Iowa Geology and Fossils

Iowa Association of Naturalists

Iowa Physical Environment Series
Iowa Association of Naturalists

The Iowa Association of Naturalists (IAN) is a nonprofit organization of people interested in promoting the development of skills and education within the art of interpreting the natural and cultural environment. IAN was founded in 1978 and may be contacted by writing the Conservation Education Center, 2473 160th Rd., Guthrie Center, IA 50115, 515/747-8383.

Iowa Physical Environment Series

Students need to be knowledgeable about both the physical and living components of their environment. The Iowa Association of Naturalists has created this series of booklets to offer a basic understandable overview of the Iowa physical environment. These booklets will assist educators in teaching students about Iowa's physical environment. The three booklets in this series are:

Iowa Weather (IAN-701)
Iowa Geology and Fossils (IAN-702)
Iowa Soils (IAN-703)

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Iowa Geology and Fossils

It's a rocky story

An open rock face with layers of stone lying one on top of the other appears when you're walking along a river bank or driving along the highway. These outcrops are like a book, each rock layer representing pages of a story. Some parts of the book have a complete story line; the stone is full of fossils. Some pages are difficult for a geologist to read; the rock has eroded or the fossil record is scant. Some pages are missing, and others were crumpled by earthquakes and mountain building. A cover exists now, but this layer of soil will probably be worn away.

Today geologists and paleontologists are piecing together Earth's history with help from these rocky exposures to reconstruct the details. They fill in gaps with help from stories told elsewhere. But to understand the plot of any book, one needs to know the characters: minerals, rocks, and fossils. The history of these characters can be understood by studying plate tectonics, time, and the geologic record. Then the whole story can be told!
Look at any rock through a hand lens and you will see it’s made up of crystals and particles. These are minerals and they come in different colors, shapes, and hardness. The most common Iowa minerals are gypsum, halite, calcite, galena, pyrite, sphalerite, quartz, limonite, and marcasite. All rocks are made of minerals. The unique combination of minerals present and how the rock was created determines its type, whether igneous, sedimentary, or metamorphic.

Igneous rocks began as molten rock in the form of lava or magma. Magma runs beneath Earth’s surface, while lava flows on the surface. In some areas, volcanic activity at Earth’s surface led to the formation of igneous rocks. In other areas, a mass of magma flowed underground and when the molten rock cooled, the minerals crystallized and igneous rocks formed.

Most sedimentary rocks start as clay, sand, or silt eroded from other rocks. Carried by wind or water, these materials settle almost anywhere on land or the ocean bottom. Gradually over time, the sediments accumulate and minerals in the water cement these layers into hard rock.

Metamorphic rocks began as igneous, sedimentary, or other metamorphic rocks but were altered through physical forces. Once buried, they are subjected to pressure and high temperatures. Sometimes the “new” rock doesn’t even look like the old one.

The following rocks are what make up Iowa’s bedrock or basement rock.
Iowa rocks

<table>
<thead>
<tr>
<th>Type</th>
<th>Iowa examples</th>
<th>Description</th>
<th>How formed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Igneous</td>
<td>Granite</td>
<td>Large pink, clear, and black crystals; in various combinations</td>
<td>Formed with slow cooling inside Earth</td>
</tr>
<tr>
<td></td>
<td>Basalt</td>
<td>Fine-grained; black</td>
<td>Fast cooling on Earth’s surface</td>
</tr>
<tr>
<td>Sedimentary</td>
<td>Limestone</td>
<td>Light-colored; flaky; contains fossils</td>
<td>Skeletons and shells buried and solidified in shallow waters</td>
</tr>
<tr>
<td></td>
<td>Dolomite</td>
<td>Light-colored; more porous than limestone; no fossils</td>
<td>Forms in same way as limestone but came in contact with water containing magnesium</td>
</tr>
<tr>
<td></td>
<td>Sandstone</td>
<td>Sandy texture</td>
<td>River or shallow sea sand cemented</td>
</tr>
<tr>
<td>Metamorphic</td>
<td>Quartzite</td>
<td>Pinkish-red; hard</td>
<td>Sandstone buried, then subjected to high temperatures and pressure</td>
</tr>
<tr>
<td></td>
<td>Gneiss and Schist</td>
<td>Coarse-textured; black and white crystals arranged in stripes</td>
<td>Buried igneous or sedimentary rocks subjected to high temperatures and pressure</td>
</tr>
</tbody>
</table>

**Fossils** are the remains of ancient life preserved in several different forms such as an impression, preserved remains of a plant or animal, and a mark made by an animal. They give us hints into what life and the environment looked like millions of years ago. They even help date rock formations and help us locate coal, oil, and other resources. Iowa is an awesome place for fossils! Museums throughout the world contain specimens and collections from Iowa. Two things are usually necessary for a fossil to form: hard parts such as bone, shell, or tooth; and rapid burial, usually by water-borne sediment, followed by mineralization.

A fossil mold in the shape of an animal or plant is left behind when its remains are completely dissolved and the cavity is not filled immediately by minerals. A fossil cast is formed when the mold is later filled with clay or some other material. Ocean conditions are perfect for fossil formation and, believe it or not, Iowa was buried under an ocean for millions of years.
## Common Iowa invertebrate fossils

<table>
<thead>
<tr>
<th>Type of Fossil</th>
<th>Description</th>
<th>Era/Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foraminifera</td>
<td>One-celled protist that secretes a calcite shell</td>
<td>Precambrian to recent</td>
</tr>
<tr>
<td>Bryozoan</td>
<td>Colonial animal that looks like a coral; secretes calcareous skeletons; fan or lacy looking</td>
<td>Ordovician to recent</td>
</tr>
<tr>
<td>Brachiopod</td>
<td>Small clam-like animal; shell overhangs the other; shell can be held by a muscle or a hinge</td>
<td>Cambrian to recent</td>
</tr>
<tr>
<td>Graptolite</td>
<td>Colonial animal that resembles a twig or leaf</td>
<td>Cambrian to Pennsylvanian; extinct</td>
</tr>
<tr>
<td>Coelenterate</td>
<td>Animal with a sac-like body, mouth tentacles, and skeleton; forms colonies</td>
<td>Ordovician to recent</td>
</tr>
<tr>
<td>• Coral</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Sponge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mollusk</td>
<td>Soft body animal with a flat foot for moving its shell; guided by tentacles; shell coiled or cup-like</td>
<td>Cambrian to recent</td>
</tr>
<tr>
<td>• Gastropod (snail)</td>
<td></td>
<td>Cambrian to recent</td>
</tr>
<tr>
<td>• Pelecypod (clam, mussel, and oyster)</td>
<td>Animal with front and back shells that are mirror images</td>
<td>Cambrian to recent</td>
</tr>
<tr>
<td>Cephalopod</td>
<td>Fast-moving predator with well-developed sense organs; ability to change color to environment; marine waters only</td>
<td>Late Cambrian to recent</td>
</tr>
<tr>
<td>• Ammonoid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Nautiloid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arthropod</td>
<td>One millimeter to one meter-long animal with armor-like exoskeleton in three longitudinal pieces; rolls up like a pill bug</td>
<td>Cambrian to Permian; extinct</td>
</tr>
<tr>
<td>• Trilobite</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Echinoderm</td>
<td>Animal with five-fold symmetry; skeleton of calcite; marine waters only; crinoids and blastoids attached to sea bed by a flexible stem; petal-like arms are attached to mouth where food is filtered; no eyes</td>
<td>Ordovician to recent; blastoids extinct</td>
</tr>
<tr>
<td>• Crinoid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Blastoid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Starfish</td>
<td>Animals with five oblong fragile arms which radiate from a flat, circular disk</td>
<td>Ordovician to recent</td>
</tr>
<tr>
<td>Worms</td>
<td>Fossils of worm bodies are rare, but their trails or burrows are abundant; one group of worms secrete a calcite tube and are found attached to fossil shells</td>
<td>Cambrian to recent</td>
</tr>
<tr>
<td>• Burrows and tubes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Story background

Continental drift and plate tectonics

Iowa is on the move and always has been. It sits on one of seven continental plates that have shifted slowly throughout time, moving and shaping not only the land masses but also the ocean floor. When they push into each other, mountains form. When they slide past each other, earthquakes occur. And when they pull apart, rifts or openings are created. When these events happen, ocean water moves from one area to another.

Plate tectonics are responsible for moving Iowa all over Earth. This state has experienced tropical climates and arctic temperatures. It's been submerged beneath oceans and forced to emerge again. With all this moving around, rock is broken down into its component parts by the process of erosion and carried away by wind, water, and ice. The degraded rock is then available to make new rocks. All of this takes an enormous amount of time.

Time

Earth is estimated to be about 4.5 billion years old. The oldest Iowa rocks are igneous rocks, found deep underground. It's estimated these rocks are 2.9 billion years old. How do geologists know the age of Earth or the age of rocks? What we do know about the age of rocks comes from radioactive dating. Many rocks contain tiny amounts of radioactive elements. These elements act like little clocks. They break down at a predictable rate so geologists can measure how old a stone is relative to one of known age. From radioactive dating, we
know the comparable age of many types of rock formations.

**Rock formations** are large sheets of rock that can be distinguished from each other based on mineral composition and types of fossils found in them. Rock formations allow geologists to map sequences of Earth's history in a region. If left undisturbed, these rock layers stack from oldest on the bottom to youngest on the top. This is called the **law of superposition**. Some formations may be jumbled or missing from the geologic record, but by studying formations found in other regions, we can make guesses about what happened. These missing rock layers are called **nonconformities**. They may have formed in a place, but then eroded away.

**Geologic record**

The **geologic column** helps us keep track of vast amounts of time represented in the rock formations. Geologic time hardly resembles the way we keep time today. Geologic time is divided into epochs, periods, and eras instead of years, centuries, and millennia. Rather than being defined by an amount of time, an era is characterized by a significant event, much like a chapter in a book. The four chapters or eras include the Precambrian, Paleozoic, Mesozoic, and Cenozoic. Using a variety of data, geologists have reconstructed the positions of ancient continents.
Chapter one: Precambrian Era

The Precambrian chapter is long in geologic time, filling more than 88 pages of a 100-page Earth history book—roughly four billion years. More than half the pages in chapter one would be blank, because we don’t know what happened. The remaining pages would be blurry.

Much of what we do know about this time is what well drillers have learned and recorded over the years. The oldest rocks—granite, gneiss, and schist—have been found in deep wells scattered around the state. These same rocks suggest that ancient peaks once existed in Iowa, formed by continental plates crashing together. With a quick glance through the window, it’s obvious that the mountains have since eroded away.

In Iowa, the only place you can see Precambrian rock is in the extreme northwest part of the state at Gitchie Manitou State Park in Lyon County. This Sioux quartzite is a beautiful red-pink formation that formed along a marine or freshwater shoreline more that a billion years ago.

Towards the end of the Precambrian Era, another major event occurred. Iowa almost split apart along a continental tear, or a cut in the plate on which Iowa lies. The earthquakes must have been tremendous. Volcanic activity followed, and lava gushed through fissures, or cracks, and hardened into basalt. This 30-mile-wide fracture zone extends from Mason City through Ames to Council Bluffs.

Like much of Iowa’s geological history, it’s not visible, buried by 1,000-4,000 feet of rocks and soil.
While all of this was happening, the North American continental plate moved from north of the equator to south of the equator. It's believed that, toward the end of the era, all the continents smashed together into one huge supercontinent.

Although no fossil record exists in Iowa for this era, fossils have been found in three-billion-year-old rocks in other sites. Scientists have discovered fossil worm burrows and, some one-celled microfossils such as algae, foraminifera, and radiolaria in its rocky formations.

**Movement of the North American continent from the Precambrian Era to Cenozoic Era.**

**Manson disturbed area**

While most Iowans drink and bathe in hard, calcium-rich waters, residents near Manson in Calhoun County drink soft water pumped straight from their wells. Their wells are drilled into an area of broken and crushed Precambrian rock that lies less than 100 feet beneath the surface. Residents living elsewhere in the state would need to drill thousands of feet underground in order to reach this aquifer.

The puzzling thing is that near Manson this rock is buried only by undisturbed glacial till. Glacial till is rock, soil, and wood brought in by glaciers only about one a million years ago or less. Geologists have created a variety of explanations for this weird situation, but evidence confirms that millions of years ago an asteroid or meteor crashed into this area.
Chapter two: Paleozoic Era

The Paleozoic chapter would fill pages 89-96 of the book, covering more than 300 million years of history. Information on the pages would be more complete but with one or two pages torn out. Six distinct periods of time make up this era and, except for the Permian Period and parts of some other eras, Iowa was under water. The same plate movements that submerged Iowa also pushed it southward into the tropics. Thick layers of sediment were deposited in warm, shallow seas, and, for millions of years, these seas deepened, creating sedimentary rock layers hundreds of feet thick. Later the seas became shallow and created shorelines. Again, the sediment buried these shores and the process continued.

Iowa’s seas were brimming with life, a stark contrast to the Precambrian Period. Through time, sea life became more abundant and complex, allowing our history to be written in more detail.

Sandstone, but where are the trilobites?
Cambrian Period

This period is known for the debut of the trilobite, an armor-wearing invertebrate that could roll up its body like today’s pill bug. Unfortunately, not many fossils have been found in Iowa’s Cambrian rocks. Some scientists seem to think the fossil record is poor because creatures living during this time had soft body parts. Bone and hard calcite shells had not yet developed. Other scientists think abrasion from the sandy rock particles swirling in the marine waters destroyed the fossils. In Iowa, worm burrows are very common in several sandstone formations, but only a few small trilobite pieces and brachiopods have been found.
The 450 million-year-old Cambrian rocks are visible at the surface only in northeast Iowa, but they are found underground all over the state. These layers accumulated late in the Cambrian as the sea shifted back and forth across Iowa, leaving mostly sandstone. The layers tilt down toward the southwest. We can’t see this. It’s concealed by rock formations and soil deposited from other more recent periods. This tilting means that, today, underground water flows slowly toward the southwest part of the state. This explains why shallow wells are suitable in northeast Iowa, but deep ones are needed in southwest Iowa. These wells tap into aquifers that lie beneath the ground. An aquifer is a layer of rock that absorbs and holds water. The most famous of these Iowan Cambrian aquifers is called the Jordan aquifer, tapped by many cities in the central and eastern part of the state for their drinking water.

Civil war: Ordovician Period

Time and underwater sediments helped create Iowa’s Ordovician layer which consists of limestone, shale, dolomite, and sandstone formations. Near Dubuque, early explorers found a rock formation that contained veins of galena and sphalerite. These are the mineral ores from which lead and zinc are extracted. During the Civil War, lead and zinc provided the raw material for lead shot.

A myriad of fossil invertebrates, including the well-known trilobite, are found in Iowa’s Ordovician rocks. Although rare in Iowa during this period, these fossils are most often found just northeast of Fayette.

Let’s snorkel!: Silurian Period

If you can remember one thing about the Silurian, let it be its Caribbean-style seas and fabulous
coral reefs. Iowa would have been a snorkeler’s delight. Examples of these fossilized coral reefs are found in outcrops, or exposed rock formations, in eastern Linn County, southern Jones County, and throughout Cedar County. Although not much of a fossil record is found in Silurian deposits, some of these rock beds are full of corals, crinoids, brachiopods, and other sea dwellers.

Non-reef rocks formed on the sea bottom near the once massive coral reefs. Most of the bedrock is covered by glacial deposits so only a few scattered outcrops are found today. These Silurian outcrops are almost entirely made up of dolomite. Most dolomite contains chert, a smooth, light-colored rock that occurs as hard, round nodules or thin layers. This was used by American Indians for their projectile points. Silurian dolomite can be found in Backbone State Park in Delaware County and Maquoketa Caves in Jackson County. Few fossils survived this extensive dolomitization. One type of fossil that did survive is called pig’s foot, a brachiopod mold found in a quarry near Maquoketa in Jackson County.

It's time to fish: Devonian Period

By the middle Devonian period, Iowa’s seas were swarming with fish and other ocean-dwelling creatures. Early types of sharks swam in the warm waters as did armored fish called placoderms that grew more than 20 feet long. Today, shark teeth may be found in fossil collecting areas from this period. A few bony plates, pieces of jaw bones, and spine-like fins from the placoderms may also be found in rock. Iowa’s fossil record for Devonian fish is meager. The skeletons of the sharks and placoderms that lived in Iowa during this period were cartilaginous, as they are today. Cartilage didn’t survive the rigors of fossilization, but
phosphate-containing teeth, plates, and jaws did, turning black when fossilized. The ray-finned fish, bony ancestors of the fish we catch today, were present in these seas toward the end of the period.

This era is recognized for the abundance of fish, but in Iowa, sea life such as brachiopods and corals is more prominent. The invertebrate fossil record is represented by all major groups such as bryozoa, echinoderms, mollusks, and arthropods. Sponges and algae are also found. Examples of the Devonian fossils and rocks may be found in the towns of Shell Rock in Butler County, and Coralville in Johnson County and in Lime Creek Conservation Area near Mason City, and at the Rockford Fossil Park in Floyd County. These places are some of the best fossil observing sites in the state, and are of special interest to paleontologists, or fossil experts. Devonian rock types include limestone, dolomite, shale, sandstone, and gypsum.

It’s a limy place: Mississippian Period

Lying above the Devonian stone is a younger strata deposited 350 million years ago. Although this sequence of stone is called the Mississippian, the Mississippi River did not exist yet. This period got its name because geologists first mapped and described these outcrops along the Mississippi River in southeast Iowa. During this period, Iowa was covered with warm, shallow, carbonate-rich seas. The carbonate came from the shelled animals as they died and sank. These sediments turned into limestone layers. Dolomite, sandstones, and shales also were deposited.

The limestone strata extends across most of the state. Geologists mapped its many formations, and fossil hunters have collected Mississippian fossils for a long time. Crinoid fossils are
especially abundant near Burlington, Marshalltown, Gilmore City, and Keokuk. Other fossils include sea urchins, trilobites, blastoids, brachiopods, bryozoa, mollusks, corals, foraminifera, conodonts (shark parts), and the rare starfish. Our state rock, the geode, also formed during this time.

**It’s “coal” out there: Pennsylvanian Period**

For 45 million years, during the Pennsylvanian Period, Iowa was located along a recurring ocean shoreline. Starting in the northeast tip of the state, the shoreline moved diagonally from north to south across Iowa. A large, ancient river flowing across Wisconsin formed a delta where the land met the sea. Today, examples of the sandstone deposits created on this changing river delta are found in several places throughout the state but none so spectacular as at Ledges State Park near Boone.

At the same time the deltas formed, swamps resembling the present-day Florida Everglades covered the southern part of the state. Jungle vegetation accumulated in these ancient swamps and was later buried by sediments. Through time, the sediments hardened into coal. Iowa coal was mined after European settlement but today it’s considered too high in sulfur content, making it uneconomical to burn. The principal coal-forming plants were *Lepidodendron*, giant bare-trunked club moss; *Cordaites*, 150-foot tall primitive conifers; and *Calamites*, giant horsetails and scouring rush. Fossilized bark, roots, and leaves from these trees can be found in several places in the state.

Since the geode is our state rock, a booklet on Iowa’s geology would not be complete without describing it. On an oxygen-starved deep sea bottom, layers of calcite-rich mud were deposited and formed into round and egg-shaped concretions. Concretions occur when a small piece of fossil or tiny crystal begins to develop a layer of calcite sediment around it, much like how a pearl forms inside an oyster. Later, the sea became more shallow, thus warmer and more oxygenated. Under these new conditions, the remaining calcite changed into small quartz crystals and a crusty shell formed. As the sea retreated and left behind land, weathering and erosion took its toll. Acidic rain water trickled into the concretions through cracks and tiny openings, dissolving the crystallized core. Some of the water left inside the core precipitated out colorful mineral crystals. While this episode occurred statewide, only a few spots in southeast Iowa are good geode hunting territories. A few decades back, families who lived near geode-strewn rivers would pack a hammer along with their Sunday lunch and spend their time geode hunting.

*During the Pennsylvanian Period, a recurring ocean shoreline moved diagonally from northeast to southwest across the state.*
The black shale layers near Madrid tell us of sharks lurking in the quiet coastal lagoons, while limestone layers also contain crinoid, brachiopod, gastropod, trilobite, nautiloid, and pelecypod fossils.

A ripped page: Permian Period

The page covering this period is ripped out. It is not clear what was happening during these 30 million years. It’s believed that Iowa was a low-lying, arid plain, subjected to years of weathering and erosion. Fossils don’t form well in dry regions and neither do rocks. While it is likely that rocks did form during this period, the weather conditions tore them down almost as quickly as they were built up. No Permian rock layer is found in Iowa, but they do exist in Nebraska and other beautiful rocky places in the world.

Chapter three: Mesozoic Era

We’re traveling closer to Iowa’s upper crust, and the next stop is the Mesozoic - the age of the dinosaurs! Most grade school students know this era as the Triassic, Jurassic, and the Cretaceous periods. The Mesozoic chapter would cover just two and a half pages in Earth’s history book - pages 96 and 97 plus half of 98. Page 96, the Triassic Period, would be ripped out. This would depict a time of erosion much like the Permian Period.

Plenty of gypsum: Jurassic Period

During the Jurassic Period, North America continued its northward drift. Gypsum found in a
Iowa Geology and Fossils

rock formation near Fort Dodge is evidence of a large salty bay that occasionally dried up. Salts precipitated out of the seawater, leaving material to manufacture wall board and blackboard chalk. The only fossils within the gypsum formation are conifer pollen and fern spores.

One big fish: Cretaceous Period

Birds, mammals, and flowering plants made their first debut 65 million years ago during the Cretaceous period. The Rocky Mountains were beginning to erupt, and although Iowa lay beneath water, there was still plenty of action in the state. The plesiosaur, a 15 to 40-foot-long marine reptile, lurked in Iowa's seas. It used its paddle-like fins to propel itself after unsuspecting prey. Some people think plesiosaurs still live in a famous lake in Scotland called Loch Ness. Most people believe the dinosaurs died out by the end of this period. We know the plesiosaur lived in Iowa because a vertebrae of this creature was found in a shale deposit in Plymouth County. Other fossils such as fish scales and shark teeth also were found in the same vicinity as the plesiosaur. Leaves that resemble poplar, magnolia, willow, and sassafras trees are fossilized in northwest Iowa sandstone. Cretaceous rock formations are located in Iowa’s northwestern corner and a few isolated places in Floyd, Allamakee, and Mitchell counties. At Stone State Park near Sioux City, 500-foot thick sandstone, shale, and limestone layers can be seen.

By the end of the Mesozoic, all the dinosaurs were gone and no one knows exactly why. Most scientists suspect a gigantic meteorite or asteroid struck Earth, creating all sorts of dust that clouded the sun and, in effect, changed the climate. All we know is dinosaurs were here and then they were gone. Most scientists think our present-day birds and amphibians evolved from the dinosaurs.
The present chapter: Cenozoic Era

The present chapter is one-and-a-half pages long. Although we’re getting to the end of the book, there’s a lot of text to cram in. It represents 65 million years and includes today. It’s our most complete chapter, but there are still missing paragraphs and unexplained phenomena. The Cenozoic is divided into two periods: the Tertiary and the Quaternary.

They’re in Nebraska: Tertiary Period

During the Tertiary Period, Iowa surfaced from the sea again only to be weathered and eroded. So a little more than one page of our chapter is again torn out. But there are clues in nearby Nebraska where common Tertiary fossils include amphibians, reptiles, insects, fish, birds, and a variety of mammals. The plates moved to almost the same position where they are today, but California and the Gulf Coast were under water.

From ice to computers: Quaternary Period

Broken down into two epochs, the Pleistocene and Holocene, the Quaternary Period brings us to the present-day. In our book, these ages would be represented by only a sentence or two on the last page. The Pleistocene began about three million years ago. Its story lies in a cold, icy environment. It was during the Pleistocene that glaciers came to Iowa. Our present epoch, the Holocene, began 10,000 years ago and will continue until another major event defines a new epoch. The Holocene is
an erosional epoch that will someday be a missing page, but for now we are living it, enjoying the scenery and the plants and animals that inhabit our world.

**It was the ice: Pleistocene Epoch**

Imagine frigid temperatures and a sheet of ice one-half mile thick inching across the state. The glacier behaved much like a bulldozer, filling in the land's cracks and crevices as it moved southward and pushed rock, wood, and soil along with it. As temperatures warmed, the ice mass began to melt and deposit some of its baggage. Then cold temperatures returned, causing the glacier to expand, and the grinding and pushing process began again.

Over a period of 2.5 million years, as many as seven of these glacial events occurred throughout Iowa, affecting every part of the state. The most recent glacial episode, called the Wisconsinan, occurred off and on between 20,000 and 14,000 years ago. The Illinoian episode sneaked into Iowa before the Wisconsinan, covering the extreme southeast part of the state. Scientists call the remaining five Iowa glacial events pre-Illinoian.

Some special plants and animals inhabited the cooler Iowa climate. We know this because of the fossilized bone and teeth left behind and buried in the soil. Fossil tree pollen verify that Iowa was once forested by northern species such as spruce, yew, hemlock, and larch. By the end of the Pleistocene, the spruce and larch disappeared, and deciduous trees such as birch dotted the landscape. An unbelievable list of animals are known to have lived in Iowa at this time, including versions of horses, pigs, camels, deer, elk, moose, caribou, musk-oxen, buffalo, and giant beaver, bear and ground sloths. Mastodons and mammoths, both hairy elephant look-alikes with huge tusks, are thought to have survived the glaciers. Their bones
have been found in almost every county of the state. In other states, they are found with pottery shards and projectile points left by ancient indigenous peoples.

Iowa is divided into seven landform regions with only slight differences between them. The gently-rolling landscape is intersected by rivers and streams. The soil is extremely rich with a glacial till base and, in most regions, lightly sprinkled with a special type of soil covering called loess (pronounced "luhss"). Farms and towns dot the landscape and people live and travel everywhere. Let’s visit the seven regions that are shaped by the erosional processes of our recent geologic epoch.

Iowa’s alluvial plains

Once the pre-Illinoian glaciers began to melt, the water had to find a path to the ocean. This is how the Mississippi, Missouri, and many other Iowa rivers and streams originated and formed alluvial plains. Alluvium is the clay, silt, sand, and
gravel deposited by rivers, and alluvial plains are the flat areas surrounding rivers where this material spreads. Larger rivers have larger alluvial areas called floodplains.

A river’s appearance depends on many different things, including flooding, the types of sediment dislodged and sent downstream, and how the water flows. Younger rivers are relatively straight since water quickly has to find a new path, while older streams meander and have oxbow lakes and sloughs nearby.

People need these liquid lifelines for travel, commerce, agriculture, and drinking water. Iowa’s rivers were well-settled before the first Europeans saw them. Some indigenous peoples farmed the fertile alluvial soils, tolerating frequent flooding because they knew that the new soils deposited would produce better crops.

Potholes, kettles, and cold water lakes: Des Moines Lobe

The most recent glacial episode, the Wisconsinan, left its mark in Iowa. The part that crept through Iowa is called the Des Moines Lobe. It advanced through North and South Dakota and Minnesota into northcentral Iowa in three major advances. Each time it froze, it moved forward, and thawed, leaving glacial till on its edge. These edges are now evidenced by little hills on the landscape. Glacial till is the soil, rocks, and wood a glacier picks up and leaves behind in a new location. The last advance stopped in what is now Des Moines where it established the course of the Raccoon River.

Behind the glacier’s edge, the ice would stagnate, leaving features behind such as kettleholes, potholes, and natural lakes. A kettlehole is a bowl-like depression where a block of ice settled and melted after a glacier receded. Freda Hafner
Kettlehole in Dickinson County is a good example. Potholes are merely shallow depressions where water does not drain quickly. A wet spring reveals these depressions in fields throughout the region becoming temporary paradises for waterfowl. The cluster of natural lakes that stays wet year-round are Iowa’s Great Lakes. Located along the Minnesota border, Lake Okoboji, Spirit Lake, Clear Lake, and Storm Lake provide playgrounds for people and homes for wildlife.

**Let’s head for the hills: Western loess hills**

Take a piece of clay. Place it in your hand where your palm meets your fingers. Now make a fist. The resulting clay form looks quite similar to the rippled hills and valleys of the western loess hills. Major loess deposits found only in China and along the Missouri River from Sioux City to Kansas City. They are home for dry-adapted animal and plant species, such as the prairie rattlesnake, the yucca and the prickly-pear cactus.

Scoop up some of the yellow-gray soil called loess on any of the hill ridges, and you’ll notice its gritty texture. Loess consists of rock, silt, and clay pulverized by the action of glaciers. The Missouri Valley served as a channelway for large volumes of glacial meltwater and sediment. During dry periods, westerly winds carried the loess laid on the river’s floodplain and blew it over Iowa’s landscape. Most of the heavier loess components ended up two to ten miles east of the Missouri River, while the finer silt and clays spread throughout the state.

**The rolling farm region: Southern Iowa drift plain**

Check out the rolling hills, farm ponds, and the numerous streams of southern Iowa. In this typical Iowa landscape, no natural lakes, no prairie
potholes, and no loess hills are found. But there are plenty of rolling hills. These hills are about the same height and about the same distance apart. This tells us that there once was soil between the hills before it was eroded away over hundreds of thousands of years. Historically, this region was heavily wooded. Although most of the forest has been cut, it still contains a significant amount of the state’s remaining forests.

**Iowa’s Little Switzerland: Paleozoic plateau**

Most of Iowa has a subtle beauty, but the northeast part of the state is dramatically different. It’s full of hills and hollows, caves, springs, woodlands, beautiful rock faces, and cool, swift, narrow streams. This is the only place in Iowa where you can fish for native trout, spelunk in an ice cave, and photograph the Pleistocene snail and a plant called eastern monkshood - two native endangered species.

This region is different because its bedrock lies so close to the surface. Evidence of its glacial past has mostly eroded away. The bedrock is made of durable sedimentary rock layers that developed over millions of years. These limestones and dolomites are covered only by a thin soil layer. So when it rains or snows, water seeps into the rock strata’s tiny cracks. This limestone dissolves when it comes into contact with rainwater, and the cracks become fissures that slowly enlarge, creating passageways. Passageways that form and extend too close to the surface collapse, creating **sinkholes**. Passageways that extend horizontally within the rock formation 25 feet or more are considered **caves**. **Springs** are places in the rock where the water table meets the surface. All these features are known collectively as **karst topography**. Karst features are beautiful but vulnerable to surface and groundwater pollution.
It was once believed that this area was never covered by glacial till so it was called the driftless area. Today, geologists have re-evaluated this name because pre-Illinoian glacial drift has been documented on isolated bluffs and uplands and a large section of the western part of the so-called driftless area.

**Iowan erosion surface and northwest Iowa Plains**

Both of these landforms lay divided by the Des Moines Lobe and covered by the Wisconsinan glacier. The Iowan erosion surface in northeast Iowa and the northwest Iowa Plains lay uncovered, taking the brunt of the winds that swept over the state during this cold, dry period. Each year, erosion unearths thousands of glacial erratics, rocks carried to Iowa via ice and deposited on its surface after melting.

The Iowan erosion surface exhibits examples of karst topography but what makes the region truly unique is its pahas. Paha is a Dakota word meaning hill or ridge. Pahas are aligned parallel to and near river valleys, indicating that they were created as dunes. But their makeup suggests a better reason for their existence. Made of a thick layer of loess on top of a thick layer of ancient impenetrable soil called a paleosol, it appears that the area around them was severely eroded, while leaving these long hills intact. Most of Iowa’s pahas can be found in Benton, Tama, and Linn counties.

The topography of the northwest Iowa plains strongly resembles the Iowan surface. However, this surface is drier, more highly elevated, and has a thicker loess deposit on a deep bed of glacial till. Because its limestone bedrock does not lay as close to the surface as in the Iowan surface, this area does not exhibit karst topography.
Iowa’s rocky economy

It’s easy to think that geology only has to do with the past. But fossils, rocks, and landforms have a lot to do with what’s happening today. We depend on the geology of the region for our livelihood. A portion of Iowa’s economy depends on quarrying and mining rock. Each rock formation was laid down under different conditions, and therefore exhibits different qualities. These different characteristics produce a variety of useful materials. Think of all the ways geology has influenced our lives. Roads are made of limestone. So are our driveways. The brick walls of our homes are made with sand and clay. The drywall inside is made of limestone and gypsum. The heat that warms our homes may come from a type of coal similar to that which is found in Iowa. Geology is not dead. We see and use it every day.

Iowa’s next chapter

Our book on Iowa’s history is not complete. It’s a never-ending story in which the characters fade away and the plot twists. We don’t know what the future will hold, but there are predictions based on science. In another 50 million years, the North American plate could slide northward. This is why the San Andreas fault is giving Californians the shakes. It may be that North America is in an interglacial period, meaning another glacier is on its way. A slight shift in world temperature with higher precipitation in polar regions could cause arctic glaciers to expand. Some scientists think more greenhouse gases are being emitted into the atmosphere, creating a warming effect. The only thing for certain is that things will change and new pages will be written in Iowa’s rocky story.
Useful resources


Fossils for Amateurs; Russell P. MacFall and Jay Wollin; Van Nostrand Reinhold Company, New York, NY; 1972.

Fossils of Iowa: Field Guide to Paleozoic Deposits; Robert Charles Wolf; Iowa State University Press; Ames, IA; 1983.

From Rift to Drift: Iowa’s Story in Stone; Jack Clayton Troeger; Iowa State University Press; Ames, IA; 1983.

Geology of Iowa; Wayne I. Anderson; Iowa State University Press; Ames, IA; 1983.

Iowa’s Natural Heritage; Tom C. Cooper, Executive Editor; Iowa Natural Heritage Foundation and the Iowa Academy of Science; Des Moines, IA; 1982.

Landforms of Iowa; Jean C. Prior; University of Iowa Press; Iowa City, IA; 1991.


Sleuthing Fossils; Alan C. Cvancara; John Wiley and Sons, Inc.; New York, NY; 1990.

The Amateur Geologist: Explorations and Investigations; Raymond Wiggers; An Amateur Science Series Book; Franklin Watts; New York, NY; 1993.

Iowa Geology and Fossils is one in a series of three booklets that are part of the Iowa Physical Environment Series. The booklets in the series include:

**Iowa Physical Environment Series**
- Iowa Weather (IAN-701)
- Iowa Geology and Fossils (IAN-702)
- Iowa Soils (IAN-703)

The Iowa Association of Naturalists also has produced six other booklet series that provide readers with a clear, understandable overview of topics concerning the Iowa environment and conservation. The booklets included in each of the other five series are listed below.

**Iowa Wildlife Series**
- Iowa Mammals (IAN-601)
- Iowa Winter Birds (IAN-602)
- Iowa Nesting Birds (IAN-603)
- Iowa Reptiles and Amphibians (IAN-604)
- Iowa Fish (IAN-605)
- Iowa Insects and Other Invertebrates (IAN-606)

**Iowa Natural Resource Heritage**
- Changing Land Use and Values (IAN 501)
- Famous Iowa Conservationists (IAN 502)
- Iowa’s Environmental Laws (IAN 503)
- Conservation Careers in Iowa (IAN 504)

**Iowa Wildlife and People**
- Iowa Wildlife Management (IAN-401)
- Keeping Iowa Wildlife Wild (IAN-402)
- Misconceptions About Iowa Wildlife (IAN-403)
- State Symbols of Iowa (IAN-404)
- Iowa Food Webs and Other Interrelationships (IAN-405)
- Natural Cycles In Iowa (IAN-406)
- Iowa Biodiversity (IAN-407)
- Adapting To Iowa (IAN-408)

**Iowa Plants**
- Iowa’s Spring Wildflowers (IAN-301)
- Iowa’s Summer and Fall Wildflowers (IAN-302)
- Benefits and Dangers of Iowa Plants (IAN-303)
- Iowa’s Trees (IAN-304)
- Seeds, Nuts, and Fruits of Iowa Plants (IAN-305)
- Iowa’s Mushrooms and Other Nonflowering Plants (IAN-306)
- Iowa’s Shrubs and Vines (IAN-307)

**Iowa’s Biological Communities**
- Iowa’s Biological Communities (IAN-201)
- Iowa Woodlands (IAN-202)
- Iowa Prairies (IAN-203)
- Iowa Wetlands (IAN-204)
- Iowa Waterways (IAN-205)

**Iowa Environmental Issues**
- Iowa Habitat Loss and Disappearing Wildlife (IAN-101)
- Iowa Air Pollution (IAN-102)
- Iowa Water Pollution (IAN-103)
- Iowa Agricultural Practices and the Environment (IAN-104)
- People, Communities, and Their Iowa Environment (IAN-105)
- Energy In Iowa (IAN-106)
- Iowa Waste Management (IAN-107)