

Geological History of the Grotto

A Visitor's Guide to the Rocks and Landscape at the University of St. Thomas

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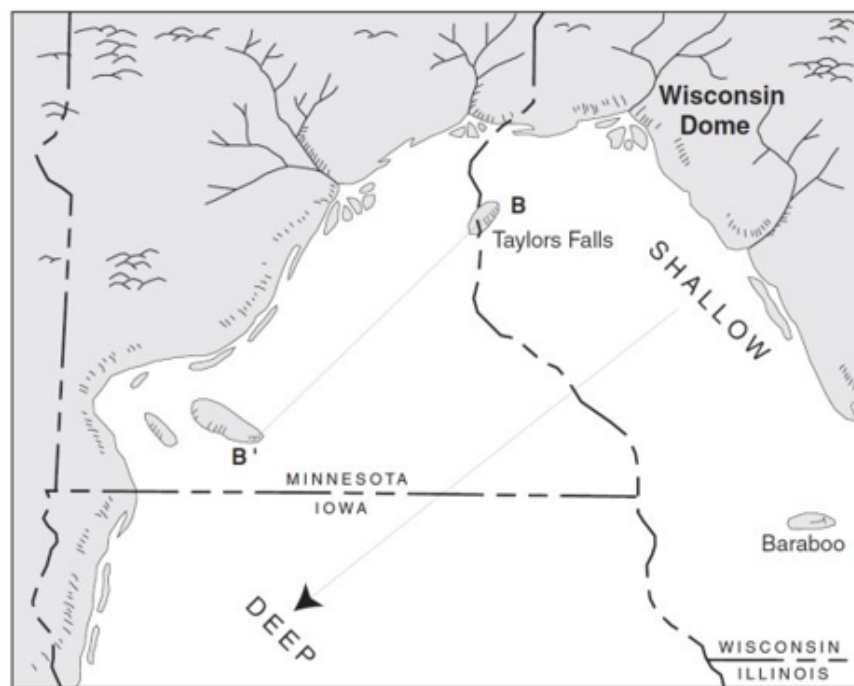
Welcome

Take a moment to look around. You're standing in the Grotto, a deep, narrow ravine cut into the bluff that St. Thomas campus sits on. At the bottom, a small brook flows west toward the Mississippi River, which runs just beyond campus through its own much deeper gorge.

How did this place form? Has it always looked like this? Not even close. The landscape around you and the rocks beneath your feet hold a story more than 460 million years old, one that involves tropical seas, glaciers, meltwater floods, and this little brook, which is still carving the ravine today.

1. Ancient Tropical Seas in Minnesota

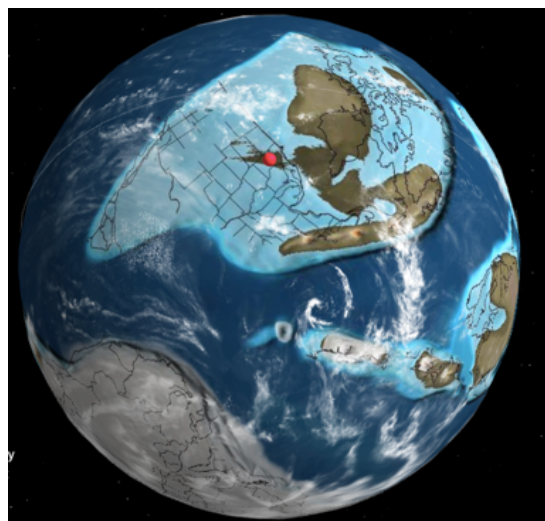
About 450 - 460 million years ago, during the Ordovician Period, this place looked very different. Much of what is now the central United States lay just south of the equator, covered by a warm, shallow tropical sea teeming with life. Sand, mud, and the shells of marine organisms settled on the sea floor in flat layers. Over time, these layers were buried, compacted, and cemented into sandstone, shale, and limestone. Those rocks are still here, beneath your feet, hidden under glacial deposits, soil, and pavement.



Why Was Minnesota Near the Equator?

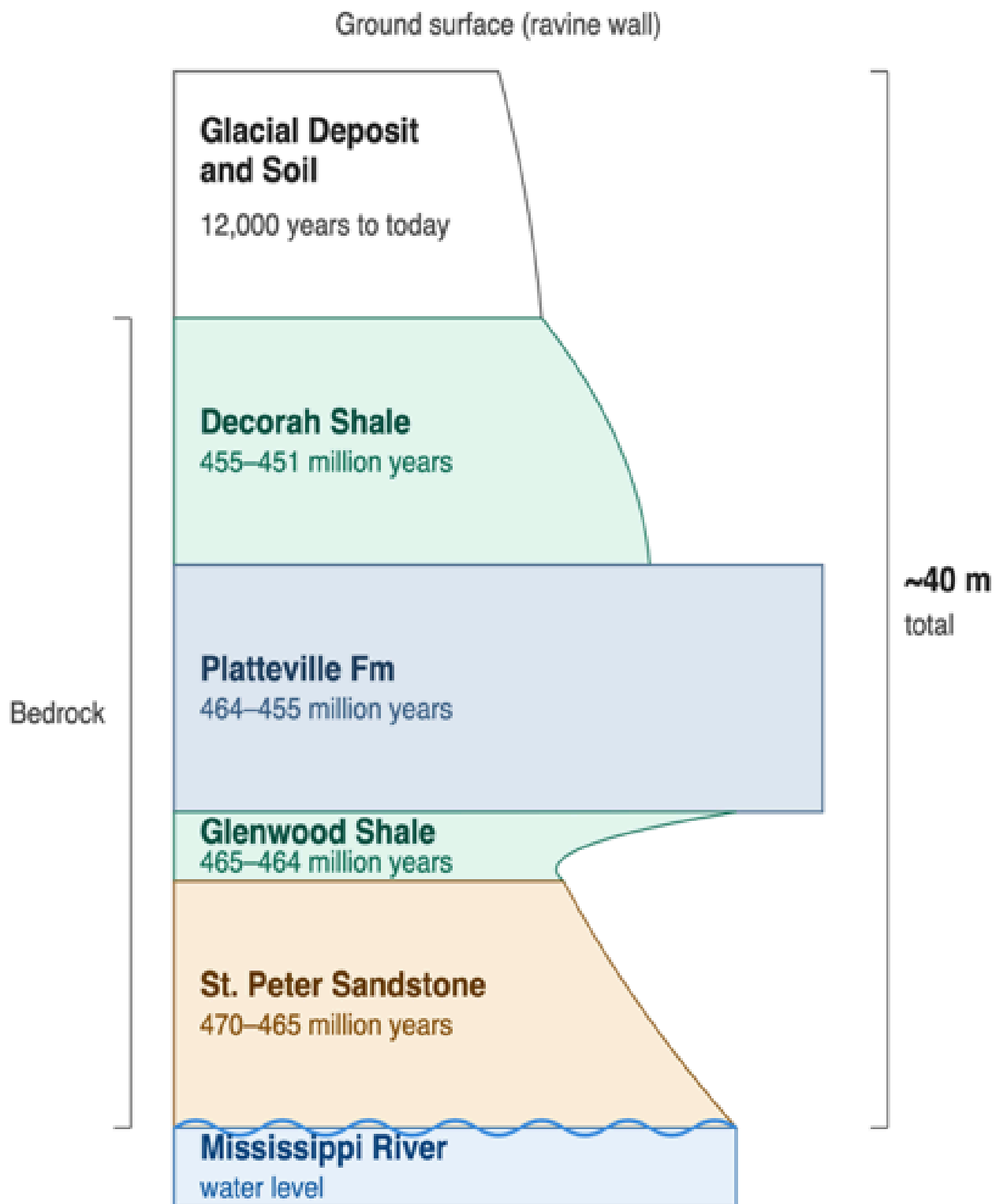
Continents are not fixed in place. Earth's outer shell is broken into large tectonic plates that slowly drift across the planet's surface. This process, called plate tectonics, causes earthquakes, builds mountains, and opens and closes ocean basins over millions of years.

Around 500-450 million years ago, the landmass that included Minnesota sat near the equator, so the climate was warm and tropical. A shallow sea flooded the region, creating ideal conditions for the sand, mud, and shell beds that later became the rocks of the Grotto. Since then, plate movements have carried North America northward to its present location.



Sedimentary Rocks Beneath Your Feet

That ancient sea did not leave behind a single, uniform layer. As sea level rose and fell and the shoreline shifted, different kinds of sediment accumulated, each recording the conditions of its time. These layers are stacked like pancakes: each was deposited on top of the one before, so the lower a layer sits, the older it is. Each layer has since hardened into a distinct rock unit. The stratigraphic column below shows these units from oldest at the bottom to youngest at the top: the St. Peter Sandstone, Glenwood Shale, Platteville Formation, and Decorah Shale. Let's look at each in turn, starting at the base.



See for yourself

These rocks are exposed in the walls of the Mississippi River gorge. The slopes of the Grotto ravine are too steep to explore safely, so to see them up close, head to the river instead. The best route down starts below the monument at the west end of Summit Avenue, next to the Shadow Falls ravine. Stay on the trail, because the gorge slopes are loose and unstable.

St. Peter Sandstone

The St. Peter Sandstone, the oldest unit in the stratigraphic column, sits at the bottom of the bluff right above the river. It is a white to pale yellow rock made of almost pure (99%) quartz sand. The rock is very soft and barely cemented; it easily crumbles if you crush it in your hand. If you look closely, you'll see the rounded almost transparent grains of uniform size, frosted like sea glass.

The St. Peter formed from well-sorted sand deposited near the shores and at the beaches of the ancient sea. Waves, tides, and wind reworked grains recycled from older rocks until almost nothing, but rounded quartz remained.





Did you know?

The soft St. Peter Sandstone once made St. Paul a mushroom capital. The growers raised mushrooms in caves dug into the West Side bluffs, where the temperature holds steady at about 48°F year-round. The caves were also used for aging beer and making blue cheese. Its purity also made it valuable for glassmaking and foundry sand, and later as a source of frac sand for oil drilling.



Glenwood Shale

The Glenwood Shale is a thin (1-2 meter), soft, clay-rich greenish layer that sits between the St. Peter Sandstone below and the Platteville Formation above. It's hard to see the shale in the outcrop because it erodes into a slope covered by rocks and slumped material.

The Glenwood was formed by deposition of fine mud in deeper, quieter water. Its position suggests that our ancient sea deepened, and mud settled over the sand. This thin unit marks the transition from the sandy shoreline environment of the St. Peter to the clearer, deeper waters that produced the limestone above.



Platteville Formation

The Platteville Formation is the 10-meter-thick unit that forms the vertical ledge on the top of the bluff. It is a hard, weathering resistant, gray-to-tan limestone, partly altered to a closely related rock called dolostone. The rock lies in distinct layers 5-30 cm thick; some are separated by thin shale layers and breaks into blocky slabs. Because it resists weathering, the Platteville juts out as ledges and overhangs above the softer Glenwood shale and St. Peter Sandstone below. This arrangement of hard rock over soft rock shapes the bluffs, the gorge, the ravine, and most of the waterfalls in the area.

The Platteville formed in shallow clear-water shelf with little mud or sand coming from land and abundant life. Lime mud and the shells and skeletons of sea creatures built up on the seafloor, were buried, and slowly hardened into limestone.



Decorah Shale

The Decorah Shale lies above the Platteville Limestone and is packed with fossils of animals that lived on an ancient seafloor about 450 million years ago. It is green-gray to blue-gray shale with thin interbeds of fossil-rich limestone. It weathers into soft, slumping, slippery slopes, with scattered remnants of thin limestone slabs full of fossils.

The Decorah Shale was formed on a muddy shelf. Fine clay washed in from distant land, clouding the water and settling as soft mud on the seafloor. The bottom lay below the reach of everyday waves, so conditions were usually calm, with mud accumulating slowly and quietly. Storms periodically stirred the seafloor and swept shells together into thin, fossil-rich limestone layers. The murky water carried nutrients along with the clay, supporting abundant animals whose remains were buried quickly by the falling mud and well preserved.





Did you know?

The Decorah Shale was used for brick-making in St. Paul. At what's now Lilydale Regional Park, the Twin City Brick Company dug the soft, clay-rich shale out of the bluffs for decades to make bricks. Some of those bricks probably ended up in buildings around the Twin Cities. The old clay pits are now one of the best-known fossils collecting sites in the metro.

Life in Ancient Sea

About 460-450 million years ago, the ground beneath your feet was covered by a warm, shallow sea, and its floor was full of animals. During this time, the number of marine animal families roughly tripled; the ocean filled with new ways of living, feeding, and hunting. Scientists call it the Great Ordovician Biodiversification Event, one of the most important episodes in the history of life!

Who lived here?

A busy underwater world was full of creatures that look strange to us today: **brachiopods**, with two-part shells that resemble clams; **bryozoans**, tiny colonial animals that formed lacy and branching structures; **crinoids**, that looked like flowers that swayed on the sea floor; **trilobites**, the armored “bugs” with compound eyes. Remains of these and other organisms preserved as fossils in the Platteville Limestone and the Decorah Shale.

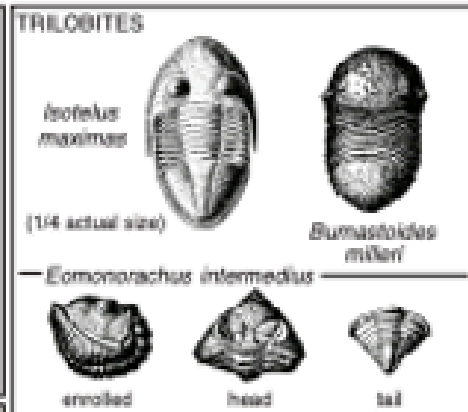
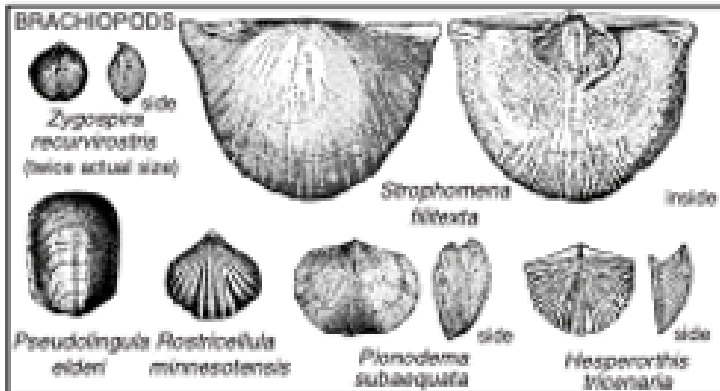
Who didn't live here?

Just as striking is what was missing. There were almost no fish in the sea, and no trees, flowers, insects, or animals on land!

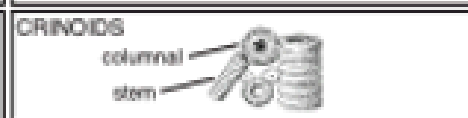
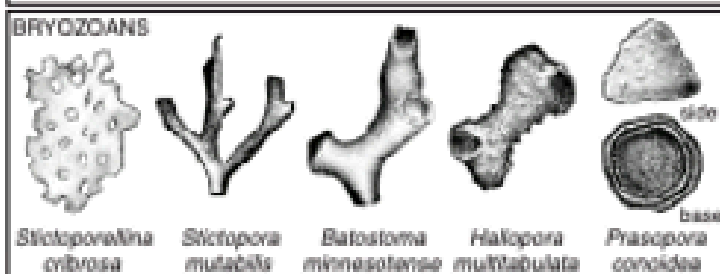
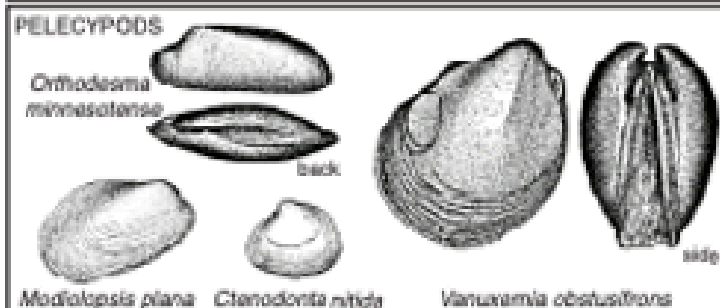
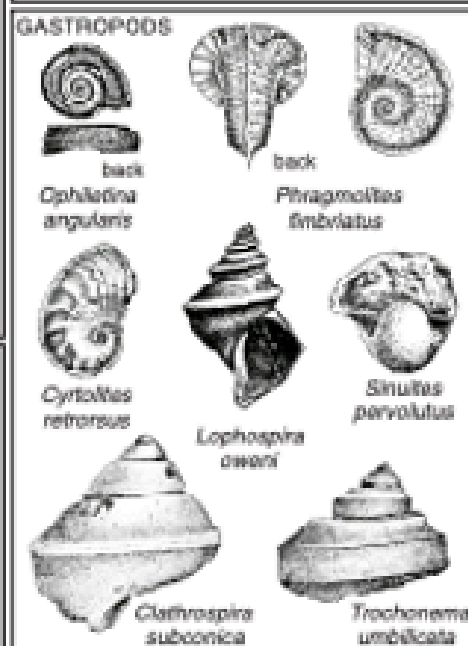
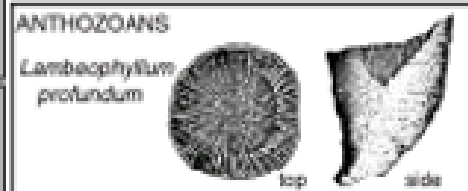
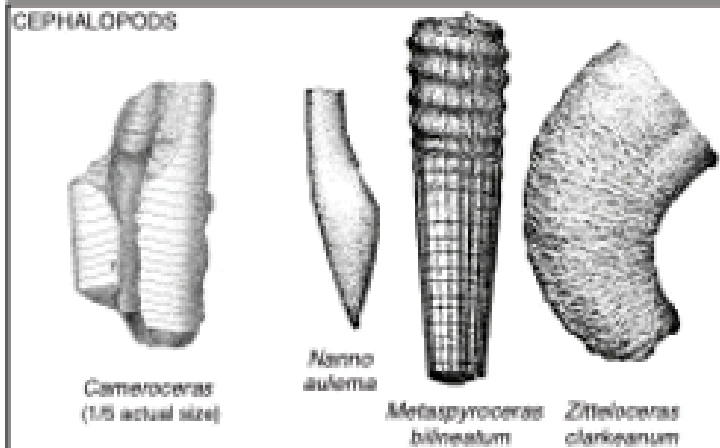
Try it yourself

Use the [Fossil Collecting in the Twin Cities Area by Minnesota Geological Survey](#) below to identify fossils in the close-up image of the Decorah Shale below





Ordovician Fossils of Minnesota



Note: Some formal fossil names shown here may now be obsolete.

Mass Extinction

This flourishing world did not last. Around 445 million years ago, an ice age caused dramatic changes sea level, and water temperatures and chemistry. In one of the five great mass extinctions in Earth's history, roughly 85 percent of marine species disappeared, and many of the brachiopods, trilobites, and other animals whose remains lie in these rocks vanished forever.

The Whole Story of the Tropical Sea

Now that we learned what each rock layer tells us about the past environments, let's put the whole story of our ancient sea together!

Imagine standing here 460 million years ago. There's no river, no ravine, no trees, nothing at all growing on land. Instead, you're on a blinding white beach just south of the equator; the sand so pure and rounded that it squeaks underfoot, polished by waves and

wind. Slowly, the sea creeps inland and buries the beach, and its sand becomes the St. Peter Sandstone. As the shore slips out of sight, calm water lets a thin layer of dark mud settle on top: the Glenwood. Slowly, the sea creeps inland and buries the beach, and its sand becomes the St. Peter Sandstone. As the shore slips out of sight, calm water lets a thin layer of dark mud settle on top: the Glenwood.

Then the water clears, and the seafloor fills with life. Brachiopods, lacy bryozoans, swaying crinoids, and trilobites crowd at the bottom while nautiloids drift overhead. Their shells pile up into the Platteville Limestone, the hard cap of today's bluffs. Still the sea rises, and soft gray-green clay drifts down over everything, forming the Decorah Shale. From bottom to top, the rock units tell one story: a sunny beach, drowned by a sea that kept coming.

Why Do These Rocks Matter Today?

The layers beneath your feet are not just a record of ancient seas; they still shape how people live here. The Platteville Limestone is hard enough to hold up the river bluffs, and for the same reason early builders quarried it. Many of the oldest stone buildings and walls in St. Paul and Minneapolis are made of this rock, so you may have walked past it downtown without knowing it formed on a tropical seafloor. Just below it, the St. Peter Sandstone is so soft, the miles of storm sewer tunnels run through it today. The thin Glenwood Shale does quiet but important work: because water moves through it slowly, it slows rain and runoff from seeping downward, protecting groundwater in the sandstone below.

2. Glacial Period in Minnesota

If you could visit Grotto 20,000 years ago, you would be standing on a sheet of ice perhaps hundreds of meters thick. Most Minnesota lay beneath the Laurentide Ice Sheet, a continental glacier that covered much of northern North America. Over the past two million years, ice advanced and retreated across the state many times, but most of today's landscape dates from the last advance, during Wisconsin glaciation, which peaked about 20,000 years ago. Its ice and meltwater shaped the land around you.



What Did the Glacier Leave Behind?

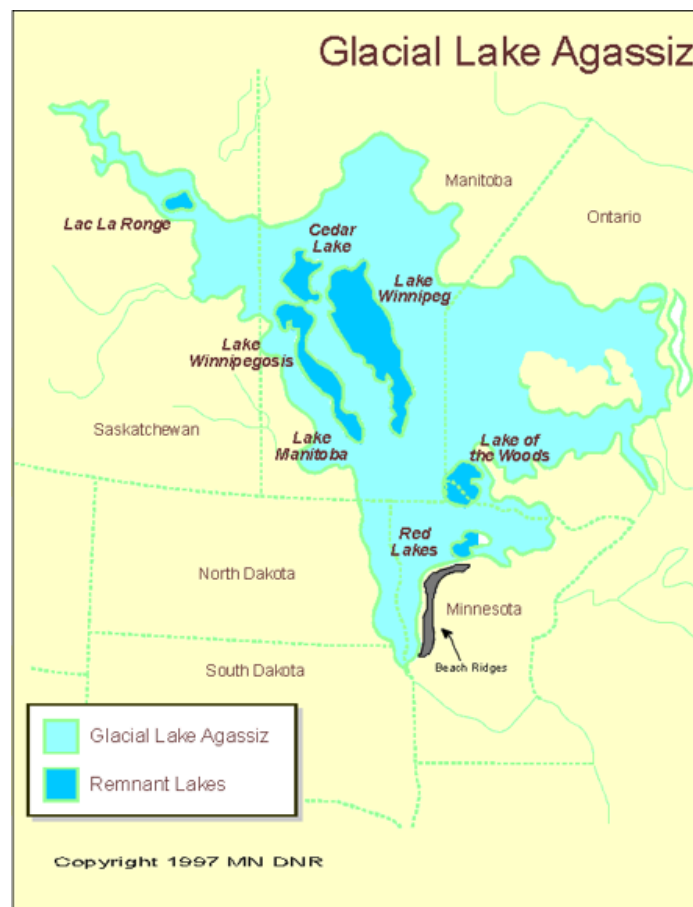
As the glacier moved across the land, it scraped soil and rock and, like a giant bulldozer, carried them along, sometimes hundreds of kilometers. When the ice melted, it dropped this load as glacial till, an unsorted mix of clay, sand, gravel, and boulders. These deposits cover the bedrock and form the slopes of the Grotto ravine. Because they are loose and erode easily, running water has been able to cut the ravine deep and steep.

Why Do the Glacial Deposits Matter Today?

Glacial deposits shape everyday life in Minnesota. Sand and gravel supply much of the state's construction aggregate. Buried deposits form aquifers that supply drinking water to many communities. Soils developed on different glacial deposits help determine where prairie, forest, and farmland thrive. We use native plants and retaining walls to hold the steep slopes in place here in the Grotto.

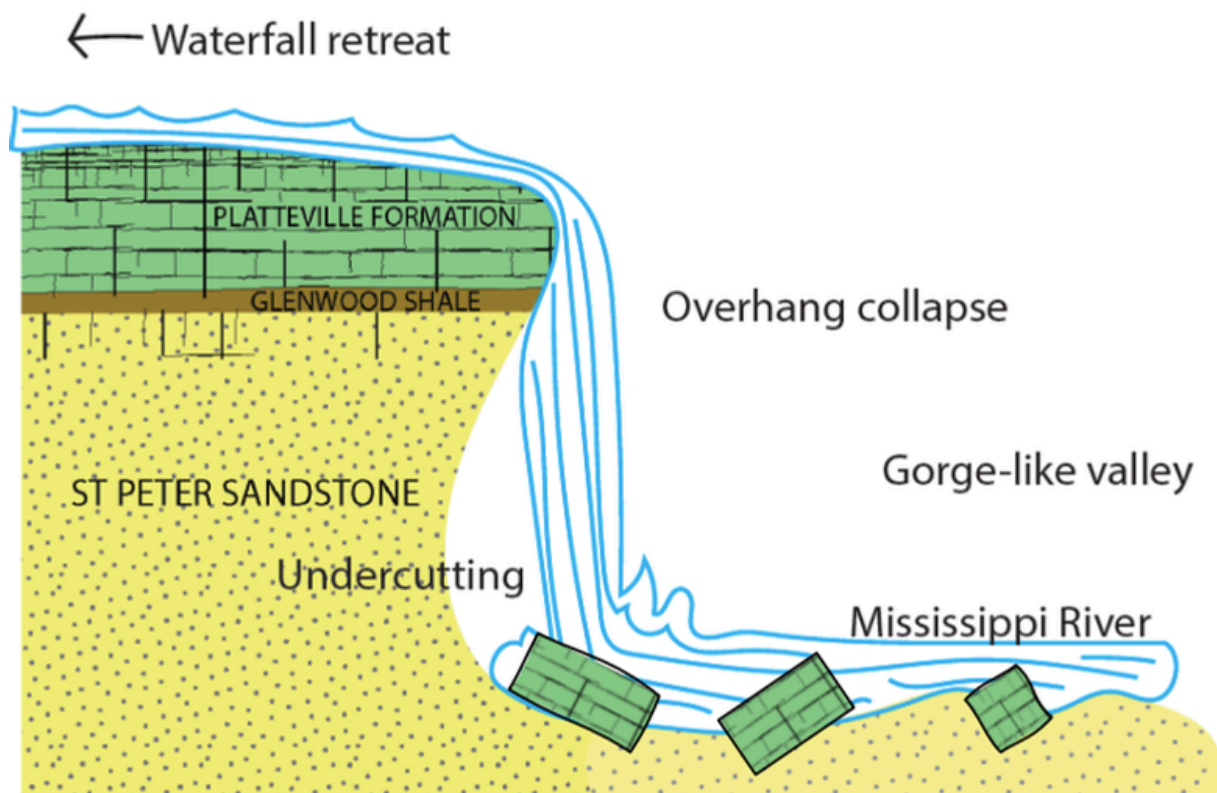
What Happened When the Ice Melted?

About 12,000 years ago, the last major ice sheet melted back from this area, releasing enormous volumes of meltwater. Glacial Lake Agassiz, a vast lake trapped by the retreating ice to the northwest, began draining south through a huge river. It carved the Minnesota River valley and continued down the Mississippi valley through St. Paul, where it plunged over a waterfall.



Waterfalls Retreat

The falls poured over hard Platteville Limestone resting on soft St. Peter Sandstone, the same rocks beneath your feet. The falling water scoured out the weak sandstone until the overhanging limestone collapsed. Repeated again and again, this made the falls retreat upstream, carving a steep gorge.



From Fort Snelling, the falls continued up the Mississippi, cutting the famous Mississippi

River gorge. They passed right by St. Thomas campus on their way to Minneapolis, where they survive today as St. Anthony Falls. In the 1800s, engineers stabilized the falls with a concrete apron to protect the mills that depended on them.

As the gorge deepened, streams flowing into the Mississippi had to drop over its steep walls, creating waterfalls of their own. Minnehaha Falls, Shadow Falls, and even small waterfalls in the Grotto all formed this way.



How Did the Grotto Ravine form?

With the Mississippi now far below, small streams like the one in the Grotto had a steep drop to reach it. Fast-moving water wore away the loose glacial sediment, cutting a deep groove down to the Platteville Limestone, where the stream still spills over a small ledge. The groove keeps growing back toward higher ground. In a sense, the ravine is still slowly “eating” its way toward campus.



Why Does the Mississippi Matter?

The Mississippi River flows more than 3,700 kilometers from Lake Itasca to the Gulf of Mexico, draining about 40 percent of the contiguous United States. It provides drinking water, transportation, irrigation, electricity, recreation, and wildlife habitat. Our campus sits on the river's edge, and runoff from our parking lots, sidewalks, and lawns reaches it within minutes. That runoff carries road salt, fertilizers, and sediment that affect people and wildlife all the way to the Gulf. Small choices, like using less salt in winter, help keep the river clean.

3. The Shrine and Landscape Rocks

Look closely at the Grotto's shrine of the Blessed Virgin Mary. Its walls and niche are built from rough boulders of different rock types. Some of these stones were placed during the original creation of the shrine in 1917-1919 by students of the Saint Paul Seminary. Rather than importing stone, they gathered boulders from the ravine itself.



Where Did the Rounded Boulders Come From?

These stones, called glacial erratics, unlike the local bedrock, were carried by ice and meltwater, then exposed as the stream cut through the glacial sediment. In this part of St. Paul, most of the rocks were brought from the Lake Superior basin to the northeast, and some from Manitoba across the Dakotas to the northwest.

Want to Identify Some Rocks?

Take your time to examine the colors, textures, and mineral grains of the rocks, and please handle them gently.

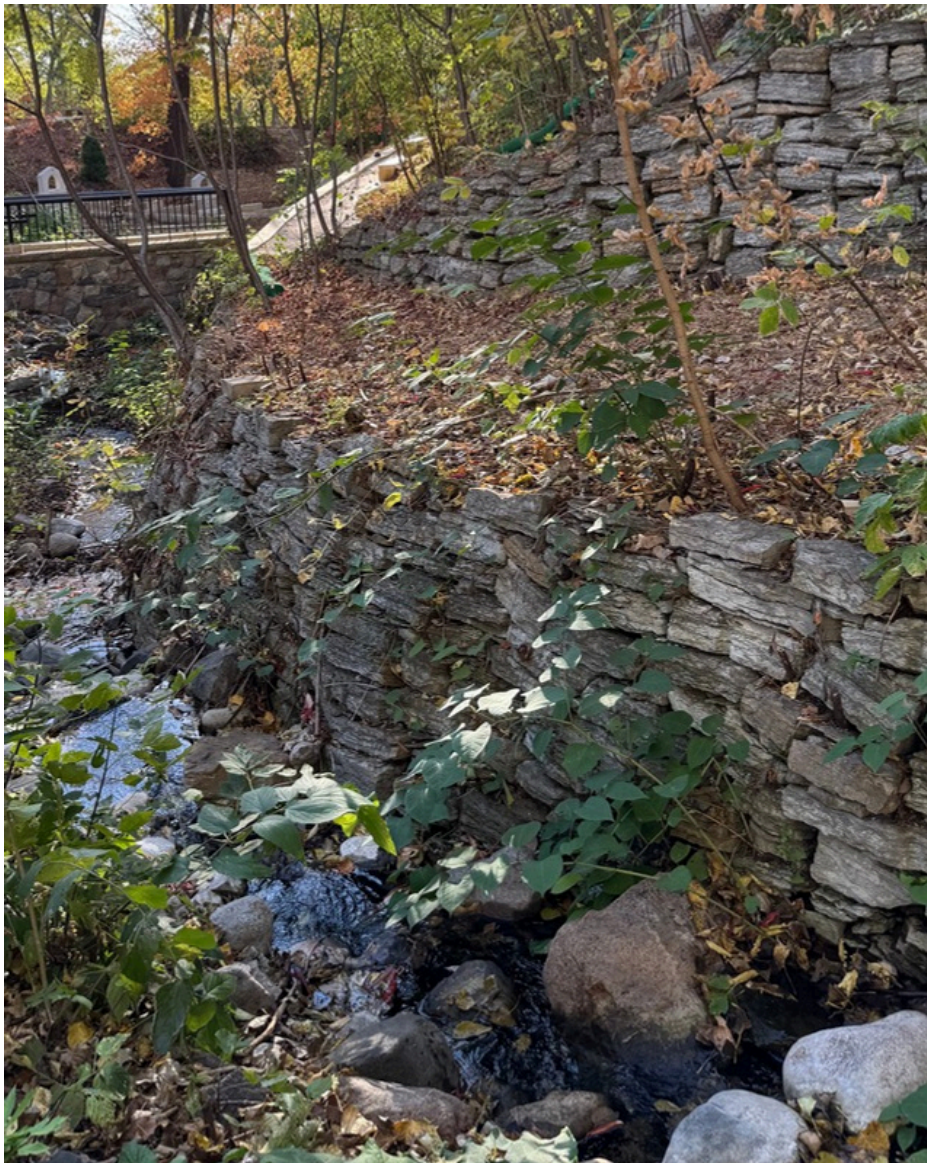
How many different rock types you can find? Try to name some of the rocks using the description below and/or in [The Virtual Egg Carton](#) by the Minnesota Geological Survey.

The main rock types to look for:

- black or reddish-brown fine-grained **basalt** (sometimes with small holes filled by white or pink minerals)
- black or grey coarse-grained **gabbro**
- red fine-grained **rhyolite**
- coarse-grained **granite** with pink, white, and black minerals
- **gneiss**, a metamorphic rock with characteristic light and dark mineral bands and eye-catching folds.

Want More Rocks?

Identify the rocks in the stone walls along the Grotto stream. How do they differ from glacial erratics? Do they remind you of some rocks described earlier in this guide?



Putting It All Together

Standing in the Grotto, you can hold three very different times in your mind at once:

- A warm tropical sea near the equator about 460 million years ago, where sand beaches, mud flats, and shell beds became the rocks under your feet - made possible because plate tectonics had placed Minnesota in the tropics.
- A hundred meters thick ice sheet about 20,000 years ago, that scraped and buried the landscape, then melted and unleashed the floodwaters that carved the Mississippi gorge and the Grotto.
- The modern river corridor - an urban natural area whose health depends on how carefully we treat the land and water around it.

Geology is the story of change written in stone and landscape. The story of the Grotto is a reminder that the landscape we enjoy today is both ancient and still being shaped. Enjoy your walk, look closely at the rocks and landscape, and take care of this special place.