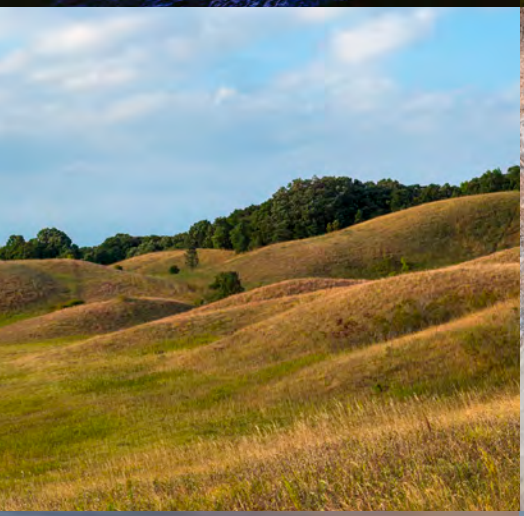

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7 Geological *Wonders* of Minnesota State Parks

By *Mary Hoff*

See how the earth was shaped by looking at the clue-filled landscapes in these parks.

Rocky cliffs, sandy beaches, roaring waterfalls, fish-filled lakes—each of Minnesota's 65 state parks has a unique set of fascinating features. Each of them brings not only beauty, but also mystery. Where did it come from? Why is it here and not there? The answers often have to do with Minnesota's geological history—the story of how volcanoes, glaciers, flowing water, and other forces shaped the surface of our state.

Let's take a tour of seven Minnesota state parks for a peek at how heat, water, ice, and wind have altered Minnesota's landscape over Earth's four and a half billion years of existence. Then consider planning a trip to a state park near you to see for yourself and learn more about the ancient surprises left behind.

Heat, Water, Ice, and Wind

Minnesota seems like a relatively stable place. The hills and lakes and rivers around you are mostly the same as they were last year at this time.

But over billions of years, this part of the planet has seen many changes. The land mass we now stand on has been transported around via underlying flowing, molten rock—sometimes above the equator, sometimes below, sometimes turned 90 or even 180 degrees from its current orientation. It has been covered in massive ice sheets and worn down by weather and water.

Through these processes it has gone from blazing hot to freezing cold. Bumping into other chunks of land, it has folded and creased and crinkled, and even started to split apart. Buffeted by wind, solid rock has been worn down into sand and silt. Sand and silt in turn have become rock as minerals glue them together. And sometimes pressure and heat have transformed this rock into yet other kinds of rock.

Over billions of years, the land we now know as Minnesota has gone through *lots* of change. And all that change has written its story in the land around you, everywhere you look.

Big movements. These are the major geological events that shaped this place:

- 2.7 billion years ago—mountains, volcanoes
- 1.1 billion years ago—volcanoes; thinning and stretching of land masses
- 500–65 million years ago—seas repeatedly cover the land
- 2 million years ago—glaciers begin to periodically flow over the surface

How do we know? When we look at the land around us, most of us see—well, the land around us. But geologists see a story of that land's ancient past.

The minerals that make up rocks, and the way they are combined, provide clues as to where they came from and what forces shaped them. The shapes and textures of the land offer insights into what has happened in the past, in the same way a wrinkled bedspread might tip you off that someone took a nap.

By learning about past discoveries and making discoveries of their own, geologists can turn what they see into a story of a place's past.

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Jay Cooke: Ancient Seas

Foaming water splashes amid jagged, white-streaked dark gray rocks as the St. Louis River rushes toward Lake Superior in Jay Cooke State Park. Why does the river run here? Why are the rocks gray and jagged? And what are those white stripes?

Two billion years ago—more than a billion years before the first animal appeared on Earth—this part of the world was underwater. Just as the bottom of your favorite lake is covered with mud and sand, the bottom of this big sea was covered with fine particles, too. Then things got hot—literally. About 1.8 billion years ago, an ancient mountain-building event caused these sedimentary rocks to heat up so the mud bits glued together to form a rock known as *shale*, and the sand bits—grains of the rocks *quartz* and *feldspar*—glued together to form a rock known as *graywacke*.

Pressure from below deformed and tilted the graywacke and shale, forcing them to point upward and forming cracks. A lighter-colored mineral, *milky quartz*, filled the cracks to form quartz veins, the whitish stripes we see today.

As Earth cooled off a couple million years ago, huge masses of ice periodically covered this area. About 11,000 years ago, they formed a humongous lake known as Glacial Lake Duluth. Silt, sand, and pebbles settled to the bottom of the lake. Since then, water and wind have worn down the exposed rock, smoothing sharp edges and creating more silt and sand.

Today you can easily see the results of all this geological action as you cross the Swinging Bridge near Jay Cooke's visitor center. Can you find the dark graywacke? How about the milky quartz that filled the cracks? As you stand on the bridge, send your mind back in time to imagine the many events that shaped this place.

GARY ALAN NELSON

Blue Mounds: Rocky Surprise

Imagine traveling across the gently rolling prairies that once covered what we now know as southwestern Minnesota 1,000 years ago. Suddenly, on the horizon, a 90-foot-high cliff appears. Eventually you get closer and find a route that takes you to the top. As you climb higher, you see ripples and scratches in the pinkish rock. What's it all about?

In a nutshell, wind and water.

Around 1.7 billion years ago, many streams flowed over this region. Sand settled to the bottom and formed ripples. Eventually it stuck together to form *sandstone*. Over eons of time, more sediment settled in, creating additional layers. Chemical reactions, heat, and pressure turned the sandstone into a harder rock called *quartzite*, tinted pinkish by tiny amounts of iron. As the surface of the earth shifted and cold alternated with heat, the rocks tilted and broke into chunks.

Next came the *glaciers*! Huge sheets of ice 1,000 feet thick or more periodically scraped the surface of the rock. In some places they left scratch marks. In others they left pebbles and boulders behind. Since then, wind, cold, and heat have continued to reshape the rocks, smoothing, cracking, and smoothing again.

As you hike along the trails at Blue Mounds, look for the pink quartzite. Look for signs the glaciers left behind. Can you see places where wind and water have worn down the rock, too? Then imagine: Based on what you know about this place's past, how might it look different a thousand—or a million—years from now?

GARY ALAN NELSON

Tettegouche: Liquid Rock

If you like places where rock and water meet, you'll love Tettegouche State Park. Here, you can watch the Baptism River tumble down a series of four waterfalls as it flows across rocky outcroppings to Lake Superior. And if you hike the trail toward the lake from the visitor center, you can see and even walk atop Shovel Point, a rugged cliff towering hundreds of feet over the icy water below.

The story of this landscape began more than a billion years ago when North America begin splitting apart here. Rock from far below the surface that was so hot it was liquid burbled out of the giant crack. As the melted rock cooled, it solidified into the reddish rock, *rhyolite*, that underlays Tettegouche. Vertical cracks formed during the cooling process, creating the columns you can see when you look at Shovel Point from the side. Rhyolite is some of the hardest rock found in Minnesota. That's why the bed beneath the Baptism River and the tall columns of Shovel Point have withstood wind and water better and literally stand out from their surroundings.

If you look closely, you might see specks of white in the rock. Those are made of two minerals, feldspar and quartz, that crystallized out of the molten rock as it cooled.

DEBORAH ROSE, DNR

Forestville/Mystery Cave: Holey Ground

How can you not love a park with the word "mystery" in its name? The mystery here is that some of the most exciting features of Forestville/Mystery Cave State Park are literally out of sight.

Far beneath the surface, tunnels lead in many directions through surrounding rock. Some go through rooms containing icicle-shaped formations hanging from the ceiling—*stalactites*—or sticking up from the floor—*stalagmites*. Pools of water have lily-pad-like deposits of stone floating in them. And everywhere is darkness—and the sound of dripping water.

This underground wonder began—like many of Minnesota's geological features—under the sea. Half a billion years ago, sand, silt, and shells settled to the bottom of the water covering this part of our planet. Over time, the sediments squished together to form a thick layer of calcium-rich rock called *limestone*. Eventually, the limestone cracked. As water from the surface trickled down through the cracks, it dissolved some of the limestone, creating passageways—some big enough to walk through—and even open rooms beneath the ground.

Even as parts of the rock are being dissolved away, water containing dissolved mineral from the limestone seeps into the underground open spaces and then evaporates, leaving thin layers of hardened minerals behind. Those thin layers gradually add up, creating the stalactites, stalagmites, *flowstone*, and other unusual features you can see as you walk through the cave on one of the park's guided tours.

GARY ALAN NELSON

Zippel Bay: World's Biggest Lake

Standing on the 2-mile-long beach at Zippel Bay State Park, looking out at the watery horizon, you might imagine you're on the edge of the world's biggest lake. Lake of the Woods is not that. But this shoreline and this park contain leftovers of what once was the world's biggest lake—Glacial Lake Agassiz.

This huge lake, 250 miles wide and 700 miles long—more than four times the size of Lake Superior today—covered this part of North America some 14,000 years ago. It formed after giant ice sheets moving down from the north scrubbed a giant depression in the surface of the continent, then started melting, leaving behind massive amounts of freshwater to fill it.

After about 6,000 years, Glacial Lake Agassiz drained northward into the ocean through Hudson Bay. Five "pretty great" lake basins—Lake of the Woods, Rainy Lake, Red Lake, Lake Winnipeg, and Lake Manitoba—remain today as a reminder of the once-massive extent of their ancestor.

If you walk along a ridge in Zippel Bay, there's a good chance you're walking on what's left of an ancient beach of this ancient lake. The gray rocks and outcrops you might see while hiking around the park or looking out at the peninsula to the northwest are *granite*, *gneiss*, and *basalt*, remainders of the mountains and volcanoes that were here long before the glaciers.

As you enjoy the water, sun, and sand on the beach, gather some pebbles and look closely at each. How are they similar? How are they different? How do you think they formed? What story might each have carried with it from ancient times and faraway places?

GARY ALAN NELSON

Glacial Lakes: Glaciers' Garbage Bin

With rolling hills surrounding small, round water bodies, Glacial Lakes State Park might seem rather boring from the standpoint of somebody who studies rocks. But beneath the surface lies a geologist's treasure trove of rocks, pebbles, stones, and soil that giant ice sheets carried here from distant lands.

A couple of million years ago, the part of our planet north of what is now Minnesota was so cold that ice formed in layers a thousand feet thick or more. The ice's sheer weight made it flow downslope to the south. As it did, it picked up boulders and pebbles along the way, much as a dishcloth might pick up crumbs as you wipe off your kitchen counter.

Eventually, the glacier stopped moving south and began to melt, leaving its rock collection in its tracks. The hills you see today, known in glacier talk as *kames*, are mounds of gravel dumped by these ancient ice sheets and coated with soil, grass, and trees. Between them are *kettle lakes*, places hollowed out by the glacier and since filled with water. As you hike the winding trails across this park's gentle geology, watch for *erratics*—boulders from far away that the ice carried here and left behind.

Teachers resources. Find a Teachers Guide and other resources for this and other Young Naturalists stories at *mndnr.gov/young_naturalists*.

GARY ALAN NELSON

Interstate: Swirling Stones

Walking east on the rocky trail from the parking lot at Interstate State Park, the first thing that captures your attention will probably be the sight of the mighty St. Croix River rushing past the cliffs below. The second thing? The puzzling cylindrical holes carved into the solid stone around you. Ranging up to 60 feet deep, they look like holes drilled by a giant using an equally giant drill.

The secret lies in the river rushing past below, which used to be much larger and more powerful. Some 11,000 years ago, as Glacial Lake Duluth began to drain southward, the water leaving the lake rushed down the corridor that now holds the St. Croix River. Sand and pebbles carried by the water swirled against the sandstone and rock laid down here from previous geological events, much as water spirals down a sink drain when you pull out the plug. The swirling action gradually carved holes in the oldest rock. As the river level dropped, it left the resulting *potholes* high and dry on the cliffs above.

The black rock in which the potholes formed is basalt, the cooled version of hot lava that flowed from cracks in the earth's crust a billion years ago. The weather-resistant cliffs formed by this rock makes Interstate a favorite spot for rock climbers.

Hike the Sandstone Bluffs or Railroad trails at Interstate and you can find clues that this area was covered by a sea some 500 to 600 million years ago. Need a hint? Think about the shape that sand at the edge of the water takes after waves have been lapping at it—then look for rock with a similar rippled surface.