Geology of Interstate Park

The St. Croix Dalles

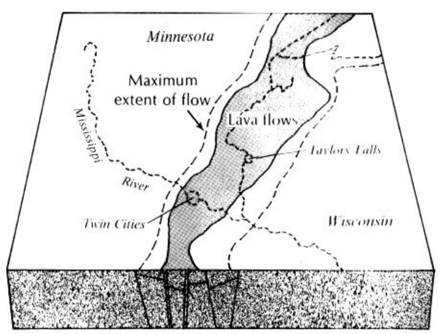
Home of the World's Deepest Potholes

Interstate State Park, at Taylors Falls, Minnesota, contains some of the most outstanding and unique geological features to be found anywhere in the world. The story of how these features came to be as we see them today is complex but fascinating.

Geological events as interpreted by modern scientists take place so slowly and over such immense stretches of time that it's difficult to imagine how things were in the distant, geologic past of an area. Interstate State Park is no exception: the story of its formations goes back over a billion years.

Lava Eruptions

The story begins with a shifting of the Earth's crust similar to that which split North and South America away from Europe and Africa. About eleven hundred million years ago the North American continent began to tear into two parts along a line through the location of present-day Lake Superior and south into what is now Iowa. As the Earth's crust stretched and split open, huge flows of lava spread from the widening cracks. These flows would have dwarfed any volcano seen on Earth today.



Beginning 1,100 million years ago, movement of the earth's crust opened cracks through which lava from inside the earth erupted to the surface over a large area. The lava cooled and hardened into a layer of rock called basalt or "traprock".

For millions of years the shifting crust kept closing and reopening the cracks, and new lava poured out over the earlier flows. This lava hardened into a strong, dark-grey rock called "basalt". In some parts of the Midwest the flows piled up one on top of another until the layer of basalt they formed was almost four miles thick. Drilling and seismic exploration have revealed that the area covered by the basalt extends from Canada and Michigan to Nebraska and Kansas.

The scenic, towering cliffs along the St. Croix River at Interstate State Park are made of basalt from the ancient lava flows. If you look closely at these formations, you will see layers of tiny, empty, bubble-like spaces running through the cliffs. Each of these layers marks what was once the top of a lava flow. The less dense minerals in the lava rose up through it as it flowed, and were trapped just below the surface as the lava cooled and hardened, just like bubbles trapped in ice. From river level to the highest rocks near Taylors Falls there are seven major layers visible, so we know that at least seven different lava flows formed the bedrock we see today.

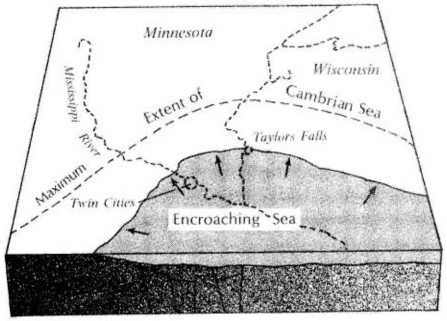
In some parts of the Midwest, various minerals were deposited in these bubble-like spaces and in cracks in the cooled lava. The most common minerals were feldspar and quartz, which sometimes formed semiprecious stones we call agates. Quartz and feldspar can be found in the basalt at Interstate, but not in the form of agates.

Minnesota, the Ocean State

For many millions of years after the great rift flows of basalt lava, we have little trace of events around Interstate. We know that the rift stopped widening. A lot of things may have happened, but any evidence they left was destroyed by later events.

One of these events was the coming of the sea to the area. Minnesota has many sedimentary or water-deposited rock formations, and fossils in these formations are of a variety of small sea animals. In and around Interstate fossils of trilobites and primitive mollusks can be found. These date back to Cambrian times, about 500 to 550 million years ago, when trilobites were the most advanced form of life to be found.

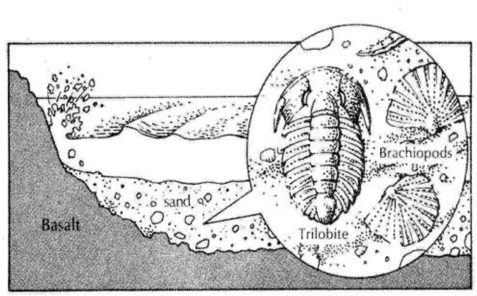
As the sea covered the area that was to become Interstate Park, it encountered high outcrops of basalt that had been resisting erosion for hundreds of millions of years since their formation. Ocean waves started to speed up this erosion, and broke loose large chunks of basalt, which fell into the sea and were covered with sand. Remains of



Minnesota has been an ocean state more than once. 500 to 550 million years ago, this area was gradually covered by an advancing sea. The sandy beaches left behind when the sea retreated have now become sandstone.

trilobites and other sea animals were also covered by this sand, and were the cause of the fossils we find today. A formation made from large pieces of rock held together by fine particles is called "conglomerate". The conglomerate that was formed here by the wave-rounded chunks of Precambrian basalt embedded in a beach of Cambrian sand is one of the rarest kinds in the world. There is an outcrop of this conglomerate near the old Mill Street road in Interstate Park, so the formation has been named "Mill Street Conglomerate".

The sea also deposited sand and fine silt in areas farther away from the basalt cliffs, and eventually was deep enough to cover the cliffs themselves and deposit sand over them as well. The fine silt deposited by the Cambrian sea was compressed and hardened over time into a type of rock called shale, which may be found in a few spots along Curtain Falls trail in the park, and near river level upstream of the highway bridge at Taylors Falls. The sand which the sea brought and deposited layer after layer also hardened and became sandstone. The sandstone formations in and around the park are named "Franconia Sandstone" after the town of Franconia on the St. Croix River downstream of the park. Fossils can be found in both the shale and the sandstone, but remember that it is against the law to damage rock formations in the park or to remove any specimens found in the park without special permission.

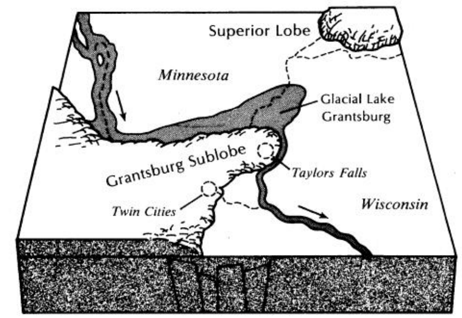


As the sea covered this area, its storm waves broke against the outcrops of basalt, breaking chunks loose. These chunks fell to the sea bottom and were embedded in sand along with the skeletons of trilobites and other sea animals of that period.

Among the cliffs along the Sandstone Bluffs Trail is the waterfall that gave the trail its old name, Curtain Falls Trail. The falls are dry most of the year, running only after a rainstorm or in the spring when the snow melts. But the ledge the falls drops off of looks like it was once the location of a much bigger falls at one time. Curtain Falls formed recently, only ten or eleven thousand years ago, and a lot happened between the retreat of the sea and the beginning of Curtain Falls.

Minnesota's Four Seasons: Winter, Winter, Winter, & Winter

The seas retreated from Minnesota, but returned again many times before leaving for good. But they never reached as far as Interstate Park after Cambrian times. There is no clear evidence in the park of events after the sea's retreat until relatively recent times, about 100 thousand years ago.

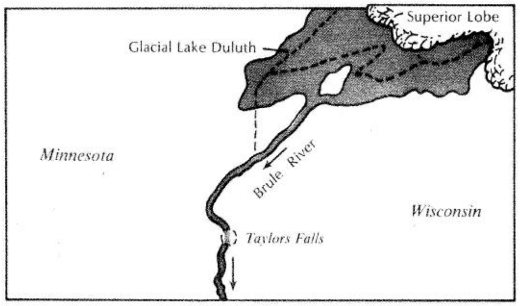


The last glacial ice to cover this area was the Grantsburg Sublobe, which blocked the drainage of the meltwater from the north and forced the St. Croix to run east of its present course at Taylors Falls.

This was the time of the last advance of the great ice sheets from the north. Minnesota had been covered with ice several times before, but the most recent advance (called the Wisconsin Ice Age because it left so many traces in that state) was the one that affected Interstate Park the most and gave the scenery here its final touches.

Imagine a time of cold, when summers were not warm enough to melt all of the snow that fell the winter before. After years of this, the snow piled up deep enough to crush the snow at the bottom of the pile into ice, and then piled up more. Even ice will flow if enough pressure is put on it, and when it is forced to flow, it is hard to stop. Great, mile-thick flows of ice, glaciers, moved slowly over Minnesota from the north, eventually covering most of the state.

A glacier is a very powerful cause of erosion. It can wear away hills, freeze into boulders and drag them for hundreds of miles (slowly but surely), and gouge out broad valleys in which to flow more easily. A moving glacier changes the landscape it moves over, but we can't see very much evidence of this at Interstate. What we see mostly is the St. Croix River and its valley, which formed as the glaciers were melting away for the last time.



After the meltback of the Grantsburg Sublobe, the St. Croix flowed in its present course past Taylors Falls. Its size was tremendously increased by the meltwater draining from Glacial Lake Duluth via the course of today's Brule River. This huge flow cut the gorge we see today.

The St. Croix didn't always follow the course we see it in today. There is evidence that it once flowed through a valley farther west, where the Sunrise River is now. But glaciers disturb the normal paths of flowing water. When a glacier melts away, all of the rocks and other sediment frozen into it get dumped as the ice melts. Plains and ridges of sand and gravel called "moraines" are the result.

The earlier course of the St. Croix was clogged by moraines as the glacial ice retreated, and the river had to find a new course. It flowed away from its older channel and for many years it ran east of Taylors Falls, forming a valley that is still visible today near Dresser, Wisconsin. At that time, Taylors Falls was still covered by the ice of the Grantsburg Sublobe of the glacier, but when the ice melted, the river was able to run where the ice had been, where it runs today. But it didn't look at all like it does today, because there were no cliffs and no deep gorge. The St. Croix was in a wide, shallow valley at first.

Taylors Falls – the Waterfall

Then came the final chapter of the story of Interstate Park's geology. It happened very recently in terms of geological time- only ten thousand years ago.

If you imagine the amount of water that you'd get from melting a mile-thick sheet of ice the size of the State of Minnesota, and then imagine all of that water running down one river, you'll have an idea of what made the St. Croix Valley and its features look as they do today. As the ice melted, the Glacial St. Croix River became much larger than the river we see now. But this alone doesn't account for the mile-wide valley that today's river runs in.

Glacial Lake Duluth, the ancestor of present-day Lake Superior, was also filling up with meltwater from the glaciers. The lake's eastern end was still blocked by an arm of the glacier, so the water had nowhere to go. It rose until it was four or five hundred feet higher than the level of today's Lake Superior. It became deep enough to overflow the hills around it to the south, at the point where the Brule River of Wisconsin now enters the lake.

Once the lake began to overflow, the rushing water cut the gap even wider and deeper, so that the water could run out faster. This huge flood joined the Glacial St. Croix and poured south through what is now Interstate Park, gouging out a valley wide and deep enough to let it flow smoothly. This flood continued for tens, possibly hundreds of years, before the ice melted away from the eastern exit of Glacial Lake Duluth and allowed water to flow towards the Atlantic Ocean instead of to the south.

If you stand in the campground at Interstate today, you'll be standing near the bottom of the Glacial St. Croix River. If you stand at the overlooks along the highway or the River Trail, you'll be standing at a point that was covered by the river when it was at its largest. If you stand at the overlook on the Sandstone Bluffs Trail, you'll be able to look out over the mile-wide valley that the Glacial St. Croix once flowed in.

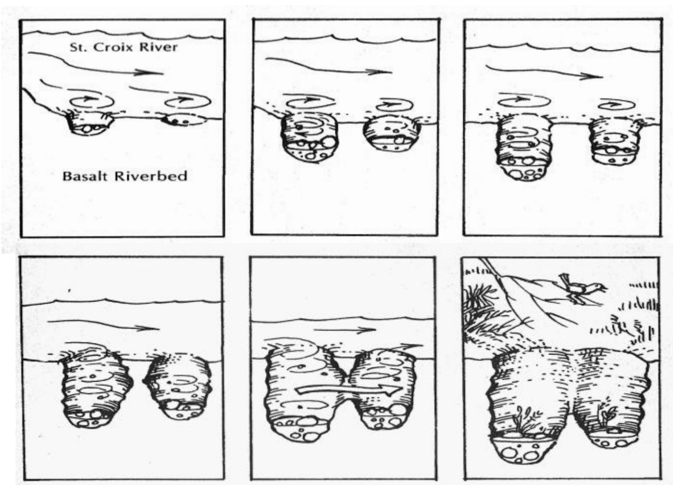
The most dramatic reminders of the size and force of the Glacial St. Croix are found at the north entrance to the Interstate Park, near the highway bridge. Here you can see the high cliffs of the narrow river gorge called "The Dalles of the St. Croix". These cliffs were carved from solid basalt by the river as it cut its channel ten thousand years ago. At first the river flowed over the top of the basalt formations, but farther south it cut deep into the much more easily eroded sandstone, and a falls or rapids formed. This waterfall, though it was never seen by any human that we know of, was the original ancestor of Taylors Falls. Curtain Falls, fed by ice melting to the west, also formed at this time when its creek reached the much deeper valley of the Glacial St. Croix and fell to meet the river.

Water going over the edge of a falls wears away the edge rapidly, and the turbulent water pounding away at the foot of the falls also wears rock away and undermines the falls. As a result, a

At its maximum, the Glacial St. Croix River covered all of the area occupied by the town of Taylors Falls, Highway 8, and Interstate's potholes.

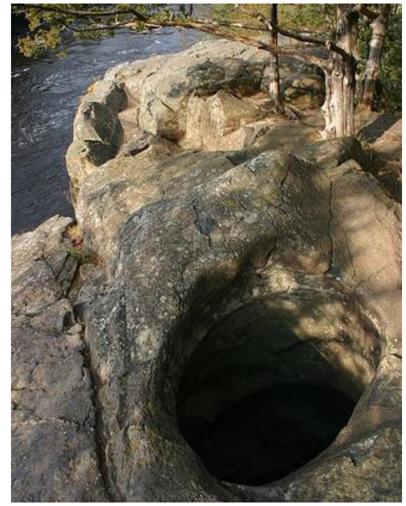
waterfall will gradually cut its way upstream. The waterfall on the Glacial St. Croix moved upstream rapidly because of the tremendous supply of water power coming from Glacial Lake Duluth, and because the basalt along the course of today's St. Croix River had been weakened by an early period of earth movement and faulting. The erosion of the basalt by the falls of the Glacial St. Croix created the Dalles and its scenic cliffs. There is little left to see of the falls now that the river has succeeded in cutting its way through the basalt. All that remained when the first white settlers came was an impressive rapids, which was named (along with the town) Taylors Falls, after Jesse Taylor, who built a sawmill on the Minnesota side of the rapids. The lower part of this rapids is at the foot of the highway bridge over the river, and the upper part is hidden by a hydroelectric dam built in the early 1900's.

World's Deepest Potholes



Eddies in the rapids swirl silt against rock, cutting a shallow depression. As the hole enlarges, more silt is trapped and cutting increases. Larger stones are trapped and worn smooth while a spiral current may cut a corkscrew pattern inside the pothole. When the potholes are close together, an increase in size may wear away the wall between them, forming a single, oval-shaped pothole. As the glacial river retreated it often filled these holes in with sand, soil, and silt.

The Glacial St. Croix left more than a wide valley and high cliffs to impress visitors. It also drilled holes in the basalt, some of them so deep that it's hard to see how water alone could form them. The truth is that water alone couldn't do the job. But, look at a fast-moving stream, and see if water is the only thing moving. Fast, powerful streams carry a lot of sediment with them, and the Glacial St. Croix was faster and bigger than any river in North America today. It carried huge amounts of silt and sand, and you can see how the rocks it once ran over were smoothed by this "liquid sandpaper".

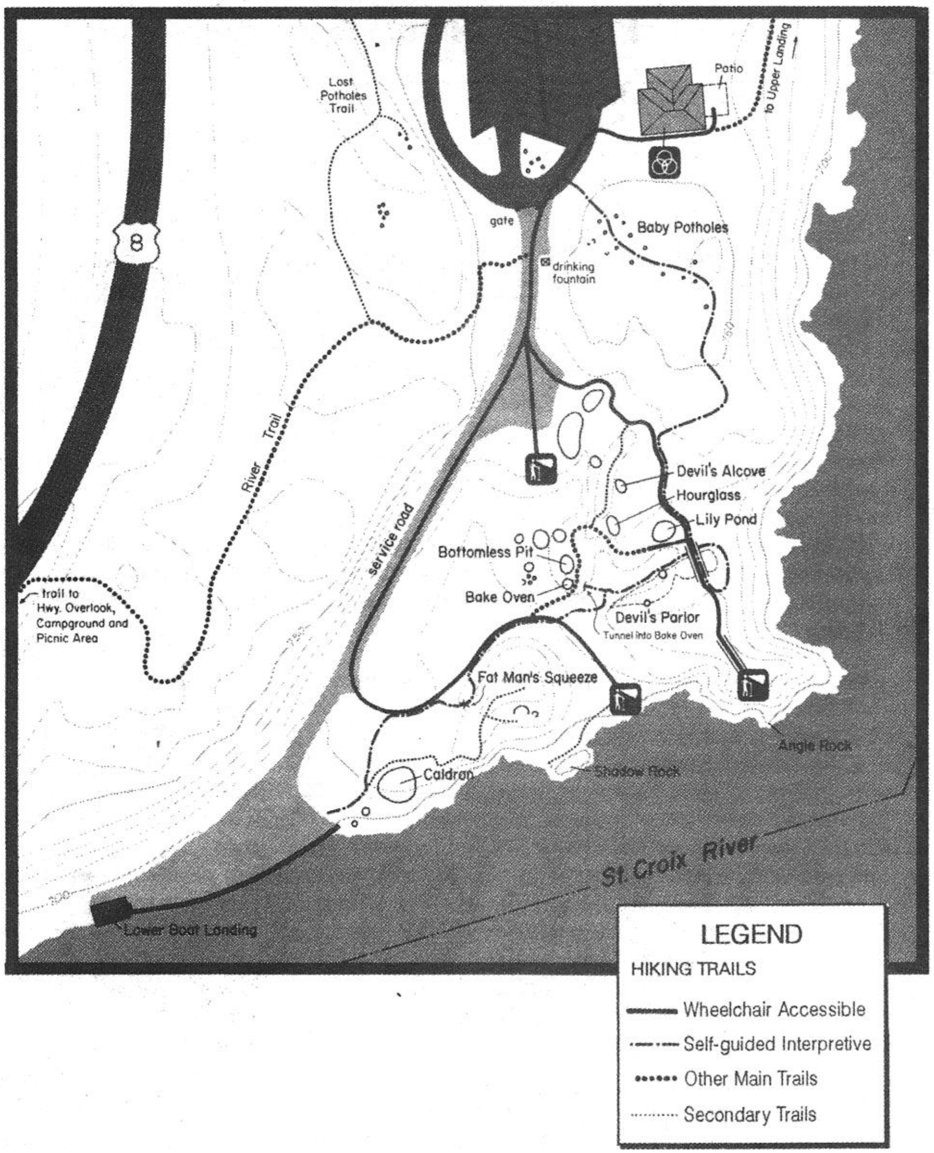


If you take another look at a fast-moving stream where it tumbles down a rapids over a rocky bottom, you'll probably find spots where the water forms a swirl or eddy that spins and stays in one place. You may even find a small pothole on the bottom of the stream below the eddy. If there is enough water power and enough sand and silt in the water, an eddy like this will gradually carve a shallow hole in the rock of the river bottom. As the hole gets bigger, more water will swirl through it, and that will help the river wear away the rock even faster. If a stone too big for the current to move gets into the hole, the swirling silt will carve away at it, and gradually make it smooth and round enough to roll around on the bottom of the pothole. Such "grindstones" are frequently found in potholes. If the river becomes slower or smaller, the wearing process will stop, and the pothole and its grinders will eventually be left high and dry.

Remember the Glacial St. Croix and its rapids? If you look around the area between Interstate's Interpretive Center and the old steamboat landing at the edge of the river, you'll find a lot of potholes that were carved out when the river was deep and strong from the glacial meltwater. They could not have been formed except for the combination of the very hard basalt rock of the lava flows, the tremendous force of the water draining from Glacial Lake Duluth, and the softer sandstone downstream being worn away rapidly so that a waterfall could form.

Interstate Park contains more potholes in a smaller area than any other location in the world, and has the world's deepest known potholes as well. The deepest one that has been measured accurately, the "Bottomless Pit", is just under sixty feet deep and twelve to fifteen feet wide. Another pothole nearby is suspected of being even deeper, over eighty feet. The widest pothole in the park is "The Cauldron" near the boat landing: it is over twenty feet wide. It has never been checked for depth, because it is nearly full of sand, rocks and boulders. Smaller potholes range in size from a few inches across to five or more feet.

If you look hard and try to count every pothole in the park, you should be able to find more than a hundred of them, all in an area of less than twenty acres. More may yet remain to be discovered under the sediment of the small marsh beside the road to the landing. Many of the low gullies that run through the area were formed when a string of potholes had the walls between them worn away by the force of the river. These then became new channels for the river's main flow, and frequently caused more potholes to form downstream of them. Our biggest potholes are in an area where several such channels come together, right on the edge of the marsh. Who knows? Maybe the *true* biggest pothole in the world is yet to be discovered. Interstate Park contains many wonders, but its potholes are the most special of all.



Minnesota Department of Natural Resources
Division of Parks and Trails
Interpretive Services
2009

Text: Dave Crawford
Illustrations: Joe Niznik, Keith Leaman
Photographs: Tony Rix, Kacie Carlson
Project Coordinator: Ron Miles