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Ohio Before Ohio

State Geology and Topography

The history of Perry County, which sits in predominantly rural south central Ohio, is in many ways representative of the history of the state as a whole. The northern half underwent several phases of glaciation while the southern half lies in the more rugged unglaciated Allegheny Plateau. Lying just to the south of the famous prehistoric Newark Earthworks and Flint Ridge quarries, the county has numerous Woodland-period mounds as well as much older outcrops of the Flint Ridge and Upper Mercer flints that Ohio's earliest inhabitants prized highly. The county boasts several locations on the National Register of Historic Places, including Somerset's Saint Joseph's Church (the state's first Catholic Church) and Somerset's Old Courthouse (the oldest continuously used public building in the Northwest Territory). Although agriculture has always been important to the county other commercial pursuits have traditionally driven its economy. The National Ceramic Museum and Heritage center in Roseville celebrates only one of the many industries that once flourished in the area. Salt-making, centered in McCuneville, was the county's first industry, followed soon thereafter by lime production in Maxville. By the middle of the nineteenth century mining started in earnest, and for a while Perry was the largest coal-producing county in the state, with major operations in the "black diamond" region of Shawnee, Congo, and New Straitsville. This combined with locally produced lime and the iron ore, found primarily in the southern part of the county, gave rise to a significant smelting industry with as many as seven blast furnaces operating within the county by the late 1800s. Commercial production of gas and oil in Corning and Junction City had augmented this economic boom by the early 1890s with the county reaching its peak population in the 1920s. As with the rest of the Appalachian region, Perry County faced increasingly difficult times starting with the Great Depression and has never fully recovered

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from the decline of its mining and iron industries. By the late twentieth century the county experienced increasingly low median incomes and high unemployment. Nevertheless, the county is still home to some of its historic industries, including the ceramic manufacturers Petro Ware in Crooksville and CertainTeed Corporation/Ludowic Roof Tile in New Lexington (the world's largest roofing tile firm).

However well Perry County may represent the highs and lows of Ohio's social and economic development it is an even better exemplar of the significance of Ohio's geology to its development. The flint obtained from Flint Ridge, which was such a valuable resource for early Native American groups, was a product of a unique set of silicon dioxide deposits made during the Pennsylvanian period. The saltwater that created Perry County's early salt mining industry was a remnant of Silurian period seas that covered the area, and one can trace its lime industry to the shells of the creatures that lived in those seas. The clays that formed the basis of the county's enduring ceramic industry—as well as the bricks that make up Saint Joseph's Church and Somerset's Old Courthouse—were drawn from deposits made by Mississippian and Pennsylvanian seas and by glaciers that came hundreds of millions of years later. The iron ore processed by Perry County blast furnaces, as well as the coal that made them run, came from the Pennsylvanian period, while the limestone used as flux to remove impurities from the iron came primarily from the Devonian and Mississippian periods. Life forms from these periods probably formed the gas and oil that Ohioans began to use in the late nineteenth century. The 21 percent of Perry County's land that is used for agriculture has a complex geological signature with the rich soil having developed from both the erosion of ancient rock strata and relatively more recent glacial deposits. Although most residents there probably give it little thought, Perry County's history has been at least half a billion years in the making.

This case study of just one of Ohio's eighty-eight counties shows how important an understanding of Ohio geology is to understanding its history. To comprehend what happened to Ohioans through the ages, it is first necessary to appreciate what went on beneath their feet. Their stories and lives, explored in this book, are inextricably entwined with the nature of the land.

Geology

The substructure of Ohio can be thought of as a kind of multilayered cake that has been pushed up from the bottom and shaved off the top, leaving slanting edges of layers exposed on the surface. This differential exposure has given different regions of Ohio different surface rock types and resources. Each of these exposed strata, plus others that remain buried far beneath the surface, are the product of millions of years of geological processes. Figure 1.1, a geologic map of Ohio, shows the formations beneath Ohioan's feet.

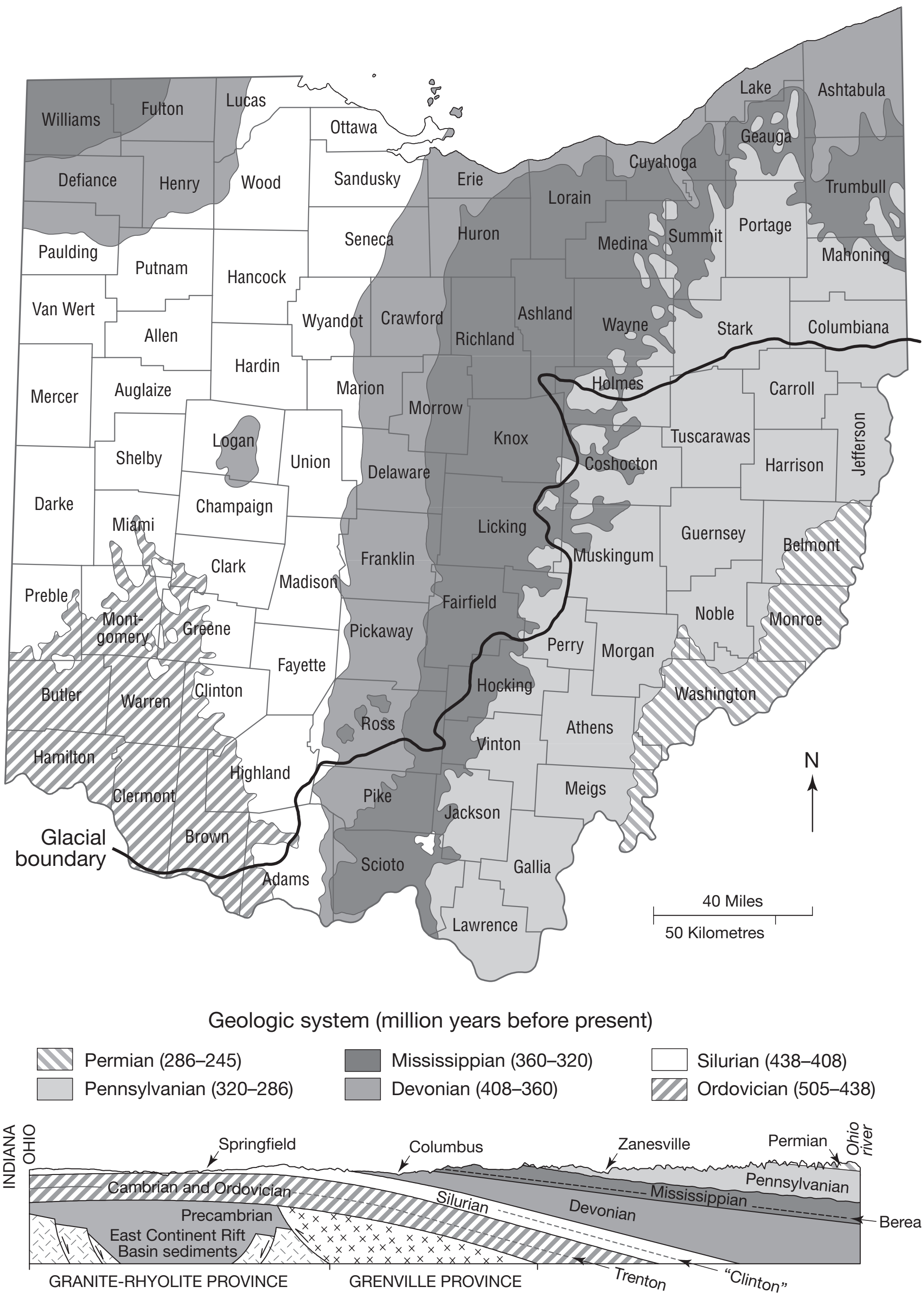

Figure 1.1 Geologic map and cross-section of Ohio.
Source: Ohio Department of Natural Resources, Division of Geological Survey

Precambrian era

The oldest, "basement," layer of Ohio's substructure is a several-mile-thick and multilayered sheet of igneous and metamorphic rocks laid down between 1.5 billion and 800 million years ago. The most notable feature of this layer is the eastern edge of the "Granite-Rhyolite Province," an uprising or "superswell" in the earth's mantle under what is now Ohio and states farther west. This extending and splitting of the crust created a deep feature called the East Continent Rift Basin. At about the time that the superswell activity ceased, the continent that would become North America—of which Eastern Ohio lay on the edge—collided with another protocontinent to the east. The impact caused significant compression of the crust, the formation of faults, and a prehistoric range (known as the Grenville Mountains) that was gradually worn down over the following hundreds of millions of years.

Ohio's Precambrian layer is not visible anywhere in the state, lying anywhere between 2,500 and 13,000 feet below the surface. Although it cannot be seen sometimes it can be felt. The relatively minor earthquakes that sometimes occur in Ohio arise from the rifts and faults of its basement layer.

Paleozoic era

At the end of the Precambrian era (about 570 million years ago) the continent that became North America began to separate from the one it had collided with 300 million years earlier. Sitting on the edge of the continent Ohio was engulfed by the body of water geologists call the Iapetus Ocean. For most of the next 300 million years much or all of Ohio lay under water. This era is known as the Paleozoic and it marked by the proliferation of multicellular marine life forms worldwide. This era is the most significant to Ohio geology, not only because of the various resources these life forms left behind, but also because nearly all of the strata that comprise Ohio's current surface were laid down during this time.

Cambrian and Ordovician periods

When the Iapetus Ocean flooded what is now Ohio it brought new geologic processes to bear on the landscape. It deposited layer after layer of silt, sand, mud, as well as shells and skeletons of countless sea creatures over the course of what is known as the Cambrian period. During the early Cambrian period most of Ohio was under a relatively shallow, tropical ocean shelf that left a thick layer (as much as 400 feet in some places) of sandstone. An above-water feature that geologists call the Kerbel Delta formed in north and central Ohio during the middle Cambrian period. At the same time ocean waters began to rise. By the late Cambrian and into the Ordovician period (505–440 million years ago), the entire state was again covered by a warm, shallow sea. Although low muddy islands emerged periodically in the western part of the state the sea eventually reclaimed all of the state by the later Ordovician. At this time, a growing abundance of more complex life forms appeared and flourished.

Sponges, jellyfish, bryozoans (and their coral cousins), brachiopods (clamlike creatures), trilobites (one type of which, *Isoletus*, is Ohio's official state fossil), cephalopods (ancestors of octopi and nautiluses), echinoderms (related to sea stars), snails, and even primitive fish left their traces in the geologic record—not only as fossils, but also as the ever-deepening layers of calcium carbonate from their shells and skeletons. These became the earliest layers of Ohio limestone that were hundreds of feet thick in some places. It is upper Ordovician strata that formed a large island known as the Cincinnati Arch in southwest Ohio. Sitting at the top of the Precambrian superswell these layers are the oldest surface rocks in the state.

Silurian and Devonian periods

At the end of the Ordovician, an ice age in the southern hemisphere (where Ohio was then located) reduced sea levels, making Ohio into dry land by the beginning of the Silurian period (440 million years ago). Warm shallow seas returned and by the middle Silurian they deepened and blanketed all but the most southeastern part of the state. By the late Silurian the seas abated again and had all but dried up by the time the Devonian period began (about 410 million years ago). The retreating Silurian seas left behind vast beds of halite (salt) and gypsum as well as more layers of limestone and shale. By the early Devonian period most of Ohio and parts of Kentucky and Indiana were part of a large island surrounded by tropical waters that lapped the eastern Ohio shore. The first true land plants grew in Ohio at this time. By the middle Devonian period shallow seas once again covered Ohio. The remnants of the shells and large coral reefs of this period became another thick layer of limestone this time with numerous fossils of fish embedded in it. By the late Devonian period, increased volcanic activity from mountain building to the east not only blanketed the area with toxic ash but also created fast-flowing rivers that dumped immense amounts of mud into the increasingly stagnant and lifeless late Devonian sea. These deposits make up the Ohio Shale, which also contains numerous iron concretions and pockets of natural gas (see Figure 1.2 for Ohio's major shale regions). Silurian and Devonian strata make up much of today's surface stone of western Ohio.

Mississippian and Pennsylvanian periods

The ebb and flow of prehistoric seas continued for the rest of the Paleozoic era. The increasingly muddy waters of the late Devonian period continued into the early Mississippian (starting about 360 million years ago) and then eventually gave way to more silt and sand deposits as the period progressed. The early Mississippian mud turned into the Bedford Shale, while the later sandy deposits became the Black Hand and Berea sandstones. A late Mississippian sea laid down more limestone before retreating at the end of the period. Land plants became increasingly abundant during the periods of sea retreat, a trend that continued into the Pennsylvanian period (325–286 million years ago). As the Mississippian sea retreated, much of eastern Ohio became a large delta onto which flowed the pebbly erosion from mountains to the north and east. This eventually created an abundant rock known as the Sharon Conglomerate. In time, a vast tropical swamp forest stretched throughout much of the Pennsylvania, Ohio, West Virginia, Kentucky, and Indiana areas, leaving millions of years of organic deposits. These forested swamps were periodically overtaken by advancing

Figure 1.2 The extent of shales in Ohio.
Source: Courtesy of the State of Ohio Environmental Protection Agency

seas, which buried the plant and animal material under layers of sand and clay, with the cycle repeating many times. The marine-formed strata became new layers of limestone, the silica-rich Middle Pennsylvanian Vanport Limestone in particular, that formed the famous Flint Ridge flint. The Upper Mercer Limestone of the Pottsville formation, which created the prized black flint from Coshocton County, also came from this period. As the layers from the advancing and retreating seas accumulated over the course of the Pennsylvanian period, they created enough pressure on lower strata to convert the trapped swamp forest-life deposits into coal.

Most of the surface rocks seen today in eastern Ohio were created during the Late Pennsylvanian period. Known as “the coal measures,” these alternating layers of shales, sandstones, limestones, clays, and coals—up to 2,000 feet thick in some places—suggest numerous episodes of the swamp forest-to-sea cycle. The seas retreated from nearly all of Ohio permanently at the end of the Pennsylvanian and, apart from a narrow band in extreme southeastern Ohio that was a coastal swamp during the Permian period (286–248 million years ago), no further geological strata developed in what became Ohio. However, over the next quarter of a billion years many other processes altered the Ohio landscape significantly.

Topography

Several major factors since the Permian period helped to create Ohio's current landscape. The most significant of these have been orogeny (mountain building) and glaciation (the formation and movement of glaciers) and their effects that include erosion, river and lake formation, and the creation of soil through the deposition of material brought by glaciers (glacial till) and vast amounts of wind-blown silt that accompanied them (loess).

Allegheny uplift

To the east of what is now Ohio the tectonic plate that carried most of North America began to collide with another one as early as the Late Mississippian period to help create the supercontinent of Pangea. Over the next several tens of millions of years these plates ground together, folding and thrusting up the earth at its boundaries to create the Allegheny Mountains. These were originally much higher and rockier. This process continued until the Late Permian period when what is now the North American continent began to move north from its traditionally tropical latitudes on its way to its present location. Although the mountain formation did not occur in what is now Ohio the process significantly altered Ohio's topography. First, the tectonic collision uplifted the entire area, which helped to cause the final retreat of the seas that had periodically flooded Ohio during most of the Paleozoic era. Today, Ohio's mean elevation is 850 feet (259 meters) above sea level. Ohio's lowest point (on the Ohio River where it exits the state) has an elevation of 455 feet (139 meters). Second, over the course of the Mesozoic and Cenozoic eras that followed the Paleozoic, the uplifted plateaus of eastern Ohio began to receive rivers and erosion from the new mountain chain to the east, as well as experience its own weathering and erosion. These forces created the hilly Appalachian Plateau, the characteristic topography of eastern Ohio.

Teays River

At some point during the Tertiary period of the Cenozoic era (roughly 65 to 2 million years ago) a great river rose on the western side of the Appalachians in what is now western North Carolina near Blowing Rock and flowed north and west. Geologists call this river and its tributaries the Teays River system. At one it time drained much of the east-central United States, including Ohio. Entering Ohio in Scioto County and proceeding north, the Teays then proceeded west through the state to Mercer County on the Indiana Border, ultimately flowing into an arm of the Gulf of Mexico that at one time extended up the current Mississippi Valley to southern Illinois (some geologists suggest that the river instead continued to flow north to an extinct river system where Lake Erie is now). As wide as two miles in places, this river cut a broad swath through the Ohio countryside and carved a number of flat-bottomed valleys, some of which are still the beds of contemporary rivers in the southern part of the state. Now buried as much as 500 feet deep in places in northern Ohio, the old Teays riverbed still serves as an aquifer supplying well water to communities living above it.

Glaciation

The reason there is no Teays River today—and indeed the reason why there is an Ohio River instead—can be attributed to the last major event that dramatically affected Ohio's topography: the advance and retreat of glaciers. By the late Cenozoic period the North American continent had more or less arrived at its present latitude, and the climate was considerably cooler than it had been for most of the previous eon. In addition, by the middle of the Pleistocene period (about 1.8 million to 10 thousand years ago) the climate of the entire earth began to cool, and ice caps began to form on earth's polar regions. Around 300,000 years ago, the Laurentide Ice Sheet to the north began a series of glacial advances southward and retreats northward that did not cease in Ohio until about 14,000 years ago. Glaciers are huge juggernauts of ice that move very slowly but scour and rearrange the earth's surface dramatically in their wake. As a result, scientists know relatively little about the specific effects of most early glacial episodes because subsequent glaciers scraped away much of the evidence their predecessors left behind. They do know, however, that these numerous ice sheet advances and retreats significantly altered Ohio's landscape through both erosion and deposition, and the legacy of the glaciers largely explains most of the topography of northern and western Ohio.

Pre-Illinoisan and Illinoisan stages

The first period of glaciation was a series of as many as eleven separate glacial events collectively known as the Pre-Illinoian stage (also known as the Kansan and Nebraskan glaciations) from about 1.8 million to about 300,000 years ago. Although much of the evidence of this event in Ohio became obscured by subsequent episodes, part of Hamilton County in southwest Ohio untouched by other ice sheets reveals evidence of this earliest set of glaciations. This area is marked by ground moraines, which are gently rolling hills of material that were deposited under the moving ice (see Figure 1.3). Similarly, a larger section of southwest Ohio and a ribbon of territory stretching northeast from Ross to Richland counties (see Figure 1.1), as well as another thin sliver in Stark and Columbiana

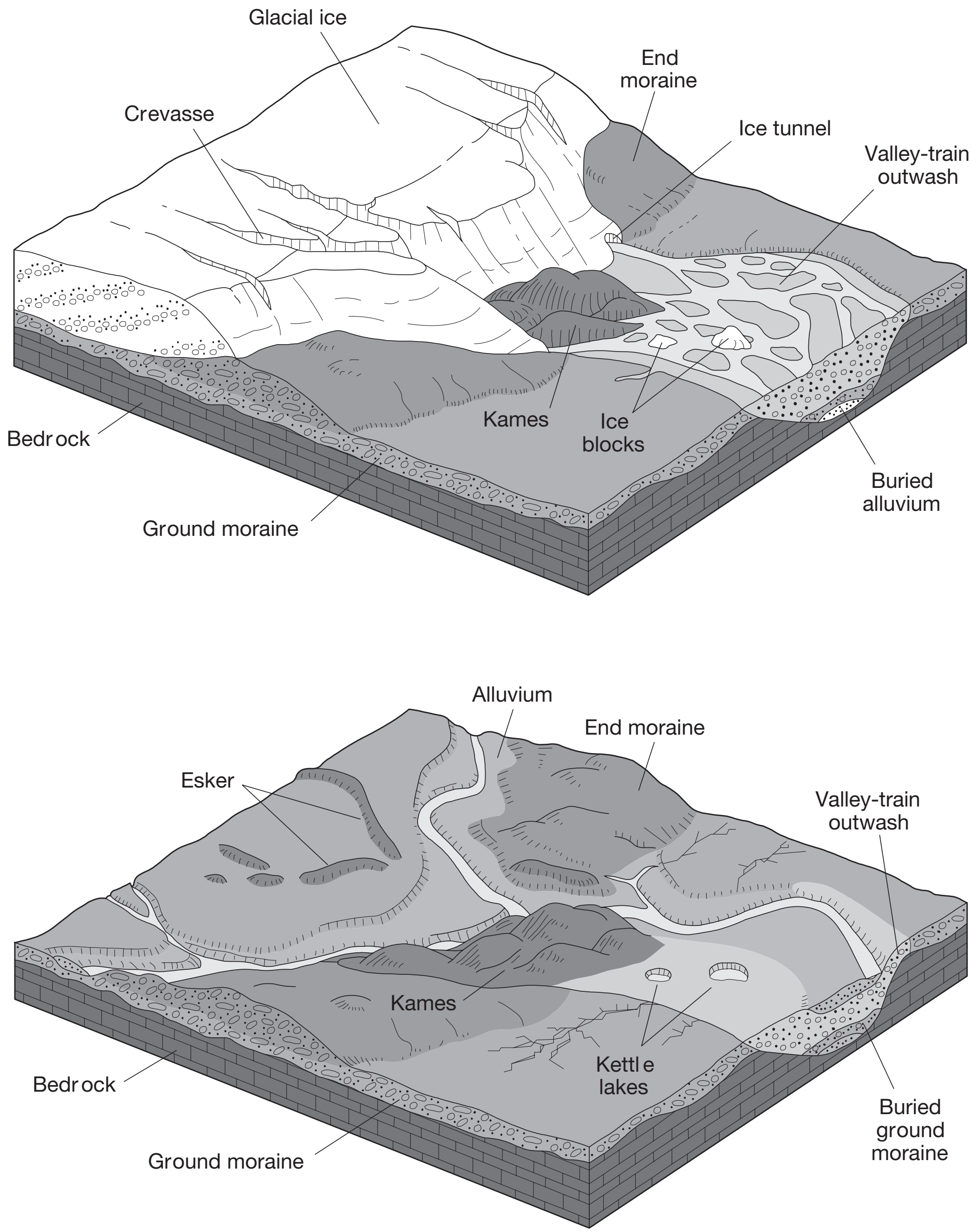

Figure 1.3 Landscape form at the maximum extent and after the retreat of ice.
Source: Ohio Department of Natural Resources, Division of Geological Survey

counties, shows evidence of unsorted rocks, gravel, and other material (till) left over from the Illinoian Stage of glaciation (two periods lasting from 300,000 to 132,000 years ago).

Besides scraping and redepositing material throughout the north and western parts of the state, these early glacial periods also fundamentally changed other aspects of Ohio's landscape. The Pre-Illinoian stage glaciers, for example, destroyed the Teays River system by blocking its path and covering its bed with as much as 500 feet of sediment. Dammed by the glacier, the waters of the Teays created a vast lake in southern Ohio and parts of West Virginia and Kentucky. Called “Lake Tight” by geologists, it was nearly 900 feet deep and up to 7,000 square miles in size (about 70 percent the size of modern Lake Erie). Lasting thousands of years, Lake Tight not only deposited large quantities of clay in central Ohio but it also eventually overcame ancient drainage divides and redirected new drainage channels to the south. This new drainage pattern (known as “Deep Stage”) was the beginning of the modern Ohio River.

Wisconsin glaciation

The last major advance of the Laurentide Ice Sheet started about 40,000 years ago and is the most recent stage of the Wisconsin glaciation. Moving about 160–220 feet per year it took the glacier 6,000 years to make its way into Ohio and another 12,000 years to make it to the middle of the state. It advanced irregularly, with major lobes protruding down the Miami and Scioto River valleys, and smaller ones advancing up the Killbuck Creek and Grand River valleys to the east. At its peak, the Wisconsin Glacier was at least a mile thick over modern-day Cleveland and 50 to 200 feet thick at its edge, which stretched from Hamilton County in the southwest to Columbiana County in the northeast. This stage of glaciation ended in Ohio about 14,000 years ago but it continued to have an effect on the state’s environment and landscape for thousands of years afterward.

Glaciation fundamentally altered the landscape of much of Ohio. The scraping action of rocks and debris trapped in the glacier scouring the surface below can be seen most dramatically in the deep grooves cut into rocks on Kelleys Island in Lake Erie (see Figure 1.4). However, these same phenomena had a much larger impact, broadening and deepening entire river valleys and eroding hills wherever the glaciers advanced and depositing their collected materials in various ways as they retreated. Apart from spreading vast general deposits of till found throughout the northwestern part of the state, the glaciers also left numerous topographical features. “Terminal” and “recessional moraines” are elongated ridges of till left from the edge of glacial advances that can be as high as 100 feet. The Wabash Moraine, for example, is a glacial ridge that stretches from Celina on the western side of the state all the way to Akron on the east. The Defiance Moraine (Ohio’s northernmost) that runs from the south of Cleveland to Defiance, is the reason for the large ridge that runs through the otherwise fairly flat landscape of Seneca and Hancock counties.

Some of the topographical features left by the Wisconsin glaciers were caused by the melting process as a glacier retreated. Kames, for example, are large mounds of material deposited by water melting at the edge of an ice sheet. The highest concentration of kames in Ohio lies in Portage, Stark, Summit and Geauga counties, but they can also be found in dozens of other counties throughout the state. Kames are often accompanied by kettles, small ponds or lakes formed by melting blocks of ice left in depressions among kames by a retreating glacier. The waters from retreating glaciers also left their marks on the landscape, distributing sands, clays, gravels, and other debris in outwash areas of the glacial edge. These waters eventually fed and deepened the new streams and channels that became Ohio’s modern river system. The redirection of the old Teays drainage into the more recent Ohio

Figure 1.4 The glacial grooves on Kelleys Island in Lake Erie demonstrate one of the powerful ways in which glaciers could change the landscape. Here, they scoured deep gashes hundreds of feet long into the limestone bedrock of the Island before retreating.
Source: Ohio Department of Natural Resources, Division of Geological Survey

River Valley is just one manifestation of the transformative nature of glaciers on Ohio's natural drainage. Ohio's current "continental divide"—a line that runs across the northern third of the state and marks the boundary between waters that ultimately flow to the Atlantic via Lake Erie and those that end up in the Gulf of Mexico—is a product of glacial action (see dotted line on Figure 1.5).

One of the most significant changes caused by glaciation in Ohio was the effect it had on the formation of the Great Lakes, particularly Lake Erie. By scouring and deepening the lake basin from a previous river valley and filling it with melting water, the Laurentide ice sheet essentially created Ohio's "North Coast." "Lake Maumee," which these melt waters created about 14,000 years ago, was a larger presence in Ohio at one point, keeping much of the northwestern part of the state underwater for thousands of years. Not only did this extension of what became Lake Erie deposit a layer of silt that gave northwest Ohio its distinctive soils, but it also left the Great Black Swamp in its wake, a feature that existed until settlers drained it in the nineteenth century.

Thus, the current topography of Ohio is the product of events stretching from hundreds of millions to just a few thousand years ago. Straddling both the Appalachian and Central Lowlands systems of North America, contemporary Ohio features five distinct landform regions as defined by geologists. The largest of these is the Till Plains, which make up most of the western part of the state (see Figure 1.5). Generally characterized by

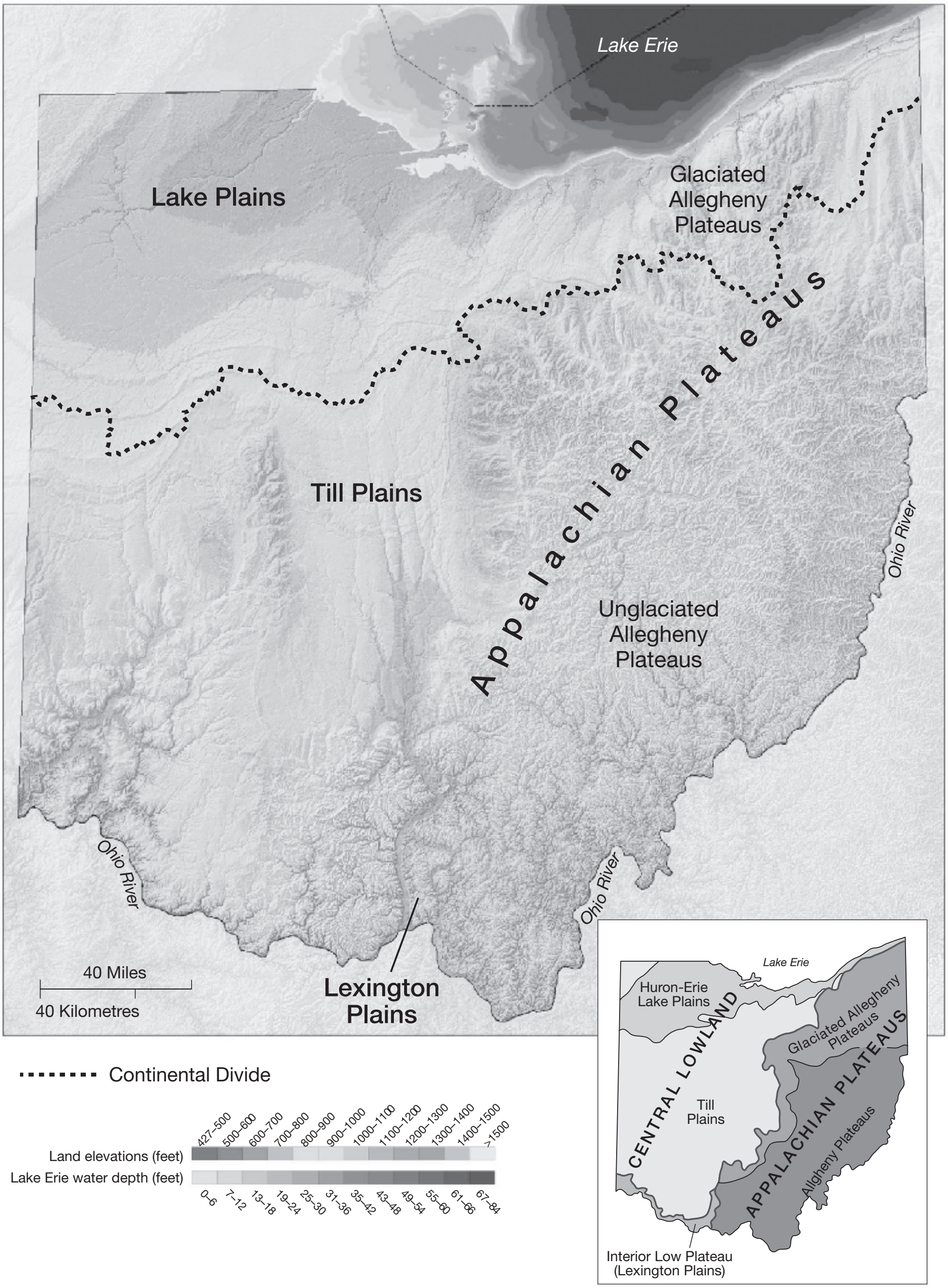

Figure 1.5 Elevation map of Ohio.

flat or rolling landscape, the Till Plains get their name from the vast amounts of till deposited there when the region was glaciated. The Lake Plains stretch from the southern shore of Lake Erie deep into the Maumee Valley of northwest Ohio. Predominantly flat and covered with the sediments of various stages of lake development, the Lake Plains hold many features that reflect their origin including: terraces left by fluctuating lake levels over the years, beach ridge formations, and elevated sand ridges where prehistoric beaches once stood.

The plains of the western part of Ohio give way to the Appalachian Plateau of the east. The Glaciated Plateau, an ever-widening band stretching from Ross County in south-central Ohio to encompass most of the northeastern part of the state, is comprised of the part of the Allegheny Plateau once covered by glaciers. Here, the glaciers leveled the topography by eroding hills and filling valleys. They also created new topographical features by leaving kames, kettles, and new watercourses as well as expanding and deepening other valleys. The Unglaciated Plateau is the most southeastern quarter of the state that remained untouched by the various glacial episodes of the Pleistocene series. As a result it is still a very rugged and hilly remnant of the uplift and erosion of the Appalachians. Soil quality is relatively poor here apart from the river valleys that cut deep into the landscape. The only other general landform represented in Ohio is a finger of land extending from Northern Kentucky into Adams County and parts of Brown and Highland counties. Called the Lexington Plain (or "Bluegrass region"), it is geologically part of an eroded dome called the "Cincinnati Arch"—part of the continent's Interior Low Plateau characterized by flat-topped hills and sinkholes from the erosion of underlying limestone and dolomite layers.

Importance of Ohio Geology and Topography

Although history ultimately concerns itself with the past actions of human beings, it is impossible to understand these fully without a basic knowledge of the land on which they lived. Ohio's topography has always had a significant and varied influence on its inhabitants. Culturally, for example, the kames were some of the earliest known burial locations for Native American groups and many archaeologists believe the kames inspired the mound-building activities of Woodland-period populations. Demographically, the topography of Ohio has deeply influenced population size and settlement patterns throughout the state's history. The best example of this is the fact that the Seven Ranges—the first western public lands opened for sale by the new United States in the 1780s—remain to this day one of the most sparsely-populated areas of the state due in part to its largely unfavorable terrain. Similarly, the swampy areas of northwest Ohio diverted significant U.S. settlement around it to the north and south until the middle of the nineteenth century. What settlement did occur in this area—from prehistoric times until it was largely drained in the late 1800s—was along the elevated glacial moraines and beach ridges left over from glaciers and earlier lakes.

Entire books could be written just about the cultural and demographic significance of Ohio's geology and topography. However, perhaps the most direct and lasting influence these phenomena have had has been the materials they created and the landscape they formed. These minerals and other resources ultimately drew and sustained the millions of people who have lived in what is now Ohio, and have in many ways defined Ohio's historical development.

Minerals

The extraction of minerals has, since prehistoric times, played an important part of the human experience in Ohio. Perhaps the most significant early example of this is the Vanport or "Flint Ridge" variety of flint from Pennsylvanian-period quarries, which was not only highly favored by early Ohio tool makers but was also an important trade item that came to be distributed widely throughout eastern North America. Prehistoric populations also took salt from Ohio's salt springs and turned its clays into ceramics. However, it is the industrial use of minerals that has defined Ohio's development over the past two hundred years. Even though much of Ohio's industrial base had withered by the late twentieth century eighty-six of its eighty-eight counties still extract at least one mineral commercially.

Salt

Salt (or halite) is one of the oldest extracted minerals in the state, most of it being the product of Silurian seas. It was also one of the first minerals to be gathered by humans: archaeologists have discovered that Native Americans made use of Ohio's salt water springs as early as 8,000 years ago. Salt production from boiling the brine from salt licks in large kettles became the first modern industry practiced by European settlers in the late eighteenth and early nineteenth centuries. The resource was considered so important that just weeks after becoming a state the new government passed legislation regulating public salt works and forbidding the state to sell its salt lands in present-day Jackson County. Ohio was the nation's leading salt producer by the time of the Civil War and the discovery of large rock salt deposits near Cleveland in the late 1800s introduced large-scale industrial mining techniques to northeast Ohio. Large underground mines continue to operate near Lake Erie in Lake and Cuyahoga counties, and brining operations (pumping superheated water into underground salt beds and evaporating the resulting brine) take place in Barberton, Rittman, and Newark. Even at the turn of the twentieth century, Ohio still ranked fourth nationally in salt production, with over $100 million in annual sales. Although some of this salt was used as additives for animal feed and water-softening agents, most of Ohio's salt made its way back to the ground in the form of ice control on highways, streets, and sidewalks.

Clay and shale

Clay was another mineral used extensively by prehistoric Native Americans and early U.S. settlers in Ohio. As the next chapter will demonstrate, Native American groups made ceramics from Ohio clays for millennia, and people in the first official U.S. settlement at Marietta made bricks from local clay in the 1780s. Early brickworks and ceramic operations tended to use more recent, glacial-era clay deposits, but as industrial ceramic operations began to grow, the plentiful Mississippian and Pennsylvanian shale strata became increasingly popular raw materials. Eastern Ohio was the primary focus of the ceramic industry, which by the late nineteenth century was one of the state's most important. Brickworks abounded with the demand caused by the rise of industrialization, and they consumed increasing quantities of the clay and shale mined from the Early Mississippian Bedford Shale found in Franklin County. Major stoneware operations developed in New Philadelphia and elsewhere, and businessmen in Akron used the large deposits of native clays found in the region to make the city (for a while) the sewer pipe and toy marble capital of the world. Most of the pipes (agricultural tile) that farmers used to drain the old Black Swamp in Northwest Ohio came from factories processing locally produced clay. Although most of Ohio's ceramic products were utilitarian in nature, the Roseville Pottery Company began producing highly regarded artistic pottery by the start of the twentieth century. Clay and shale continue to make significant contributions to the Ohio economy, with the $15 million worth mined in 2006 ranking seventh nationally. Much of this was destined for use in Ohio industries, including bricks, ceramics, tiles, cement, and landfill covers and linings.

Limestone and dolomite

One of Ohio's most useful and plentiful natural resources comes from the numerous layers of aquatic shells and skeletons that built up from the Ordovician through the Mississippian periods. Limestone (primarily calcium carbonate) and its geological and chemical cousin dolomite (primarily calcium magnesium carbonate) are so versatile that they have been called "the duct tape of geologically derived materials." Major types of limestone found in Ohio come from virtually every period of its geologic past: from the Ordovician Black River group, to the Silurian-derived Brassfield formation of limestone, dolomite, and shale, to Devonian Columbus and Dundee limestones, to the Upper-Mississippian Maxville Limestone, to the Pennsylvanian Putnam Hill and Vanport Limestones. Found in nearly every part of the state, limestone and dolomite have been and continue to be one of the state's most important economic resources. In 2003, 114 mines in 50 counties produced 78.2 million tons.

Early industrial uses for limestone and dolomite in Ohio included the production of lime and building materials, which continue as the primary use of these minerals. First used as the key ingredient of plaster and whitewash, lime soon played a major role in the nascent iron and steel industries of the mid-nineteenth century, as both a flux to remove impurities and as lining for steel furnaces. In the twentieth century, lime's uses expanded to include the chemical industry, notably in the production of rubber. As a building material, Ohio limestone served early settlers of the state as foundation stones, hearth stones, and windowsills. The primary construction use of these materials since the mid-1800s has been as an additive for cement and as aggregate for concrete and asphalt. This continues to be the final destination for most of the limestone and dolomite mined in Ohio. Other uses for these minerals include water purification, sugar refining, glass-making, and the production of heavy chemicals, fertilizers, chalk, paper, plastics, antacids, and porcelain. As a result of its many uses, and because of Ohio's abundant supply, limestone and dolomite have been a rare constant in Ohio's economic profile throughout its industrial history. At the time of Ohio's bicentennial (2003) the state still ranked fourth nationally in the production of lime and fifth in the production of crushed stone (which also includes some sandstone). This resource has an annual value of more than $500 million.

Sandstone and conglomerate

The Paleozoic seas and deltas that laid down layer after layer of sand created the basis of sandstones that have been highly valued for a number of purposes. Although Sharon Conglomerate from the Pennsylvanian period is abundant and has been mined throughout eastern Ohio, the Mississippian-period Berea Sandstone has traditionally been the most highly prized of all Ohio sandstones because of its physical qualities. Pulled from several locations in northern Ohio locations, it derived its name from the Berea quarries, and put Berea on the map as the "Grindstone Capital of the World." At first valued primarily for use as grindstones and millstones, Berea Sandstone reached its highest profile as a building material. Architects used it in the construction of more than twenty Ohio county courthouses and the state capitol building in Ohio during the late nineteenth century. However, its popularity extended far beyond the state. Such landmarks as the Palmer House Hotel in Chicago, the John Hancock Mutual Life Building in Boston, and Denver's Taber Opera House were built with Berea Sandstone, as were prominent buildings at Princeton, Harvard, and Cornell universities. Government buildings ranging from county courthouses to federal post offices, customs houses, or courthouses in at least twenty states are still-standing uses of the stone. The National Parliament building in Ottawa and the Hockey Hall of Fame in Toronto are just two of the scores of buildings in Canada constructed from it.

Although sandstone's popularity as a building stone began to decline in the twentieth century Ohio still ranked third in production of this material in the early twenty-first century. In addition, Ohio sandstone has been put to a number of other traditional uses, including aggregate, filler gravel, glass sand, foundries, filtration, and even pool table surfaces. Newer uses include silica for the computer industry and core samples the petroleum industry, which it uses for testing purposes.

Sand and gravel

The last of Ohio's major minerals to be mined are also among the most widespread. Created by the action of glaciers and bodies of water, sand and gravel have been commercially mined in eighty-four of Ohio's eighty-eight counties in the past fifty years. Whether dredged from Lake Erie or pulled from glacial moraines, kames, and depositional pits, sand and gravel have had a wide range of uses, starting with road paving in the early twentieth century and extending to cement and concrete manufacture, road base, fill dirt, ice control, iron molding, glass making, and water filtration. With a value of more than $250 million in 2006 Ohio ranked fifth nationally in the production of construction sand and gravel, and ninth in the production of industrial sand.

Coal

Few minerals have had as profound an influence on the history of Ohio as has coal. In many ways the history of its uses traces that of the state itself. Prehistoric Native American groups used it to make decorative ornaments and pigments, and Europeans first noted outcrops by the mid-1700s. The first reported commercial production of coal in Ohio was in 1800, three years before statehood. Since that time Ohio has produced 3.7 billion tons, primarily from Pennsylvanian-period Allegheny Plateau deposits in its southern and eastern counties. Coal mining began as a relatively minor activity but with the new markets created by the completion of the canal system in the 1820s and 1830s, demand for Ohio coal increased. Coal fueled not only more and more homes, but also the country's rapid industrialization during latter half of the nineteenth century. Railroads, power plants, iron and steel mills, as well as other "smokestack industries" created a nearly insatiable demand for it, and annual production topped 50 million tons by the 1910s. Many of the environmental challenges Ohio faced in the late twentieth century were directly related to the coal industry, not only because the sulfur-heavy nature of the smoke it created polluted the air and returned to earth as acid rain, but also because of the ravaging effects of strip-mining and residual toxins on the countryside. As manufacturing flagged in the late twentieth century, so too did coal production, but it is still an important part of Ohio's everyday life. Although its 22.7 million tons produced in 2006 was only 2 percent of the nation's total and ranked only fourteenth nationwide, its value exceeded $600 million. Furthermore, because Ohio ranked third in the consumption of coal (more than 90 percent of it destined for the electric utility industry), most Ohioans probably were at least indirectly affected by the state's coal industry on any given day.

Other minerals

Over the years, Ohio has excavated commercial quantities of several other materials as well. For example, gypsum—as with halite a Silurian-period evaporite—was mined in Ottawa County for use as plaster and wallboard as recently as 2003. Similarly, peat (a soil-like fibrous material derived from old plant deposits) was extracted from old bogs and glacial kettle lakes in Portage, Champaign, and Williams Counties until the 1990s. Iron ore is perhaps the most historically significant of Ohio's other minerals. Although no longer mined in Ohio, the state exploited its Pennsylvanian-period iron deposits heavily in the 1800s, and this ore—along with domestically produced limestone and coal—enabled Ohio to be one of the largest iron- and steel-producing states in the country until the late twentieth century.

Hydrocarbons

Oil and natural gas are the products of the decay of organic matter laid down throughout the Paleozoic era. As they are in liquid and gaseous form respectively they can migrate through other rock strata until they get trapped by relatively impermeable layers to form pools large enough to be tapped by wells. Most of Ohio's reserves seem to rest in Silurian strata, although deposits can be found from pre-Cambrian through Pennsylvanian layers. In some places, oil seeps to the surface and these areas marked the first places where both Native Americans and early European settlers gathered small quantities to use for lamps and even patent medicines. Ohio actually holds the distinction of the first discovery of oil from a drilled well when early salt-industry drillers looking for saltwater in 1814, in what is now Noble County, discovered oil instead. Residents of Findlay in northwest Ohio discovered and used natural gas as early as 1838, but it was not until the late 1800s that oil and gas became a big industry in Ohio. For a brief time the oil and gas fields of northwest Ohio supplanted those in Pennsylvania to become the most productive in the nation. The industry also created boom towns and new industries like glassworks, which thrived on the cleaner-burning and easier to control natural gas. Although Ohio's hydrocarbon heyday has long since passed, its wells had produced more than one billion barrels of oil and 8.26 trillion cubic feet of gas by 2007. Hundreds of new wells were being drilled each year throughout the late 1990s and early 2000s. Most Ohio counties have productive wells, but the vast majority of the active extraction is in the eastern half of the state. The state produced over 5.5 million barrels of oil in 2007, with a value of almost $369 million. Its gas wells were even more valuable creating $652 million. Although Ohio is not in the top fifteen states in terms of production, the billion dollars' worth of annual production of hydrocarbons make them the state's most valuable extracted resource in the early twenty-first century.

Water

Water was the single most important factor in Ohio's geological development: from the Paleozoic seas that created its landscape to the glaciers that reworked it into its present form. With Lake Erie to the north, a 451-mile stretch of the Ohio river to the south, and more than 25,000 miles of streams and rivers plus countless lakes and ponds in between, Ohio is fortunate to have so many bodies of water (created both through glacial action and water management) as well as the vast aquifers that lie underground. Ohio's plentiful water supply has supported diverse kinds of life and agriculture and long served as vital transportation routes. Ohio's water is also a critical raw material in all sorts of energy and industrial production. Its abundance has also caused some difficulties from time to time, as the frequent flooding in the twentieth century has demonstrated (see, for example, chapter 13).

Soils

Of all the geological activity in Ohio perhaps none have had quite as great an impact on Ohio's history as those forces that created Ohio's soils. Ohio's fertile land and bountiful wildlife attracted its first inhabitants thousands of years ago, and they were the primary factor in drawing its earliest U.S. settlers. For Ohio's entire history as a state, agriculture has played a major role in its economy and although the number of farms and farm acreage has dropped dramatically over the years in the early twenty-first century 55 percent of the state was still farmland, with food production and agriculture creating a $79 billion-a-year industry. One of the main reasons for Ohio's marked agricultural productivity is the quality of its soils. The federal government has designated nearly half of the state's land as "prime farmland" making Ohio one of only five states in the nation to bear that distinction.

Lying at the eastern end of the nation's corn belt, most of Ohio's soils have largely been produced by the same kinds of direct and indirect glacial action that created the rich soils to the west. In addition to the till and water that the glaciers brought to the state they also brought vast amounts of loess, wind-borne dust, and other sediments that swept the face of the ice sheet and blanketed the lands around the glaciers. Although it erodes easily, loess contributes greatly to the fertility of soils and has helped make Ohio's land some of the most agriculturally productive in the United States.

Certainly, there are other aspects of Ohio's geology and topography that have played a role in its historical development, but the examples in this chapter are sufficient to illustrate the point that understanding the formation of Ohio's substructure and topography serves as a good basis for understanding all that came later. Just as Perry County's history—from the Upper Mercer flint that was the state's first processed resource to the gas and oil that continue to be extracted today—was in many ways directed, or at least nudged, by the processes that created its distinctive suite of resources, so too is Ohio's history deeply rooted in the land on which it unfolded. From the tectonic forces that moved and uplifted the very deepest parts of the state, to the seas and plants that deposited millions of years worth of material and converted them into its many layers of bedrock, to the weathering and aging that exposed these layers to the surface, to the vast ice sheets that put much of the state into its current configuration, all of these forces contributed in some way to Ohio's unique history. Yet this chapter's discussion of these contributions has arguably left out the single most important one. The same glacial period that so dramatically altered Ohio's landscape also directly led to something without which our understanding of Ohio history would be impossible: the first Ohioans.

Further Reading

For further information on Ohio Geology, see an excellent collection of pieces on Ohio Geology hosted by The Ohio Department of Natural Resources: *Geofacts*, available at: http://www.dnr.state.oh.us/tabid/7882/default.aspx. Several chapters of Artimus Keefer's edited book *The Geography of Ohio* deal with Ohio geology and geography (2008. 2nd ed. Kent: Kent State University Press). For this and subsequent chapters, George Knepper's *Ohio and Its People* is an invaluable reference work (2003. 3rd ed. Kent: Kent State University Press).