PALEOECOLOGY

Natural world keeps detailed records of its ecological past

The history of Maine is literally beneath our feet. Rocks alongside the road tell tales of glaciers and ancient life, and marine clay soils in flower beds as far north as Millinocket paint a picture of oceans stretching far inland.

But to understand the past, paleoecologists — those who study the history of Earth's plant and animal communities — dig much deeper.

The sediments beneath lakes and bogs have quietly been transcribing a changing world since they were formed with the retreat of the glaciers from Maine at least 12,000 years ago. Every year, pollen and leaves fall from the trees and slowly drift to lake bottoms or cling to sphagnum moss.

"It's like having a recorder, running from the day the lake is formed," said George Jacobson, a paleoecologist at the Climate Change Institute at the University of Maine.

In places like Maine, where glaciers no longer exist, biological records often provide the best view into the ecological past.

"There are quite a few parts of the world that don't have thick ice sheets to sample," Jacobson said.

Some Maine lakes have offered sediment cores that reach as far back as 17,000 years, though 10,000- to 12,000-year cores are far more common, particularly in bogs, many of which didn't develop until several thousand years after the ice completed its retreat. Others offer just a blink in geologic time.

"You may find that the lake just formed 1,000 years ago, and you're out of luck," said Ron Davis, a professor emeritus at the university and one of the founding members of the Climate Change Institute.

Perhaps 60 cores that extend all the way back to the retreat of the glaciers have been taken in Maine and fully examined by biologists. Many more samples are in storage awaiting someone with the time and funds to undertake the six solid months of research it can require to analyze a sample, Davis said.

Tests of the soil chemistry can give scientists important clues about the ancient atmosphere. Pollen grains, which have a surface particularly resistant to decay, can tell researchers which trees and plants lived in the region over time. Radiocarbon dating of organic matter in the sample can link the findings to a precise point in time.

But the organisms that allow sediment samples to be carbon dated also can mar the data. A burrowing insect or shellfish disturbs just a few inches of lake bottom, but those inches might represent 50 years of history, which become blended together, Davis explained.

Some of these less precise records remain useful, as proof of sweeping climatic change. Other, less common cores, from lakes where fewer insects or shellfish existed, can be nearly as precise as ice cores, offering a year-by-year history of the region, Davis said.

The only sediment records than can begin to challenge ice for sheer longevity are the cores of ocean sediment that can contain hundreds of thousands of years of history.

"The deep ocean just receives sediment. It just goes to the bottom [and stays there]. There's no erosion," said Harold "Hal" Borns, a professor emeritus at the University of Maine and the founder of the Climate Change Institute.

Elsewhere in the world, scientists also study tree rings and the similar annual development patterns of ocean corals and cave growths such as stalactites to understand a shifting climate. A wider ring could mean a milder season or an increase in precipitation, while a slight change in the chemical makeup of coral can reveal a great deal about the ancient ocean and atmosphere.

One biological record by itself means very little, but when hundreds of samples all show the same trends, scientists can begin to piece together a mosaic of ancient landscapes, Jacobson said.

"It's really a tremendous natural history," he said. "It allows us to piece the whole story together in a way that's pretty incredible."

Ice Age Trail will follow glaciers' legacy in the landscape of coastal Maine

Today, blueberry bushes drenched in the greens of spring or aflame with the colors of autumn blanket the ridges of Maine's Down East region.

But somewhere between 23,000 and 28,000 years ago, when a mile-deep mountain of ice was beginning the long, slow retreat that would mark the end of a glacial period in Maine, the frigid coast was no Vacationland.

The very hills that give blueberry country its well-drained, sandy soil were once glacial moraines — moat-like deposits of sand and gravel that formed as water rushed from the melting glacier.

Sediment samples and other data reveal that Maine's climate at the time probably resembled far northern Canada or portions of Greenland that are today within the Arctic Circle.

Glaciers shaped the state of Maine, covering every inch of its land and weighing down the surface so much so that when the ice rapidly melted, seawater flooded in, following the Penobscot River valley as far north and east as Millinocket.

In Maine, the signs of glaciation are all around, from Acadia's famed Bubble Rock — an orphan boulder known as a "glacial erratic" that was dropped by the ice as it passed over South Bubble Mountain — to the Great Basin of Mount Katahdin itself, shaped by the glaciers that once nestled into its valleys.

Harold "Hal" Borns, founder of the University of Maine's Climate Change Institute, has spent his life studying the geological signals of glaciers and is amazed at how little people know about the catastrophic climate shift that shaped their state.

"[Mainers] live and die on this landscape, and most of it is glacial," he said.

Borns is creating an Ice Age Trail, a journey across coastal Maine with glacial clues as its signposts. The trail winds through Hancock and Washington counties highlighting some of the most accessible features that were sculpted into the landscape by tons of moving ice. The trail includes Cadillac Mountain — the first land to emerge from the ice as it made its final retreat — and continues east across the land where glaciers once met the sea. Between 12,000 and 17,000 years ago, the glaciers were gone from Maine, but their footprints remain.

For tens of thousands of years, ice was on the move, seasonally advancing and retreating as it slowly receded, all the while scraping bedrock, dropping boulders and hollowing out lakes. The first Ice Age Trail map will focus on the moraines of coastal Maine, where the ice sheet made its last stand. Borns hopes eventually to expand the trail to the entire state of Maine.

"There are spectacular examples of just about everything … eskers, moraines, deltas, erratics [throughout the state]," said Woodrow Thompson, a geologist with the Maine Geological Survey.

Climate change doesn't just affect the weather and it doesn't just change the habitat for plants and animals. When mountains of ice scrape across Earth, climate change has the power to alter the very landscape.

Borns likes to use a three-dimensional map of Maine's landscape to explain the recession of glaciers across the state over thousands of years.

"There's a climate change right there," Borns said, pointing to a long ridge near Addison that clearly shows one of the moraines that criss-cross Washington County.

Wisconsin offers tourists the National Ice Age Trail, while Washington is considering a trail to educate people about the glacial origins of the Cascades region. Borns and his colleagues have spent decades mapping glacial footprints on Maine's landscape. "So why not a trail here?" he asked himself.

"We've got all the science done. All we've got to do is put it together in a map," Borns said.

With federal funding, Borns has been working on the project for several years and he hopes to make available by this spring a printed map of a driving route between glacial features along the coast. He already shares considerable information about some of the locations in an interactive map online at: http://iceagetrail.umaine.edu.

The Ice Age in Maine

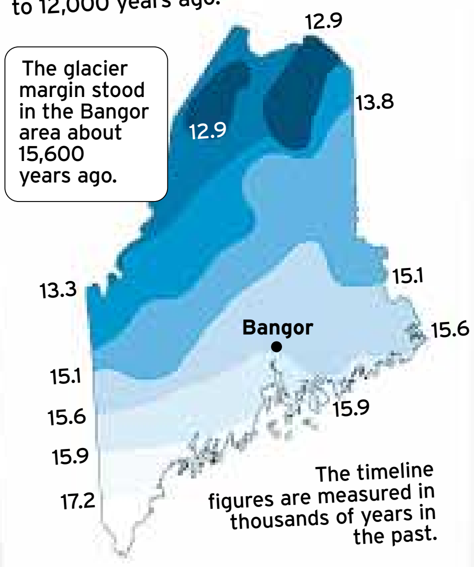
Vast ice sheets (similar to the ones that now cover Greenland and Antarctica) once blanketed a significant portion of the North American continent. During the last million years, roughly the time during which humans have existed as a species, Earth experienced about a dozen glaciations. During the greatest of them, about 650,000 years ago, the Laurentide Continental Ice Sheet, with its northernmost reaches up near Hudson Bay, covered Chicago and points south in ice perhaps a mile thick. So much water was bound up in ice that the level of the seas was about 400 feet lower than it is currently.

Glacial periods tended to last much longer than the interglacial periods, with the last glacial period in human experience peaking about 20,000 years ago, with most of the ice melting during the period 17,500-12,500 years ago. Much of what we call human civilization, therefore, including the practice of agriculture, emerged only during the most recent interglacial period.

During the last million years or so (the Pleistocene Epoch), glacial periods have come at fairly regular intervals of about 100,000 years. This periodicity is partly explained by the "Milankovitch hypothesis," which states that regular wobbles and tilts in Earth's axis of spin, as well as stretches in its orbit, cause changes in how warm the planet is, especially in the Northern Hemisphere.

Maine's last ice sheet

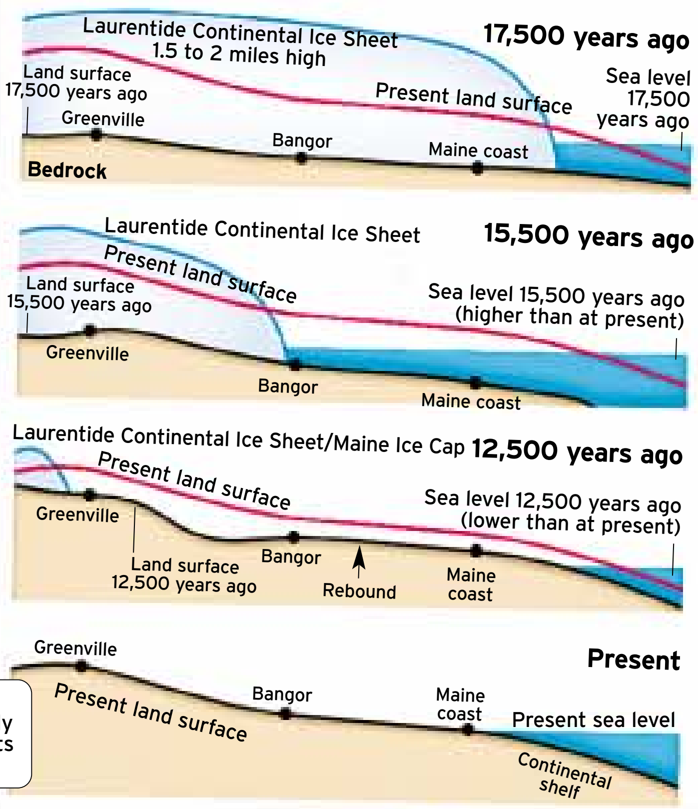
Maine and the progressive retreat of the southern edge of the last ice sheet, 17,500 to 12,000 years ago.

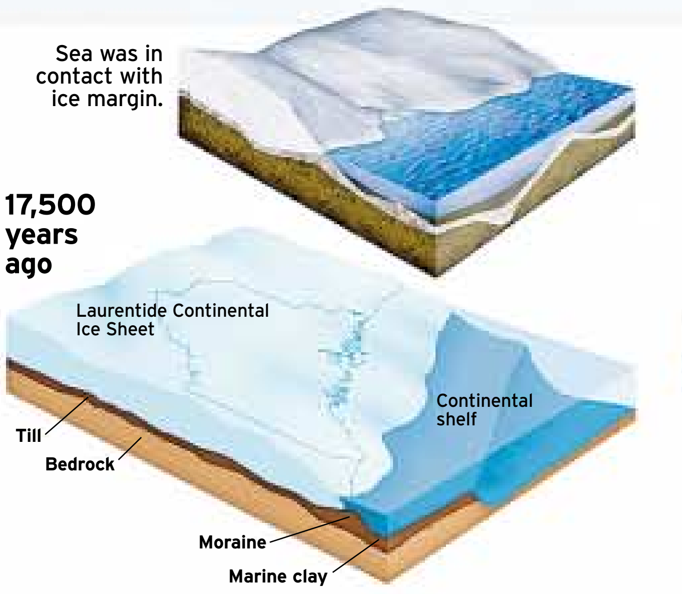


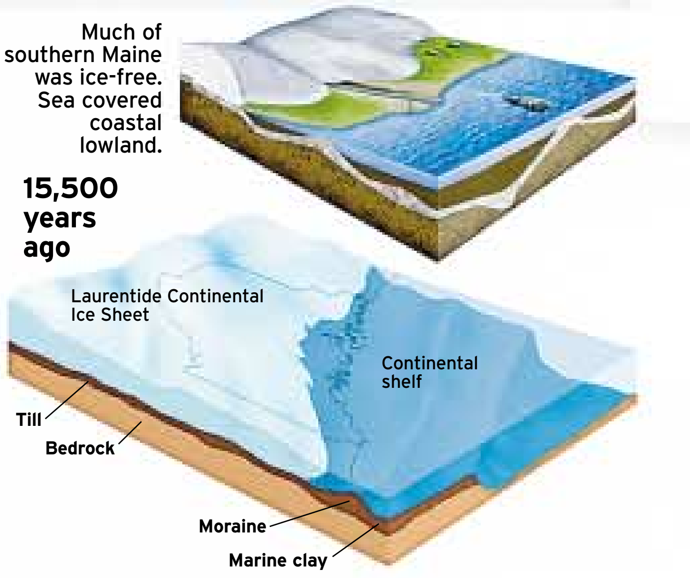
After glacial ice receded, the depressed ground slowly rebounded, released from its load of ice.

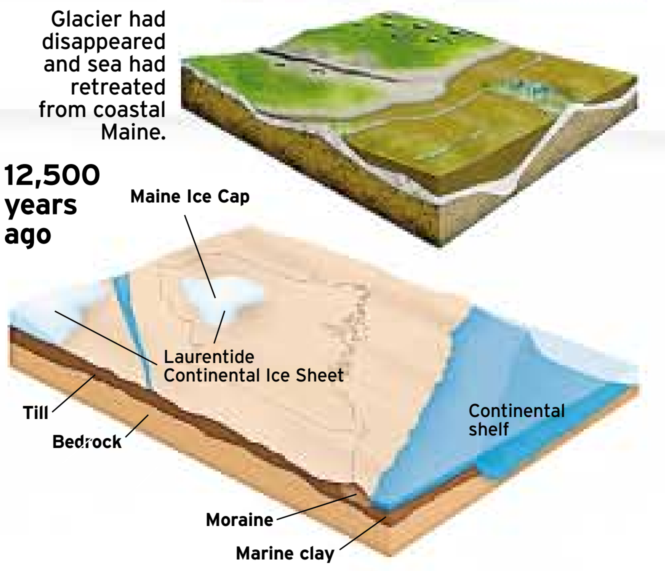
Glacial melt and land rebound

As glaciers receded, previously depressed land rebounded, released from the weight of the ice load.



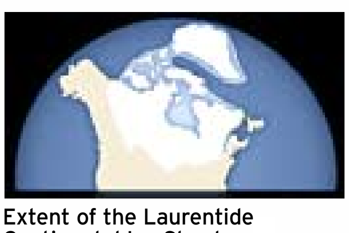






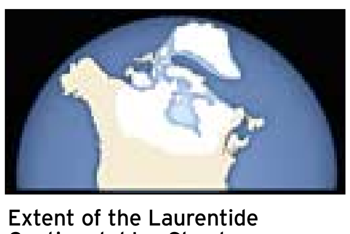
Maximum extent of the Laurentide Continental Ice Sheet on North America

1. Thick Laurentide Continental Ice Sheet advances out onto the Continental Shelf into the Gulf of Maine
2. Weight of the ice depresses land surface downward.
3. Relative sea level at ice front is about 300 feet higher than present-day sea level.



Extent of the Laurentide Continental Ice Sheet on North America

1. Ice front retreats to stationary position just north of present-day Bangor.
2. Land surface/crust remains mostly depressed, but release of ice's weight causes crust to begin to rebound.
3. In contact with the retreating ice margin, sea level is at about 400 feet above present-day sea level.



Extent of the Laurentide Continental Ice Sheet on North America

1. A small isolated segment of ice is present in northern Maine.
2. Released from the weight of the ice, land surface/crust rebounds and emerges up and out of the ocean.
3. Relative sea level drops to a low-stand well off the present coast to about 200 feet below the present-day sea level.

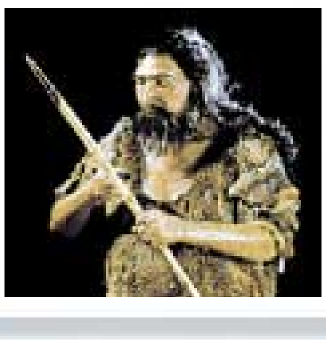
Present-Day Profile

1. Laurentide Continental Ice Sheet has melted and disappeared from North America. The Greenland Ice Cap is the only remnant of last ice age.
2. The land surface-crust has rebounded and been restored to its present-day level.
3. Sea level rose once again to its present position at the coast due to the infilling of the ocean by the meltwater from the collapse of the Laurentide Continental Ice Sheet in North America, and the Scandinavian Ice Sheet in Europe.

65 million years ago
The end of the era of the dinosaurs. Today, many scientists support the theory that a massive asteroid struck Earth, filling the atmosphere with dust and debris for several years and causing a drastic but temporary climate change that few species could survive.

5.8 million to 5.2 million years ago
Man's earliest-known ancestor, Ardipithecus ramidus kadabba, appears in Africa.

2 million to 1.6 million years ago
The beginning of the Quaternary Period, in which Earth's climate continues to cool, introducing a long glacial cycle that lasts to the present. Glaciers have advanced into temperate zones at least nine times, each occurrence bringing at least 90,000 years of ice buildup, followed by rapid melting and around 10,000 years of relief known as an "interglacial" period. Geologic evidence of at least two of these glaciations exists in New England.



100,000 years ago
The first modern humans, Homo sapiens, appear in Africa.