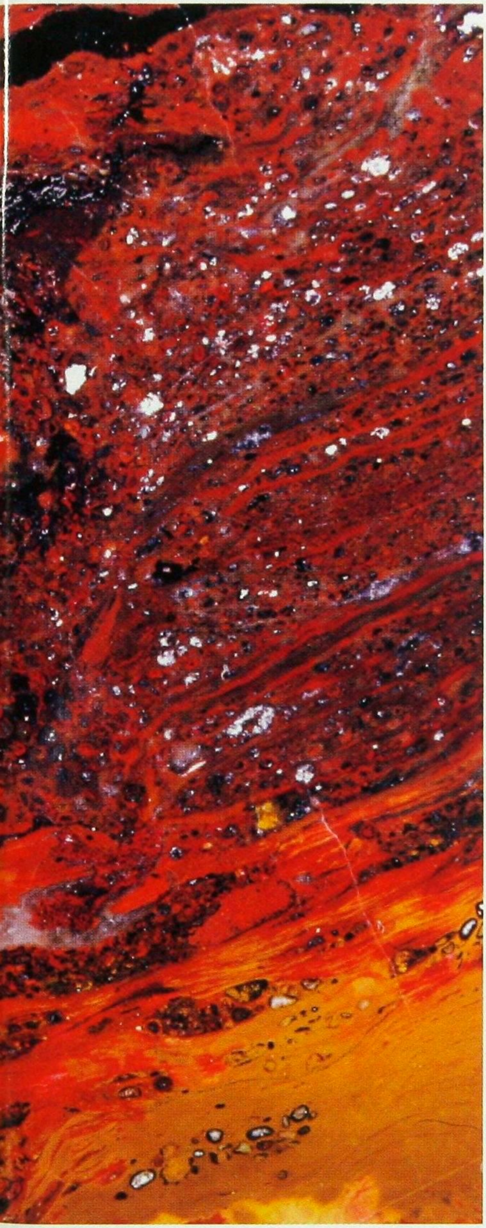
The Rise and Fall of Stromatolites

Scientists find clues to our planet's earliest history in these 2-billion-year-old fossils.

BY JON KRAMER

PHOTOGRAPH OF FOSSIL STROMATOLITE BY LAYNE KENNEDY



IN THE OLD MINES OF THE MESABI Iron Range in northern Minnesota, scientists are uncovering new evidence of the world's most ancient life forms. They are studying microscopic fossil organisms embedded in iron ore. Not surprisingly, the fossil clues point to a connection between earth's earliest inhabitants and the genesis of our present atmosphere.

Worldwide, most of the fossil record comes from the Phanerozoic Eon, which is the last 600 million years or so of the planet's 4.5-billion-year history. Minnesota is one of a few places where rocks preserve the time when life first secured a foothold on earth. These rocks date from the Animikean Era, some 2 billion years ago.

Simple Life. The earliest life forms we know of lived about 3.5 billion years ago and were so simple in structure it is hard to say if they qualified as "cells" in the true sense of the word. Later, however, there appeared microbes that can confidently be classified as cellular life, if only to a limited degree. These were the prokaryotes—cellular organisms that lack a nucleus yet compose an entire kingdom of life forms.

All life on earth owes its existence to these industrious little creatures. By 2.2 billion years ago, advanced prokaryotes known as cyanobacteria had developed photosynthesis—a great evolutionary leap. Before

Animikean time, earth's atmosphere was devoid of free oxygen. This important molecule is a fortunate byproduct of the photosynthetic process. Thus cyanobacteria created earth's original atmospheric oxygen, which indirectly led to a virtual explosion of life worldwide.

Cyanobacteria built the first biological "reefs" in what was once sea by grouping together and forming hardened colonial structures called stromatolites. Nowhere are early stromatolite reefs more important than they are on the Mesabi Range. Here, the fossilized stromatolite colonies are exceptionally abundant, underlying the entire range. This ancient reef system extended from the Canadian border at Gunflint Lake southwest to Grand Rapids. The Mesabi Range provides researchers from museums and universities around the world a rare chance to study these hard-to-find fossils.

Two billion years ago the most common Minnesota stromatolite-forming organism was *Collenia undosa,* which formed domes in a shallow near-shore marine environment. By studying the closest mod-

Sliced, polished, and photographed under slight magnification, fossil stromatolites show off bizarre shapes and brilliant colors, depending on their mineral content.

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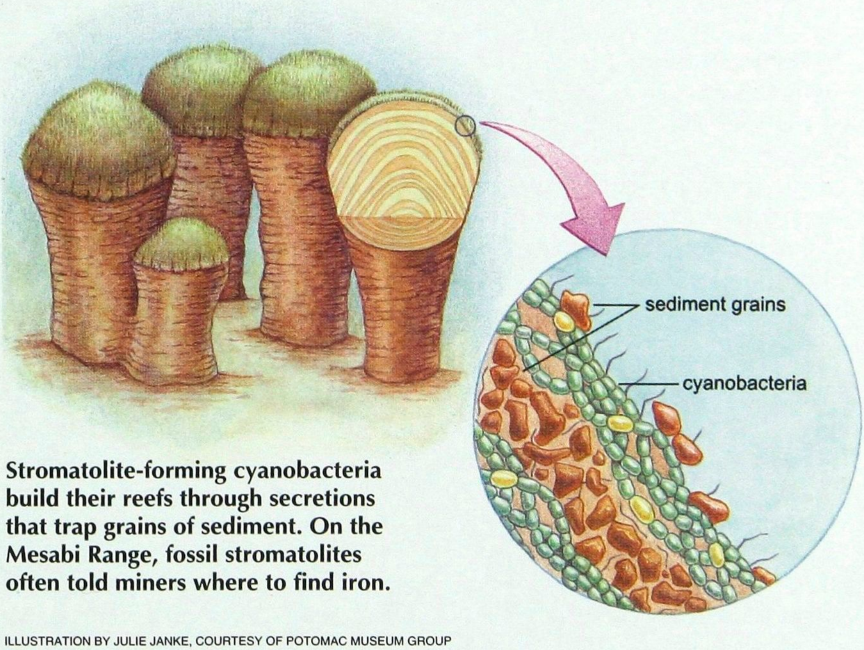
ern descendants of C. *undosa,* we are learning how stromatolite reefs formed.

Iron Connection. Ancient stromatolite-forming organisms, like their modern counterparts, built structures in much the same way as other reef builders such as coral—by secreting layers of minerals and trapping sediment grains. Through consecutive cycles of mineral-sediment laminating, the stromatolite grows larger and taller. In addition, it keeps itself elevated above rapidly accumulating sediments. As a result, many stromatolite colonies are dome-shaped. They range from a quarter inch to 20 feet in diameter.

In the early days of Minnesota iron explorations, mining companies paid little attention to the fossil stromatolite layers they sometimes encountered while excavating iron ore. Even scientists had no idea what the strange fossil layers represented and placed them into a catchall for paleontological castaways called *cryptozoa,* literally "puzzling life."

Only later did geologists realize they could trace iron deposits by locating stromatolite layers. If you could find the fossil, you knew the ore was close by. Often locating the main fossil layer was both a blessing



Stromatolite-forming cyanobacteria build their reefs through secretions that trap grains of sediment. On the Mesabi Range, fossil stromatolites often told miners where to find iron.

ILLUSTRATION BY JULIE JANKE, COURTESY OF POTOMAC MUSEUM GROUP and a curse because quartz-rich stromatolite layers, as thick as 15 feet, covered the ore. Not only is quartz difficult and costly to remove, but it also quickly wears down machinery in the refining process.

Geologists now believe that stromatolites played a crucial role in concentrating iron on the range. The same may be true of other major iron deposits around the world. As quickly as stromatolites produced oxygen, the oxygen bonded with dissolved iron in the surrounding water, creating a molecule of oxidized iron, which settled on the sea floor and enriched the sediments. The indirect result, eons later, is the Mesabi Range and others like it around the world.

Grazing Gastropods. As anyone who owns a fish aquarium can tell you, snails do a fairly good job of keeping the glass clean by eating the algae that grow on it. Many snails are grazing animals, continually munching on algae and reproducing quickly. Before you know it, they can multiply and overrun the tank. And so they have multiplied since nature invented them 600 million years ago.

Snails, known scientifically as gastropods, were the ultimate bad news for stromatolites. Unable to move or mount a defense, stromatolites were virtual sitting ducks for snails and other marine grazers. The gastropods nearly grazed the stromatolites into extinction.

Happily, though, the story of stromatolites is not over. A few stromatolite reefs persist; some are actually thriving. Most, however, have a tenuous existence, confined to a handful of locations worldwide. The most famous living stromatolite reefs are in western Australia, where the supersaline conditions of Shark Bay prevent snails from invading, at least for now. The Bahamas, the Middle East, Baja California, and a half dozen lakes in Minnesota harbor living stromatolite colonies.

We don't know much about the preservation mechanisms at work in these waters. Although Minnesota's lakes with stromatolites vary greatly in size, depth, temperature, and other characteristics, they share a common feature: All appear to be spring-fed. Why spring-fed lakes favor stromatolite formation is a mystery—as is the way in which the stromatolite-forming organisms entered the lakes in the first place. Because of the rarity and fragility of stromatolites, the exact location of lakes with stromatolites is kept quiet. At this point, we are unsure if the Minnesota colonies are thriving or threatened.

Lake-living stromatolites in our region resemble coral-like

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growths—up to about a foot in diameter—on rocks. They are usually found in 10 to 20 feet of water, often where the bottom is sandy. If you see stromatolites, make note of the exact spot and report it to Potomac Museum Group. Please do not touch or disturb the stromatolites in any way.

In central Minnesota, some of the lakes that have modern stromatolites are less than 100 miles from the Mesabi Iron Range, home of their ancestors 2.2 billion years ago. In virtual obscurity, these colonies have endured while, through the eons, more than 99 percent of all species ever to exist on earth have become extinct. The persistence of stromatolites is a true testament to a simple design developed billions of years ago. ❑

By producing free oxygen through photosynthesis, stromatolite colonies formed life-giving atmosphere and concentrated the iron we mine 2.2 billion years later.