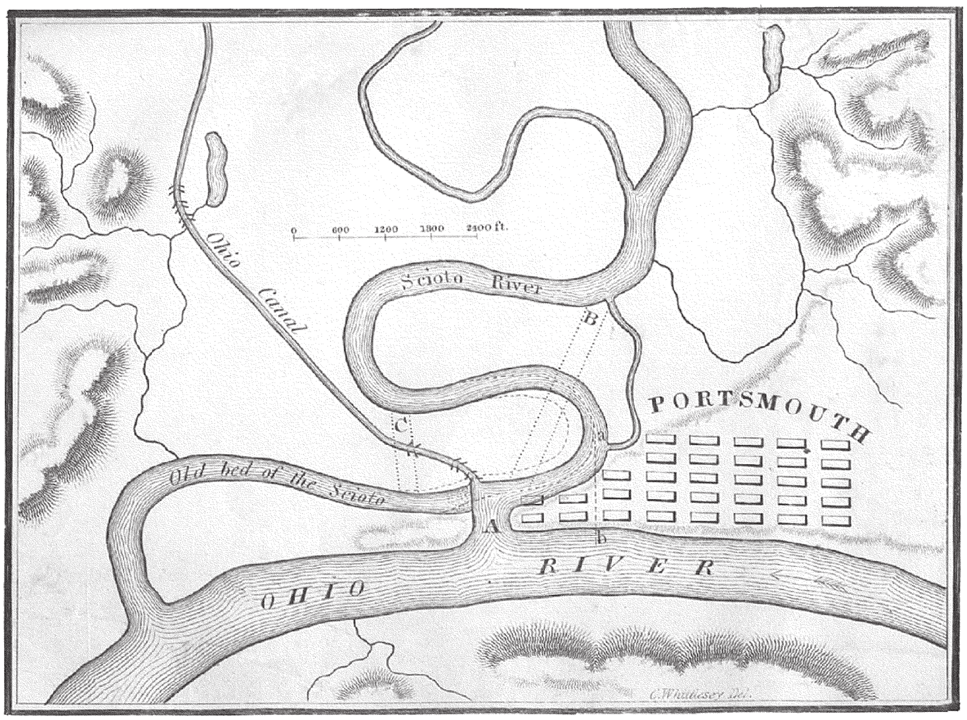


FIGURE 48.—Whittlesey's (1838) map of the Portsmouth area, showing the artificial mouth (A) of the Scioto River engineered for the passage of canal boats. Symbols (╥) along canal indicate positions of locks.

THE MIAMI & ERIE CANAL AND ITS TRIBUTARIES

The Miami & Erie Canal extended from Toledo at its northern end to Cincinnati at its southern end (see fig. 1). The canal was constructed along the valleys of the Maumee River, the Auglaize River, Turtle Creek, the Great Miami River, and Mill Creek. The Miami & Erie Canal was begun in 1825; the Cincinnati-to-Dayton segment was completed in early 1829. The entire Cincinnati-to-Toledo length of the canal was completed in 1845. The canal was 250 miles (402 km) long. There was one summit, the Loramie Summit, located between New Bremen and Lockington. The length of time needed to construct the canal was necessitated by its piecemeal construction as three separate canals: the Miami Canal, the Miami Extension Canal, and the Wabash & Erie Canal. Various tributary canals were added, including the Warren County Canal, constructed between 1834 and 1840; the Wabash & Erie Canal, constructed between 1837 and 1843; and the Cincinnati & Whitewater Canal, constructed between 1839 and 1843. The Milan Canal, a small canal connecting Milan and Huron with Lake Erie, was built between 1833 and 1839; it is separate from the two large canals, but commonly is grouped with the Miami & Erie Canal for discussion purposes.

STOP 10. SIDE CUT METROPARK, MAUMEE, LOCKS 2-4 OF THE MIAMI & ERIE CANAL

This Toledo area metropolitan park is just south of Ohio Rte. 24 and north of the Maumee River in southwest Maumee (see fig. 49 and U.S. Geological Survey Maumee 7.5-minute quadrangle map). The parking lot for the park is on the north side of South River Road. This side cut connected the main part of the Miami & Erie Canal with the Maumee River. Three fairly well preserved limestone locks (Locks 2-4) are located here, just uphill of the parking area, and there are some canal-related exhibits in the Lamb Heritage Center in the park.

Lock 4 (figs. 50, 51) is closest to the parking lot. The stone for the locks is a very light gray limestone containing a variety of fossils, including **corals** (both **horn corals** and **colonial** corals), **sea lily** columnals (discoidal segments of the sea lily stem), and articulate **brachiopods** (see Feldmann and Hackathorn, 1996, for more information on these fossils). This stone is probably the Columbus Limestone, a Middle Devonian rock unit noted for its coral diversity. The rock here represents a reeflike environment of deposition. It is possible, however, that the stone was locally quarried from the Dundee Formation, also of Middle Devonian age (Mark J. Camp, personal commun., 1998). The stone used for the locks exhibits finely bush hammered surfaces and drafted margins (fig. 51).

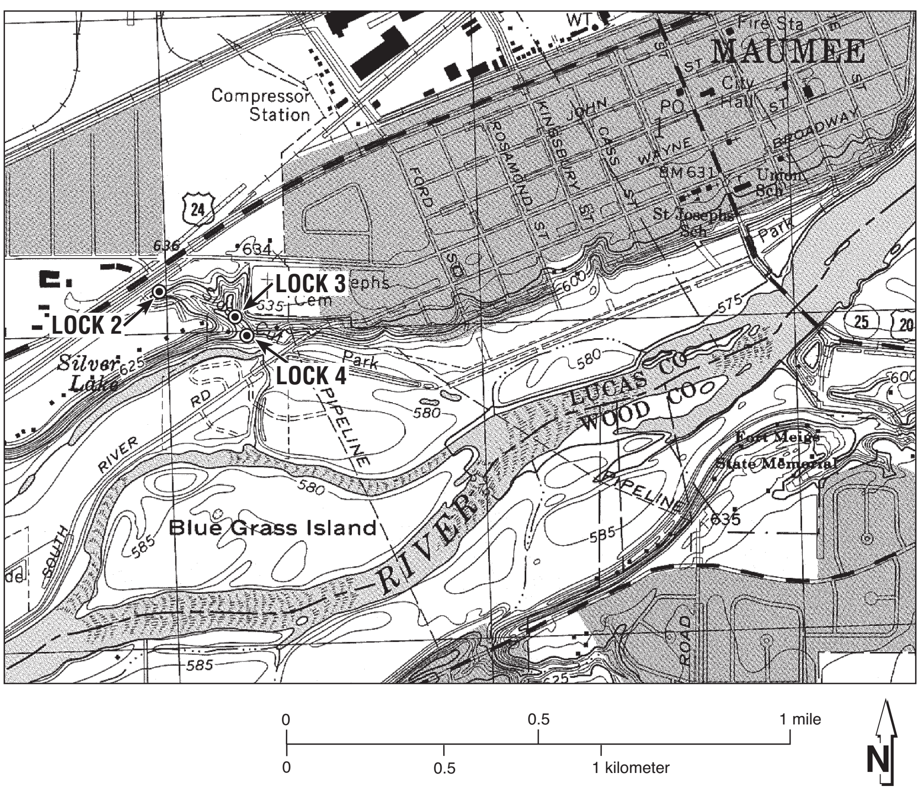


FIGURE 49.—Portion of U.S. Geological Survey Maumee, Ohio, 7.5-minute quadrangle showing location of Locks 2-4 of the Miami & Erie Canal in Side Cut Metropark. Contour interval is 5 feet (1.5 meters).

FIGURE 50.—Lock 4, Side Cut Metropark, Maumee. Unfinished stone to the left was not intended to be exposed. December 1997 photo.

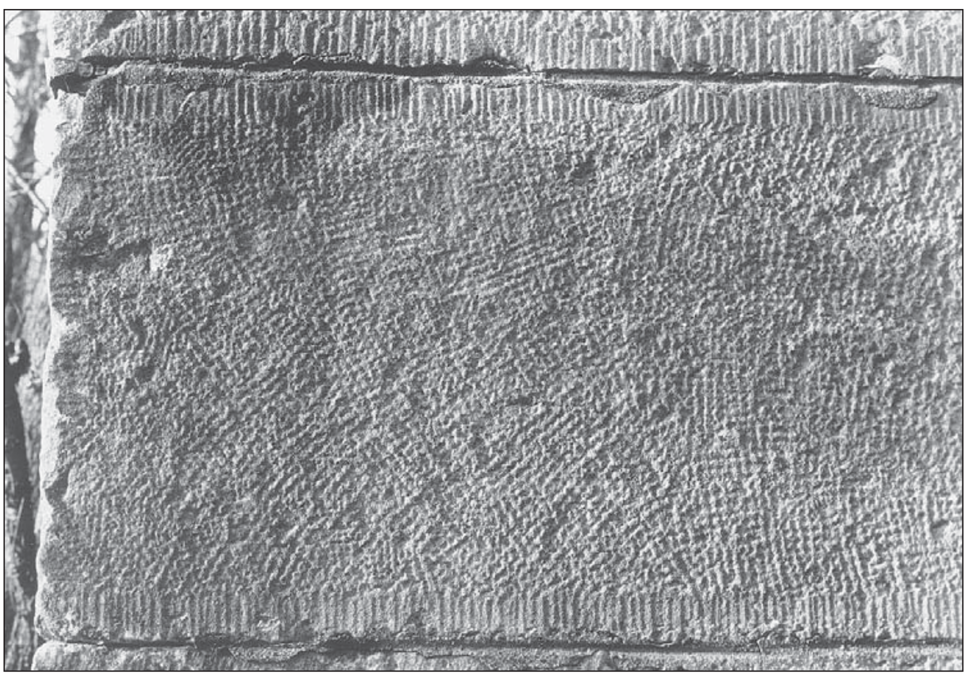


FIGURE 51.—Finely tooled stone block of Lock 4, Side Cut Metropark, Maumee. Note drafted margins and bush-hammered interior. December 1997 photo.

STOP 11. PROVIDENCE METROPARK, LOCK 44 OF THE MIAMI & ERIE CANAL

Providence Metropark, part of the Toledo area metropolitan park system, is located off U.S. Rte. 24 just north of the Maumee River opposite the town of Grand Rapids (see fig. 52 and U.S. Geological Survey Grand Rapids 7.5-minute quadrangle map). Lock 44 (figs. 53-55), also known as Providence Lock 9, is preserved here. Canal boat rides on *The Volunteer*, available seasonally, provide an opportunity to experience "locking through" a lock (figs. 54, 55). The old Isaac Ludwig Mill here is powered by water from the canal.

The foundation of Lock 44 is on bedrock (Studer, 1995, p. 44). Most of the lock is stone, but the upper-level end is concrete. At least two, and probably three, types of stone are used for this lock. The most prominent stone is the Middle Devonian Columbus Limestone. Its color ranges from light gray to yellowish gray to pinkish gray. It contains a variety of fossils, including corals, sea lilies, and articulate brachiopods. The corals are especially prominent. Horn corals are up to 4 inches (10 cm) long, although most are smaller, having diameters of 0.4 to 1 inch (1 to 3 cm). Colonial corals include *Favosites*, which has very thin (2 mm), polygonal **corallites**, and *Hexagonaria*, whose individual corallites are about 0.4 inch (1 cm) in diameter. (See Feldmann and Hackathorn, 1996, for views of such coral fossils in top and side view.) The sea lilies are represented mostly by small round segments called columnals, which are typically 1 to 2 mm in diameter. According to Huffman (1995, p. 14), the stone for this lock was shipped via barge and wagon from the quarries at Marblehead in 1839.

Another stone used for this lock is a fine- to medium-grained quartz sandstone used for part of the coping. Both this sandstone and the Columbus Limestone used for this lock are similar in color. The sandstone is pinkish gray and thus blends in very well with the light- to yellowish- to pinkish-gray limestone. The sandstone has rounded grains, best seen with a hand lens. Most likely, this stone is the Middle Devonian Sylvania Sandstone. The Sylvania typically is a pure quartz sandstone, but may be **dolomitic** (Carman, 1936, p. 259, fig. 4). It has been interpreted as having been deposited as a beach sand (Hatfield and others, 1968). Briggs (1838, p. 112) noted that a sandy limestone found in this area was to be used for canal construction.

Lower courses of stone, normally hidden below water level, are said to have been of yet another rock type, quarried in the Maumee River (Studer, 1995, p. 51). The stone in the river is an Upper Silurian **dolostone**, considered part of the Bass Islands Group in older literature (Mark J. Camp, personal commun., 1998). In 1840, stone quarried from the river bed at Providence was used for the bases of some locks in the region (Durbin, 1983).

Blocks have drafted margins and bush-hammered interiors. These features are best seen in raking natural light. The coping stone of the lock has numerous rope grooves on the lower level side and along the length of the lock.

The lock here was noted as being the rowdiest of the Miami & Erie Canal. This is no longer true. More information on this lock and other features of Providence Metropark can be found in Studer (1995).

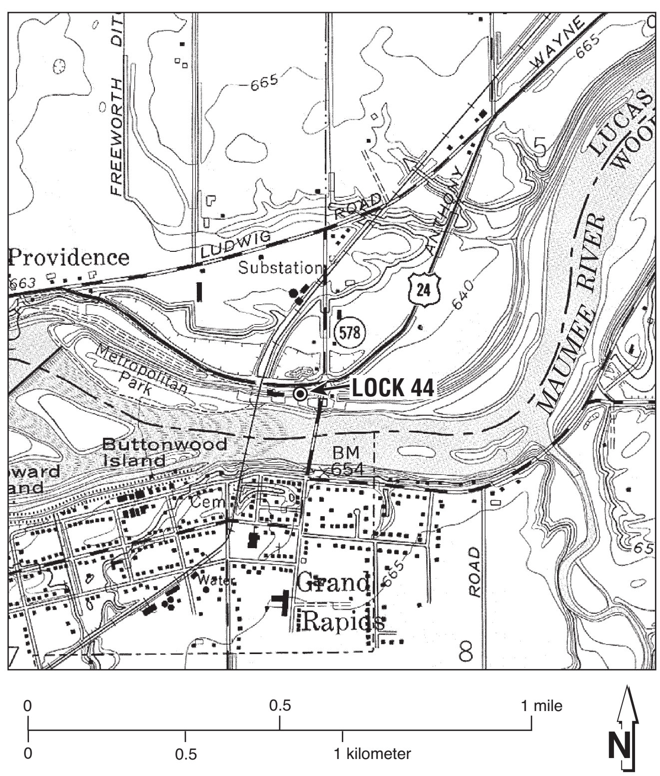


FIGURE 52.—Portion of U.S. Geological Survey Grand Rapids, Ohio, 7.5-minute quadrangle showing location of Lock 44 of the Miami & Erie Canal. Contour interval is 5 feet (1.5 meters).

FIGURE 53.—Lock 44, Providence Metropark. December 1997 photo.

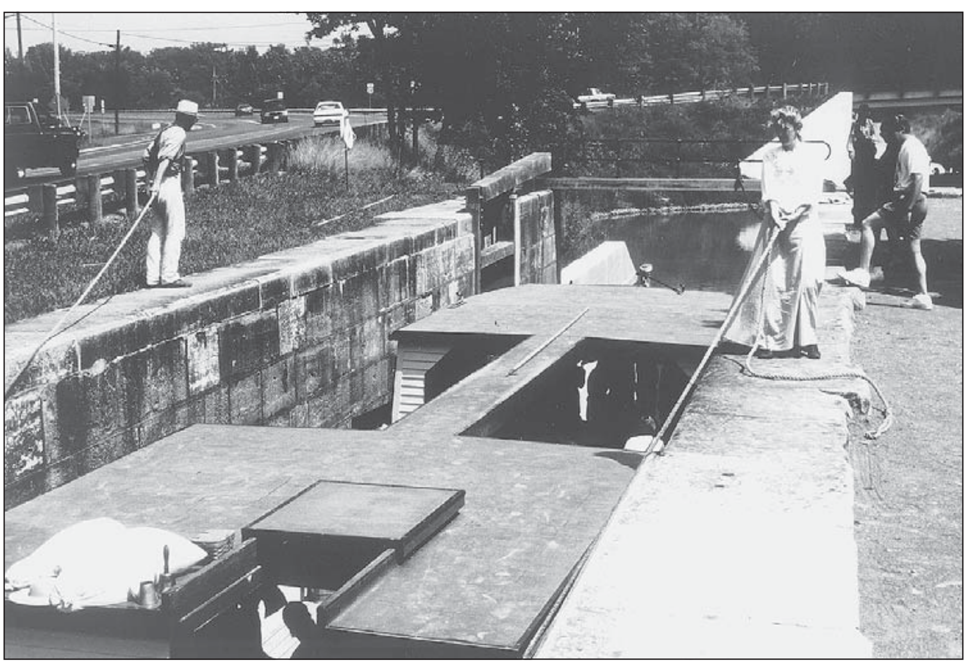


FIGURE 54.—Locking through Lock 44 at Providence Metropark. *The Volunteer*, a replica canal boat, is being guided through the canal by means of plastic ropes. August 1995 photo.

FIGURE 55.—*The Volunteer* clearing the lower gates of Lock 44 at Providence Metropark. The boat is being pulled by mules (just out of view on towpath to right). Note how the gates fit into the gate recesses. Also note rope grooves in coping in right foreground. August 1995 photo.

STOP 12. LOCKINGTON LOCKS, LOCKS 1-5 OF THE MIAMI & ERIE CANAL

The staircase of locks that makes up Lockington Locks 1 to 5 is located in Lockington (fig. 56), in Shelby County, along a stretch of parkway that extends from Cross Street, near its intersection with Museum Street, to Loramie Street and Loramie Creek (see U.S. Geological Survey Piqua East 7.5-minute quadrangle map). These locks, which descend down the south side of the Loramie Summit of the Miami & Erie Canal, span about 65 feet (20 meters) in elevation over a space of $^1/_2$ mile (0.8 km). The foundations of an aqueduct can be seen at Loramie Creek, and Lock 6, the so-called "crooked lock," is located on the west side of the creek. The area between Cross Street and Loramie Creek is administered by the Ohio Historical Society. It is open to the public and is easily accessible.

The Sidney Feeder Canal joined the Miami & Erie Canal just east of Lockington (Neuhardt, 1985), supplying water to the summit. Lockington was once known as Locksport, but the name was changed because there were two other towns in Ohio with very similar names (Morthorst, 1997, p. 31).

Lock 1 (figs. 57-60), also known as the "Big Lock," is an especially well-known and elaborate structure that is often illustrated in canal literature (for example, Trevorrow, 1978b, fig. 7; Gieck, 1992, p. 172-173). Because of their topographically high position, the spillways of this and other locks at this location have not been covered by sediment and can be easily seen; this is not true for many other locks because of siltation (Trevorrow, 1978b, p. 46).

In the 1970's, wooden struts (fig. 58) were strategically placed to keep Lock 1 from collapsing. Problems with stability are related to the position of this lock, which has been left high and dry for most of the time. Thus, the wood foundation of the lock, which was intended to always be in saturated sediment, dries out. Another problem is the storm sewer that opens immediately uphill of Lock 1; this outfall causes alternate wetting and drying of the lock's wooden foundation (Morthorst, 1997, p. 11-12). Stone blocks also are separating from adjacent blocks in places. This problem of separation is not entirely recent, however. Some of these areas of separation can be seen in turn-of-the-century photographs.

The locks here are fashioned from rock from the Dayton Formation, a Silurian-age carbonate unit. This stone commonly has been called *Dayton limestone*. According to Ohio Historical Society signage at this site, the stone came from south of Dayton via ox cart and was cut on site. However, the 1838 Board of Canal Commissions Report indicated that the stone for the locks at Lockington was transported along the then-completed section of the Miami & Erie Canal (Trevorrow, 1978a, p. 36). Montgomery County quarries were said to have supplied the stone for "nearly all the canal locks from Cincinnati to Toledo" (Howe, 1847, p. 369). Although this is true for the stone for these locks, it is not true for all locks along the canal.

The limestone is fossiliferous, containing colonial and horn corals, **stromatoporoids**, and sea lily fragments. The large colonial coral *Arachnophyllum* preserved in the coping of Lock 1 (fig. 59) is especially impressive. *Halysites*, a colonial coral that has a chainlike appearance, also is found in the stone used at this site. **Pyrite** inclusions, ranging from microscopic crystals to aggregates of 0.8 inch (2 cm) or more in diameter, are common. Hawes (1884a, p. 616) noted this occurrence of pyrite, but also remarked that its presence was not so disastrous as it would have been in stones with greater porosity. Some of the pyrite causes reddish stains. The stone has characteristic wavy bedding (see Hannibal and Davis, 1992, fig. 25). Some blocks have weathered preferentially along these wavy surfaces. Some horizontal surfaces are marked by irregular grooves, at least some of them representing eroding trace fossils. Stone from the Dayton Formation is well known for such differential weathering of fossil trackways (Sandy, 1992, p. 24, fig. 5.1). More information on the Dayton Formation and its uses can be found in Sandy (1992).

The stone blocks originally had bush-hammered interiors and drafted margins. Many of the blocks are highly weathered, however, and these features commonly are difficult to see.

Rope grooves (fig. 60), angled grooves cut into the stone by ropes used during the time the canals were active, are prominent in Lock 1. They are found on the top and sides of the lower parts of this and other Lockington locks, on the sides of the lock opposite the spillway. Hemp ropes were used early on along the canals. Later other types of ropes, including wire ropes designed by famed engineer John A. Roebling (1806-1869), were used along some canals. Similar rope grooves have been noted by geologists along the Chesapeake & Ohio Canal (Davies, 1989, p. 8) and along British canals (Robinson, 1997, p. 175).

Locks 2 through 5 of the Lockington staircase are downhill from Lock 1. A turning basin and dry dock were located on the west side of the canal between Locks 1 and 2. Lock 2 and subsequent locks are not as elaborate as Lock 1. Rotting wood foundations can be seen on the inside of Lock 3 (fig. 61). The stone blocks of this lock also are slipping out of place. A sawmill was once located next to Lock 3. There was formerly a hydraulic canal basin on the west side of Lock 4. Stone remains of a canal aqueduct can be seen on the sides of, and in, Loramie Creek. The finish of most of the stone on the river side of the aqueduct is **rock faced**.

More information on the locks, canals, and other structures in this area can be found in Morthorst (1997), and more information on the history of the water supply for the summit can be found in Neuhardt (1985).

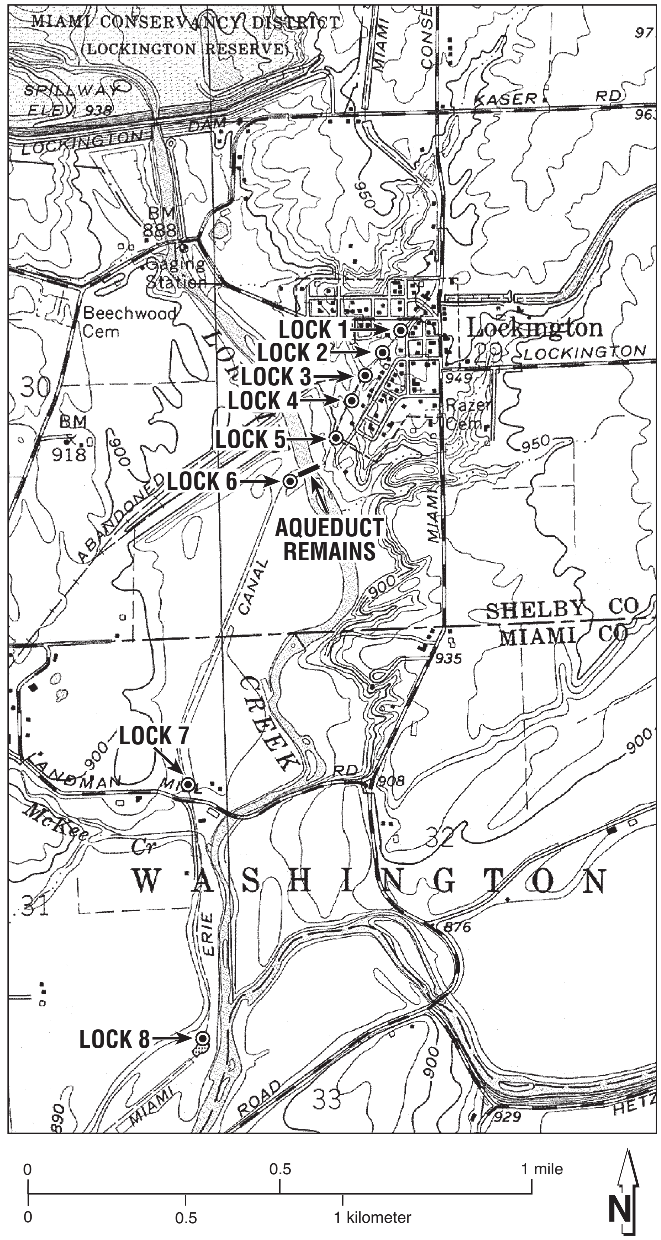


FIGURE 56.—Portion of U.S. Geological Survey Piqua East, Ohio, 7.5-minute quadrangle showing location of Locks 1 through 7 of the Miami & Erie Canal and the aqueduct remains along Loramie Creek. The location of Lock 8, described under Stop 13, also is shown. Contour interval is 10 feet (3 meters).

FIGURE 57.—Lower side of Lock 1, Big Lock, at Lockington. The tumble of the spillway is the two-level opening to the left; the lock chamber is to the right. October 1997 photo.

FIGURE 58.—Closer view of lower side of Lock 1, Big Lock, at Lockington. This lock is topographically high and is affected by a storm sewer just uphill. Note the inward tilt of the lock walls, the wooden structure holding the walls apart, and the separation of some of the blocks to the right. The edge of the spillway is to the left. August 1994 photograph.

FIGURE 59.—Top view of fossiliferous area on the coping of the southwestern part of Lock 1, Big Lock, at Lockington. The large, light-colored structure with curved layers is the colonial coral *Arachnophyllum*. Smaller colonial corals, horn corals, and sea lily parts also are present. Scale = 10 cm. August 1994 photo.

FIGURE 60.—Top of coping of southwest corner of Lock 1, Big Lock, at Lockington showing horizontal grooves formed by ropes. Such grooves are more common in limestone locks (see figs. 51, 52). Scale = 10 cm. August 1994 photo.

FIGURE 61.—Decaying wood at base of Lock 3, Lockington. Note slipping blocks of stone. August 1994 photo.

STOP 13. PIQUA HISTORICAL AREA, LOCK 8 OF THE MIAMI & ERIE CANAL

The Piqua Historical Area is in Miami County 3 miles (4.8 km) south of Lockington (Stop 12) (see fig. 62 and U.S. Geological Survey Piqua West 7.5-minute quadrangle map). This historical area includes canal-related exhibits, the 1815 house of the canal commissioner, John Johnston, and a segment of the Miami & Erie Canal. The *Genl. Harrison* (fig. 63), a wooden replica of a passenger and cargo canal boat, operates seasonally. For more information contact the Piqua Historical Area, 9845 North Hardin Road, Piqua, OH 45356, telephone 937-773-2522.

Lock 8 (fig. 64; see fig. 56 for location) can be seen at the turn-around at the end of one of the canal boat rides originating at the pier near the Visitors Center at the Piqua Historical Area. From the canal boat, one may observe the rounded corners of the lower part of the lock typical of locks along the Miami & Erie Canal (Gieck, 1992, p. 171) and an interesting, semi-alternating sequence of heights among the courses of stone blocks. The lock walls are leaning toward each other, much like the locks at Lockington (Stop 12). The blocks are limestone, probably the Dayton Formation. Wavy bedding characteristic of the Dayton Formation and similar stone can be seen from the boat. Reconstruction of the canal segment at this site and construction of the *Genl. Harrison* have been described by Hutslar (1978).

Lock 7 (see fig. 56 for location) is located nearby, along Landman Mill Road, just west of Loramie Creek. It is on private property. This lock is similar to Lock 8.

Piqua-area quarries were very important sources of dimension stone in the nineteenth century. Hawes (1884a, p. 613) noted that the stone from the Piqua area was transported by rail, canal, and animal teams to localities in Ohio and Indiana and that it was used primarily for rough building purposes. Bownocker (1915, p. 25) noted that the "Clinton Limestone" (Brassfield Formation of modern usage) at Piqua was reportedly used for a lock 2.5 miles (4 km) south of Piqua. More information on the "Clinton Limestone" can be found under Stop 15, Excello.

Piqua-area quarries are still important today. Currently, the Brassfield Formation, the Dayton Formation, and the Laurel Limestone, all Silurian-age units, are quarried at Piqua, primarily for crushed stone for use in road construction and various industrial purposes.

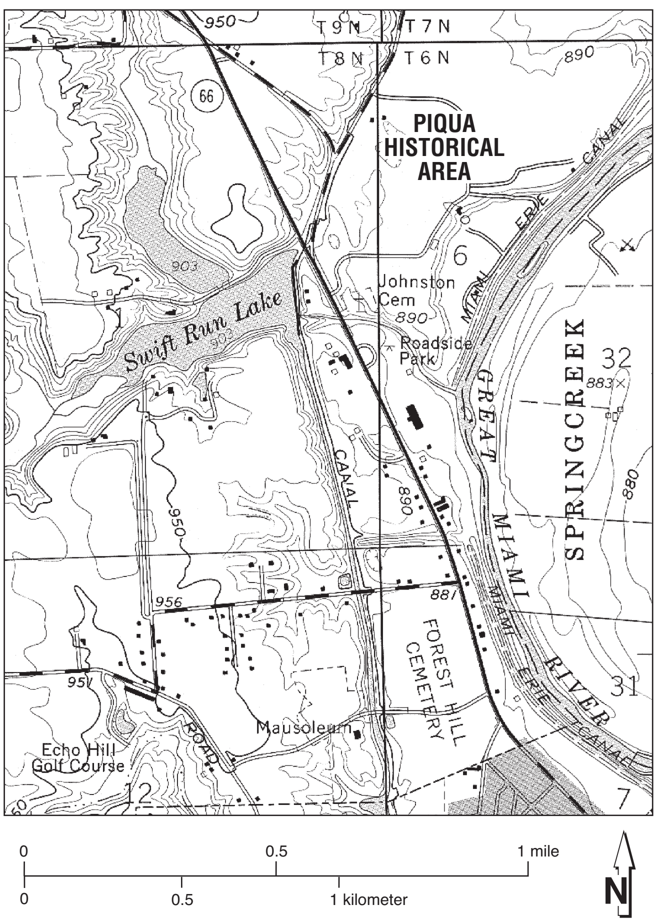


FIGURE 62.—Portion of U.S. Geological Survey Piqua West, Ohio, 7.5-minute quadrangle showing location of Piqua Historical Area and stretch of Miami & Erie Canal along Great Miami River. See figure 56 for location of Lock 8. Contour interval is 10 feet (3 meters).

FIGURE 63.—The replica canal boat *Genl. Harrison* docked at Piqua Historical Area. Note Belgian mules on towpath in upper right part of photo. August 1994 photo.

FIGURE 64.—Lock 8, Piqua Historical Area. Note greater deterioration of stone at water level and the leaning of the locks inward. Photo taken from the *Genl. Harrison* at a turn-around of the canal boat ride. August 1994 photo.

STOP 14. CARILLON HISTORICAL PARK, DAYTON, RECONSTRUCTED LOCK 17 OF THE MIAMI & ERIE CANAL

Carillon Historical Park is located along Carillon Boulevard, just southeast of the Miami River and east of I-75 (see fig. 65 and U.S. Geological Survey Dayton South 7.5-minute quadrangle map). The park is open seasonally; the address is Carillon Historical Park, 2001 South Patterson Blvd., Dayton OH 45409-2023, telephone 937-293-3638. Lock 17 (figs. 66-68), now located in the canal bed in this park, was originally located north of Dayton in Huber Heights. The park also includes an 1895 canal superintendent's office, moved to the site from its original site between Second and Third Streets in downtown Dayton, as well as many other historical exhibits.

The stone used for Lock 17 is a pinkish-gray fossiliferous limestone that includes abundant sea lily parts, as well as horn corals, colonial corals, and stromatoporoids. The colonial corals generally are rounded and may be $10^1/_2$ inches (27 cm) or more in diameter. There are also horizontal trace fossils, 0.4 to 0.8 inch (1 to 2 cm) in diameter. This stone is the *Dayton limestone* (Dayton Formation), a unit well known for its body-fossil and trace-fossil content (Sandy, 1992).

The stone used for Lock 17 is well preserved; it is finely bush hammered and has drafted margins. The stone used for the spillway is rougher. Rope grooves are visible on the coping of the lock in both side (fig. 66) and top (fig. 67) views. Bedding planes are accentuated by weathering; this feature can be seen on both the tops of the coping (fig. 68) and in side view along the sides. The presence of trace fossils probably contributes to the accentuated bedding planes. Some vertical drill holes, made when the stone was quarried, can be seen on the inside of the lock.

Another limestone is used for parts of the lock. This limestone is coarse grained and fossiliferous; it may be *Indiana limestone* or a similar stone and is probably replacement stone.

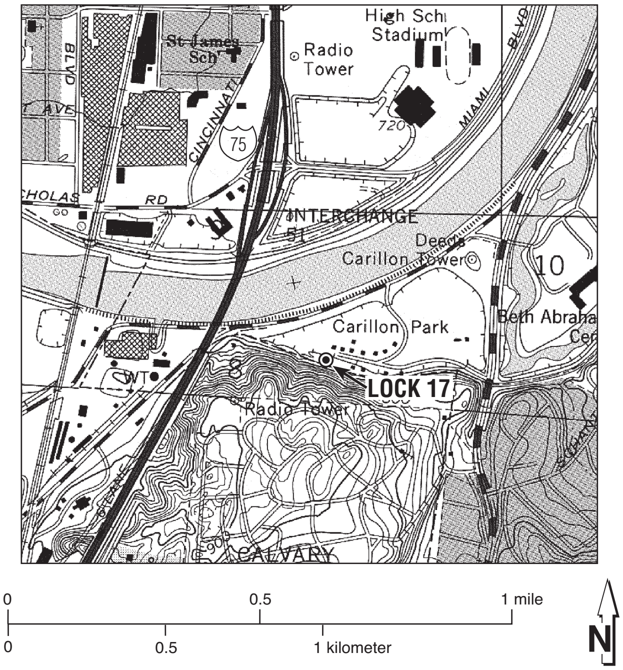


FIGURE 65.—Portion of U.S. Geological Survey Dayton South, Ohio, 7.5-minute quadrangle showing location of Lock 17 of the Miami & Erie Canal. Contour interval is 10 feet (3 meters).

FIGURE 66.—West side of Lock 17, Carillon Historical Park, Dayton. Note grooves (in cross-sectional view here) made by ropes in top of coping of lock. Some horizontal bedding features of the limestone are preferentially weathered. August 1995 photo.

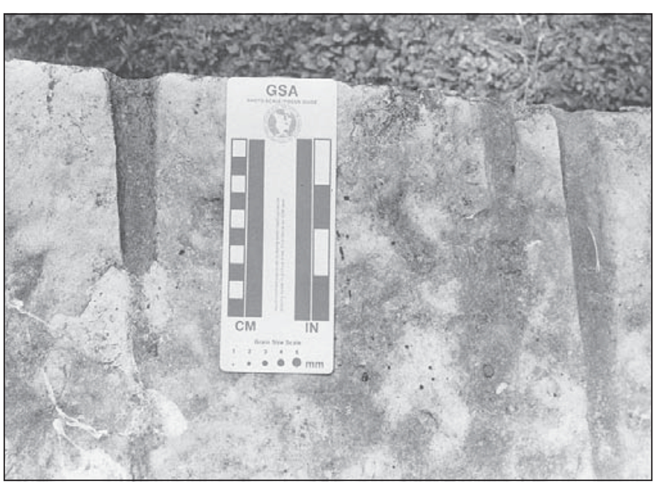


FIGURE 67.—Top view of rope grooves in coping of Lock 17, Carillon Historical Park, Dayton. August 1995 photo.

FIGURE 68.—Top of coping of Lock 17, Carillon Historical Park, Dayton, showing differential weathering of limestone. Pattern is probably due to trace-fossil content. Scale in decimeters. August 1995 photo.

STOP 15. EXCELLO LOCK, LOCK 34 OF THE MIAMI & ERIE CANAL

Lock 34 is located in a small Butler County metropark on the east side of South Main Street (Hamilton-Middletown Road), 0.25 mile (0.4 km) south of Oxford State Road in the community of Excello (fig. 69), on the southwest side of Middletown (see U.S. Geological Survey Trenton 7.5-minute quadrangle map). The park is between Dicks Creek and a set of railroad tracks. The locks in this area were the first to be constructed along the Miami Canal, which later became the southern part of the Miami & Erie Canal. Because of its early construction, this lock also is known as Lock 1 or Lock 3 of the Miami Canal.

An early photograph (Gieck, 1992, p. 149) shows that Lock 34 was originally constructed of stone, but most of the lock was replaced with concrete in the early 1900's (figs. 70-72). However, a few courses of stone can still be seen at the base of the interior of the upper end of the lock (fig. 71, arrow). These blocks have chamfered (beveled) faces. Old blocks of this same stone (fig. 73) that were probably once used for this structure can be examined along the parking area for the lock. This stone is a pinkish-gray limestone composed of a hash of fossil grains consisting of sea lily parts and bryozoan pieces. Mineralogically, the fossil grains are calcite. In fact, some sea lily parts, including columnals, are composed of single crystals of calcite, giving the rock a crystalline appearance. This stone belongs to the Brassfield Formation, which was once known as the "Clinton Limestone" (Bownocker, 1915, p. 24-25). It is likely that the Brassfield used here was quarried in the Centerville area, to the north in Montgomery County; there are no outcrops of this rock unit near Excello. The Brassfield is Silurian in age and was deposited in a very shallow water environment (Ausich, 1987, p. 422). More information on the quarrying and the use of this stone for building can be found in Sandy (1992, 1996).

A historical marker at this site commemorating the Excello locks, erected by the Middletown Historical Society, consists of a block of the Brassfield, probably a remnant of the original canal structure. The reconstructed concrete portions of the lock contain a plaque (fig. 72 and inset) commemorating the 1826 construction of the lock. This plaque probably was set into the original stone walls of the lock and then reset in the concrete walls erected in the 1900's. The plaque is a fossiliferous, pinkish-gray limestone and has badly deteriorated. Concrete used for the lock contains abundant snail shells.

The spillway of the lock (fig. 74) is made of a different stone than the lock. It is constructed of very light gray *Dayton limestone* and contains trace fossils and wavy bedding characteristic of this stone. More information on this stone can be found under Stop 12, Lockington Locks. The stone blocks are bush hammered and have drafted margins.

The Middletown Historical Society's Canal Museum is located in a replica of a lock tender's house at 1605 North Verity Parkway, in nearby Middletown. The building is a replica of the house that once stood at the old Amanda Lock (Lock 33) (Sam Ashworth, Middletown Canal Museum, personal commun., 1998). The museum is open seasonally and contains canal memorabilia and exhibits; call 513-539-7798 for more information.

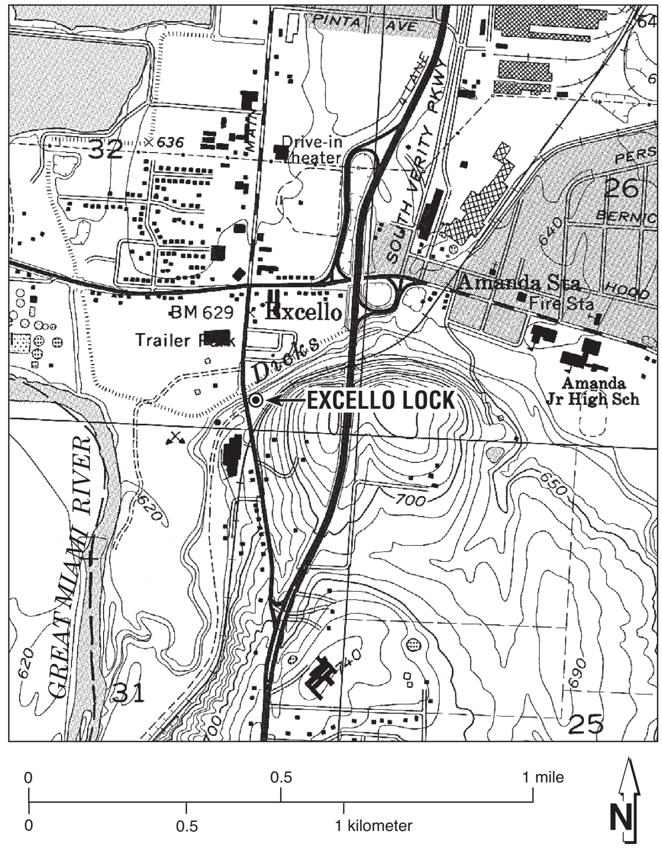


FIGURE 69.—Portion of U.S. Geological Survey Trenton, Ohio, 7.5-minute quadrangle showing location of Excello Lock, Lock 34 of the Miami & Erie Canal. This lock is also known as Lock 1 or Lock 3 of the Miami Canal. Contour interval is 10 feet (3 meters).

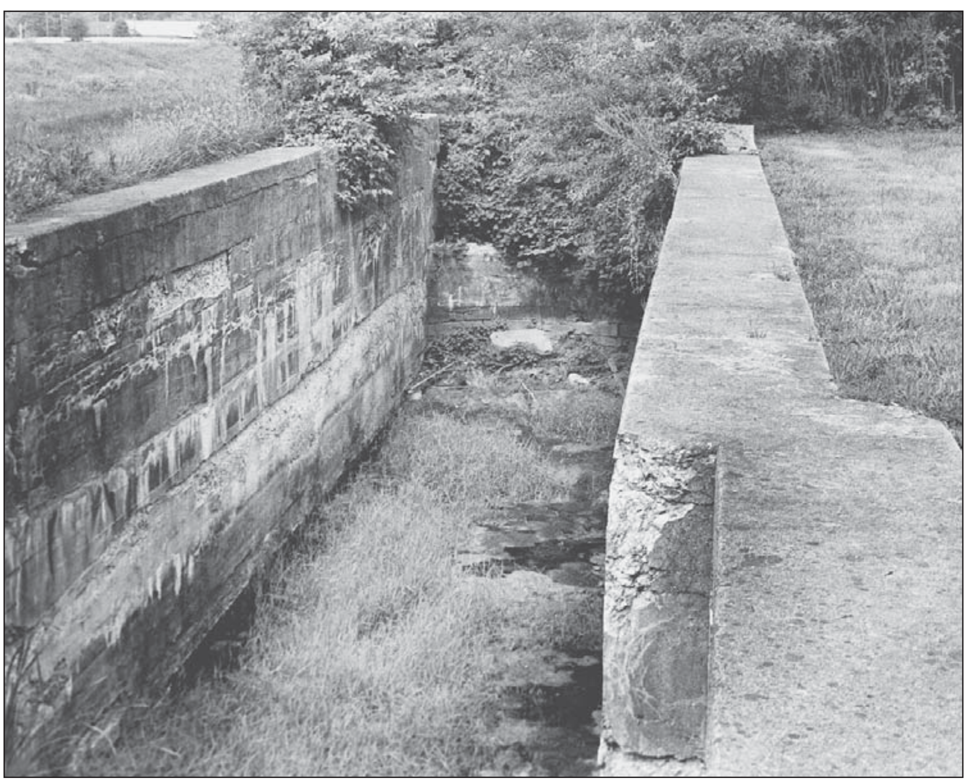


FIGURE 70.—View of Lock 34 of the Miami & Erie Canal, Excello, looking toward upstream end of lock. August 1998 photo. Most of lock visible here is concrete.

FIGURE 71.—Detail of upper end of Lock 34, Excello. Arrow points to a few courses of original stone. Remainder of the lock is concrete. August 1998 photo.

FIGURE 72.—Lower end of Lock 34, Excello. Original limestone marker (see inset) for Lock 1 of the Miami Canal is embedded in the concrete wall just below the young woman. August 1998 photo.

FIGURE 73.—Two pieces of limestone from the original Lock 34, Excello. August 1998 photo.

FIGURE 74.—Spillway at Lock 34, Excello, constructed of *Dayton limestone*. August 1998 photo.

STOP 16. WHITEWATER CANAL HISTORIC SITE, METAMORA, INDIANA, LOCKS 24 AND 25 OF THE WHITEWATER CANAL

The Whitewater Canal Historic Site is located two blocks south of Metamora Road (Indiana Rte. 52) in Metamora, Indiana (see fig. 75 and U.S. Geological Survey Metamora and Brookville, Indiana, 7.5-minute quadrangle maps). From Metamora Road turn south on Columbia Street and follow the signs for state historic site. Metamora is about 30 miles (48 km) southwest of Richmond, Indiana.

The Whitewater Canal was connected to Cincinnati by the Cincinnati & Whitewater Canal. Unfortunately, much of the remains of the Cincinnati & Whitewater Canal in southwest Ohio are buried beneath Cincinnati. Fortunately, Locks 24 and 25 of the Indiana section of the Whitewater Canal at Metamora are restored, allowing one to easily examine stone used along this system. Visitors also may take a ride on a replica canal boat, the *Ben Franklin III*. The canal boat ride passes over the restored Duck Creek Aqueduct. There is also a restored grist mill at Lock 25. The telephone number for the canal boat ride and mill is 765-647-6512.

The architecture and stone composition of the locks at Metamora resemble those of Ohio's Miami & Erie Canal; locks have rounded corners and are made of limestone. Lock 25 (figs. 76-78), next to the Metamora Grist Mill, is most convenient to examine. It is constructed primarily of blocks of very pale orange to light-olive-gray limestone; some blocks contain fossil brachiopods such as *Leptaena*, **bryozoans**, and trace fossils, including *Diplocraterion* (see Feldmann and Hackathorn, 1996, for illustrations of these fossils). The stone is early **Paleozoic** in age. At least some of the stone for this lock and other nearby structures is said to have been quarried nearby. Some of the stone may be Ordovician in age; some of the stone may have been quarried from Silurian rock units located to the northwest in Laurel, Indiana. Some replacement material is probably Salem Limestone, which is Mississippian in age. As a building stone, Salem Limestone is known as *Indiana limestone*.

Several effects of weathering, primarily chemical weathering, can be seen in Lock 25. In some places, burrow fillings (trace fossils) have weathered preferentially compared to the rock matrix, and body fossils have become more apparent over time. Stone blocks also have weathered preferentially along irregular horizontal bedding planes (fig. 76). The limestone is marked by a system of joints (cracks) that have developed at least in part owing to chemical weathering (fig. 77). Blocks are breaking preferentially along these joints (fig. 78).

The Duck Creek Aqueduct has had a complex history. It was destroyed in 1846 (Fatout, 1972, p. 149) and was rebuilt soon after and in 1946 its top was raised (Jay Dishman, Whitewater Canal Historic Site, personal commun., 1998). The visible portion of the stone, as seen from the canal boat ride, appears to be Salem Limestone. The stone also may be seen from the path along the canal.

Lock 24, located on Indiana Rte. 52, $^1/_2$ mile (0.8 km) east of Metamora (fig. 75), is composed of at least two types of stone. Part of the coping of the lock is Salem Limestone, cut with grooves on its sides to make it look older. The Salem Limestone has weathered differentially, causing fossils such as horn corals, bryozoans, snails, and sea lily parts to protrude from the surface. The original stone, preserved in the lower part of the canal, is a somewhat fossiliferous, very pale orange to medium-light-gray limestone. Some of the stone has been coated with concrete.

As in Ohio, geologists in Indiana made note of stone used for its canals. Owen (1839, p. 28-29), for instance, noted that a dark limestone from Honey Creek was used for the Indiana Cross-Cut Canal.

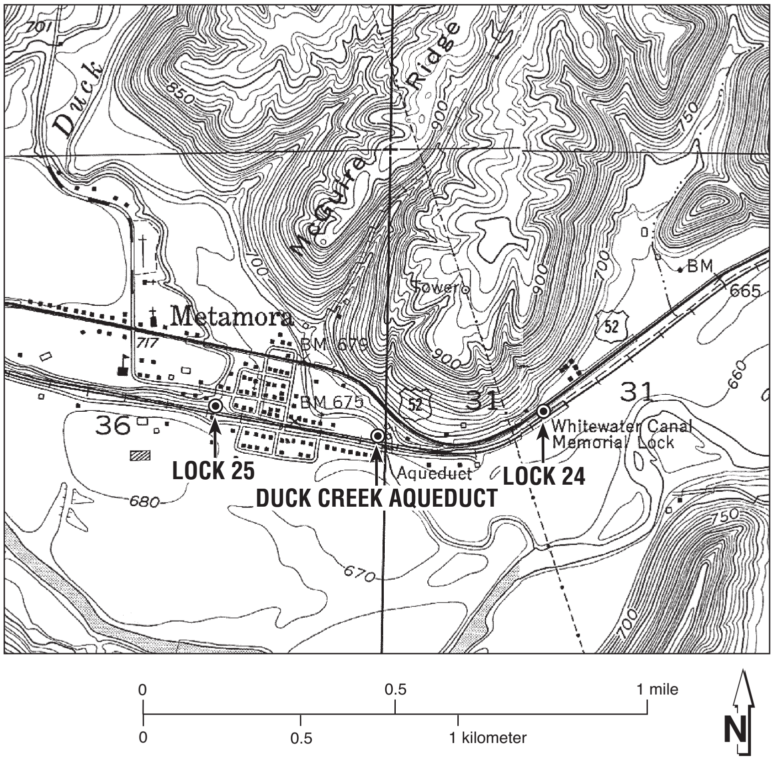


FIGURE 75.—Portions of U.S. Geological Survey Metamora and Brookville, Indiana, 7.5-minute quadrangles showing location of Locks 24 and 25 of the Whitewater Canal and the Duck Creek Aqueduct. Contour interval is 10 feet (3 meters).

FIGURE 76.—Lock 25 and spillway of the Whitewater Canal, Metamora, Indiana. Many bedding planes of the stone blocks have weathered deeply. August 1995 photo.

FIGURE 77.—Cracking in limestone used for coping of middle of south wall of Lock 25 at Metamora, Indiana. Pattern of cracks is typical of many limestones. August 1995 photo.

FIGURE 78.—Polygonal chunk of limestone breaking apart from coping of west end of Lock 25 at Metamora, Indiana. August 1995 photo.

ADDITIONAL SITES

This guidebook is only an introduction to the geology of the canals. There are many more locks and other stone structures that deserve to be investigated. Types of stone used for canals and other geological aspects of Ohio's great canal systems deserve further study. Those who would like more information on other localities should consult the guidebooks and other publications of the Canal Society of Ohio.

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GLOSSARY

aqueduct An artificial duct, or conduit, used to allow a canal to pass over a body of water, such as a stream, or other feature. Aqueducts along the canal also had to provide a path for the canal towpath.

bedrock The solid rock that underlies a particular region.

body fossil The actual or mineralized remains of an organism, or a mold or cast of an organism, as distinguished from **trace fossils**.

brachiopod A marine invertebrate that has a shell that superficially resembles that of a clam. The shell consists of two valves that are each bilaterally symmetrical, but, unlike the shells of most clams, each valve is not the mirror image of the other.

bryozoan A small, aquatic, **colonial** invertebrate. The individual tubes within a bryozoan colony are characteristically less than 1/2 mm wide. Forms commonly found as **fossils** may resemble small twigs or miniature, lacy fans.

buffer whales Wooden bumpers built into the sides of canal boats. Also known as rub rails. Buffer whales commonly were faced with an iron band to provide further protection to the boat.

building stone A natural or manmade stone used for building.

bush hammer (adjective = **bush hammered**) A multi-pointed steel tool used to **dress** stone. The resulting finish is referred to as a bush-hammered surface. The tool generally consists of a prismatic-shaped piece of steel that has grooves filed into the end, creating a set of pyramidal points similar to those found on a meat tenderizer. Another type of bush hammer consists of a holder that grasps a set of pointed steel bars. A bush hammer also is known as a facing hammer or a crandal.

calcite A generally light-colored mineral composed of **calcium carbonate**. Calcite is fairly soft and effervesces (bubbles) in weak acids. It is the principal mineral in **limestone** and in many **marbles**.

calcium carbonate The chemical compound $CaCO_3$. A common natural form is the mineral **calcite**.

carbonate Material, such as **limestone**, composed of oxides of calcium and carbon.

cement A powder made of lime and other mineral matter that, when mixed with water, can be used as mortar between stone blocks, or which can be mixed with water and aggregate (granular material such as sand or gravel) to form **concrete**.

Cenozoic Era The large division of geologic time following the **Mesozoic Era**, spanning from about 66 million years ago to the present.

change bridge A bridge that allowed the towpath to cross from one side of the canal to another.

clastic Refers to rocks, such as **siltstones**, **sandstones**, and **conglomerates**, that consist of particles derived from pre-existing rocks or minerals and that have been transported from their place of origin.

colonial (noun = **colony**) Refers to animals that live together as an interconnected unit.

concrete A manmade mixture of **cement**, aggregate (granular material such as sand or gravel), and water which hardens into a rocklike mass.

concretion A mass of **sedimentary** rock, commonly nodular, found within another type of sedimentary rock. Concretions are typically harder than the surrounding rock but may have soft centers.

conglomerate (adjective = **conglomeratic**) A **clastic sedimentary** rock composed of small, generally sand-size, particles and larger, rounded fragments greater than 2 mm in diameter.

coping The top level or **course** of stone capping a structure.

coral A marine invertebrate that has a soft body and a hard external structure composed of **calcium carbonate**. Corals live attached to the sea floor, especially in shallow, tropical seas. Modern corals, as well as many **fossil** corals, are **colonial** and form extensive reefs. Some fossil forms were solitary, such as **horn corals**.

corallite The skeleton of an individual **coral** animal.

course A horizontal layer of stone block used in a canal lock, **aqueduct**, building, or other structure.

cramp A flat iron bar having bent ends, used to clamp two stone blocks together.

cross-bedding The layering of sediment inclined at an angle to the horizontal.

culvert A covered passageway for portions of a canal or other waterway. Culverts typically consisted of stone archways covered with sediment that allowed the canal to cross over them.

deltaic Related to a delta, which is a deposit of sediment formed where a river flows into a lake or ocean.

derrick In the stone industry, a mechanism composed of a central post, held in place by guy wires, and an adjustable boom, used to hoist and lower blocks of stone and other material.

Devonian A mid-**Paleozoic** period of geologic time. It began about 408 million years ago and lasted until about 360 million years ago.

dimension stone Stone that has been or is intended to be cut into slabs, blocks, or other regular shapes.

dolomite (adjective = **dolomitic**) A light-colored mineral composed of calcium-magnesium carbonate, $(CaMg)CO_3$. It is fairly soft and dissolves in weak acids, but effervesces less than **calcite**. It is a common mineral in some **limestones** and in many **marbles**. The term also is used to refer to a rock dominated by the mineral dolomite, as an alternative to the term **dolostone**.

dolostone A rock composed primarily of the mineral **dolomite**.

drafted margins Tooled margins on the surfaces of a stone block. The width of drafted margins reflects the width of the blade of the chisel used to draft them.

dressed Refers to stone that has its exposed surfaces smoothed, and in many cases, covered with decorative tool marks.

dry dock A boat dock from which water could be removed so that a boat could be repaired. Dry docks were built next to the canals so that canal boats could be floated into them.

end moraine A linear mound or ridge of unlayered sand and gravel laid down at the margin of a glacier.

exfoliating Refers to a type of **weathering** in which concentric pieces of rock successively break away from the rock surface.

feeder A channel used to conduct water from a reservoir or other body of water into a canal.

feeder canal A stretch of **feeder** suitable for use by canal boats.

fluvial Relating to rivers.

formation A particular body of rock or sequence of rock layers. It is identified by its composition, texture, and its position relative to other rock units. Formal formation names consist of two parts: the name of a geographic locality and either the word formation or the name of a type of rock, such as **sandstone** or **shale**.

fossil (adjective = **fossiliferous**) Any preserved remains or trace of prehistoric organisms.

freestone A fine- or medium-grained stone, typically a **sand-stone** or **limestone**, that can be cut easily in any direction and which will not split in any particular direction.

gongoozler A British term for a person who stands around staring at something, especially things related to canals.

goose neck A U-shaped device used to hold the top part of the **heel post** of a lock gate in place. It consisted of two parts, a set of curved iron bars bolted to, and commonly set into, the **coping**, and a circular collar or strap.

granite Technically, a light-colored, coarsely crystalline, **plutonic** rock that consists primarily of potassium feldspars and plagioclase feldspars and contains quartz. Granite also may contain **mica** and other minerals. Builders and architects use this term in a broader sense to indicate any very hard crystalline rock used for building purposes. The term is used in this more general sense in this guidebook.

group Two or more associated **formations**.

heel post The upright post at the end of a lock gate upon which the gate turns.

hollow quoin A curved recess having the shape of a half cylinder, set into the inside of a canal lock. **Heel posts** were set into this space.

horn coral A solitary **coral** having a cup or hornlike shape. They are common in many **Paleozoic limestones**.

laminar flow Water flow in which the stream lines remain distinct and the flow direction at every point remains unchanged over time, so that flow is relatively calm, not turbulent.

limestone A **sedimentary** rock composed predominantly of the mineral **calcite**.

marble A crystalline rock resulting from the metamorphism of **limestone** or **dolomite**. Marble thus has the same basic chemical composition as limestone or dolomite.

member A subdivision of a **formation**.

Mesozoic Era The large division of geologic time between the **Paleozoic** and **Cenozoic Eras**, spanning from about 245 to 66 million years ago.

mica A group of common rock-forming minerals that have a flat shape and split easily into thin layers or sheets. One common mica is muscovite.

mineralogy The science that studies the composition, formation, and other attributes of minerals.

Mississippian A period of geologic time in the late **Paleozoic**. It began about 360 million years ago and lasted until about 320 million years ago.

mitre sill A triangular structure on the floor of a lock that abutted the base of the gates of a lock when they were closed. Mitre sills were typically made of wood.

Ordovician A period of geologic time during the early **Paleozoic**. It spanned from 505 to 438 million years ago.

Paleozoic Era The large division of geologic time between the **Precambrian** and the **Mesozoic Era**. It began about 540 million years ago and lasted until about 245 million years ago.

pavers Stone blocks used for paving walkways. Their exposed surface is typically rectangular.

pelmatozoan A marine invertebrate that has a central stalk-like supporting column and a flowerlike body. Pelmatozoans are relatives of starfish and sea urchins; some are known informally as **sea lilies**.

Pennsylvanian A period of geologic time in the late **Paleozoic**. It began about 320 million years ago and lasted until about 286 million years ago.

Pleistocene Epoch A subdivision of the **Quaternary**. The Pleistocene began about 1.6 million years ago and ended about 10,000 years ago.

plug and feathers A tool consisting of a steel wedge, called the "plug," and a set of thin pieces of iron, each rounded halfway around, called the "feathers." Sets of feathers are inserted into a line of holes drilled in a stone. Plugs are then set into the feathers and hammered down to split the stone along the line of drill holes.

plutonic An igneous rock, or relating to igneous rock, that crystallized below the surface of the Earth. The crystals in a plutonic rock are the size of grains of sugar or larger.

Precambrian An informal term for all of geologic time from the formation of the Earth, about 4.6 billion years ago, to the beginning of the **Paleozoic Era**, about 540 million years ago.

pyrite A gold-colored mineral composed of iron sulfide. It is informally known as "fool's gold."

quartz A common glassy, clear to gray, rock-forming mineral composed of **silica**.

Quaternary The most recent period of the **Cenozoic Era**. It began about 1.6 million years ago. We are still living in the Quaternary today.

Recent A subdivision of the **Quaternary**. This epoch of geologic time encompasses the past 10,000 years. Also called the Holocene.

rock faced A rough type of facing, resembling a natural surface, used for the exposed sides of blocks of **building stone**.

rock-unit name The name given to a body of rock, such as a **formation**, at the time of its first formal geologic description.

sandstone A **sedimentary** rock composed of sand-size grains (between $^1/_{16}$ and 2 mm in diameter), held together by mineral cement.

sea lily A colloquial term for certain types of **pelmatozoans**.

sedimentary Relating to or consisting of sediment—solid material, such as sand and silt particles and **fossil** fragments—that has been transported by wind or water or both. Sediments are characteristically deposited in layers.

shale A **sedimentary** rock composed of clay minerals or clay-size particles (less than $^1/_{256}$ mm in diameter), distinguished from the slightly coarser rock, **siltstone**, by its smooth feel. A true shale also can be split readily into thin layers.

side cut A stretch of canal connecting a place with a main canal.

silica Silicon dioxide, SiO_2, a rather hard material common as cement in sandstones. Chert, jasper, and **quartz** also are composed of silica.

siltstone A **sedimentary** rock composed of silt-sized grains (between $^1/_{256}$ and $^1/_{16}$ mm in diameter), distinguished from finer grained shale by its gritty feel.

Silurian A period of geologic time during the early **Paleozoic**. It began about 438 million years ago and lasted until about 408 million years ago.

slackwater Water that is kept at a certain level by a dam. In some cases, the canals used stretches of rivers that were kept at a navigable level by such a dam.

spalling Splitting away of part of a stone, commonly as scales or as sheetlike slabs.

spillway A channel used to regulate the amount of water entering a lock. Spillways were built parallel to or alongside the lock. They were also known as regulating channels, sluices, tumbleways, waste weirs, and other terms.

split faced A somewhat roughened face of a stone block created by roughly splitting the rock in a machine.

staircase A set of closely spaced locks, such as those found at Akron and Lockington.

stromatoporoid An extinct, spongelike organism. Stromatoporoids generally are finely layered when seen in cross section.

stylolites (adjective = **stylolitic**) Natural, irregular seams in **limestone** that formed where the rock was sutured back together after portions of the limestone dissolved away. Limestone is easily dissolved by weak acids. The dark color of freshly exposed stylolites is due to a concentration of insoluble materials that remained behind.

summit A high point of a canal. There were two summits on the Ohio & Erie Canal and one summit on the Miami & Erie Canal. Lock-numbering systems began on each side of the summits.

till Generally unstratified material deposited by a glacier.

till plains Flat areas of land covered by **till**.

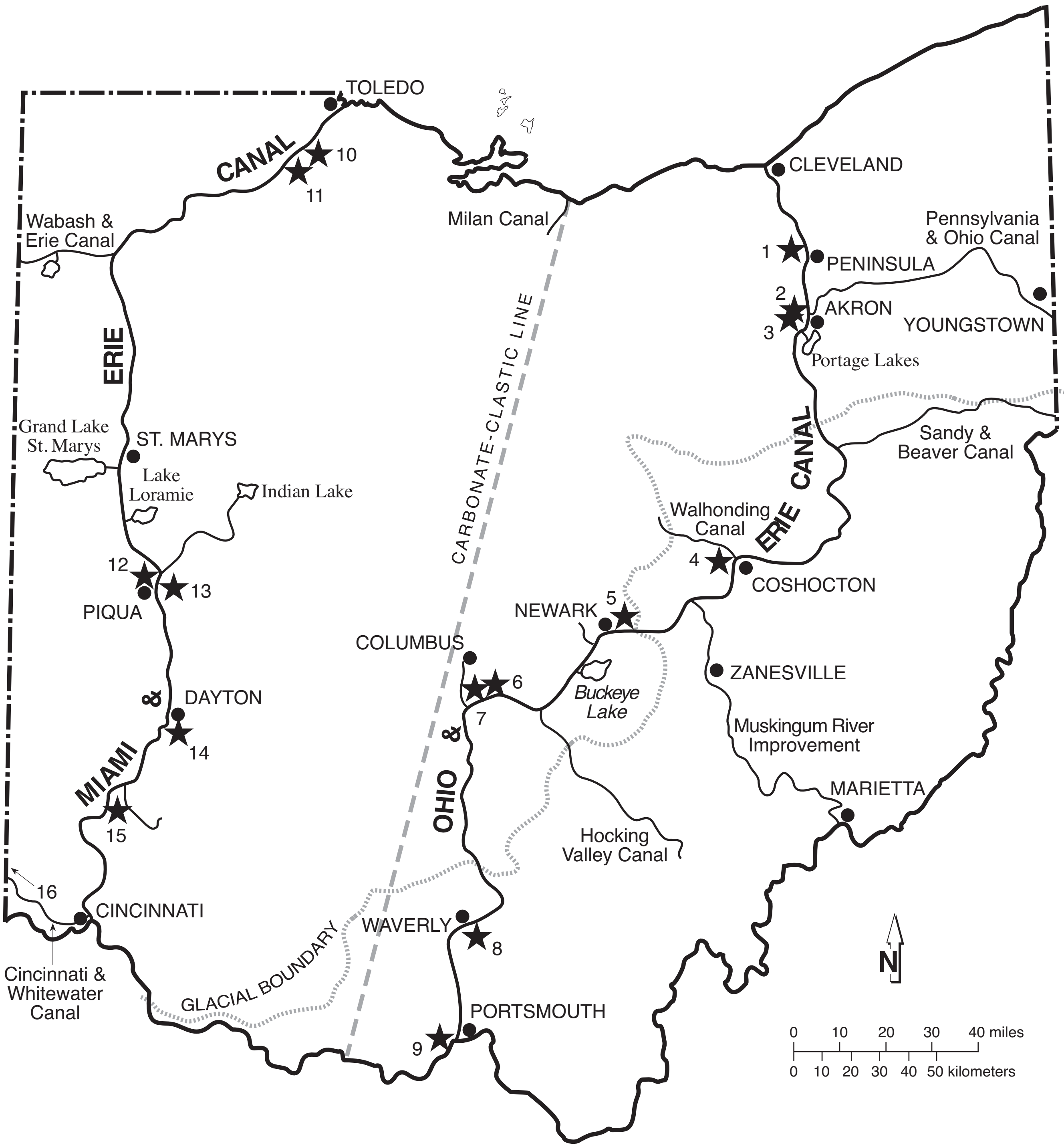
tongs A forcepslike device used in hoisting and lowering blocks of stone. The tips of the two prongs of the tongs are placed into cone-shaped holes cut into opposite sides of a block of stone. When the tongs are lifted, the stone is held up by pressure put on the stone by the tips of the tongs. Also known as grab hooks.

trace fossil A footprint, trackway, burrow, or other indirect evidence of a prehistoric organism. Trace fossils are distinguished from **body fossils**.

trade name A manufacturer's name for a product, such as a **building stone**, for example, *Indiana limestone*. Trade names are italicized in this report.

unconsolidated Refers to material composed of grains that are not firmly cemented together.

weathering (adjective = **weathered**) The processes that change the character of rock at or near the Earth's surface. Weathering may be caused by water, wind, or other atmospheric elements. Chemical weathering involves a chemical reaction, such as the solution of limestone by acids. Physical weathering involves a physical process, such as abrasion or freezing and thawing.



★ STOPS

1. Cuyahoga Valley National Recreation Area
2. Cascade Locks, Akron
3. Lock II Park, Akron
4. Triple Locks, Coshocton
5. Black Hand Gorge
6. Groveport
7. Lockbourne
8. Canal Park, Waverly
9. West Portsmouth
10. Side Cut Metropark, Maumee
11. Providence Metropark
12. Lockington Locks, Lockington
13. Piqua Historical Area, Piqua
14. Carillon Historical Park, Dayton
15. Excello Lock, Excello
16. Whitewater Canal Historic Site, Metamora, Indiana

GENERALIZED MAP OF FIELD-TRIP AREA