How the Ice Age Shaped Indiana

Jerry Wilson

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of this book. I have wandered Indiana to get a first-hand view of some of the effects of glaciation. Although I find that some authors differ on such things as the dates of the glacial advances, the precise naming of the ancestral Great Lakes, and the extent of their coverage, I have tried to find as much common ground as I could, and use corroborating research when possible. When two authors differ on a certain point, the author who has the more recent publication was used as the primary reference.

In addition to its use as a supplement for classroom teachers, I hope this book will be of use to those who just like to take in the countryside of Indiana. Visitors to the state and residents who want to visit Indiana's wonders of nature may find this book helpful in understanding why Indiana's geologic features look the way they do. From the falls of Clifty Creek to the sand dunes of Lake Michigan. Indiana has more geologic features worthy of a tourist's attention than most people may think.

Pre-Glacial Indiana

Picturing the Ice Age, some people imagine tribes of cave men out hunting woolly mammoths or saber-toothed tigers. That might not be far from a true image of ice age life, but only as it existed near the end of the vast stretch of time that is known as Earth's last great Ice Age.

The Ice Age lasted more than two million years. And during that time, there were at least four major glacial advances in the northern hemisphere. But between the ice advances, the climate may not have been much different than it is today. Also, prior to the last advance, which ended about 10,000 years ago, pre-human society was not advanced enough to have gathered in tribes and used tools for the purpose of hunting large animals. Early humans did not start using tools until roughly 50,000 years ago, in Africa.

Back in what was to become Indiana, human ancestors may or may not have existed at the end of the Ice Age. There are various hypotheses that have been put forth that try to explain where North American inhabitants came from and when they first came. The verdict is still out as much more study is needed. Humans as old as Cro-Magnon Man, the human that dwelled in caves and hunted for a living, probably never existed in what is now Indiana.

What can be said for sure is that more than two-thirds of the state owes its landscape to the activity of the vast ice sheets of the last great glacial advance. Before the ice sheets encroached, more than two million years ago, Indiana, and much of the Midwest, was a maturely-dissected low plateau. It contained numerous hills, what are called knobs, separated by broad valleys. Indiana's landscape was similar to the present topography of Kentucky and Missouri. And, in fact, all of Indiana's landscape was very similar to what one would currently find in the southern third of the state. The last ice sheet never advanced as far south as the present-day Ohio River, which marks the southern boundary of Indiana. The southern limit of that ice sheet ran on a wavy line connecting present-day Terra Haute, Edinburgh, and Richmond. At least two of the earlier ice sheets advanced farther south, but none as far as Evansville, Bloomington, or New Albany. So the southern Wabash Valley and the valleys of the East Fork White River and Muskatatuck River were all spared the encroachment of the ice sheets. Drainage patterns in Southern Indiana were changed enormously by the glaciers of the Ice Age, however.

Another clue as to what most of northern and central Indiana might have looked like prior to the Ice Age comes from Wisconsin. One might think that,

tains of Missouri. All three areas are described as plateaus, meaning they are uplifted regions underlain by rock layers that are horizontal and parallel to each other. There is little tilting and folding of the rock. Southern Indiana is a low plateau, meaning there has been very little uplift. The Ozark Mountains are not true mountains at all, but an eroded plateau. But the land there has been uplifted much higher than the land of Indiana, so erosion has resulted in much more prominent relief in Missouri. The Colorado Plateau is much higher elevation than either Indiana or Missouri, but the landscape there is stark. Both Indiana and Missouri get plenty of annual rainfall. The landscape of both regions is typical of wet-climate erosion. Arizona, by contrast, has a very dry climate. Dry-climate erosion of a plateau typically results in canyons, mesas, spires, and arches. So the wetter the climate and lower the elevation the gentler will be the landscape.

Since the Precambrian Era ended over half a billion years ago, much of what is now North America, including Indiana, has been invaded by inland seas several times. Deposition of sediments in the seas eventually led to the formation of layers of sedimentary rock. These rock layers form the bedrock of Indiana. The basement rock of Precambrian age, called the craton, consists of compressed igneous rock, mostly granite. This nucleus of Precambrian rock does not cut the surface anywhere in Indiana or the lower Midwest. It does break through the surface in northern areas of Minnesota and throughout Canada. There, it is called the Canadian Shield. In Indiana, the craton is buried beneath sedimentary rock layers ranging between 3,000 and 13,000 feet thick.

The age of Indiana's bedrock that breaks the surface ranges between 450 million and 300 million years old. The Ordovician shale and limestone that occur as outcrops in the southeastern part of the state contain many fossils. The younger rock layers that are exposed in the southwestern region of the state consist mainly of shale, sandstone, and limestone. They are of Pennsylvanian and Mississippian age, about 300 million years old, and therefore contain deposits of coal. Much of the south-central region of the state is underlain by 340-million-year-old limestone. This rock is mined for use as building material. The Empire State Building in New York City is constructed of Indiana Limestone. But since Indiana does not contain bedrock any more recent than 300 million years old, no dinosaur fossils are found in the state. Dinosaurs did not arrive in force until about 225 million years ago.

About 300 million years ago, Indiana was in a tropical environment. The abundant plant life, mostly ferns and tree ferns, led to the formation of peat bogs as dead plant material accumulated to a depth of many feet within the marshy areas. Peat forms as a result of compaction and anaerobic decay of plant matter. It is the first step in the long process of coal formation. Lignite, the lowest grade of coal because of its high moisture and sulfur content, forms from the further compaction of peat as more layers of sediment are deposited on top of the peat bog. Later, as more sediment accumulates over the lignite, and as heat and pressure increase, the lignite is transformed into bituminous coal. The coal deposits of western Indiana are of this type. Anthracite is a metamorphic coal formed by continued compression and compaction of bituminous coal. It is the highest grade of coal, composed of almost pure carbon. There are very few anthracite deposits remaining in North America, and none in Indiana.

As landscapes go, Indiana is very flat. There is a variation in elevation of no more than 600 feet from the highest point in the state, near Richmond in the east, to the lowest point near the confluence of the Wabash and Ohio Rivers in the southwest. Yet, going from east to west across southern Indiana, the ages of various rock layers at the surface vary by about 150 million years. That corresponds to a vertical accumulation of sedimentary rock of 7000 feet. How, then, can 7000-feet worth of bedrock exist at the surface in various places across the state?

Although the layers of the bedrock are parallel, and they appear to be com-

It is easy to understand that younger layers of bedrock overlay older layers; sediment is built up from bottom to top as it accumulates on the floor of ancient seas and lakes. So the relative ages of rock layers are easy to figure out. But how do geologists determine the actual age of sedimentary rocks? The age of a sedimentary rock layer can be deduced from the type of fossils it contains. Index fossils are those which are peculiar to a certain geologic age, but widespread enough to be useful in determining the age of rocks in other regions of the planet. The age of index fossils is known, either because of direct radiometric dating or because the age of the rock layer that contains them has been determined by another method. The presence of index fossils within a rock layer will, therefore, give up the age of the layer. Although igneous rocks, like granite, and metamorphic rock, like gneiss, can be determined directly through radiometric dating techniques, these methods would not work on sedimentary rock. Trying to date a sedimentary rock layer using a radiometric method would give only the age of the sediments within it, not when those loose sediments became rock.

Some regions of south-central Indiana, from near the Ohio River to Mitchell, have enormous deposits of limestone near the surface. The thick layers of limestone have been attacked by the weakly-acidic drainage water that percolates through the soil. Limestone is dissolved by acidic solutions. This area of the state, therefore, is riddled with caves, sinkholes, and underground rivers. The landscape of a region that consists of these features is called karst topography. At Spring Mill State Park near Mitchell, tour guides take tourists on a trip through Twin Caves in a flat-bottomed boat. The cave’s floor is completely

Ages of Ice

The Ice Age began about two million years ago and ended about 10,000 years ago. Or did it? Could it be that, despite global warming, the ice age isn't over yet?

During the two million years since the Ice Age began, there have been four major advances of the ice sheets from the north. But in between those advances the climate was much warmer and the ice sheets retreated into Canada or disappeared entirely. These warmer periods, known as interglacials, lasted for a few thousand years each. It has been 10,000 years since the ice sheets retreated last. Could it be that we are currently living within a interglacial period? Some scientists believe that the ice sheets will be back, but when is anyone's guess. Some interglacials last 12,000 years while others can last 50,000 years or more. Some scientists predict our current interglacial will end in about 25,000 years based on orbital cycles of the earth.

The last ice age, or our current one if we are in an interglacial period, is not the only ice age the world has had. There have been at least four major ice ages. The most severe ice age of the last billion years started about 850 million years ago and lasted for 200 million years. It was so severe that the entire planet was covered with ice, miles thick in places. This resulted in what has been termed a Snowball Earth. It ended when plate tectonics caused massive volcanic eruptions, which poured out carbon dioxide into the atmosphere. This resulted in a period of natural global warming which melted the planetary ice packs.

The most recent ice age had four glacial advances, each named for the present-day state in which their presence is most evident. The first of these advances began more than a million years ago and is called the Nebraskan glacial. Little evidence still remains of this stage because it happened so long ago and much of the evidence was buried by more recent glacial advances.

Following the Nebraskan glacial was a relatively warm interglacial period. This, in turn, was followed by the Kansan glacial, beginning about 700,000 years ago. There are some Kansan deposits at the surface in scattered sites in parts of northern Brown County, Indiana. For the most part, though, the glacial drift left by the Kansan ice sheet was covered by the next advance, the Illinoian glacial, which began roughly 300,000 years ago. The Illinoian glacier extended farther south than any of the other three glacial advances. In Indiana, it reached to the Ohio River in the southeastern part of the state and to Brown County in the south-central region.

About 70,000 years ago, the Wisconsin glacial began. The Wisconsin ice sheet did not extend as far south as did the previous stages. It extended to the central part of Indiana, just south of Indianapolis, along a line from Terra Haute to Edinburgh, to Richmond. This last glacial advance began retreating about 20,000 years ago. By 10,000 years ago, the present interglacial period had begun.

There were several ice lobes associated with the Wisconsin glacial. The Michigan lobe entered Indiana from the northwest. The Huron and Erie lobes entered the state from the northeast. The prints of these lobes can be clearly seen from the arrangement of end moraines, ridges of unsorted glacial sediment. Moraines are just one example of landforms that can be created by glaciers. By studying post-glacial topography, scientists can gain a complete understanding of how the ice sheets advanced and retreated.

Some evidence suggests that minor glaciation began about 2.5 million years ago, but pre-Nebraskan glacials, if they existed, cannot be as easily studied since most of the evidence would have been covered by later periods of glaciation.

Landscapes Formed by Ice

The ice sheets associated with the last ice age were, in places, three miles thick. This extremely heavy layer of ice carved out valleys and scraped the bedrock in Canada, eroding the gouged-out debris to the south as the ice sheet advanced. As the glaciers approached the limits of their southward progression the debris was scattered over the surface of the bedrock in the Midwest, including Indiana. The term applied to any sediment or debris deposited by a glacier of sediment. Sand settled out above the pebbles, followed by layers of silt and then clay, the sediment composed of the smallest particles. Landforms created by glaciers that consist of stratified layers of sediment, therefore, were laid down by flowing melt water.

Melt water flowing southward away from the leading edge of the ice sheets covering northern Indiana deposited stratified drift in a broad, level plain called an outwash plain. The Kankakee Outwash Plain is the fertile farmland that stretches for miles in an area of Northwest Indiana south of Valparaiso. The Kankakee River, a slow-flowing stream with a very wide flood plain, is the remnant of the torrents that formed the plain about 12,000 years ago.

As a glacier melts, large chunks of ice often break loose and fall from the receding edge. This process is known as calving. In the sea, these chunks of ice form icebergs. On land, the ice chunks sink deep into the outwash plain and form depressions called kettles. The kettles normally fill with water from the melting ice to form a kettle lake. Many kettle lakes dot the countryside of northern Indiana. Some examples include Cedar Lake in northwestern Indiana as well as Hamilton Lake and Lake Wawasee in northeastern Indiana.

Glaciers are often riddled with ice tunnels, holes, and cracks. Melt water that flows down a vertical hole to the ground below often deposits its load of sediment as stratified drift, eventually forming a mound or hill. When the glacier retreats, these hills that are left behind are called kames. One of these kames is School Hill in Edinburgh in Johnson County. Melt water flowing through tunnels in the ice, or channels on top of it, leave stratified drift in long, sinuous ridges known as eskers.

But a glacier can also deposit its load of sediment directly from the ice. This type of debris, ranging is size from large boulders to sand and clay, is unsorted and not stratified. It is called glacial till. The central third of Indiana is a gently-rolling till plain averaging 40 feet thick. The thickness of the till layer across the northern two-thirds of the state varies in thickness from only a few inches to 265 feet near Michigan City on the southern shore of Lake Michigan. The thickest till deposit in the Midwest is 1,189 feet near Cadillac, Michigan. The extreme southeast corner of Indiana, which was covered by the Illinoian glacial but untouched by the later Wisconsin ice is covered by a think, nearly insignificant layer of till that is more than 100,000 years old.

more so than the severity of the winters, is the prime determiner of a glacial climate. Unless snow and ice can remain on the ground all summer, there is no chance that a glacier can begin, no matter how cold the winters are. This idea was first proposed by Wladimir Koppen in 1914.

Snow is formed of hexagonal crystals. Over time the hexagonal nature of the snowflakes break down. The crystals become granular and the snowfield is more dense and compact. If the snow survives the melting season, the granular snowcover is termed firn. As the firn layer gets thicker as years go by, its density gets greater and eventually it becomes glacial ice. When the glacial ice has accumulated to several thousand feet, the ice near the bottom is compressed into a plastic-like material. It is able to flow very slowly and is squeezed out in front of the glacier. This accumulation of amorphous ice at the front edge of a glacier over time is how a glacier moves forward. Snow and ice begin accumulating on the leading edge of the glacier and, because white reflects most of the sunlight, the cooling effect is enhanced. It is self-perpetuating.

Rocks, soil, and other debris are carved from the surface of the land and become embedded in the ice. This debris is carried with the glacier as it moves and is deposited at the margins, where the ice melts during warmer periods.

Landscape Regions of Indiana

The landscape of the northern-two thirds of the state is almost 100 percent due to the action of the ice sheets, particularly during the Wisconsin advance. The part of the state shaped by the ice can be broken down into four physiographic regions

The Calumet Lacustrine Plain is the small area that extends from the south shore of Lake Michigan to the Valparaiso Moraine. The term, lacustrine, refers to lake deposits. This region contains deposits that were left by glacial Lake Chicago when it existed at its former shoreline along the Valparaiso Moraine. Most of this region is sandy, but there are significant clay deposits near Hobart.

The area south of the Valpaaraiso Moraine, extending to near Rensselear and then swinging northeastward, paralleling the Kankakee River, is called the Kankakee Outwash Plain. It is a flat area of sorted sediments carried by the melt water flowing over the moraines from the glacier.

The northeast quarter of the state is a moraine region. Numerous moraines deposited by the Erie and Huron lobes of the Wisconsin ice sheet exist in this area. The most prominent of these is the Packerton Moraine, extending from the northeast to the southwest near South Bend.

South of a line from Forte Wayne to Rensselear and extending to the southernmost boundary of the Wisconsin glacier is the Tipton Till Plain. It is a broad, flat or gently-rolling region of unsorted drift deposited by the ice as the Wisconsin glacier retreated northward. Valley train sediments occur near rivers.

Indiana is one of the states in the so-called Breadbasket of the United States. It helps feed the world with its sprawling farms. It owes this legacy to the Great Ice Age, whose vast ice sheets deposited the soils, and then leveled them, making the northern two-thirds of the state an ideal farmland.

The southern third of Indiana, south of a line from near Vincennes to Richmond, is broken down into seven physiographic regions. All these regions exist as a result of the bedrock and are not due to the action of glaciers.

stone intermingled with shale. The region, which includes the city of Madison, is quite hilly. To the west is the Muscatatuck Slope. It is a rolling area that is generally lower in elevation. It blends into the next region, the Scottsburg Lowland. This is a rather low, flat region consisting mainly of shale.

To the west of the Scottsburg Lowland is a rather obvious escarpment which begins the Norman Upland. It consists of sandstone and limestone layers. West of here is the Mitchell Plain, an area of karst topography formed from layers of pure limestone.

The Crawford Upland is west of the Mitchell Plain. Finally, the Wabash Lowland extends to the Wabash River. Each of these regions extends well into northern Indiana before the ice sheets covered them with drift.

The Great Lakes: Legacy of Ice

Indiana has a shoreline on one of the Great Lakes, Lake Michigan. It is the shortest lakeshore line of any of the Great Lakes states, but it is still long enough to have Indiana Dunes National Lakeshore, part of the national parks system. There are several municipal beaches and the Indiana Dunes State Park on the shoreline as well. Lake Michigan and the other four Great Lakes were created by the glaciers of the Ice Age.

As the Wisconsin ice sheet retreated, its melt water formed the ancestors of the modern Great Lakes system. Before the advance of the glaciers, the area now occupied by the Great Lakes was a plain with very broad river valleys. The region covered the southern part of what is now known as the Canadian Shield, and area of bedrock of Precambrian age consisting of granite and a metamorphic rock called gneiss. This area was laid bare by the scouring action of the glaciers.

Before the Ice Age, however, the areas which are now the Great Lakes consisted of a wide basin that was filled with thick deposits of sedimentary rock that were laid down by the repeated encroachment of ancient inland seas. Studies of the sedimentary rock layers within this basin show that it is bowl-shaped, with the layers up-turned slightly around the edge. The ice sheets carved sections of this basin into the present basins of the Great Lakes.

Dolomite is a sedimentary rock that is similar to limestone but tends to resist weathering. A resistant layer of dolomite, known as the Niagaran Formation, was laid down in the basin and helped to shape the Great Lakes. The Niagaran dolomite is exposed as a rim of resistant rock starting in New York, east of Niagara Falls, cutting through the falls, then turning northward where it borders the northern and eastern shores of Lake Huron, separating the main lake from Georgian Bay. It then turns westward, bordering the northern boundary of Lake Michigan. The rim follows the western shore of Lake Michigan to the south where it turns east at the southern tip of Lake Michigan. It then traverses northern Indiana and Ohio where it forms the southern boundary of Lake Erie. The younger rocks on the inside of this rim are less resistant are have been carved by the glaciers into Lakes Michigan, Erie, and Huron, west of Georgian Bay. The rock layers lying outside the Niagaran Formation are older, but still less resistant and have been carved into Lake Ontario and Georgian Bay. Lake Superior, the largest of the Great Lakes, has a more complicated history that will be addressed a little later.

Of the five Great Lakes, the one that is most familiar to Indiana residents is

Lake Michigan. But this lake has not always been as stable as it is today. Its current shoreline arcs between the Indiana and Illinois border near Chicago to the Michigan border just northeast of Michigan City. But Lake Michigan has had three other shorelines that lie farther south. These old shorelines can be deduced from the location of ancient sand dunes, as well as the current elevation differences of the landscape.

The earliest precursor to Lake Michigan, which existed during the time the ice sheets were retreating into Canada, was glacial Lake Chicago. It changed its size, and its shoreline location, several times. The earliest stage of glacial Lake Chicago produced no beach as can be found surrounding the present-day Lake Michigan. It was a relatively short-lived lake occurring completely within the borders of present-day Indiana. At this stage, glacial Lake Chicago was a crescent-shaped lake bounded by the ice sheet to the north and the Valplies9i207 TT0*orthicae.T f2

Ancient Shorelines of Glacial Lake Chicago

The earliest shoreline of glacial Lake Chicago occurred when its waters were held in place by the Valparaiso Moraine. This was at a time when the southern margin of the Wisconsin ice sheet was just exiting what is now Indiana. As the ice sheet retreated, Lake Chicago's shoreline receded to a new location, near Merrillville, Indiana. The ancient Glenwood Shoreline occurs today along U.S. Highway 30 that runs through Northwest Indiana. The lake water level was at 640 feet when this shoreline formed between 14,500 and 12,500 years ago. It is named for the city of Glenwood, Illinois where the former beach is clearly evident. A small, elongated island was present in glacial Lake Chicago during this stage. It is called Hobart Island and lies just west of Hobart, Indiana. Today, Hobart Island is a raised area of glacial till surrounded by beach deposits of sand.

In Gary, Indiana, there is a street called Ridge Road for reasons that are obvious to those traveling along it. On the south side of the street, houses are built atop a high ridge made of ancient sand that formed dunes when glacial Lake Chicago was located at the Calumet shoreline. This ancient shoreline parallels Ridge Road in Gary to Munster, Indiana and runs through the east end of Lake Station. The lake level was at 620 feet when the shoreline and accompanying dunes were formed about 11,000 years ago. The outlet at Chicago that allowed the lake to spill southward was eroding, with a resulting decrease in the lake water level. But a layer of resistant rocks in the Valparaiso Moraine halted the erosion for awhile at the 620-foot level.

present-day Des Plains River over the Valparaiso Moraine. The eastward drainage into the Hudson River was also still active.

A striking artifact of the isostatic rebound of the earth's crust near the end of the Ice Age occurs on Mackinac Island in Michigan. The island sits in the Straits of Mackinac that separate Lakes Michigan from Huron. On one of the highest points on the island sits Arch Rock. It is a limestone rock formation in the form of an archway, carved by the waves of glacial Lake Algonquin. But Lake Algonquin's water level was at 605 feet, the elevation of the Tolleston shoreline. And the present lake level is 580 feet. Arch Rock stands hundreds of feet above the current lake level. The only explanation for this is that the crust of the earth was uplifted.

From about 1,500 years ago Lakes Michigan and Huron have been at elevation 580 feet on the average. Lake Michigan drains directly into Lake Huron, which drains via the Detroit River into Lake Erie. Lake Superior drains into Lake Huron via the St. Mary's River. Finally, Lake Erie drains into Lake Ontario over Niagara Falls in the Niagara River.

The age of the Great Lakes and the resulting shorelines can be determined by a number of different methods. The years gone by since any particular period of glaciation can normally be obtained by a study of the magnetism contained within ocean core samples. The earth's magnetic field has flipped a number of times during the past million years. A record of these reversals is locked in the sediment deposited in the ocean. Other ways of determining the length of ice

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the Precambrian Era, half a billion years ago. It is the only lake whose shape and history has not been influenced by the dolomite of the Niagaran Formation.

Lake Michigan's Effects on the Landscape of Northwest Indiana

Lake, Porter, and LaPorte Counties are the three Northwest Indiana counties that border on the southern tip of Lake Michigan. The current lake and its predecessor, glacial Lake Chicago, have had a striking effect on the landscape of the region. Most of the rivers in Northwest Indiana tend to run east and west. This is because there are valleys formed between the ancient sand dune areas formed when glacial Lake Chicago existed at the Calumet shoreline or the Glenwood shoreline. These dune ridges paralleled the ancient shorelines, which ran east and west. Drainage in northern Lake County is poor because of the extremely small slope of the land and because of the parallel ridges of sand.

Going from eat to west along Ridge Road from Hobart into Gary one can see an ancient sand dune ridge on the south side of the street. The houses are built on this dune. Looking northward along any cross street, a gradual dip in the elevation is apparent. This is where the Calumet shoreline existed, sloping downward under the old lake level. It runs eastward, curing up through Lake Station and on to Michigan City. The hilly region on the east side of Lake Station is the remains of old sand dunes.

Driving eastward along U.S. 20 in Miller, one can see another series of dunes. These look more recent in origin because they are clearly recognizable as being made of sand. They were formed when the lake was occupying the Tolleston shoreline. Sand dunes in a current stage of formation can be seen just south of the present shoreline of Lake Michigan in the Indiana Dunes National Lakeshore at West Beach.

During times of flooding, the low-lying areas between the ancient dune regions are affected most. Cemeteries in the Calumet area are all constructed on a former shoreline, which is at a higher elevation and less flood-prone. The clay pits in Hobart represent sediment laid down when Lake Chicago was occupying the Calumet shoreline. Hobart lies in a low area between the Glenwood and Calumet shorelines. During wet weather when Lake Chicago existed at the Calumet shoreline, water accumulated and deposited clay and sand in sorted layers called varves in the area near Hobart.

Dune formation is a story in itself. Currents caused by waves hitting the shore at an angle, called longshore currents, flow southward along the western shore of Lake Michigan. These currents and the waves erode the bedrock and soil from areas of Wisconsin and Illinois and deposit them along the shoreline in Indiana and southern Michigan. Most of the minerals that make up this earth debris are unstable at the earth's surface and tend to weather away rapidly. The quartz, which is a major component of many rocks, is the most stable mineral at the surface and tends to resist weathering. Consequently, the quartz particles remain after the other minerals have eroded away. The sand of the Indiana Dunes is composed of these quartz particles, which have been rounded by the winds and the waves. They pile up on the southern shore of Lake Michigan to form sandy beaches. They are blown by the wind and pile up in ridges and mounds called sand dunes.

Mount Baldy in Michigan City is the tallest living sand dune in Indiana. Living sand dunes are those that are currently migrating due to the prevailing winds. As dunes migrate inland, grasses, such as Marram Grass and Little Blue Stem begin to take root in the sand and stabilize its movement. The dunes are very fragile, however. If the scanty vegetation is killed in a small area on the windward side of a dune, a blow-out is the result. This is a large area devoid of vegetation, causing the dune to become hollowed out at that location. Many features of sand dune succession can be seen at West Beach, part of the Indiana Dunes National Lakeshore, and at Indiana Dunes State Park near Chesterton.

The Rivers of Indiana

The Ice Age totally changed the drainage pattern of Indiana. In fact, the drainage pattern of the entire nation was radically altered. The ancestral Missouri River drained to the northeast into the Arctic Ocean. The ancestral Ohio River was much farther to the north, running through central Ohio and northward to empty into Lake Erie.

Unlike the mountainous Continental Divide of the Rockies, Indiana's divide runs only atop the end moraines left by the Ice Age. In Chicago, the divide is only 10 feet above the present level of Lake Michigan.

experience glacial activity at certain intervals of time. The cycles are collectively known as the Milankovitch cycles after Milutin Milankovitch, a Serbian mathematician who devoted much of his life to the study of the effects of these cycles on climate. If the Milankovitch cycles are in a favorable position for cool summers and if there is land on or near at least one of the poles, the stage is set for an ice age to begin. These astronomical cycles occur more quickly than the drifting of the continents. A continent moves so slowly that it effectively remains in place of millions of years. The orbital cycles are in a favorable position for an ice age to begin about every 100,000 years. The Milankovitch cycles, therefore, apparently are responsible for the many glacial advances within a period of a much longer age of ice.

Note that the earth presently has a land mass covering the South Pole and land masses surround the North Pole. Thus, it is believed, we are currently in a warm interglacial period of a much longer ice age. When the Milankovitch cycles return to the appropriate conditions, a new period of glaciation will likely begin.

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