BODACIOUS dream EXPEDITIONS

EXPEDITION EXPLORER GUIDE

Fox Glacier: The Power of Ice

For years now, we've been hearing story after story about how human activity and global warming have affected glaciers around the world. Experiencing firsthand the amazing forces at Fox Glacier and the incredible speed with which that change is happening, brought those many stories to a very different level of reality for me.

Touring A River of Ice

Glaciers by their nature are constantly changing and flowing. Ice pushes down through mountain canyons carrying along with it the dust and debris of history. Evidence of earlier weather and life cycles become exposed once the ice melts at the *terminal* end. This cycle alarms people today, because the process is happening at such an accelerated pace. To the casual observer, glaciers appear static, but to experienced and trained observers, glaciers reveal a constantly unfolding window into how our earth and the forces of nature are undergoing constant change. Fox Glacier is where we visited but the same accelerated changes are happening around the globe

At the entrance to Fox Glacier, you can see canyon walls that have been scraped clean by the glacier as it receded from this area over the past 50 years. Our guide told us the glacier was melting at the rate of 6 inches (15cm) a day! That's 3.5 feet a week, 15 feet a month, 180 feet a year! Glaciers don't do anything quickly, but they sure do it steadily. They gather snowfall up in the mountains, compress it so that it can't help but move, ever so slowly, changing and sculpting the earth on its way.

Of all the sights I witnessed on my visit, the one that stood out for me was an enormous boulder. First spotted five years ago, the boulder is about the size of a small truck and tilted up on its edge as if it might fall over at any moment. The Fox Glacier Guides have been keeping an eye on it as it is carried down by the glacier. In those five years, they have seen the boulder reposition itself in many different angles and positions, but no one has ever actually seen it move!

Fox Glacier Facts

- There are over 3000 glaciers in New Zealand!
- Fox Glacier is one of the few in the world that ends in a rainforest before emptying into the ocean.
- Fox Glacier is over 1000 feet thick (300m) at its deepest point
- Fox Glacier flows at the rate of 600 feet (183m) per year
- The thickness of the ice near the terminal face is up to 100 feet (30m) thick
- Measurement of the change in ice thickness is done by placing long pipes, called ablation poles, vertically into the glacier. They start level with the ice surface and gradually become exposed as the glacier melts. At the time we were there, one meter of pipe was showing, indicating about two weeks' worth of change (melt).
- Half the glacier is contained in the upper "bowl" area, where the snow collects and compresses into ice.
- The other half is called the "tongue," which is the mass that flows down to the river area.
- Fissures and crevasses happen perpendicular to the compression stress of the glacier; closing and opening as the great masses of ice move and shift daily.

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Ice is one of the greatest creators of landscapes. The immense weight and pressure of glaciers moving downslope creates a history of features we can observe.

The Power of Ice: Discovering the Glacial Landscape

Glaciers and ice sheets form landscapes through two methods. The first happens when glaciers erode the landscape by scraping up the soil and bedrock and depositing this material in other places.

Depending on the type of rock that a glacier is moving over, different glacial features are left behind. Soft rocks like sandstone or limestone are easily ground up by the pressure of the ice, while harder rocks like granite are usually eroded through a process called "plucking." Water from the glacier melts into cracks in the rocks which than refreezes. As the ice in the glacier moves, it plucks away pieces of rock which are caught in the ice. Water also expands when it freezes and is capable of breaking apart rocks in what is called "freeze-thaw weathering." The results are beautiful U-shaped valleys and cirques formed by glaciers moving through mountain landscapes.

The second method of erosion is called a "*roche moutonnée* or a whaleback. This is an area of exposed bedrock that has a smooth, gently sloped side and a steep vertical side. The photo shows a few roche moutonnée which are only a few feet tall though it is possible to see very large ones as well. The sloping side is the direction the glacier was coming from and the ice grinds down that side of the rock. The steep side is the direction the glacier was going and this is where the process called plucking happens. The tops of roche moutonnées often have scratches called striations which are horizontal scape marks from the rocks and debris in the ice.

Varieties of Glacier Created Landforms

Another erosional feature is called a *crag and tail* which is a tall hill usually with exposed rock and a gently sloping tail of softer rock behind it. In this case, the steep side of the hill is the direction that the glacier came from. The most famous crag and tail is Edinburgh Castle and the Royal Mile in Edinburgh, Scotland. The crag is an area of very hard rock, usually a volcanic plug which forms when magma cools inside the vent of a volcano creating a column of very hard rock. When the glacier hits this rock it can't erode it, so it is forced to flow around the plug like water flowing around rocks in a stream. The plug protects the softer rock behind it leading to the formation of the tail.

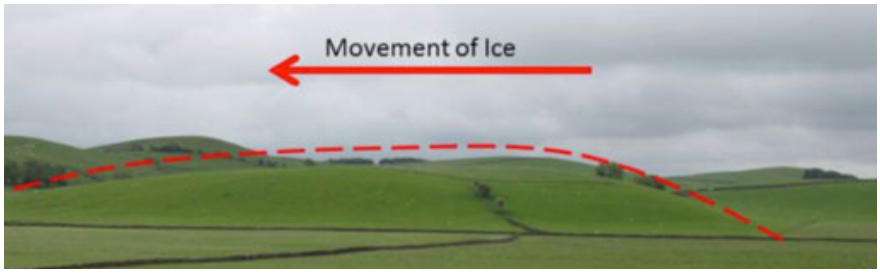
All that eroded material has to go somewhere and glaciers leave behind particular landforms as evidence. Sediment left behind by glaciers is usually called *till*, which is made up of sand and gravel and rocks of every size. *Erratics* are large rocks left behind by a retreating glacier. Geologists can study the mineral structure of erratics to learn where they come from and learn more about the behavior of glaciers and ice sheets.

A glacier is essentially a river of ice always on the move. The immense weight of the ice causes it to deform internally, which results in unstoppable movement. Gravity and meltwater underneath the glacier also help it move downslope. Areas at the edges are under less pressure so this is where great cracks and crevasses form. When pieces of ice fall off the base of the glacier it is call *calving*.

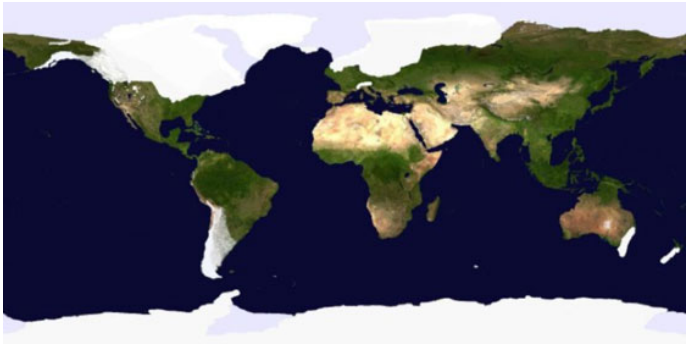
Varieties of Landforms (continued)

As glaciers move, they push up ridges of material called *moraines*. Ridges formed at the base of the glacier are called *terminal moraines*. Those formed at the edges of the glacier are called *lateral moraines*. Cape Cod and Long Island on the US east coast have a series of terminal moraines formed by the Laurentide ice sheet thousands of years ago. As a glacier retreats, it can leave behind a series of terminal moraines which reflect the extent of the ice at different periods. In some valleys we can see where a terminal moraine has blocked meltwater from a glacier and left behind a lake.

Another landform feature is called a *drumlin*. When you look at a drumlin, like in the photo below, you might be reminded of the shape of a crag and tail or a roche moutonnée. A drumlin is a type of hill which looks roughly like the bowl of a spoon held upside down. Here too, you can tell which way the glacier was moving. The wide side is the direction the glacier was coming from and the narrower end is the way the glacier was going. Drumlins are formed underneath the ice as the internal movement adds material, or "till" to the core of the drumlin. Drumlins often occur in large groups called drumlin fields or swarms of drumlins. Many are found in areas with agricultural activity because glacial sediments can be very good for growing crops.



Glaciers of the Past



At times throughout Earth's history, huge areas of the planet have been covered by ice. We know that some of these ice sheets covered thousands of miles and could be several miles thick. Such ice ages can last for millions of years and go through a series of glacial and inter-glacial periods where ice cover increases and decreases. The last ice age started 2.6 million years ago and is still ongoing today. We are currently in an interglacial period called the *Holocene*, which started 12,000 years ago. When people talk about the "Ice Age" they are usually talking about the previous glacial period, which occurred from 110,000 to 12,000 years ago. The ice was at its greatest expanse just 22,000 years ago when most of the northern half of North America and northern Europe and Asia were covered in ice. In the southern hemisphere, the Andes in South America and Southern Alps in New Zealand had large ice caps as well. The wonder of it all is that we can visit many of these glaciers, put on special ice-climbing cleats called "cramp-ons" and see for ourselves what is happening, while we imagine what similar events happening at other glaciers around the planet.

The growth of a glacier is based on something called *mass balance*. Snow falls on the top of the glacier and freezes, while ice from the bottom of the glacier melts or breaks off, a process called *ablation*. As long as the accumulation at the top outweighs the ablation at the bottom, the glacier will grow. However, if the opposite happens the glacier will retreat. This is the case at Fox Glacier, and unfortunately for many glaciers around the world.

Test Your Knowledge

1. What is the name of the special equipment you put on your boots so you can walk on the ice?
2. What is unique about the climate where the Fox Glacier ends and melts into the Fox River?
3. About how long would it take a large rock to move from the top of Fox Glacier down to the terminal face?
4. You see lots of cracks and breaks in the glacier. When these open up wide enough to fall into, what are they called?
5. What is it called when a big chunk of ice breaks off the edge of a glacier?
6. What is the scientific name for the large rocks that are moved around by glaciers?
7. What is the technical term for the process that is the melting away of the glacier?
8. What causes the snow that falls in the mountains to turn into the ice that is the glacier?
9. Where would you see another glacier with the same climate at the end point?
10. How thick is Fox Glacier in the thickest part?
11. What is the name given to the hilly land left from the debris of a glacier as it melts away?

What happens when massive ice sheets disappear?

The most important thing to remember is that ice sheets and glaciers hold a huge amount of water. The sea level was about 120 meters lower during the last glacial period than it is today. We still have two major ice sheets on earth, the Antarctic Ice Sheet and the Greenland Ice Sheet. If these were to melt – which they give every indication of doing, and quite rapidly, we would see increases to sea level, which would threaten many coastal cities and sea-dependent communities across the globe.