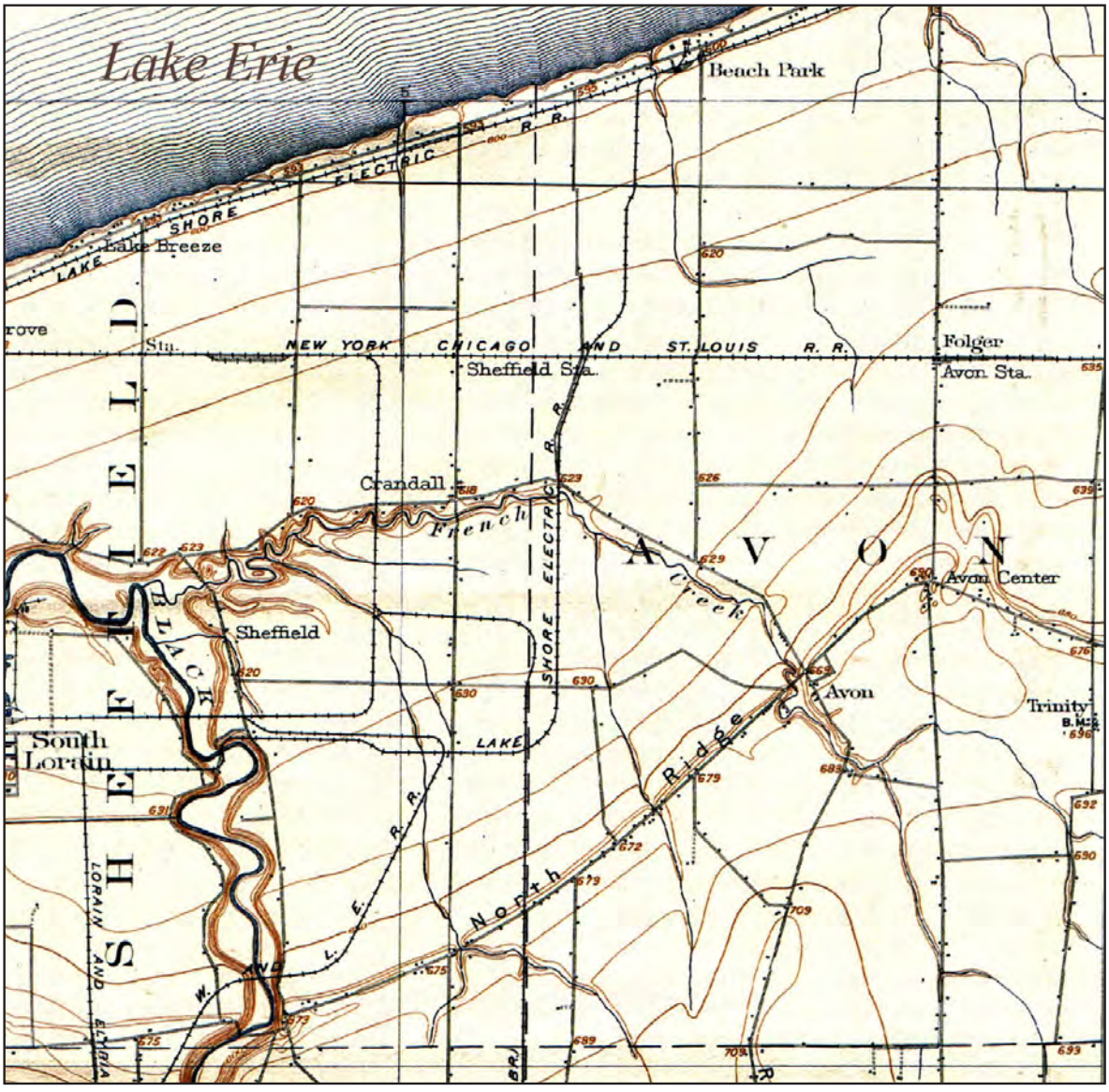
# GEOLOGY

## LANDFORMS

The ***North Ridge Scenic Byway*** corridor lies in the Erie Lake Plain landform of the Central Lowlands Physiographic Province of the United States (Fenneman 1938; Brockman 2002). The Lake Plain consists of wide expanses of level or nearly level land interrupted only by sandy ridges that are remnants of glacial-lake beaches and by river valleys carved into Paleozoic bedrock. With the exception of the sandy ridges, much of the Lake Plain in Avon and Sheffield was a dense swamp forest prior to settlement. The ***North Ridge Scenic Byway*** follows the northernmost ancient beach ridge as it traverses Sheffield and Avon at an elevation ranging from 675 to 690 feet above sea level, some 105 to 120 feet above modern Lake Erie.



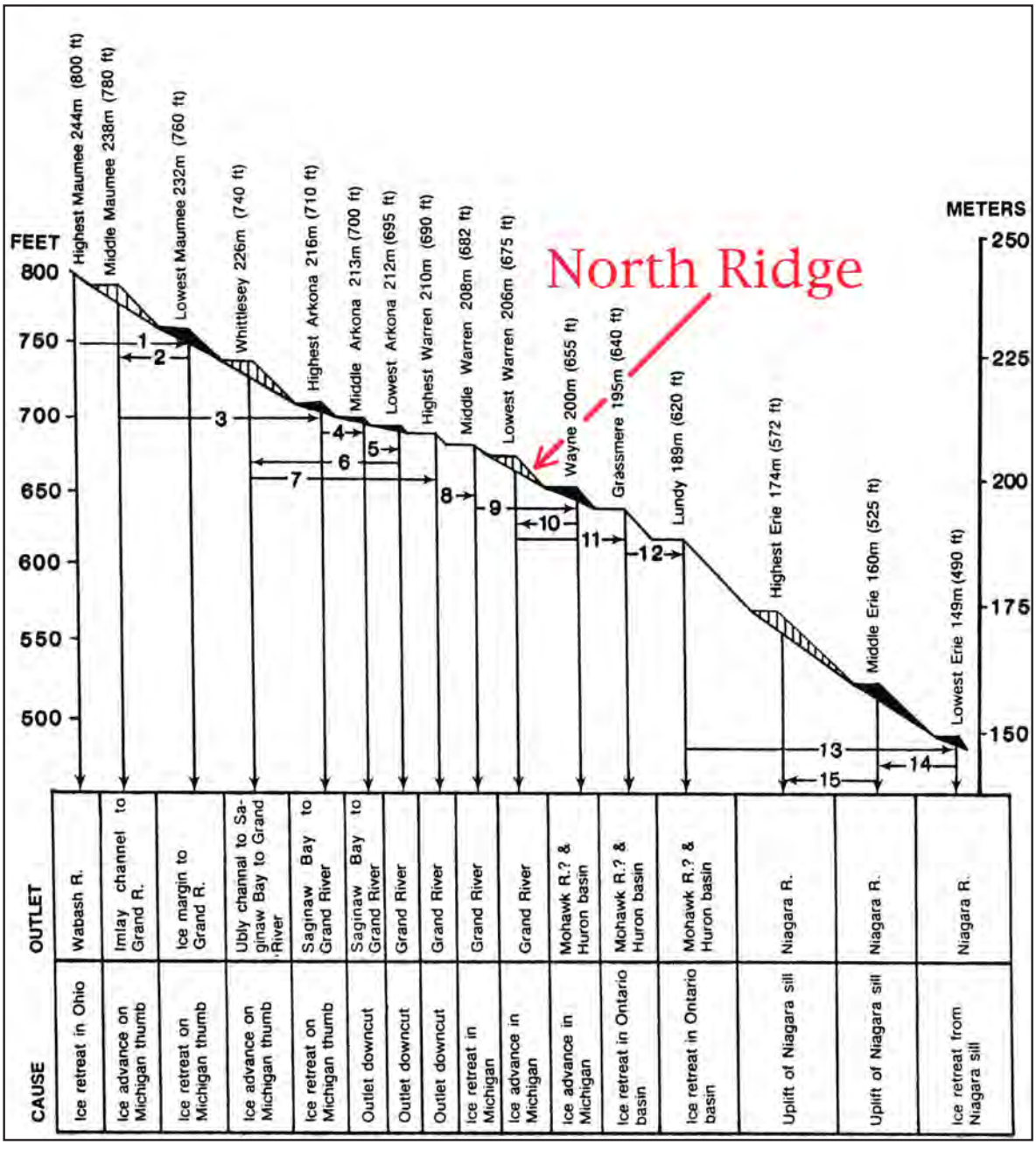

*Topography of Sheffield and Avon Townships as surveyed in 1901, showing North Ridge near the center of the map (courtesy of U.S. Geological Survey, Oberlin, Ohio Quadrangle 1903).*

## FORMATION OF NORTH RIDGE

Approximately 18,000 years ago, the last continental glacier blanketed northern Ohio as it pushed down from the north to its maximum southern thrust. The ice sheet reached as far south as Cincinnati, Ohio, then it began to melt back. As the glacier paused in its retreat, piles of rock and clay debris [known as *end moraines*] were built up at the ice margins. Granite boulders carried by the ice sheets from Canada, known as glacial erratics, are common in theses glacial deposits. In places these moraines were deposited in such a way as to dam the natural drainage and thereby form large lakes in depressions that the ice had scoured. Lake Erie is the remnant of such a lake, which at its highest stage was 230 feet above the present level of the lake. As the ice retreated, new outlets were uncovered and several lake stages were formed at successively lower levels.

The chronology of lake stages in the Lake Erie basin relates a fascinating story of glacial action, movements of the earth's crust and erosion by waves to form the body of water we see today. The story begins nearly 15,000 years ago as the last glacier [known as the Wisconsinan ice sheet] temporarily halted to form the Fort Wayne Moraine in northwestern Ohio, northeastern Indiana and southwestern Michigan. When the ice retreated further, the first lake in the Great Lakes basin was formed between the glacier and the moraine. This glacial lake has come to be known as *Lake Maumee*. With further ice retreat, the next lake stage, known as *Lake Whittlesey* was formed about 170 feet above the current level of Lake Erie. Finally, the last major glacial lake, *Lake Warren*, was established at 120 feet above modern Lake Erie. All of these glacial lake stages occurred within a span of less than 2,000 years.

*Granite boulder, glacially transported from the Canadian Shield and deposited in the Black River valley in Sheffield. Rocks of this type, removed from their area of origin, are known as "glacial erratics."*

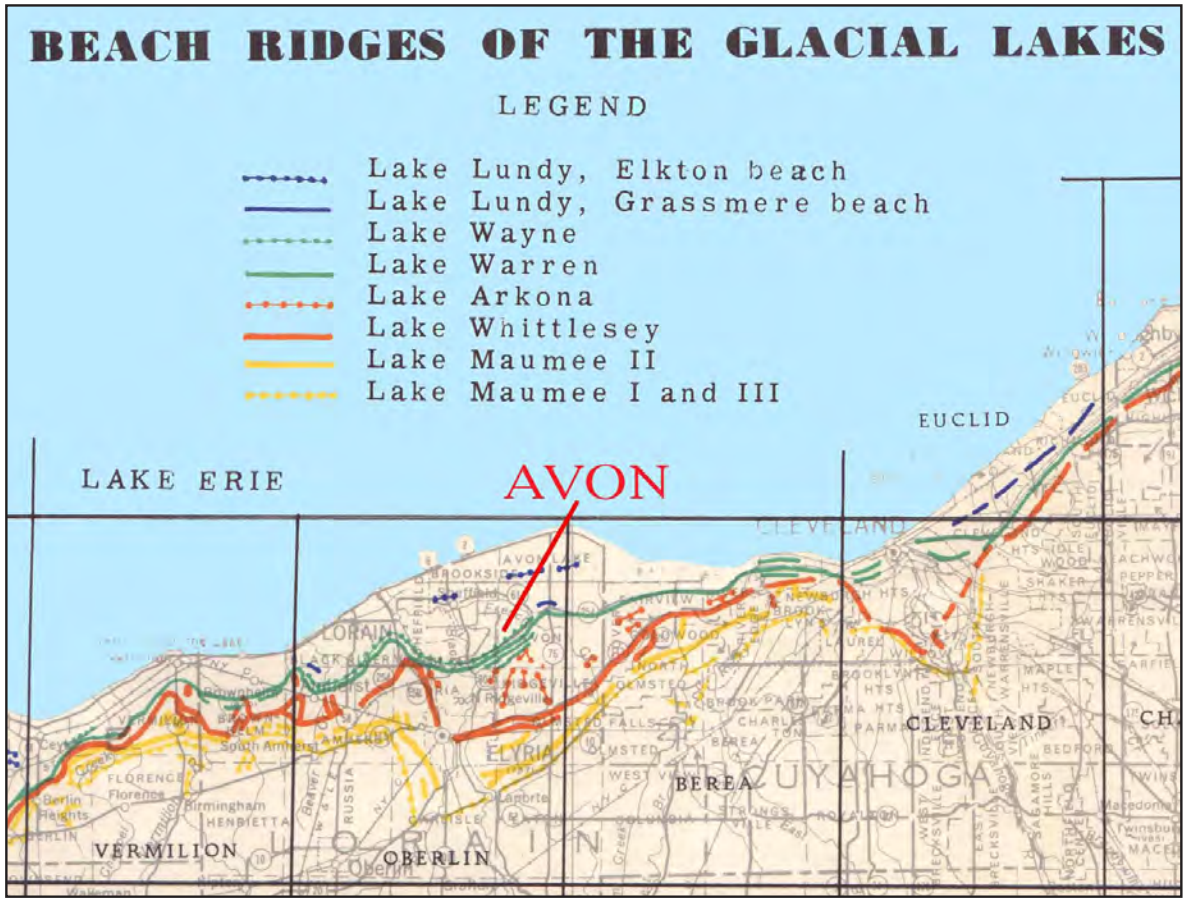



*Profile depicting the sequence of beach ridge formation in northern Ohio in the past 14,000 years (numbers 1 through 15, in order of occurence). Beaches in black were submerged after formation and partially destroyed, while those with vertical lines were not submerged, thus they are more prominent features of the landscape. The present level of Lake Erie (Highest Erie) has been approximately stable for the past 3,000 years (after Herdendorf 1989).*

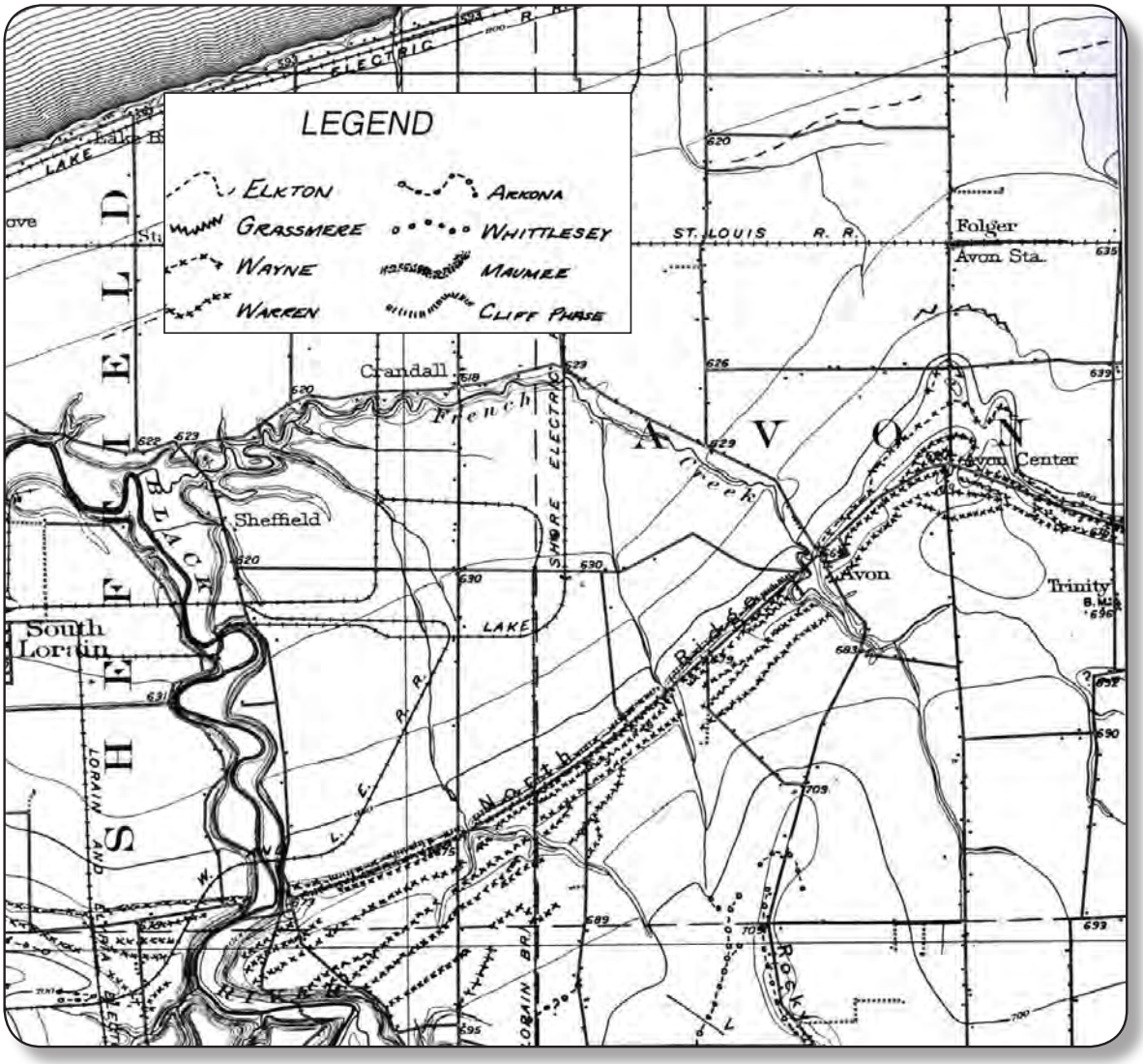
Low, continuous sandy ridges within a few miles of the Lake Erie shore, throughout Lorain County, are the most conspicuous reminders of the former glacial lakes (Forsyth 1959). Each ridge represents an ancient beach, formed along the shore of a former lake, which once occupied the Lake Erie basin at an elevation higher than the present lake [major stages: *Maumee*, *Whittlesey*, and *Warren*, along with minor stages: *Arkona*, *Wayne*, and *Lundy* (*Grassmere* & *Elkton* beaches)]. Because these former lakes each had a different outlet and stood at a different elevation, each stage is marked by a separate set of beaches at a characteristic elevation.

Beaches formed by a slowly falling water level are much more pronounced than those, which have been totally submerged when minor readvances of the ice caused higher lake levels. Because temporary submergence permits the erosion of former beaches by waves and alongshore currents, only three former beaches are easily recognizable, *Maumee*, *Whittlesey* and *Warren*. At places where the former lakeshore was rocky (such as Amherst in eastern Lorain County and to a lesser extent at Avon Center), spectacular cliff features resembling sea caves, arches and stacks can be seen.

Ohio Route 254 follows the crest of the northernmost prominent ridge, the one known as *Lake Warren* that was formed some 12,800 years ago. At that time ice still occupied the Niagara Escarpment preventing drainage to the east, so *Lake Warren* drained to the west along the ice margin into what is now Saginaw Bay of Lake Huron. *Lake Warren* had an elevation of approximately 680 feet above sea level and lasted about 300 years During this period, a minor and temporary ice retreat to the northeast opened a new lower outlet to the Mohawk River valley in New York and

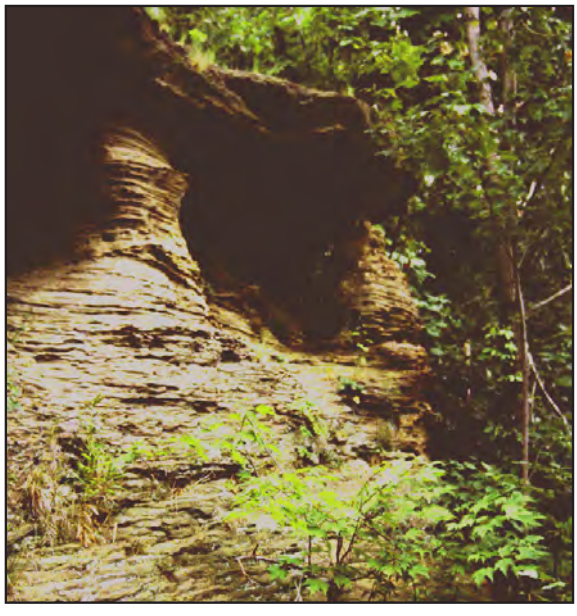



*Beach ridges of the glacial lakes in north central Ohio, showing the position of Lakes Warren and Wayne beaches, the causative factor in the formation of North Ridge (after Forsyth 1959).*




*Detailed map of beach ridges formed by glacial lakes in Sheffield and Avon (after Carney 1910).*

the lake fell to an elevation of 660 feet. This lower stage, called *Lake Wayne*, lasted for less than 100 years and was ended when the ice readvanced and the *Lake Warren* stage was reestablished. Thus, as one travels along the ***North Ridge Scenic Byway*** a double beach ridge can be seen to the north—first the crest of *Lake Warren* on which the highway was built, then the northward slope of the ridge for a few hundred feet to a second beach crest created by *Lake Wayne*, and finally the slope of that beach toward what at one time was the offshore waters of the lake. Renewed retreat of the ice margin about 12,500 years ago ended *Lake Warren* and eventually led to the creation of the Niagara River and present Lake Erie.



*Wave-cut sandstone cliff on North Ridge.*

*Wave-cut cliff in sandstone outcrop on North Ridge in Amherst, Ohio.*

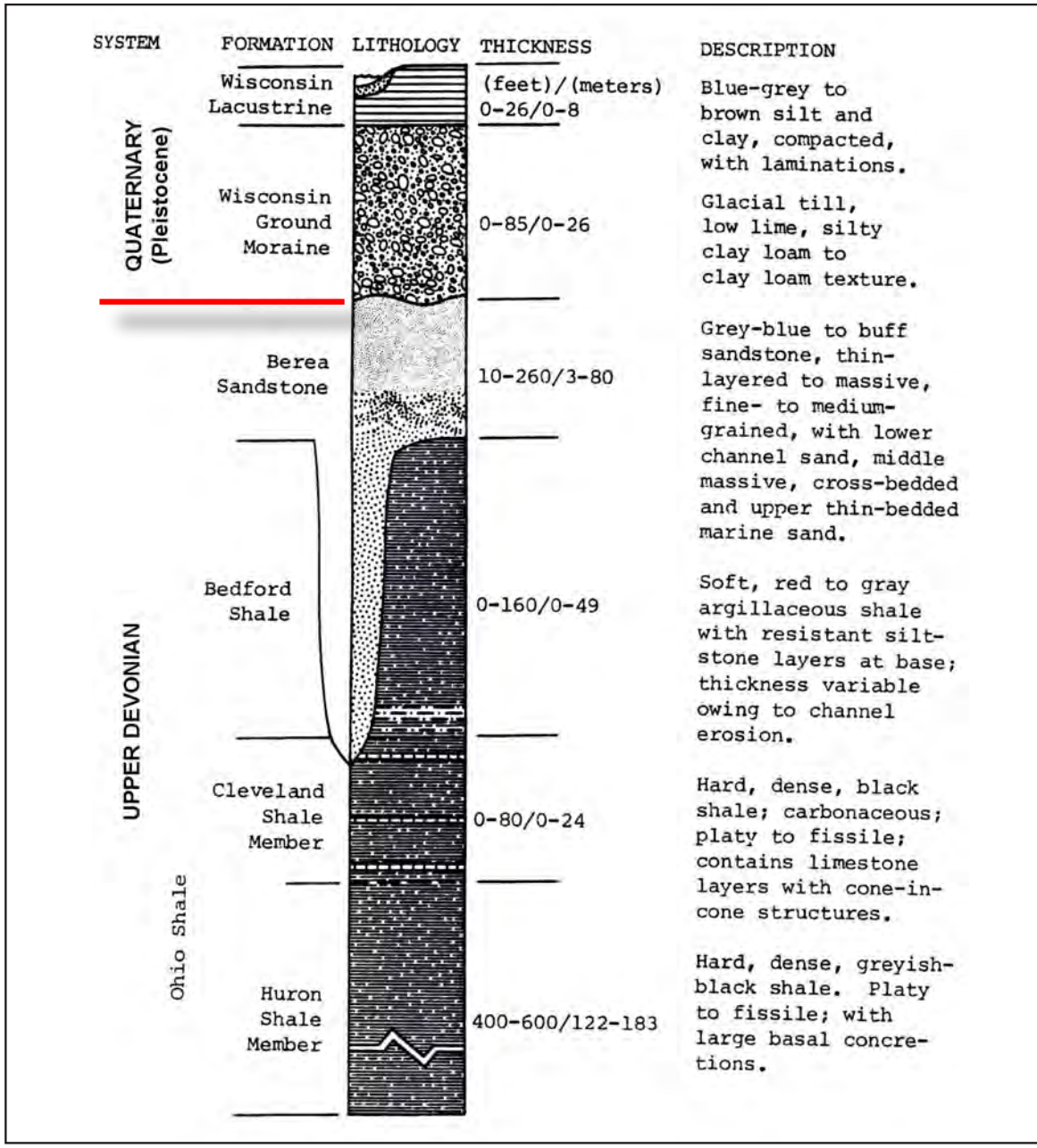
*Ancient Lake Warren beach ridge along Route 254 in Avon.*

*Ancient Lake Wayne beach ridge at the base of the Lake Warren beach ridge in Sheffield.*

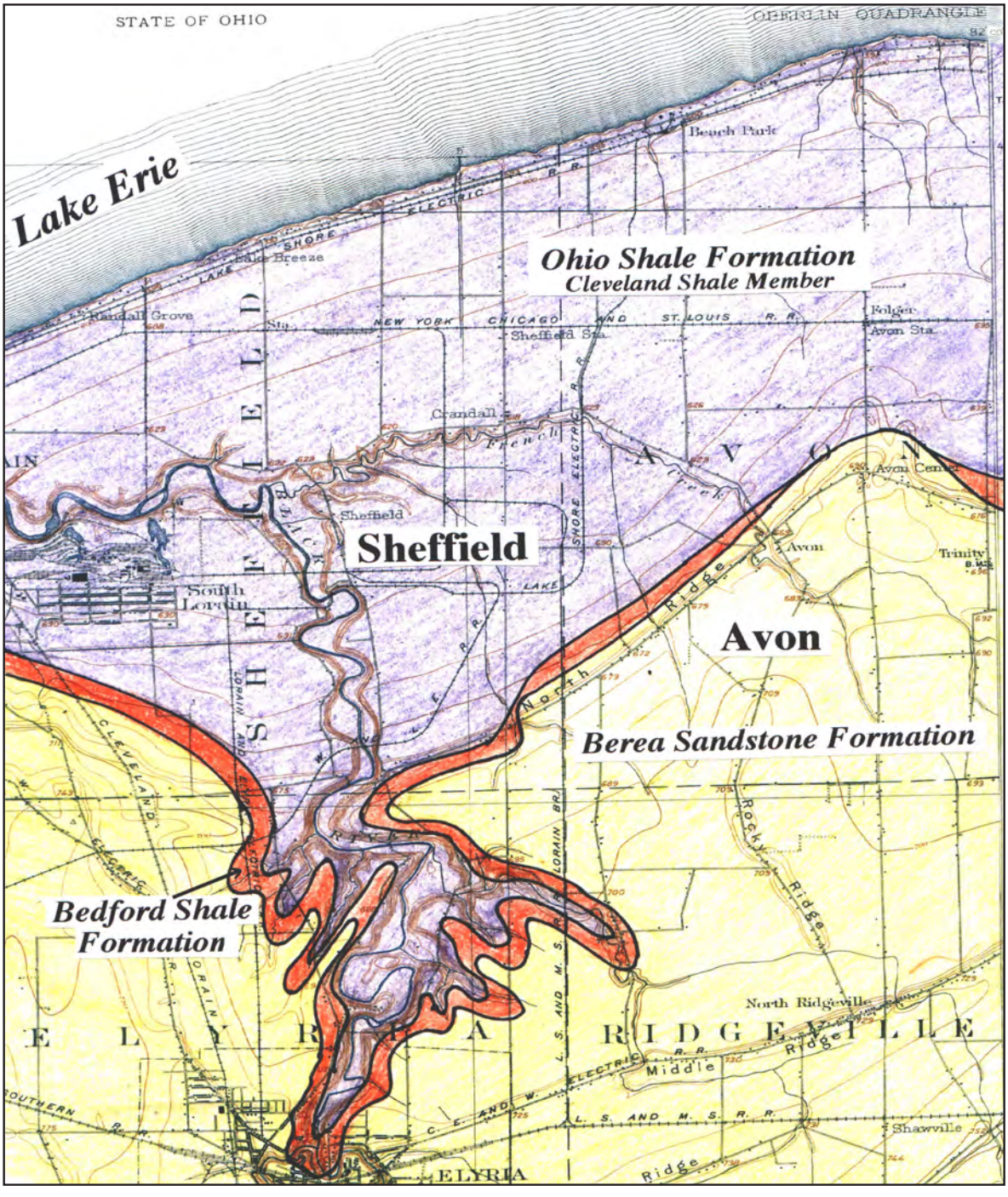
*Lake Warren beach ridge (foreground) and Lake Wayne beach ridge (center right) on the north side of Route 254 in Avon.*

## BEDROCK GEOLOGY

The bedrock underlying the ***North Ridge Scenic Byway*** corridor was formed during the middle portion of the Paleozoic Era—that span of geologic time from 400 to 350 million years ago. These rocks consist of thick beds of shale, thin limestone and siltstone lenses, and massive deposits of sandstone deposited in tropical seas during the Upper Devonian geological period. At that time, the landmass we now know as Ohio was the bottom of a shallow embayment of an ocean known as Ohio Bay, which was located below the equator at about the latitude of present day Polynesian island of Tahiti. As a result of plate tectonic forces, causing continental drift, Africa had collided with North America at that time, pushing up the beginnings of the Appalachian Mountains. Clays, silts and sands from the erosion of theses mountains were deposited in an arm of the sea, known as Ohio Bay, and were eventually compacted into the shale, siltstones, and sandstones that underlie the ***North Ridge Scenic Byway***.




*Geologic column of bedrock found in the vicinity of North Ridge (after Herdendorf 1963).*




*Geologic map of the bedrock found in the vicinity of North Ridge in Sheffield and Avon (compiled from the following sources: Newberry 1874; Cushing et al. 1931; Pepper et al. 1954; Herdendorf 1963).*

The oldest geologic formation along the highway is the Ohio Shale Formation, which is spectacularly exposed in the nearly 100-foot walls of the Black River valley. These black and gray beds can best be observed from Garfield Bridge as one travels east on Ohio Route 254 or on foot from the Bridgeway Trail in the Lorain County Metro Parks' Black River Reservation which passes under Garfield Bridge. This shale formation is noteworthy for fossils of ferocious placoderm fishes and sharks found in these beds, excellent examples of which can be viewed at the Cleveland Museum of Natural History.

The next bedrock formations to be formed, the Bedford Shale and Berea Sandstone

Formations, also had their origin in the creation of the Appalachian Mountains, which in turn was the result of the collision of continental plates—a process know as *plate tectonics*. Toward the end of the Devonian Period, as ancestral North America collided with Africa, the narrow sea that separated these landmasses began to slowly close at a rate of a few centimeters a year. Strong compressional forces from this collision deformed the rocks (folded and uplifted) forming the original northern Appalachian Mountains of eastern North America. At about the same time Europe crashed into the Maritime Provinces of North America (area known as the *Land of Acadia*), forming another belt of folded mountains in Great Britain and Norway known as the Caledonians. This mountain building event has been named the *Acadian Orogeny*. The Appalachians and the Caledonians were part of a single mountain belt where Africa, Europe, and North America came together to form the supercontinent, *Pangaea*. This belt of mountains was comparable to the present-day Himalayas.

*Fossil of a Devonian armored fish (Dunkleosteus terrelli) found in the Cleveland Member of the Ohio Shale (courtesy of Cleveland Museum of Natural History). This fish reached 20 feet in length.*

The collision of the continents folded the Appalachian mountain belt to elevations approaching 30,000 feet. The added weight of the mountain mass depressed the continental crust well below sea level to the west of the folded belt, allowing the ocean to spread over much of Ohio. Volcanic activity, with the formation of lava islands-arcs, was also associated with the early mountain-building process as indicated by a widespread layer of volcanic ash near the top of the limestone beds

*Ohio Shale cliff formed by 12,000 years of Black River erosion at North Ridge in Sheffield.*

that underlie the Upper Devonian rocks. As the mountains began to erode, sand and muds were transported westward and deposited in the interior sea that covered much of the Midwest. An embayment of this sea, known as Ohio Bay, initially received muddy sediment from the north and east. Later, large sandy deltas were formed which eventually became consolidated as the Bedford Shale and the Berea Sandstone.

Following the deposition of the black and gray beds of the Ohio Shale in the deepening sea, uplands to the north contributed red sediments derived from the erosion of tropical soils in what is now Ontario [at this time, Ohio was just south of the equator]. These soils had undergone humid equatorial weathering yielding oxides of aluminum and iron which imparted a red color to the sediments. These red beds (Bedford Shale) formed large deltas into which deep distributary channels were eventually cut. In places, the channels extended down into the black and gray beds of the Ohio Shale. Some of the Bedford beds lost their vermilion color when the sediments were deposited in estuaries where organic matter reduced the iron oxides to yield gray muds. Locally the Bedford sediments contain sufficient amounts of sand and/or silt to form more massive beds or lentils. One of these, the Euclid Bluestone, has been quarried in Cuyahoga County. In Lorain County, a siltstone lentil forms a prominent ledge near the top of the Vermilion River bluff at Mill Hollow Metro Park in Brownhelm Township.

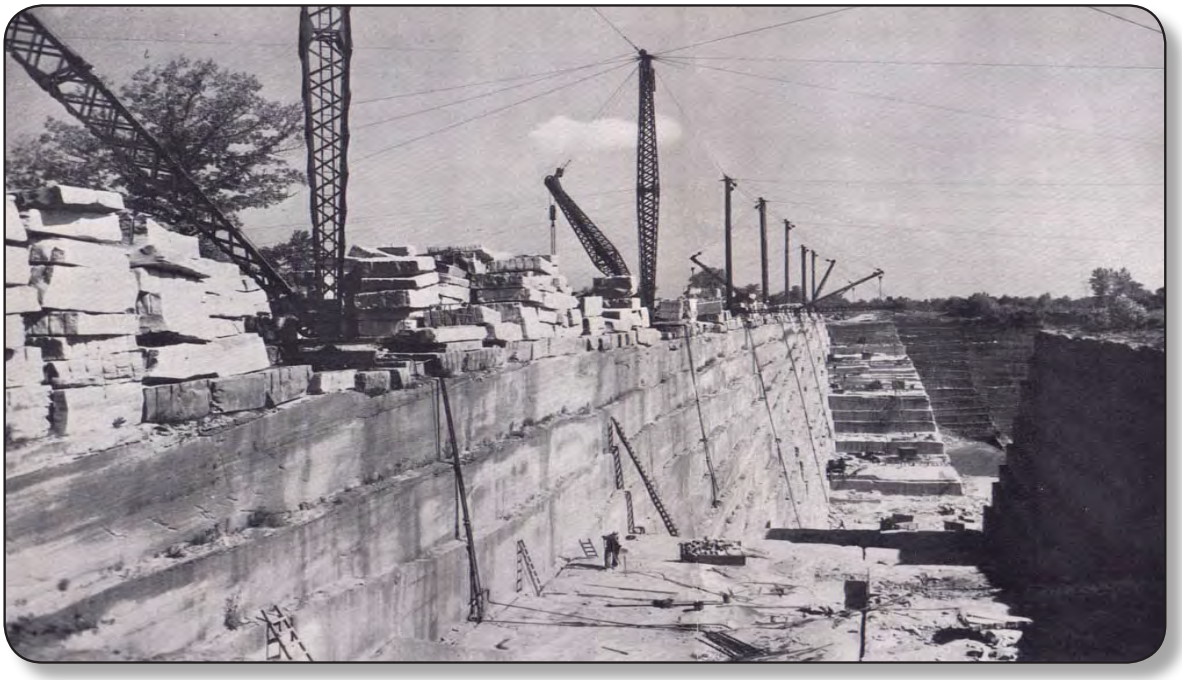
At the close of Bedford Shale deposition, mountain building further uplifted the Ontario region and the introduction of coarser sand sediments into the Bedford streams marks the beginning of Berea deposition. The sand eventually filled and overloaded the stream channels, forming deltas farther offshore, and subsequently spread out over the deltas between the distributaries. Thus, the Berea Sandstone in Lorain County can be divided into three distinct units. The lower unit consists of a channel sandstone present only in isolated areas where the Berea sand fills erosional channels in the Bedford and Ohio Shales. Steep walls, sinuous alignment, and rounded bottom profiles that commonly contain flow rolls and other slump features characterize the channels. Asymmetrical, current-type ripple marks, typical of stream bottoms, are also preserved in the channel sands. The sandstone from the deep channels produces the best stone for construction and was widely used for foundations and door stoops by the builders of early homes on North Ridge. The middle unit contains massive beds that are strongly cross-bedded, indicating deltaic deposition. As the sands were spread broadly over the low plain the upper unit, a thin-bedded marine sandstone, was deposited. It exhibits symmetrical oscillation-type ripple marks, typical of the type formed in a non-flowing body of water where wave orbits have a to-and-fro motion or oscillation. Such ripple marks can be seen in the exposures of Berea Sandstone on the bed of French Creek at Avon Isle Park.


*Creation of Berea delta in Ohio Bay during the Late Devonian period, 350 million years ago. Deposition of these deltaic sediments resulted in the formation of the Bedford Shale and Berea Sandstone (after Pepper et al. 1954).*

*Waterfalls at Cascade Park in Elyria, a cataract formed by the erosion-resistant Berea Sandstone.*

The Berea Sandstone is best exposed in the Black River valley where they create spectacular waterfalls at Cascade Park, about 2 miles south of Route 254, and in the French Creek valley at Avon Isle Park. Because the Berea Sandstone is considerably more resistant to erosion, a northward projection of these rocks in Avon caused the Lake Warren beach ridge to swing northward and correspondingly Route 254 swings north reaching its apex at the Ohio Route 83 junction. Early settlers in northern Lorain County opened a number of quarries in the Berea Sandstone. This stone proved to be very satisfactory for grindstones, building foundations, harbor breakwaters, and exterior walls of buildings, The best quarries were found in Amherst, but local ones, such as Eschtruth Quarry located near the western terminus of the ***Scenic Byway***, produced sandstone material for many North Ridge homes. These quarries are now abandoned.

*Ripple marks in the upper unit of the Berea Sandstone exposed in French Creek at Avon Isle Park.*



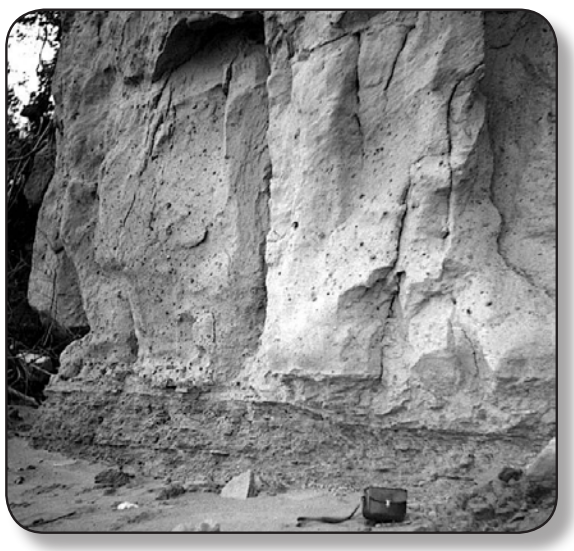
*Cleveland Quarries Company's sandstone quarry No. 7 at South Amherst, Ohio in full operation during the 1960s (courtesy of Amherst Historical Society).*

*Eschtruth Quarry in Vincent, near the intersection of Routes 57 and 254, produced sandstone for many North Ridge homes in the 19th century (courtesy of Albert Doane).*

*Abandoned Buckeye Quarry at South Amherst, once one of the largest sandstone quarries in the world.*

## GLACIAL DEPOSITS

A long period of erosion ensued following the deposition of these Upper Paleozoic rocks and little is known of the geologic processes in the area for nearly 350 million years. Here, the geologic record stops until the glacial deposits of the Pleistocene Epoch of the Quaternary Period, which began less than a million years ago. The glacial deposits in the corridor are ground moraines composed of *till*—a mixture of clay and rock fragments including erratic boulders—deposited by at least four glacial episodes, as well as the sandy deposits of the abandoned beach ridges, on which early trails and roadways were developed. Throughout most of the ***Scenic Byway*** corridor the bedrock foundations are masked by glacial-period deposits, at places up to a depth of 15 to 20 feet.



*Glacial till bluff along the Lake Erie shoreline. Note rock fragments embedded in the till.*

*Glacial till overlying Ohio Shale beds along the Lake Erie shoreline.*

*Soils of North Ridge. The light colored soil in the foreground is Oshtemo sandy loam formed from beach ridge parent material. The darker soil in the background is Mermill loam, a wetland soil formed in ancient lake deposits.*