[Can you name the **rocks** in this group? See quiz on page 55.]

ASK A ROCK

Would you like to hear a good story? Ask a rock.

BIG OR SMALL, sharp or round, each rock you see has a tale to tell about how the land around it has been shaped for millions or even billions of years. Just as detectives use clues to figure out how something happened, geologists use rocks to understand how natural forces change our planet. If you look and listen closely, rocks can tell you stories of oceans and volcanoes, great sheets of ice, and gushing rivers—all right here in what we now know as Minnesota.

Rocks are made up of minerals. Minerals are made up of molecules that line up in regular arrangements, called *crystalline structure.* How a rock looks depends on the kinds and amounts of minerals in it. A rock's size, shape, and location can give clues about what has happened to it over time.

Three rocks picked from the same field can have wildly different stories. One could have formed on an ancient shore when dinosaurs roamed the Earth. Another formed when Minnesota had volcanoes. A third rock formed miles underground under high temperatures and pressure from megatons of other rock. A glacier moving across the land more than 12,000 years ago carried all three rocks to this place.

Let's listen to the stories of a dozen of Minnesota's most famous rocks.

By Mary Hoff

DEBORAH ROSE, DNR

FUN Fact: The water tower and commissary building at Fort Ridgely State Park are built with gneiss.

DEBORAH ROSE, DNR

Fort Ridgely, built in 1853, was used by the U.S. Army. This wall, made of gneiss, was part of the commissary, a store with food and other supplies. Fort Ridgely became a state park in 1911. In the 1930s workers in the Civilian Conservation Corps repaired the old commissary, using locally quarried blocks of gneiss.

gneiss

Morton gneiss (pronounced "nice") is among the oldest rocks in the world. It formed underground about 3.6 billion years ago when a rock called *granite* was baked, squeezed, and cooled into a rock called *gneiss*. Gneiss contains stripes of mineral crystals that lined up under heat and pressure of other rocks.

You can see bedrock outcrops of gneiss in the Minnesota River valley. In other places, you might find gneiss pebbles that glaciers broke off these outcrops and carried away.

Gneiss is often quarried (removed from the ground) in blocks. It is used to construct buildings and monuments. When polished, its swirling pink and black mineral layers make a beautiful stone sometimes called *rainbow granite*.

greenstone

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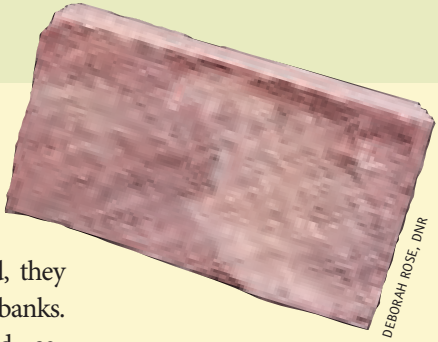
If you look at greenstone just right, it really does look green. Originally, greenstone started as melted (molten) rock. When molten rock erupts from a volcano and flows above ground, it is called *lava*. Lava flowed over islands in the ancient seas that covered what is now northern Minnesota. It cooled quickly, hardening into a rock called basalt. The Earth's crust shifted and forced the basalt deep underground. There, about 2.7 billion years ago, heat and pressure caused new green minerals to form, turning basalt into greenstone.

You can see greenstone at Soudan Underground Mine State Park.

GARY ALAN NELSON

FUN Fact: Greenstone can contain valuable metals such as copper, zinc, and gold.

quartzite



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As ancient rivers meandered, they deposited sand along their banks. Eventually, grains of sand cemented together into sandstone. Shifts in the Earth's crust pushed sandstone underground. Under heat and pressure, the sandstone turned into quartzite about 1.7 billion years ago in southwestern Minnesota.

You can see a famous cliff of this pinkish-purple quartzite at Blue Mounds State Park.

FUN Fact: The pink color of Minnesota's quartzite comes from small amounts of iron. Some people think the color makes quartzite look like a chunk of ham.

FUN Fact: The mineral magnetite will attract a magnet.

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Iron Formation

At top is banded iron formation. A reddish wall of natural iron ore shows above a pit lake in Hill Annex Mine State Park. The mine produced 63 million tons of iron ore.

Red-and-black mottled or layered rocks make up Minnesota's iron formations. They formed about 2.7 billion years ago on what later became known as the Vermilion Iron Range. On the Mesabi and Cuyuna ranges, they formed about 1.8 billion years ago.

Beneath ancient seas in northern Minnesota, tiny bits of iron-rich minerals called *magnetite* moved down through the water and settled on the shallow sea floor. Layers and layers of minerals built up and stuck together, forming mud. Later the mud hardened into rock.

People use iron to make steel. Miners dig the rock called *iron ore.* Workers load the iron ore onto trains. It travels by rail to Lake Superior and then by ship to steel mills near Lakes Erie and Michigan. There ore is melted and mixed with carbon and other elements to make steel. Because steel is so strong, people use it to build skyscrapers, cars, railroad tracks, and bridges.

At Hill Annex Mine State Park, you can learn more about the history of iron.

PHOTOGRAPHS BY GARY ALAN NELSON

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JENNIFER ENGSTROM, DNR

Large amounts of taconite are mined and later crushed to obtain iron ore. An electric shovel (above) loads taconite onto a giant dump truck, which can hold 240 tons of taconite.

taconite

More than 1 billion years ago, ancient seawater flooded the upper part of the iron formation, washed away the mineral *silica,* and turned magnetite into rust-colored minerals called *hematite* and *goethite.* This iron-rich rock is called *natural ore.*

Miners dug the natural ore until it was almost gone. Then they mined the much harder taconite, which had less iron.

To make taconite worth mining, workers crush it into powder. They use magnets to separate the iron-rich powder. Next, they mix clay and limestone with the powder, shape the mixture into balls, cook them into hard pellets, and ship the pellets to steel-making mills.

FUN Fact: MinnesotaandMichiganaretheonlytwoU.S.stateswhereironismined.

schist

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Layers of cemented mud form a rock called *mudstone* or *shale.* Mudstone exposed to heat and pressure forms a rock called *schist. Mica schist* contains layers of a flaky, shiny mineral called *mica.* When broken, it splits parallel to the mica sheets. The mica schist in central and northern Minnesota formed more than 1.6 billion years ago.

FUN Fact: Schistgetsitsnamefromthe Greekwordfor "separated" or "divided."

FUN Fact: The Minnesota History Center in St. Paul was built with granite from Rockville. Granite from Minnesota covers the walls and lobby inside the Statue of Liberty in New York.

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granite

This rock typically formed as large bodies of molten rock rose beneath mountains in central Minnesota more than 1 billion years ago. Granite comes in lots of different color combinations, depending on the minerals it contains. Granite with lots of the potassium-rich version of the mineral *feldspar* looks salmon pink. Whiter granite has sodium- or calcium-rich feldspar.

People have long used granite to make buildings and monuments. Granite also makes sturdy steps and floors.

gabbro

Like granite, gabbro formed when molten rock cooled slowly beneath the Earth's surface. Its dark color comes from its mix of minerals, including *plagioclase*, *feldspar*, *pyroxene*, and *olivine*.

Look for 1.1-billion-year-old gabbro on the 600-foot-high cliffs above the city of Duluth.

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FUN Fact: Gabbro gets its name from the Latin word for "smooth" or "bare."

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Cobbles of basaltic rock sit atop a bedrock exposure of basalt. The cobbles eroded from bedrock and have been rounded and smoothed over many thousands of years by the movement of glaciers and waves.

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basalt

About 1.1 billion years ago, along what is now the North Shore of Lake Superior, lava flowed from giant cracks in the ground. The hot liquid cooled into layers of basalt, similar to volcanic rock of Hawaii.

Gooseberry Falls State Park is a great place to see massive mounds of dark gray basalt, worn smooth by centuries of rainwater and snowmelt rushing from the Sawtooth Mountains to Lake Superior.

FUN Fact: Tiny holes in the basalt, some filled with minerals, are remnants of gas bubbles trapped in hot lava. The holes in Swiss cheese are formed a similar way.

Agate

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These beautiful hard rocks have bands of various colors. Agates formed when water containing *silica* (a chemical compound of dissolved quartz) seeped into bubble holes in basalt. The water left behind silica, which coated the inside of the rock, layer by layer. Various other materials create colors in the bands. Red bands tell us "iron is here."

Agates formed in basalt along Lake Superior's North Shore, but you can find them all around the state because glaciers carried them as they moved from north to south.

To learn more, visit the Agate and Geological Center at Moose Lake State Park.

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FUN Fact: The agate is Minnesota's official state gemstone.

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Sandstone

Sandstone in southeastern Minnesota is part of the same formation that can be seen along the bluffs in St. Paul.

When you see sandstone, close your eyes and imagine a tropical beach, because that's what it might have once been. Rivers carried sand to the sea that covered Minnesota some half-billion years ago. As the water reached the sea, it stopped flowing, and grains of sand settled to the sea floor. Chemicals in the water cemented the grains together into sandstone. Some sandstone is so lightly cemented together that it crumbles when you pick it up.

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Quarried blocks of limestone were used to construct walls and buildings at Fort Snelling in St. Paul.

Limestone

Minnesota limestone formed about a half-billion years ago from *calcium carbonate* and seashells at the bottom of ancient seas. Limestone in some places contains plant and animal fossils.

Some limestone is quarried in blocks for walls and buildings. Some limestone is crushed and used to make roads and concrete. Crushed limestone is spread on farm fields to help crops grow by reducing soil acidity.

At Forestville/Mystery Cave State Park, you can see steep bluffs of limestone and tour limestone caves. Tunnels and caves often form in limestone as ground water runs through cracks, dissolves the minerals, and carries them away. Water continues to dissolve the rocks today.

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Teacher Resources

Go to www.mngs.umn.edu/virt_egg/secondpg.htm *and see the Virtual Egg Carton. The carton, developed by Barbara Lusardi, Richard Lively, and Mark Jirsa of the Minnesota Geological Survey, inspired and informed this story.*

To find out more about the rocky history of North Shore state parks, a good reference book is Geology on Display.

To learn more about Minnesota's geology, visit www.mndnr.gov/education/geology *and* www.mngs.umn.edu.

1. Agate
2. Basalt
3. Sandstone
4. Quartzite
5. Iron formation
6. Gabbro
7. Taconite
8. Greenstone
9. Granite
10. Limestone
11. Gneiss
12. Schist