Record: 1

Title: A glacier was here.
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Source: Earth; Feb95, Vol. 4 Issue 1, p58, 3p, 2 diagrams, 4 color
Document Type: Article
Subject Terms: FORMATIONS (Geology) -- Wisconsin
GLACIAL landforms
Geographic Terms: WISCONSIN Report Available
UNITED States Report Available
Abstract: Discusses the geological features in Wisconsin. State's understated landscape; Glacial landforms which are reminders of the ice ages; Discussion of moraines, drumlins, eskers and kames.
Lexile: 1130
Full Text Word Count: 1146
ISSN: 1056148X
Accession Number: 9501060097
Database: MAS Ultra - School Edition

FORMS

A GLACIER WAS HERE

The landscape of Wisconsin rarely leaps, plunges, races or twists. What it mostly does is roll. The highways that cross its fields and forests rise and fall serenely over one hill after another, curve around the occasional high point and only rarely encounter a wide plain or a steep river valley. Wisconsin's beauty is low-key.

The reason for this understated landscape is clear enough: The greatest geologic upheavals of the Upper Midwest are long past, and all its high mountain ranges have worn away. Yet the region brims with the subtler reminders of the ice ages, the greatest climatic upheavals of Earth's last 20 million years. Glaciers over a mile thick inched across Canada and much of the Midwest, New England and the Great Plains as recently as 12,000 years ago. The ice applied millions of tons of pressure to the ground beneath it, carving bedrock and shaping sediments into a family of beautiful landforms, including moraines, drumlins, eskers, kames and kettle holes.

Of all glacial landforms, perhaps the simplest are moraines. These are nothing more than heaps of unsorted debris that a glacier left behind, containing everything from tiny, clay-sized particles to staggering boulders. In some places the melting ice deposited the debris in a thin, irregular carpet known as ground moraine. But moraines can also have considerable relief. A string of terminal moraines forms a broken line of irregular hills stretching along the edge of the vanished North American ice sheet from Cape Cod to the Rocky Mountains. In rugged and mountainous areas, terminal moraines are usually obscured by higher hills, but in Wisconsin they stand out as long, often tree-covered ridges rising above a low-lying landscape.

Terminal moraines, as their name implies, mark the furthest extent of a glacier's reach. They often look as if they had been bulldozed into place, but that is rarely how they formed. Ice sheets are not good at pushing obstacles forward. They're much better at running over them, especially if the obstacles are big. In fact, in creating the string of

terminal moraines, the ice acted more like a conveyor belt than a bulldozer. As it flowed, it picked up rocks, gravel, sand and clay from the ground beneath it. Bits of rock debris may also have rolled onto the glacier from nearby mountains towering above it. The sediment became embedded in the ice and then traveled for hundreds of miles as the glacier advanced. Finally, it dropped out at the front edge of the glacier when the ice melted.

Drumlins, like terminal moraines, are glacier-made hills. But it's usually easy to distinguish drumlins by their characteristic shape: They form elongated ovals, like the backs of surfacing whales. And drumlins rarely stand alone. Between Milwaukee and Madison, Wisconsin, for example, a distance of 80 miles (130 km), glacial geologists have identified more than 5,000 of them, the tallest up to 140 feet (43 m) high. Many smaller ones have probably escaped their notice. Such drumlin fields generally occur only within a narrow band set back a short distance from the glacier's terminal moraine. On a topographic map, the hills form a beautiful pattern. Their lengths line up roughly parallel but slightly splayed outward from a central line, branching out like fingers. This pattern traces the movement of a huge lobe of the continental ice sheet, which widened as it plowed south by southwest.

Despite their distinctive appearance, drumlins are probably the least understood of all common glacial landforms. Some glacial geologists think drumlins formed when the ice sheets contorted or deformed wet sediments lying beneath their bases. If you were to dig into a drumlin at a construction site or a gravel pit, you'd see some evidence for this theory. The clay, sand and rocks inside a drumlin often form complex, almost swirling layers, a sign that they were stretched and sheared by moving ice. But what gives them their characteristic oval shape? No one knows for sure.

The genesis of the long, sinuous hills known as eskers is somewhat less controversial. Seen from the air or on a topographic map, eskers appear to trace the branching and meandering courses of ancient streams. Indeed, most geologists believe that eskers were created by streams that flowed through tunnels within or beneath the ice, depositing sediments along the way. These graceful, serpentine ridges can stretch up to 100 miles (60 km).

Melting water from the glaciers also dotted the landscape with mounds known as kames. The word kame is actually a catch-all term for any pile of waterborne sediment deposited in contact with ice. Many kames probably formed when streams cascaded off the top of ice sheets and onto bare ground, dropping sediment in the process. But northern Wisconsin has a group of conical hills whose unusual symmetry suggests that they formed another way. Researchers believe these kames formed in moulins, holes that plunge straight down through the ice to the bottom. (The word moulin comes to us from French ice climbers and literally means "mills," apparently because the streams flowing into deep holes reminded the climbers of whirling water at grain mills.) When meltwater from the top of the glacier plunges into the moulin, it deposits a load of sediment that piles up into a cone, much as sand will in an hourglass.

Moraines, drumlins, eskers and kames - all are natural monuments to the ice sheets that once plowed the land. But the glaciers also remind us of their presence through absence: in the depressions they carved into the land. Lying near the edges of the vanished glaciers are many steep-sided lakes and equally steep dry holes. These kettle holes, as they're called, formed as the dying ice sheets broke into pieces and began to melt. Some of the stranded ice chunks became buried in glacial sediment. Over thousands of years, the ice and cloak of sediment gradually subsided. And when the ice was finally gone, it left the

holes behind. The glaciated area of North America contains tens of thousands of these holes. Some are filled with water, creating beautiful lakes and swimming holes in this subtle and peaceful land.

DIAGRAMS: Glaciers more than a mile thick, like the one illustrated above, plowed through Canada and much of the United States as recently as 12,000 years ago. Though the glaciers mostly smoothed and flattened the landscape, they also created new hills and depressions, including the classic glacial features shown below. (Matthew Groshek)

PHOTO: Rows of crops in southeastern Wisconsin surround a drumlin. Because of their shape, some people refer to these distinctive, elongated mounds as "whalebacks." (Richard P. Jacobs/JLM Visuals)

PHOTO: An Esker snakes its way across Wisconsin farmland.

PHOTO: Stranded blocks of melting ice formed these kettle lakes in Kewaskum, Wisconsin.

PHOTO: A cone-shaped kame rises from the prairie in Dundee, Wisconsin.

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by Tom Waters
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