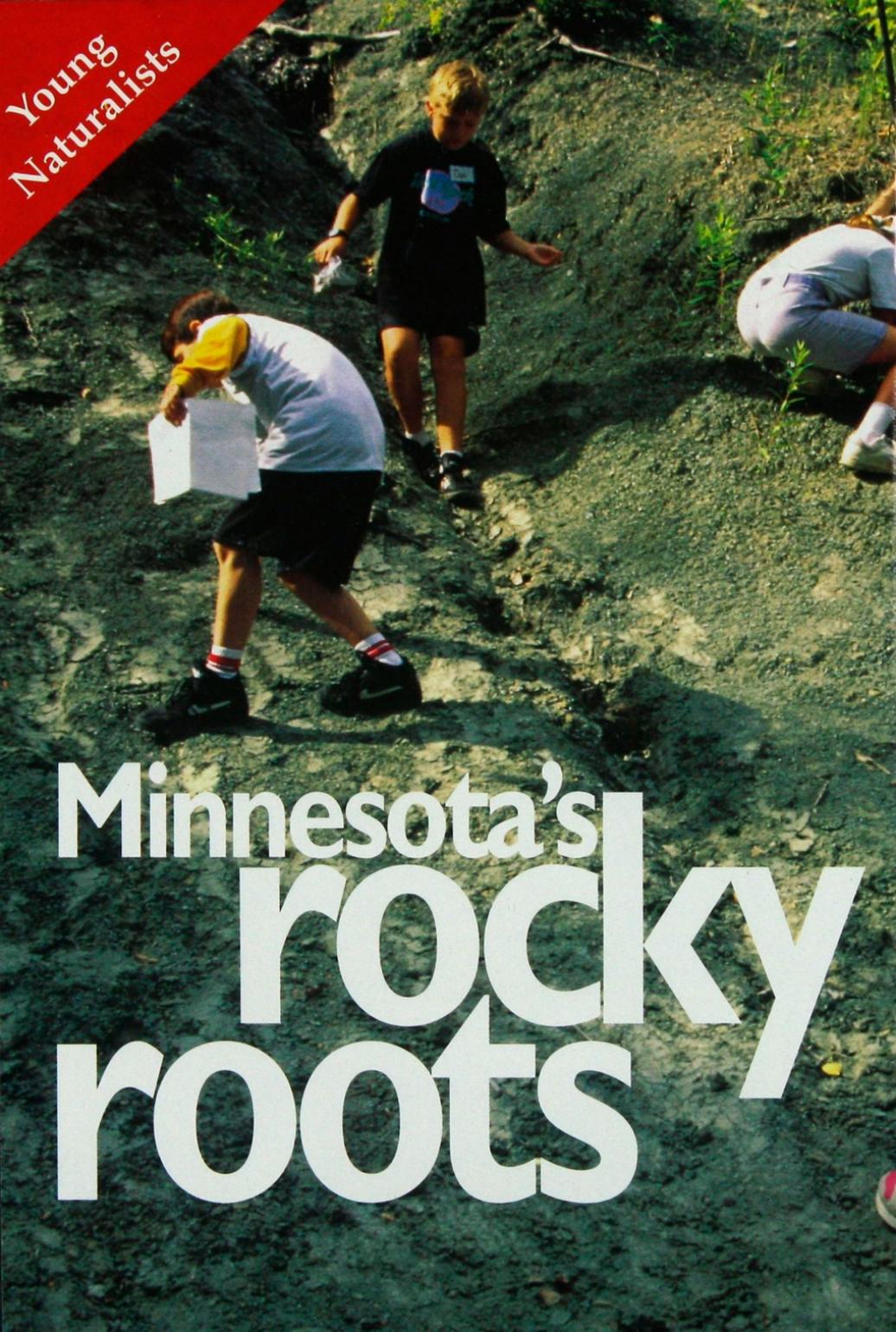


Young  
Naturalists

A photograph of three children exploring a rocky streambed. One child in the foreground is crouching and looking at a white box. Another child is standing in the middle ground, and a third is crouching on the right. The scene is outdoors with sunlight filtering through the trees.

# Minnesota's rocky roots



BY LISA  
WESTBERG PETERS

**T**he earth is made of rock, inside and out. Even the soil on the earth's surface comes from rock.

What is a rock? It is a cluster of one or more minerals, such as quartz, feldspar, and clay.

Rocks come in every color—pink, red, even green.

Layers of limestone and Decorah Shale make Lilydale Regional Park in St. Paul an excellent place for young people to dig fossils.

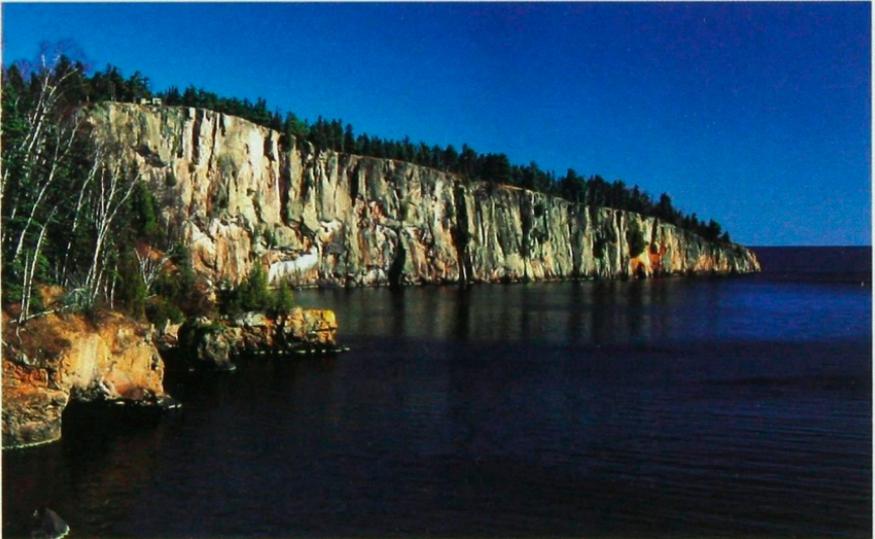
PHOTO BY L.C. DUKE



SCIENCE MUSEUM OF MINNESOTA

## Rocks Start Out As Hot Magma

Magma is molten rock deep in the earth. It may harden underground, or ooze up as *lava* (above).



RICHARD HAUG

ALLEN BLAKE SHELDON

When lava hardens, it forms *igneous* rock. Shovel Point on the North Shore of Lake Superior (above) formed from lava flowing over the surface of the earth 1.1 billion years ago.



*Metamorphic* rocks, such as these tilted layers of slate in Jay Cooke State Park, form when igneous or sedimentary rocks are heated up or squeezed inside the earth until new minerals form.



*Sedimentary* rocks form when mountains erode and rivers carry the sand and mud to sea. Layers of sand and mud pile up on the sea bed and harden. This sandstone cliff near the Mississippi River formed about 450 million years ago in a sea that has since disappeared.



<b>GEOLOGIC ERA</b> →	<b>PRECAMBRIAN ERA</b> No life on earth
<b>Number of years ago</b> →	<b>6 billion to 4.6 billion years ago</b>
<b>What was happening.</b> →	Volcanoes erupt and the Earth forms.
<b>State parks and other places to see rocks of various ages</b> →	No rocks of this age are found anywhere on earth.



SCIENCE MUSEUM OF MINNESOTA

## Building a Continent

A few billion years ago, the only life on earth was single-celled bacteria. Continents were much smaller than they are today. They moved around slowly and grew whenever they collided with islands or each other.

Scientists believe northern Minnesota was a chain of volcanic islands near the edge of a small continent. When the volcanoes erupted, red-hot lava flowed into the sea. The lava cooled and hardened into pillow-shaped black rock called basalt. Later, warm sea water seeped through the basalt and formed greenstone.

The islands collided with the small continent and crumpled into mountains at the seam. Much later another collision created a second mountain range. Gneiss (pronounced "nice") and granite rocks formed deep beneath the mountains. The mountains eventually wore down, exposing the rocks.

At the same time, Minnesota's iron ore deposits formed from volcanic sediments at the bottom of the sea.

The earth's continents are still moving. Maybe someday, mountains will rise in Minnesota again!

Single-celled bacteria

**3.8 billion years ago**

Earth cools and forms a solid crust.

No rocks in Minnesota from this time

**3.6 billion years ago**

Oldest rocks in the state form.

Gneiss (city of Morton)

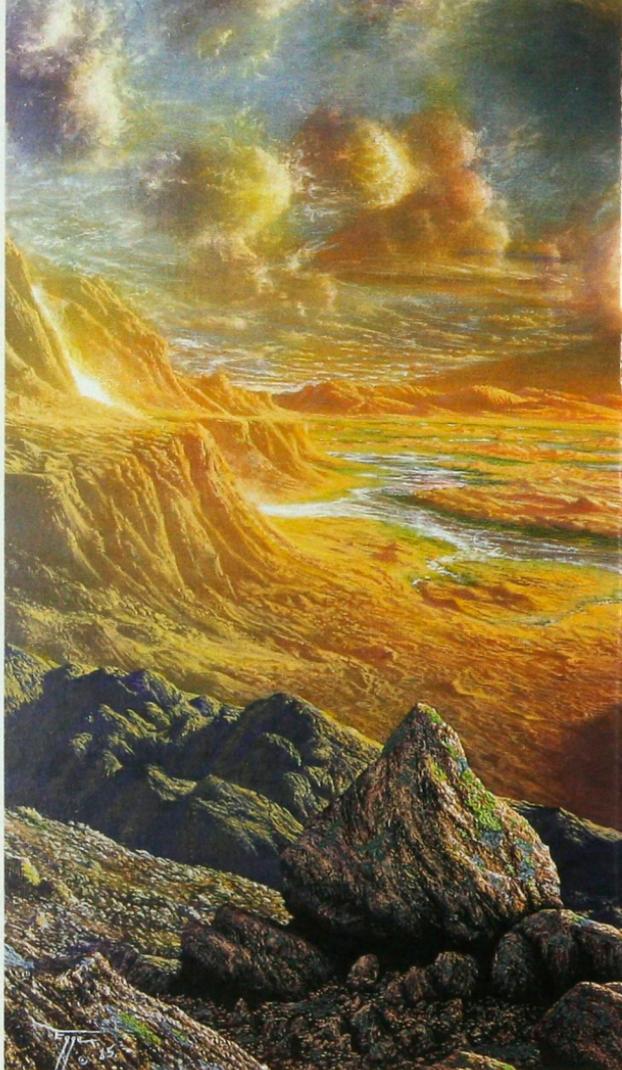
## The Continent Cracks

Long after it formed, the North American continent nearly split in two. About 1.1 billion years ago, huge cracks in the earth's crust ran from northeastern Minnesota all the way to Kansas.

For millions of years, lava from volcanoes and cracks in the crust spilled onto the land in Minnesota. Then, for reasons no one knows, the great North American split-up stopped.

Today, dirt and younger rocks cover most of the old lava flows. But you can still see thick lava flows in the cliffs of Lake Superior and St. Croix Dalles.

ILLUSTRATION BY DAVID EGGE



PRECAMBRIAN ERA

Single-celled bacteria

**2.7 billion years ago**

Mountains form across northern Minnesota.

Greenstone (city of Ely), granite (Boundary Waters Canoe Area Wilderness)



### Algae

#### **2 billion to 1.8 billion years ago**

Second mountain range forms in central Minnesota. Iron ore forms.

Granite (city of St. Cloud), iron ore (Hill Annex), slate (Jay Cooke)

#### **1.1 billion years ago**

Rift valley forms in Minnesota when the continent almost pulls apart.

Basalt cliffs (Tettegouche, Interstate)



PALEOZOIC ERA

Trilobites 

Cephalopods 

Corals 

**600 million years ago**

**450 million years ago**

Shallow sea invades parts of Minnesota.

No rocks in Minnesota from this time

Decorah Shale (Lilydale), St. Peter Sandstone  
(Fort Snelling, Minnehaha Falls)





## Explosion of Life

Life on earth quietly “exploded” about 600 million years ago. It evolved from single-celled bacteria to complex marine animals, in a fairly short time.

It was hot in North America. The continent, nearly flat, lay near the equator. Many times the tropical sea flooded the land and then drew back. Sand and mud settled on the sea bottom. The sediments, like a quiet graveyard, held the fossils of plants and animals that lived and died in the rivers and shallow areas of the sea.

The sea invaded Minnesota one last time about 100 million years ago. Those ocean muds formed the youngest rocks in Minnesota.

These trilobites and crinoids were trapped in sea mud long ago. As the mud hardened into sedimentary rock, the animals became fossils.

PHOTO BY LAYNE KENNEDY

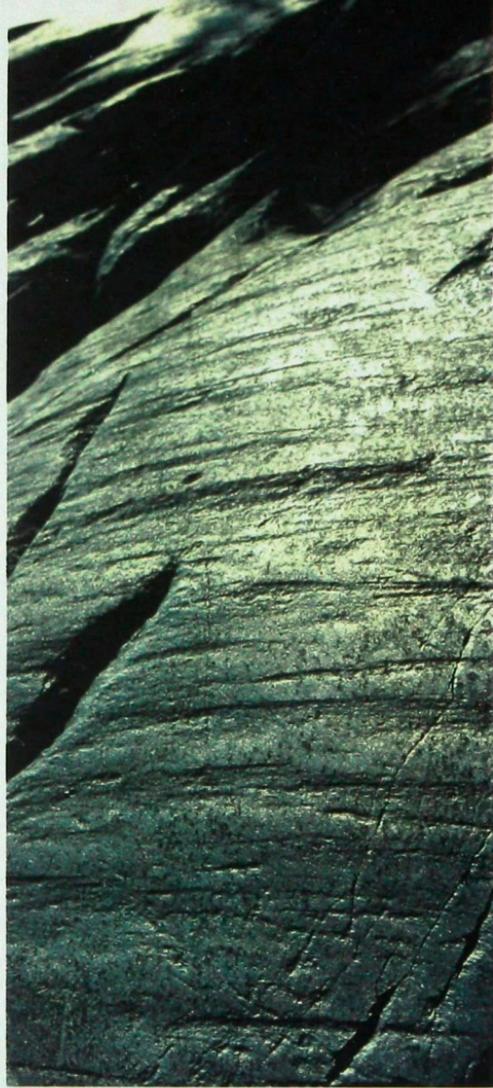
Insects   Amphibians 	MESOZOIC ERA	Reptiles 
<b>325 million years ago</b>  Tropical plants and slow rivers cover Minnesota.	<b>225 million years ago</b>  Dinosaurs roam Minnesota.	<b>100 million years ago</b>  Seas invade. Youngest Minnesota rocks form.
No rocks in Minnesota from this time	No rocks in Minnesota from this time	Shale and sandstone (Hill Annex)

## Glaciers

A few million years ago, the earth cooled off and the most recent ice age began. Snow fell on the continents and piled up into thick sheets of ice. So much water froze that sea levels fell. When the sheets of ice grew thick enough, they began to move.

The glaciers moved south from Canada into Minnesota. When they finally melted, they left behind boulders and huge piles of sand and gravel known as moraines, kames, and eskers. Our state is a showcase of glacial features.

Some of our lakes formed in the holes that glaciers scoured in solid bedrock. Others formed because the glaciers dumped their loads of sand and gravel unevenly. The low spots filled with water. Sometimes sediments buried big blocks of ice. When the ice melted, the sediments collapsed, making depressions.



MICHAEL K. BUDAK

CENOZOIC ERA

Mammals



**65 million years ago**

Rivers erode Minnesota.

No rocks in Minnesota from this time

**1.6 million to 10,000 years ago**

Glaciers advance and retreat, leaving sand, gravel, boulders.

Cone-shaped glacial hills (Glacial Lakes, Maplewood)

**Today**

Lakes fill in. Rivers erode valleys.



Find the scratch marks on the basalt in the picture above. This igneous rock formed 2.6 billion years ago. About 10,000 years ago, moving glaciers scratched the basalt. Today you can see this rock at Manitou Rapids State Wayside Rest on the Rainy River, which borders Canada.



L.C. DUKE

### **She Digs Her Work**

"I like to dig in the dirt," says Barb Lusardi, who is a geologist for the Minnesota Geological Survey in St. Paul. Barb collected rocks as a kid and became interested in geology in high school. Now she studies what glaciers left behind in Minnesota.

Barb digs in and studies rocks and dirt moved by glaciers. Her work helps people find underground water for wells and good places to build roads and houses.

Will the glaciers ever come back to Minnesota? "I would think so," says Barb, because glaciers seem to come in cycles. But they won't come soon enough for any of us to see them.

## Six Minnesota Rocks

**1. Morton Gneiss.** Metamorphic rock, 3.6 billion years old, is found near Morton. It is used for buildings, such as the downtown St. Paul telephone building.

**2. Decorah Shale.** Sedimentary rock, 450 million years old, is the hardened mud from the bottom of an old ocean. Found in St. Paul and southeastern Minnesota, it is filled with sea fossils.

**3. Agate.** This special sedimentary rock, 1.1 billion years old, has layers made of a mineral called chalcedony, deposited by hot water inside the holes of hardened lava. Agates are plentiful on North Shore beaches and gravel pits near Cloquet and Moose Lake. This is our official state rock.

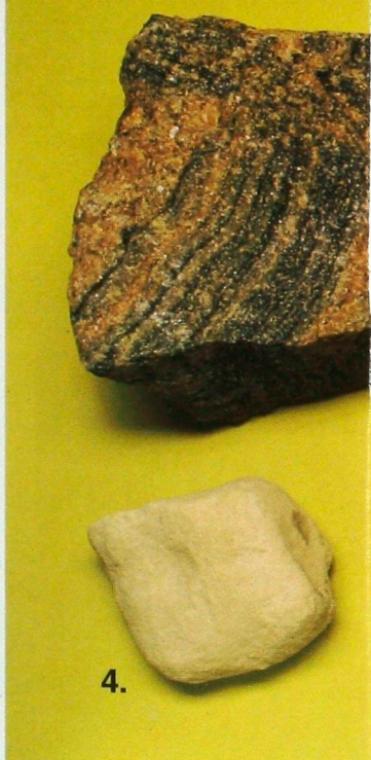
**4. St. Peter Sandstone.** Sedimentary rock, 450 million years old, looks like crumbly white sand. It is found in St. Paul and southeastern Minnesota.

**5. Granite.** Speckled pink or gray igneous rock, 1.8 billion to 2.7 billion years old, is found in many places. Minnesota granite was used in parts of the Statue of Liberty and in the Minnesota History Center in St. Paul.

**6. Basalt.** Black or dark gray igneous rock, 1.1 billion years old, is found along the North Shore and the St. Croix River at Taylors Falls.

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*Lisa Westberg Peters is a children's book author and geology enthusiast, who lives in St. Paul with her rock-collecting family.*



### Hard Facts

Two good books for rockhounds are *Minnesota's Geology* by Richard W. Ojakangas and Charles L. Matsch (University of Minnesota Press, 1982), and *Minnesota Underfoot* by Constance Jefferson Sansome (Voyageur Press, 1983).



1.



2.



3.



5.



6.

### Minnesota Mining Mix-up

The scrambled words are rocks and minerals mined in Minnesota that are used to make things you use every day. Read the following hints, then unscramble the words.

1. Speckled igneous rock used for building stone: **eitgnar**
2. Coarse rock dug from glacial deposits and used for landscaping and construction: **vlgare**
3. Reddish rock dug from open pits in northern Minnesota and used to make cars and refrigerators: **nrrio reo**
4. A sedimentary rock used for building stone: **eontsndas**

Want to find out more about rocks? Order *Digging into Minnesota Minerals*, a free children's publication from the Department of Natural Resources. Call 612-296-4807.

Answers: 1. granite 2. gravel 3. iron ore 4. sandstone