# Introduction, Part 1: Great Lakes and Glaciers

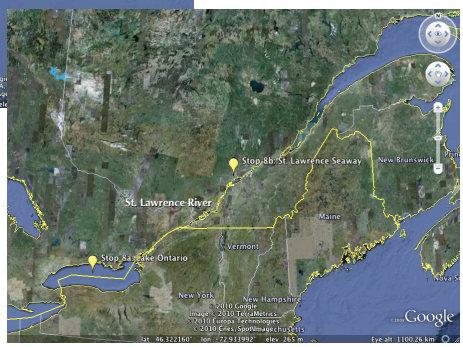
You now know that your job is to piece together the story of the Great Lakes region. In the Google Earth™ tour, you have seen the unusual landforms and geological features found in this region, including kettle lakes, terminal moraines and other unusual hills made out of poorly sorted material, erratic boulders, the Great Lakes, and the Finger Lakes. Features such as these are not found anywhere else in the country. A big part of the story of this region will have to do with glaciers and climate. Some of the big questions you will need to answer are:

- How did glaciers shape the landscape in this region?
- What can cause the climate to change?
- What clues do glaciologists and paleoclimatologists use to learn about past climates and predict future climates?
- How does climate change affect people?

**Other questions are:**

- How were Long Island and Cape Cod formed?
- When the water was so deep in the Great Lakes basins 12,000 years ago, why didn't it flow out the St. Lawrence River as it does today?


***Long Island and Cape Cod***
*Lat: 41.41°,*
*Long: -72.23°,*
*Range: 420,000 m*




***St. Lawrence River***
*Lat: 46.32°,*
*Long: -72.93°,*
*Range: 1,100,000 m*

- How did glaciers dig out the huge basins for the Great Lakes?

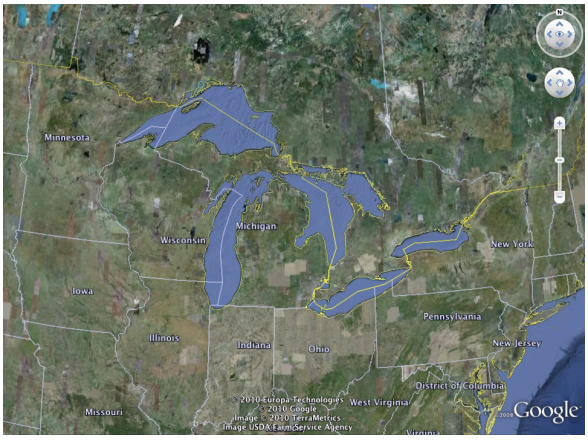
Using information from the rocks and glaciers, scientists can develop a story of the past and even make predictions about the future. But how do they do it? Each member of your team will have information that will help answer all these questions and help your team develop a story about this region.

# Introduction, Part 2: The Great Lakes Region

Imagine what it would have been like 12,000 years ago if you were able to tour this area. The climate is warming slightly, and the glaciers are slowly melting and retreating to the north. To the south there is a terminal moraine where the front of the ice sheet has stalled for a few hundred years. During that time, the ice sheet was moving forward at about the same speed as it was melting. The ice sheet continues to move glacial till to the front of the glacier, creating the terminal moraine. The moraine is over 100 meters high in places, several hundred kilometers long, and several kilometers across.

Now go north to the front of the retreating glacier. Imagine standing and looking up at the glacier towering more than a kilometer above you and stretching in both directions as far as you can see! That is a LOT of ice! Between the moraine and the glaciers are enormous, deep basins that have been gouged out by the ice sheet as it moved across this area for the past several thousand years. The basins are filled with meltwater.

The moraine to the south, the mountains to the east, and the towering glaciers to the north prevented the meltwater from escaping this area. Because of these barriers, the shoreline of the glacial lakes was much higher and the lakes several times bigger than the Great Lakes are today. The current Great Lakes were formed about 11,000 years ago after the glaciers finally retreated farther to the north. This makes the Great Lakes one of the youngest geological features on the planet.



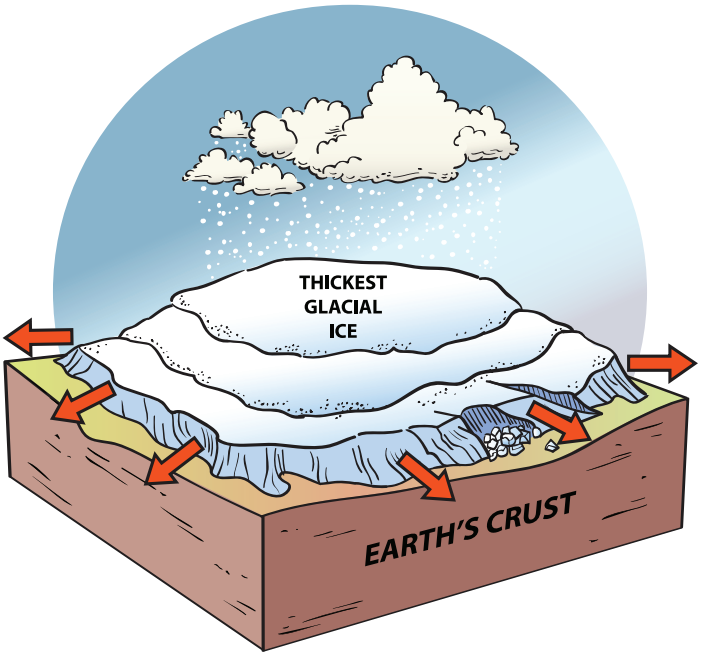

*Lat: 44.36°, Long: -84.21°, Range: 1,800,000 m*

## Introduction, Part 3: How Do Glaciers Form, Advance, and Retreat?

Earth's climate is constantly changing. During the last Ice Age, which lasted for two million years, there were probably 18–20 glacial periods. During these colder times, more snow fell in the winter than would melt during the summer. Each winter, another layer of snow was added. As the layers accumulated, the snow compacted and turned to layers of ice. The place that received the most snow was located in the Hudson Bay area in Canada. Over thousands of years, the ice sheet in that area was probably 3 or 4 kilometers thick! The weight of that much ice caused the ice sheet to slowly flow out in all directions. Part of the ice sheet moved as far south as the Midwest and Northeast United States.

Glaciers are always moving forward. As long as there is more snowfall in the winter than will melt in the summer, glaciers will **advance**. When the climate warms, or glaciers get far enough south that the temperature is warmer, glaciers begin to melt as fast as they advance.

If, however, glaciers are melting faster then they are moving forward, the front of the glacier will **retreat**, even though the glacier itself is still moving forward. During warmer interglacial periods, more snow would melt during the summer than would fall during the winter, and the glaciers would retreat. Earth is currently in an interglacial period where the only glaciers left are in the polar regions and at high altitudes.




## Introduction, Part 4: How Do You Know if Glaciers Have Been Here?

Glaciers melt and seem to leave behind nothing but water. However, they leave a lot of evidence that they were once here. As glaciers move along, they scrape up and carry along a lot of earth materials, including large, **erratic boulders**. This poorly sorted material is called **glacial till**. Melting glaciers, such as the one in the picture at right, act like a conveyor belt, carrying glacial till forward and depositing it where the glacier melts. This deposit of glacial till at the front of a glacier is called a **terminal moraine**. If glaciers continue to melt at the same location for a few hundred years, they can build up a huge terminal moraine. In some places, these moraines are as high as 100 meters or more, over 100 kilometers long, and a few kilometers across. One terminal moraine stretches east and west along most of the New York–Pennsylvania border. Other terminal moraines are much smaller. In addition to terminal moraines, glaciers deposit glacial till that produces other types of formations. Along the left side of the picture of glacial till, you can see where the glacier is depositing a long, narrow, meandering hill of glacial till as it moves down the mountain and melts.

***Glacial till***
*Photo : courtesy of J Burghardt, NPS*

***Kettle Lakes***
*Lat: 41.62°, Long: 86.74°, Alt: 4,800 m*

**Kettle lakes**, such as those in the picture at right, were created when huge chunks of glacier, sometimes even a few kilometers across, broke off and became covered up and surrounded by the glacial till deposited by the ice sheet. When the ice melted, there was a large hole in the thick layer of glacial till where the chunk of glacier had been. Water from the melted glacier filled the holes, producing kettle lakes.

As an ice sheet moves over an area, the rocks embedded in the ice can gouge out grooves and scratches in the bedrock under the glacier. These scratches indicate where the glaciers were and also show which direction the glaciers were moving.