PROJECT NATURE NEWSLETTER

OCTOBER, 2019 ISSUE

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Events

The Big Sit
Blacklick Woods Metro Park - Nature Center
12th October 10:00 am - 11:00 am
13th October 1:00 pm - 2:00 pm
Count birds at the nature center feeders for 15 minutes or more. Your data will help scientists learn about bird populations

Weekly Bird Hike
Scioto Audobon Metro Park - Grange Insurance Audobon Center
12th, 19th, 26th October 10:00 am - 11:30 am
Hike with experienced birders to find and learn about birds (Binoculars and field guides can be provided)

Walk The Creek
Blendon Woods Metro Park - Nature Center
12th October 2:00 pm - 4:00 pm
Enjoy a walk through the woodland creek

Creature Feature: Reptiles & Amphibians
Highbanks Metro Park - Nature Center
12th October 2:00 pm - 2:30 pm
Meet our education animals to learn about how we take care of them

Wild Ones: The Invisible Forest
Inniswood Metro Gardens - Innis House
12th October 10:00 am - 12:00 pm
Learn how the simple act of saving land can be the most powerful thing we can do together to protect the beauty, balance and biodiversity of our world

Who Lives Here
Blacklick Woods Metro Park - Nature Center
12th October 3:00 pm - 4:00 pm
Take a 1-mile walk to look for animal homes

Go Nuts!
Glacier Ridge Metro Park - Shelter House
12th October 2:00 pm - 3:00 pm
Learn about nuts and seeds on a short hike and make a buckeye necklace to take home!

Full Moon Hike
Battelle Darby Metro Park - Cedar Ridge
13th October 7:00 pm - 8:00 pm
Take a brisk 4-mile hike through fields and forests

Darby Creek Fall Cycle
Battelle Darby Metro Park - Nature Center
13th October 2:00 pm - 3:00 pm
Visit the living stream at the Nature Center to explore how the fall leaf cycle supports life in the Darby Creek

Sunny Sundays
Inniswood Metro Gardens - Herb Garden
13th, 20th, 27th October 1:30 pm - 3:30 pm
On Sundays throughout the summer, members of the Herb Society of America, Central Ohio Unit, will be in the Herb Garden to answer visitors' questions

Feed The Stream
Battelle Darby Metro Park - Nature Center
19th & 27th October 1:00 pm - 1:30 pm
Enjoy the fish feeding frenzy as you help feed them worms, crickets and minnows in the living stream at the Nature Center

Events

Off-Trail Ravine Hike
Highbanks Metro Park - Nature Center
19th October 2:00 pm - 4:30 pm
Join Ohio Geological Survey on an off-trail 4-mile hike in the ravine to learn about the geology of Highbanks.

Autumn Lantern Stroll
Sharon Woods Metro Park - Schrock Lake Restrooms
19th October 7:00 pm - 8:00 pm
Candle lanterns will light the way on a 1-mile stroll through the fall forest

Scarecrows and Wildlife Woes
Inniswood Metro Gardens - Greenhouse MP Center
19th October 2:00 pm - 3:00 pm
Join for a discussion about cohabitating with wildlife and learn how to appreciate animals while dealing with pest problems. Make a small, decorative scarecrow and learn recipes and tips to keep unwanted animals away from plants and other food sources

Forest Fungi
Blendon Ravines - 5280 Cambria Way
20th October 2:00 pm - 3:00 pm
Search for some common mushrooms at the Blendon Ravines property. Meet at 5280 Cambria Way. Park along the street.

Bison Bison
Battelle Darby Metro Park - Nature Center
20th October 5:00 pm - 6:00 pm
Not a cow, not a buffalo, it’s a bison! Join for a 1-mile hike and learn about this 2,000-pound animal

Web Maze
Blacklick Woods Metro Park - Ash Grove Picnic Area
20th October 3:00 pm - 4:00 pm
Walk through a web-maze and learn about spiders through this family-friendly maze

Stranger Things Display
Blacklick Woods Metro Park - Nature Center
20th October 8:00 am - 6:00 pm
Discover the weird side of nature that is seldom celebrated by viewing our display

Fall Hike
Clear Creek Metro Park - Maintenance Shop
26th October 10:00 am - 12:30 pm
Join us for a 4-mile off-trail hike through the forest to a sandstone maze and giant oak tree. Terrain in the backcountry is unimproved, uneven, and steep in areas. Water and hiking boots are recommended

Hike To The Giants
Highbanks Metro Park - Oak Coves Picnic Area
27th October 2:00 pm - 5:00 pm Signup Required!
take a rugged 4-mile off-trail hike to the 300-year old giant sycamores along the Olentangy River.
Hiking will be over rough terrain off-trail through a state nature preserve. Expect to climb up and down 60-75 degree ravines. Sturdy hiking shoes are required.

Last Leaves Tree ID Walk
Three Creeks Metro Park - Confluence Area
27th October 2:00 pm - 3:00 pm
Learn to identify trees from their leaves, bark and seeds on an easy 1-mile walk

Events

National Bison Day
Battelle Darby Metro Park - Nature Center
2nd November 1:00 pm - 4:00 pm
Celebrate the bison! Enjoy crafts, games, and snacks in the nature center. Learn all about our national mammal and meet the herd on a short walk

Weekly Bird Hike
Scioto Audubon Metro Park - Grange Insurance Audobon Center
2nd, 16th, November 10:00 am - 11:30 am
Hike with experienced birders to find and learn about birds (Binoculars and field guides can be provided)

Morning Birds
Blendon Woods Metro Park - Nature Center
3rd November 9:00 am - 10:00 am
Visit Thoreau Lake and see the wintering waterfowl

Morning Coffee and Birds
Battelle Darby Metro Park - Nature Center
3rd November 7:30 am - 8:30 am
Come grab a warm brew and watch bird in the quite early morning at the Nature Center

Nature School: Trees
Blacklick Woods Metro Park - Nature Center
9th November 2:00 pm - 3:00 pm
Come learn how to identify some common trees in central Ohio

Woodpecker Wonders
Blendon Ravines - 5280 Cambria Way
10th November 2:00 pm - 3:00 pm
Search for woodpeckers on a 1.5-mile off-trail hike through the Blendon Ravines property. Meet at 5280 Cambria Way; Park along the street

Project FeederWatch
Blendon Woods Metro Park - Nature Center
16th & 17th November 12:00 pm - 2:00 pm
Drop by the Nature Center to count birds at our feeder window and help collect data for this important citizen science project

100 Years of Coyotes
Battelle Darby Metro Park - Nature Center
16th November 4:30 pm - 5:30 pm
2019 marks 100 years of Coyotes in Ohio. Come and learn about this misunderstood animal on a 1-mile hike, as we call out to them

Winnowing Rock Hike
Clear Creek Metro Park - Park Office
16th November 10:00 am - 12:30 pm
Enjoy forest views on a 4-mile backcountry hike. Terrain in the backcountry is unimproved, uneven, and steep in areas. Water and hiking boots are recommended

Owls
Battelle Darby Metro Park - Nature Center
17th November 5:00 pm - 6:00 pm
Lure in owls using calls on a 1-mile hike

ICE AGE

When we think of the Ice Age, we tend to think of the glaciers that advanced some 100,000 years ago and retreated around 15,000 years ago. That was only one of the many cycles of glacial advancement and retreat that has taken place over the last 2.5 million years! Glaciers have defined the landscape and modified the drainage patterns (rivers). Glaciers transformed the topography by both erosion as well as deposition. They are responsible for the rich agricultural soil in all the glaciated part of the continent, and much of the raw material for the construction industry such as clay, sand and gravel, and extensive aquifers for ground water. The period of Ice Age is referred to as the **Pleistocene Epoch**. At the peak of the Pleistocene glaciation, almost one-third of the present land area of the entire planet was covered by nearly 43 million cubic kilometers of ice. Consequently, during the periods of glacial advancement, sea levels dropped, and rose back up during glacial retreat.

Suggestion of the fact that glaciers had once covered a large part of the northern hemisphere were first made in Europe around 1830. By mid 1840's, evidence of early continental glaciers that covered Canada and midwestern United States was recognized in the US. Over the next century and a half, our understanding of the Pleistocene epoch has grown greatly and continues to evolve!

Pleistocene Epoch - How It All Began!

About 250 million years ago (mya), plate tectonics brought all the continents together into a single land mass. This super continent was known as ***Pangea***. Around 180 mya, Pangea broke apart into several pieces called proto-continents. North America and South America were two separate proto-continents. Ocean currents circulated around South America in a counter clockwise pattern between the equator and the South Pole. About 2.5 mya, volcanic activity welded the two continents together with what is now known as the Isthmus of Panama. The ocean currents that circled around South America were now blocked and forced to rise up north from the equator. This current is today's *Gulf Stream*. Warmer ocean currents from the equator carried with them warmer air to the polar region. The warmer air held more moisture, which resulted in more precipitation in the form of snow. Every winter more snow piled up, turning into ice sheets that gradually advanced (at "glacial pace"!) southwards. This "short" period of geologic time starting about 2.5 mya and ending around 15,000 years ago is known as the Pleistocene Epoch.

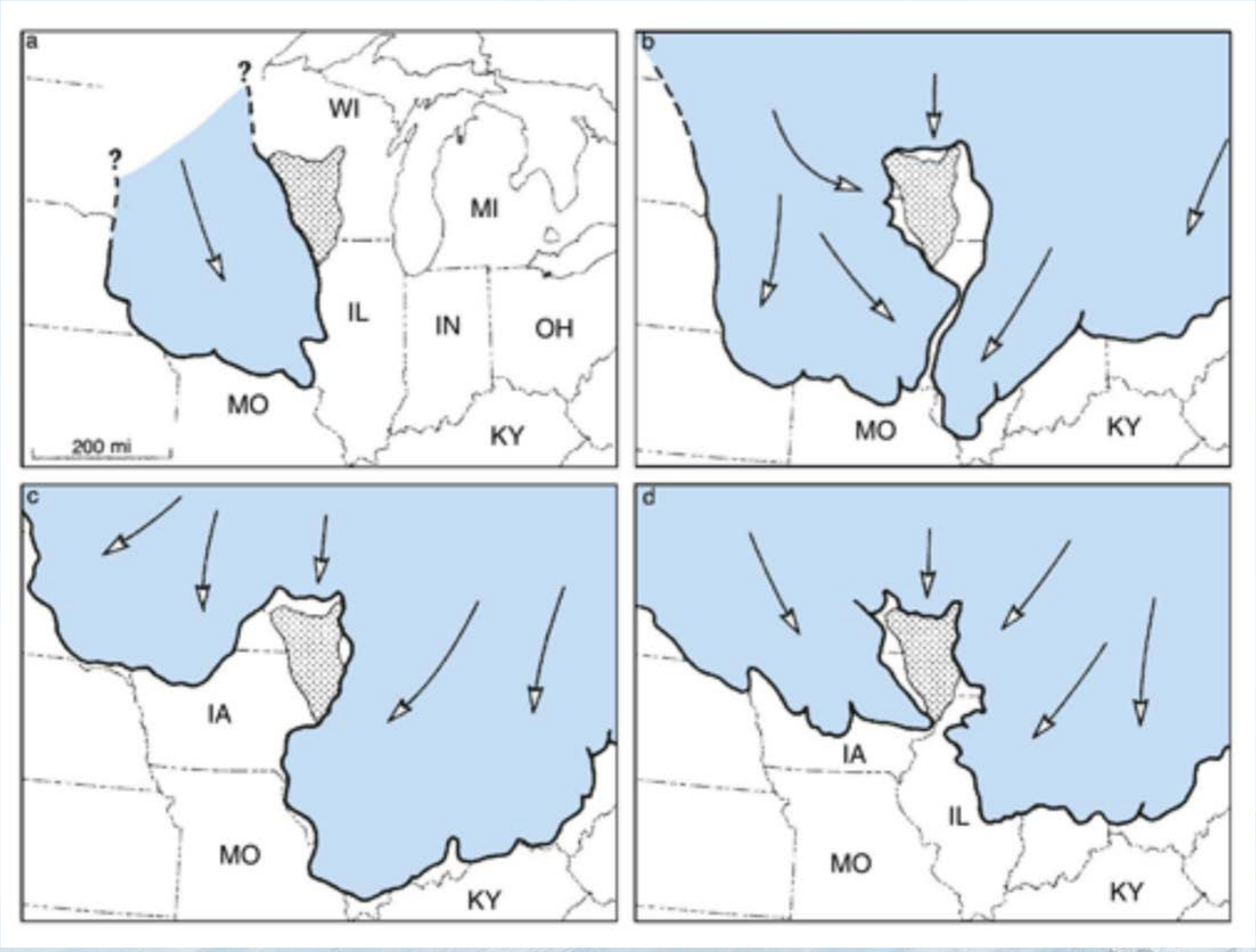
Glacial Advances and Retreats

Since the Ice Age was triggered some 2.5 mya, glaciers have advanced and retreated several times. If more snow accumulated in polar regions during the winter than could melt in the summer, glaciers advanced. Conversely, if the amount of snow that melted in the summer was greater than what precipitated in the winter, glaciers retreated. It was the low (or higher) summer temperatures, and not the winter temperatures, that dictated the glacial advancement (or retreat). But the question was what caused these cyclic events!

Milankovitch Cycles

In the 1920's, a Serbian geophysicist and astronomer, Milutin Milankovitch theorized that the slight variations in the eccentricity, axial tilt, wobble, and the orbit of earth around the sun resulted in cyclical variation in the amount of solar radiation reaching the earth's surface. These slight variations in solar radiation, that occurred in 100,000 year cycles, influenced earth's climate patterns to cause the glacial advance or retreat during the Pleistocene epoch.

While there have been almost 30 glacial advances (and retreats) during the Pleistocene epoch, the Ice Age in North America has traditionally been studied in terms of the four major cycles - ***Nebraskan***, ***Kansan***, ***Illinoian***, and ***Wisconsinian***. These have been named for the states in which the evidence of glaciers of that period was first studied and documented. The Nebraskan and Kansan cycles have now been combined and referred to as ***pre-Illinoian*** cycles. The pre-Illinoian ice sheet (before 240,000 years ago) covered western Ohio and reached as far south as northern Kentucky. For each cycle, the intermediate warm period between the retreat of glaciers and advance of the next cycle, is called the ***interglacial period***. Much of the evidence for earlier glacial cycles was eroded or reworked by succeeding glaciation. The only pre-Illinoian deposits that remain in Ohio are in the Cincinnati area. The most recent cycle - the Wisconsinian stage - has been the best studied because very little (geologic) time has elapsed since the glaciers retreated about 14,000 years ago for erosion and other forces to wear away the evidence. The Wisconsinian cycle began about 110,000 years ago originating from Hudson Bay in Canada. Glaciers entered Ohio around 24,000 years ago and retreated around 14,000 years ago.



Maximum extent of different glacial cycles
a. Early Pre-Illinoian; b. Late Pre-Illinoian; c. Illinoian; d. Wisconsinian
Source: Illinois State Geological Survey

The several glacial cycles transformed the landscape. The ice sheets are estimated to be from several hundred to several thousand feet thick in Ohio at the peak of a glacial cycle. These massive ice sheets gouged out U-shaped valleys, created hills (as moraines and eskers), formed and shaped the Great Lakes, brought in foreign rocks (glacial erratics), changed the course of rivers and left the precursor of an agriculturally rich soil (glacial till). The meltwater from the retreating glaciers brought sediments (outwash) in the form of boulders, gravel, sand and clay, which are a valuable resource for the construction industry. The outwash is also a storehouse of a vast amount of potable groundwater.

Deciphering Ice Age

There are several tools that geologists possess in their arsenal to date glacial materials, features and events. Radiometric dating (or measuring the duration of the decay of radioactive elements) is one of the most important techniques to determine Pleistocene history. Carbon-14 dating can accurately date organic materials such as wood and bone upto 60,000 years ago. Other dating methods include the K-Ar method, which could extend the dating upto 100,000 years ago; Protactinium 231-thorium 230 dating, which can date deep-sea clays back to 300,000 years ago; Oxygen-isotope analyses; and fission-track dating, among others.

Megagrooves carved into limestone bedrock at Kelleys Island in Lake Erie
Photo Source: Ohio Department of Natural Resources, Division of Geological Survey

There are other non-isotopic techniques used to study glacial sediment. For example, geologists employ ***paleomagnetism***, by which they recognize the reversal in magnetic polarity of the sediments and compare it with the standard time scale of changes in polarity of earth's magnetic field; they also track the temperature-induced reversal of coiling direction of deep-marine shells; the study of volcanic ash layers in soil provides very accurate time lines for correlation because they were deposited instantaneously. Finally, they measure the changes in the amino acid structure of conifer wood as yet another method of dating.

To distinguish sediments from different glacial cycles, geologists may employ several methods. Particle shape and the distribution of particles of different sizes within the till can help in understanding the tills from different glacial events. Ice sheets in one glacial cycle moved differently and in a slightly different direction than in the other. The orientation of the elongate pebbles and cobbles embedded within the till can point to the direction in which the ice sheets of a specific period moved. Composition of larger particles in the till can help geologists locate the parent bedrock from which it eroded. The orientation of scratches and striations left on the underlying bedrock by the moving ice sheets can be indicative of the direction in which the ice sheets moved.

Effects of Glaciation

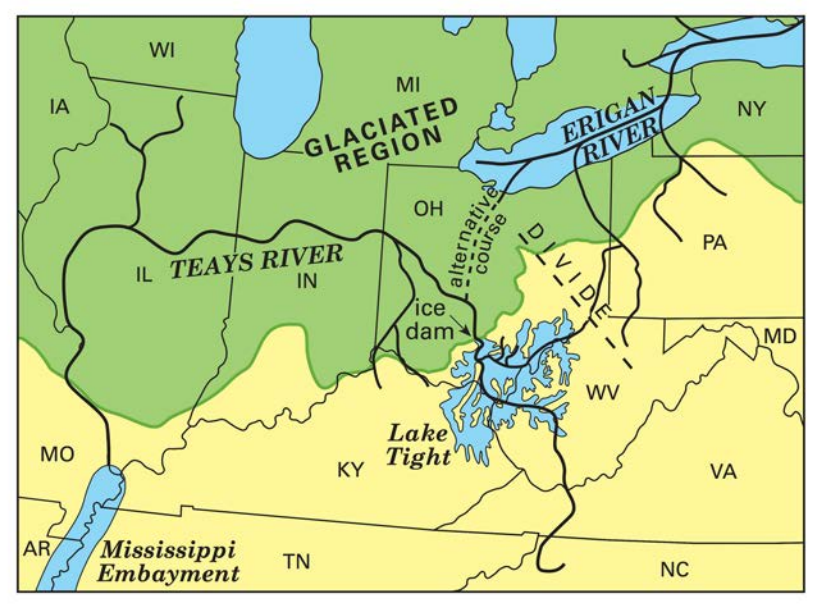
Fluctuations in Sea Level

During periods of glacial advancement, more and more water of the planet froze, and consequently, sea level dropped. Evidence of submerged beach ridges far out on the continental shelves indicates a reduction of sea level by as much as 140 meters. 25,000 year old elephant teeth have been found by fishermen from over 40 sites as far as 130 kilometers out in the Atlantic Ocean in water as much as 120 meters deep. Dating of the deep-sea sediments such as shells of organisms helps correlate the sediments with standard glacial time-scales, and hence compare glacial conditions on the continent with those in the oceans.

On the other hand, during interglacial periods as the ice melted, sea levels rose. Evidence of dead coral reefs on several oceanic islands indicates that sea levels were much higher at one point in the Pleistocene than their current level.

River Courses Altered

Prior to glaciation, several rivers in Ohio drained to the north. A major pre-glacial river system, called the ***Teays***, flowed northwestward from its headwaters in Appalachian highlands of North Carolina and West Virginia, entering Ohio, then Indiana, before joining the ancestral Mississippi river in western Illinois. Advancement of the earliest glaciers created a dam and blocked the rivers and altered the drainage system by forcing the rivers to cut new channels and flow in other directions. The blockage created a 7,000-square-mile lake in southern Ohio. This glacial lake is called ***Lake Tight*** (named after the geologist William G. Tight, who first studied the Teays River system). The lake eventually spilled over divides and cut new channels. The new channels were at a lower elevation than the pre-glacial river systems. The modern Ohio River is a result of these complex drainage changes. Evidence of the early river channels can be found in the deep valleys cut into the bedrock that are now full of glacial sediment. In the unglaciated parts, the old Teays River and its tributaries have left broad flat valleys at an elevation higher than the modern river systems.



Pre-glacial river system
Source: Ohio Department of Natural Resources, Division of Geological Survey

Great Lakes

The Great Lakes are a direct result of the Pleistocene glaciers. Lake Erie is one of Ohio's most important natural resources. When the glaciers retreated some 14,000 years ago, a large and complex network of lakes formed in the Erie basin, some of which were 230 ft deeper than today's Lake Erie. Several sets of sandy ridges, each set of which is at a similar elevation, marks the beaches that formed along the shorelines of these lake stages. Present-day Lake Erie reached its current form only about 4,000 years ago!

Isostasy

Isostasy is a fundamental geological concept that the earth's crust "floats" on the denser and fluid underlying *mantle*. This concept of the state of equilibrium or balance between the mantle and the earth's crust, is used to explain how different topographic heights exist on earth's surface.

At the peak of a glacial advancement when the ice sheets were massively high, the enormous weight of the ice sheets caused a depression in the earth's crust, much like pressing on a piece of wood floating on the surface of water. After the glaciers retreated, the crust would then rebound. Evidence of postglacial rebound exists in raised ocean and lakeshore features such as beaches. Rebound is an extremely slow process and continues to this day!

Glacial Features

Till Sediment deposited directly from glacial ice, that consists of debris of different sizes, shapes and types, is called glacial till, or simply, till. Typically gray or tan in color, till is the parent material of the soil in much of the glaciated part of Ohio. Most of the rock pieces in till are unlike the parent bedrock that underlies it. The rock fragments in the till include *granite*, *quartzite*, *gabbro*, *schist*, and *gneiss*. Their parent bedrock lies in Canada. Till is extremely rich for agriculture and is responsible for the success of agriculture in Ohio.

Outwash Sediment deposited by meltwater from retreating glaciers is called outwash. Outwash looks much different from till, and mainly consists of sand and gravel. The sediment from outwash forms well-defined layers, or *strata*, as it settles out of water. Since the sediment was carried by streams, outwash deposits developed well beyond the extent of the glacial advance. Between different lobes of ice sheets, meltwater streams poured into valleys and alternately widened, deepened and filled in valleys. These outwash-filled valleys, appearing as "fingers" on the topographical map, are called ***valley trains***.

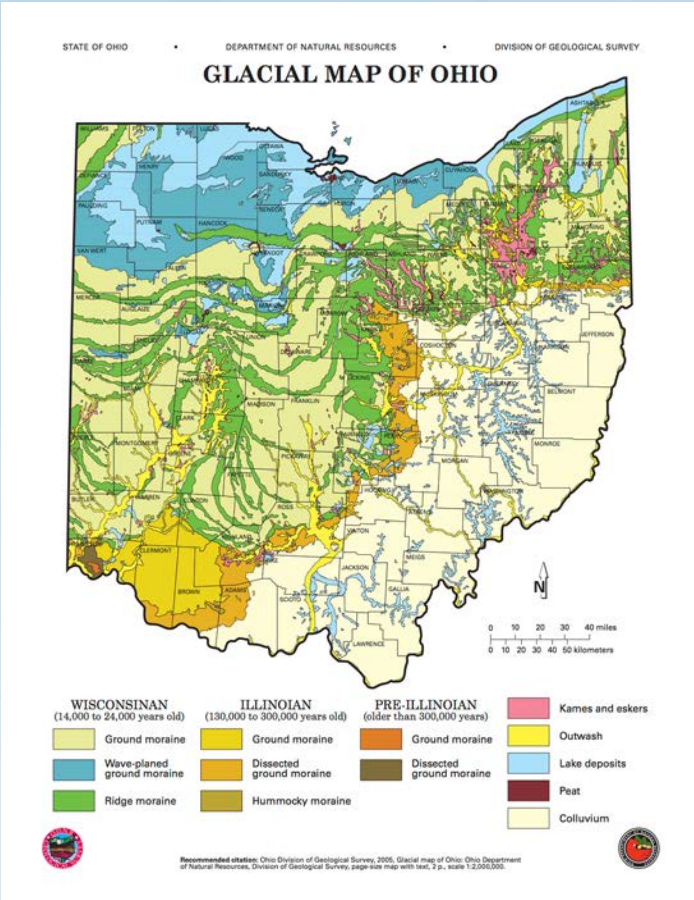
Eskers As glaciers retreated, sometimes the meltwater would form sinuous ice-walled tunnels at the base of the ice sheet. The sediment deposited in such tunnels by the meltwater, was left behind as hills after the ice completely melted. These are called eskers. Among the various geologic features formed by sediment-deposition from retreating glaciers, eskers are the most uncommon. One such relic of the glacier in Ohio is the Circleville Esker in Pickaway County. 10 miles long and about 25 ft high, it is defined as a "fossil subglacial stream deposit without an accompanying valley". Since sediments that formed eskers were deposited by flowing water, it mainly consists of sand and gravel.

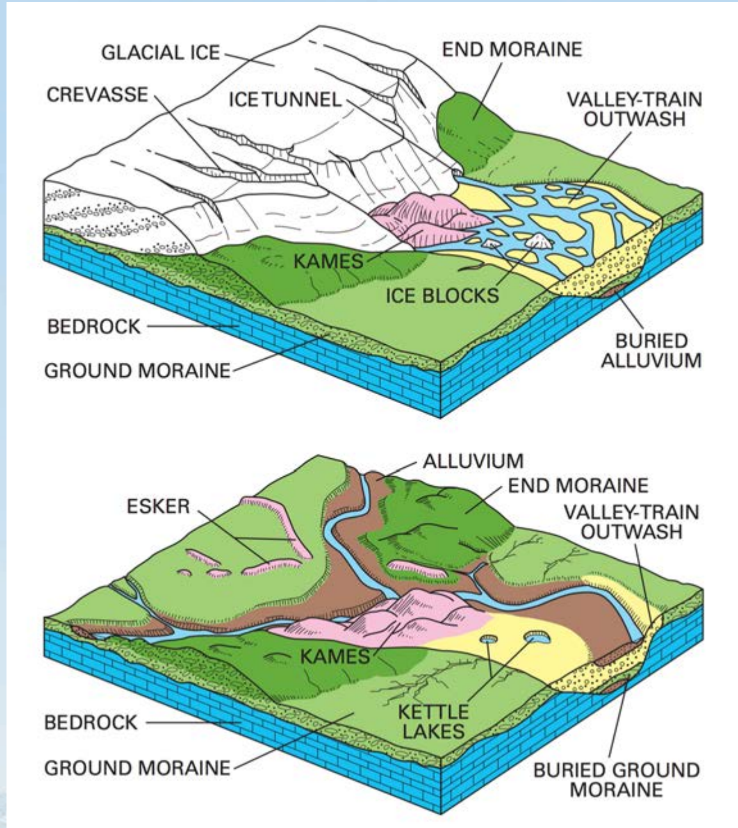
Moraines There are two kinds of moraines - **Ground Moraine** and **End Moraine**. Glacial cycles occurred over the course of several thousand years. During the slow retreat, there were intermittent periods of time, on the scale of hundreds of years, when the ice sheets stayed still at a place. This meant that rate of melting of the sheet-front during that time equaled the rate of ice accumulation. This resulted in till accumulating in one place, creating a hilly ridge, akin to a pile of gravel that forms at the end of a conveyer belt. These ridges are left behind as end moraines. End Moraines are further classified into two types - **Terminal Moraines** and **Recessional Moraines**. Terminal moraines, as the name suggests, mark the maximum advance of the glacier, whereas recessional moraines are ridges left behind as the glaciers retreated. In the glacial map of Ohio (below), the series of end moraines depicted in green are recessional moraines.

Sediment that was deposited as a flat blanket with irregular topography and no ridges, formed features that are referred to as ground moraines. Most of Ohio, for example your backyard, is relatively flat ground moraine!

Kames Outwash from meltwater streams was also deposited on top of low-lying ice or as fan-shaped pile into holes and crevasses along the ice margins or in stagnant ice. When the ice finally melted, the sediments were lowered to the ground, forming sandy hills. These mounds of stratified sand are called kames. Spangler Hill is a large kame, just north of Scioto Downs, that has been mined for sand and gravel.

Features that formed from sediments deposited by water have a common and distinctive characteristic since they were sorted by the water that deposited them. Thus outwash, kames, and eskers mainly consist of layered sand and gravel. In contrast, till, which is deposited by ice, contains non-layered sand and gravel and clay!





Landscape during maximum advance (top) and after (bottom) retreat of ice.

Glacial Map of Ohio ***Illustration of glacial features***

Source: Ohio Department of Natural Resources, Division of Geological Survey

Glacial Erratics These are non-native isolated boulders randomly occurring in glaciated parts of the world, where they typically do not belong. For example, there aren't any natural outcrops or exposures of granite - an igneous rock - in Ohio. But many boulder-size pieces of granite can be found randomly distributed throughout the state. Glacial erratics are found in all sizes, ranging from sand-size to large boulders. From their mineral composition, these erratics can be traced back to their parent outcrops further north in Canada from which they broke off and were carried down by the advancing ice sheets. For example, the 1,250 cubic foot, 103 ton piece of glacial erratic in Tawawa Park in Sidney, OH, named **Big Rock**, is similar in composition and structure to the granite outcrop between Ottawa and Sudbury in Ontario, Canada. This massive boulder was carried 700 miles by the ice sheets to Ohio and left behind after the glaciers retreated.

Striations Glacial striations are scratches or grooves carved in the bedrock by moving glaciers. Their orientation indicates the direction of the glacial movement. As ice sheets form, they pick up sand grains, coarse gravel, rock fragments and large boulders from the surface, that become embedded at the base of the sheet. As the massive ice sheet moves across the surface of bedrock, it acts like sand paper abrading the surface, creating these striations. Bigger boulders lodged in the ice sheet have the power to create large grooves on the underlying bedrock, whereas finer sediments like sand, polish the rock surface. Gushing streams of meltwater can further shape the striations. A world-famous example of glacial striations exists in Ohio at **Kelleys Island** in Lake Erie. A mile-high ice sheet that traveled multiple times back and forth over the last 2.5 million years, carved out megagrooves in the limestone bedrock. Possibly the largest and the best-preserved glacial grooves in the world, the glacial grooves at Kelleys island were designated as a **National Natural Landmark** in 1967 and are maintained as a State Memorial site by the Ohio History Connection. These semi-circular depressions, about 30 ft wide and 15 ft deep, cut into solid rock are a testament to the power of moving ice sheets!

Kettle Lakes As the glaciers receded, some blocks of the ice sheet broke off and were left behind stranded and surrounded by outwash. These huge chunks of ice remained long after the main ice sheets had retreated, and slowly melted creating a water-filled low spot in the outwash plain called kettles. Many of these depressions are still filled with water as kettle lakes or kettle ponds, while others have become filled with sediment and peat and have assumed the form of a swampy depression. Pickerington Ponds are kettles at **Pickerington Ponds Metro Park** in southeast Columbus.

Crevices and Cravasses

While both the words have similar meaning and etymology - both are derived from the French word crever, meaning "to break or burst" - a crevice is a narrow opening forming a split or a crack, usually in rocks. Crevasse refers to a deep hole or fissure in a glacier or ice sheet.

Stage's Pond near Ashville in Pickaway County - a kettle pond
Image Source: Ohio Department of Natural Resources, Division of Geological Survey

Ice Age Flora and Fauna

The plants and trees of the boreal forests in Canada were common in Ohio during the Pleistocene. These included *spruce*, *fir*, *cedar*, *tamarack*, *hemlock*, and *larch*. This northern or glacial vegetation persisted in Ohio until about 10,000 years ago when the climate warmed and the coniferous boreal forests were replaced by Oak-Hickory and Maple-Beech deciduous forests of today. (To learn more about Ohio's forests, read the August issue of Project Nature newsletter). As the climate warmed and the glacial vegetation was replaced by more warm-climate-friendly species, some regions, owing to their unique conditions, retained this vegetation as relict species. **Cedar Bog** in Champaign County is one example of this unique habitat.

Many Ice Age animals were very different from the animals we find today in Ohio. A lot of Ice Age animals went extinct for various reasons including rapid climate change, over-hunting by humans, and habitat loss. Some of the extinct Ice Age animals that roamed in Ohio were the giant beaver, mastodon, wooly mammoth, and sabertooth. Skeletal remains of these animals have been found in clay and peat that was deposited in former glacial lakes as well as in the sand and gravel deposited by meltwater. Some remains have also been found in caves and sinkholes.

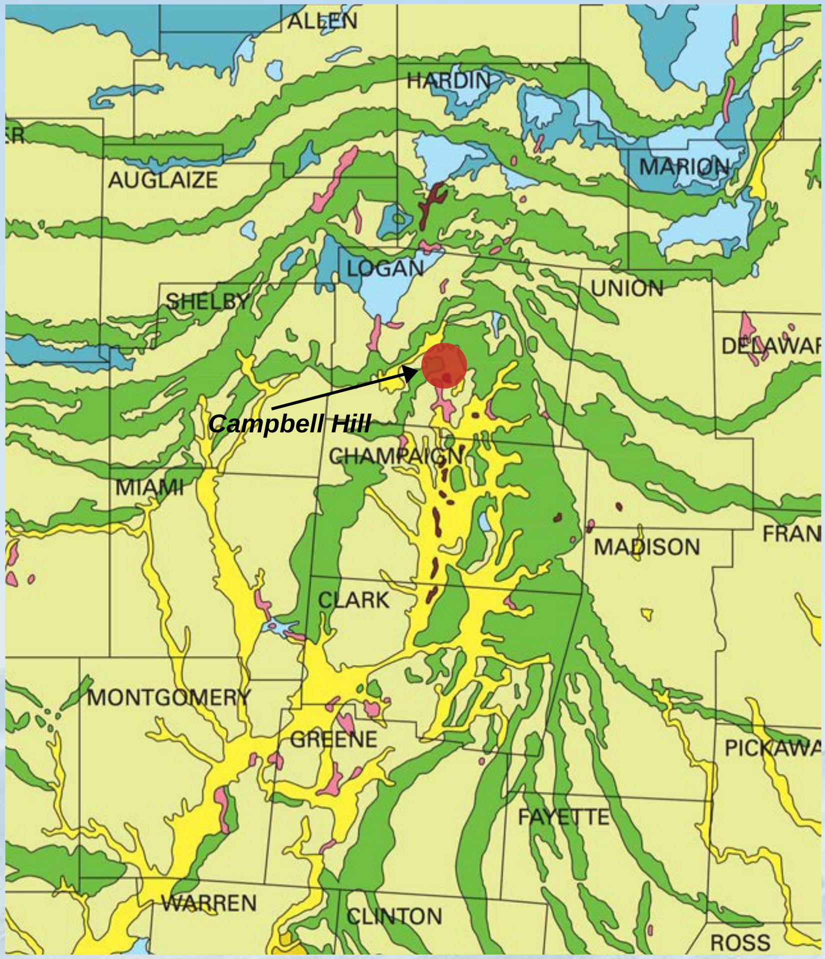
Ice Age Humans

It was believed that the first human migrants arrived in North America from Siberia by crossing the land bridge of ice across the Bering Strait between Asia and Alaska. However, it is now becoming a widely accepted theory that the first human inhabitants came via the coast, and not across the land bridge! The first human culture in North America is collectively known as the **Paleoindian**. They were nomadic hunters and gatherers. Although no skeletal remains of Paleoindians have been found in Ohio, several mastodon skeletons that have been found in the state show evidence that the animal was butchered, indicating that Paleoindians did live in Ohio. Additionally, well-crafted flint spear heads, unique to the Paleoindian culture, are widely distributed in the state.

Glaciers Rolled Into Ohio and Flattened the Landscape - No They Didn't!

It's a common notion that Ohio's flatness is due to the glaciers that ground down any hills that existed and rendered the topography flat. While it's true that the glaciers modified Ohio's landscape, they didn't bulldoze the hills and mountains and flattened the landscape. As a matter of fact, glaciers deepened valleys and left behind hills in the form of moraines and eskers. Glaciers did not grind down the mountains. Forces of erosion had already done that before the glaciers first advanced. Good evidence of this is the **Bellefontaine Outlier** in Logan County, which includes Campbell Hill - the highest point in the state at 1549 ft. The Bellefontaine Outlier is a

Devonian-age (about 380 mya) bedrock covered by glacial till. This isolated "island" of rock is surrounded by much older rock from the Silurian period (about 430 mya). While the elements eroded away layers of rocks over the course of millions of years, this *outlier* survived. When the glaciers advanced, the ice sheet did not level the rocky outcrop. The outlier rather presented a hard barrier to the ice sheet. So, instead of grinding the outlier down, the glaciers bifurcated into two lobes from that point - the **Scioto glacial lobe** and the **Miami glacial lobe**. Consequently, the ridge moraines in the west-central part of Ohio form curvilinear profiles with an apex at the Bellefontaine Outlier. This can be clearly seen on the glacial map of the state, where the ridge moraines (depicted in green) appear like a garland draped on a Christmas tree!



Curved ridge moraines around the Bellefontaine Outlier
Source: Ohio Department of Natural Resources, Division of Geological Survey

One way, however, in which glaciers did flatten the landscape in some areas was by filling the valleys with sediment. For example, along Interstate 70 near Springfield, an area that is very flat, there is a buried valley 400 feet deep, entirely filled with glacial sediment. Such buried valleys are important water resources – Dayton gets its water from them!

Outlier and Inlier

A geological outlier is an area of isolated rock surrounded by older rock.

Conversely, an inlier is an isolated rock surrounded by younger rock.

What Comes Next!

We defined the end of Pleistocene Epoch when the glaciers receded about 14,000 years ago and called a new epoch - **Holocene** - following that event. But the Ice Age hasn't ended! Just as the glacial cycle has been repeating itself for the last 2.5 million years, it is only logical to predict that the planet will cool down once again and another glacial ice sheet will advance. We just happen to be living in an interglacial period. The past glacial cycles had an interglacial period of about 10,000 years. We have been experiencing interglacial conditions for about 10,000 years now. So, if the Milankovitch cycles continued, we should be reaching full glaciation in the next 25,000 years. The question is if there is anything unusual about this interglacial period. In just the past century, the average global temperatures over land and ocean have increased by about 0.74 degrees C. It has been a well-accepted fact in the science community that this is a direct result of human activity. It's not coincidental that this spike in global temperatures started with the industrial revolution. While a mere 0.7 degrees C might sound like a very small number, consider the following. Study of ice cores from the Greenland ice cap has revealed that the difference in overall average yearly temperature between normal and glacial climate is less than 10 degrees C. This implies that our planet has a very sensitive thermal budget, and from that reference scale, 0.7 degrees C is a rather large temperature-increase.

Only time will tell what comes next, but it would be fair to say that humans have made a significant impact on the the course of natural events, and whatever comes next will be very different from anything in the past!

To subscribe to the newsletter or for any questions/comments/feedback, please email

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