



Glacial Erosion

EARTH SCIENCE • GEOLOGY • GLACIAL EROSION

Section 1: Glacier Formation

• What is a glacier?

A glacier is a large accumulation of ice that is slowly moving downhill under its own weight. Glaciers usually form in mountainous areas, and are found in those parts of the world where regional temperatures are low. These include the polar regions, where glaciers flow out from larger ice caps and ice sheets, and high mountain regions, where glaciers tend to be relatively smaller. In the Alps, for example, they are referred to as mountain valley glaciers, as they generally flow through what would have been a river valley, widening and deepening it as they travel downhill. In recent decades, many mountain glaciers have seen a reduction in their ice mass due to global warming.



Glaciers form when ice and snow builds up faster than it disappears

• Suggested Films

- Glaciers
- Yosemite's Valleys

• How do glaciers form?

There is a simple starting point to the formation of any large mass of ice: snowfall during the winter survives through the summer months, so that the snowfall from the following winter lands on top of it. This process, repeated many times, causes the weight of the snow layers to slowly squeeze the air out of the snowpack, and turns the snow to ice over a period of around 40 years. Old glacier ice will eventually become a blue colour as it contains very little air. This is likely to happen in hollows on the shaded side of mountains. As the hollow fills, the ice mass begins to 'flow' slowly downhill. Periods of lower than usual temperatures are called glacial periods, or ice ages, and occur periodically; warmer periods are called interglacials.

• Suggested Film

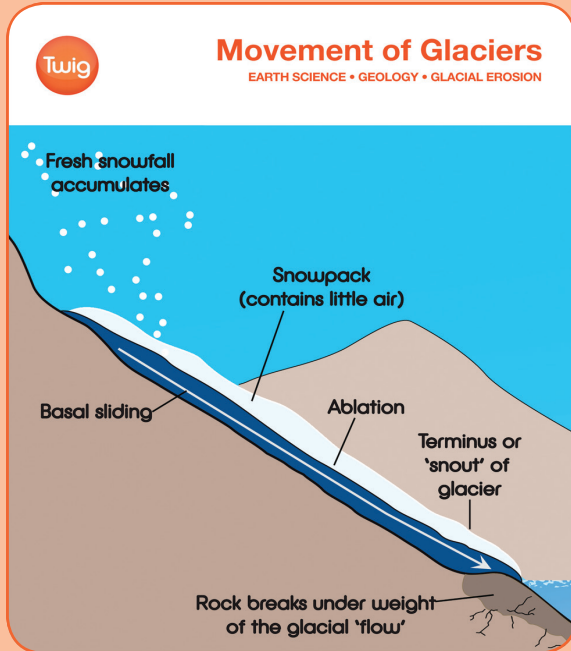
- Glaciers

• How do glaciers move?

Although ice is solid, the weight of a thick layer of it will cause the bottom layers to melt. This melting water reduces the friction between the ice and the rock it sits on, and the ice will begin to slide (basal sliding). At the same time, the ice begins to deform under the weight and 'flows' in what is called a plastic state. This movement (called internal deformation) is very slow, perhaps a few centimetres or less a day. Finally, the weight of the ice mass itself will force the rock in front of it to break up and allow the ice to move over it more easily.

Ice moves from a zone where it is forming (accumulation) to one where it is melting (ablation). If there is more ice formed than is melting, the glacier advances. Like a river, the fastest flow of a glacier is away from the valley floor and sides.

DIAGRAM 01:



Extension Question

Q1. Where are glaciers found?

Glaciers are found where local conditions allow snowfall to survive all year round. Most large accumulations of ice are found in the polar regions, where temperatures don't rise high enough to completely melt the winter snow. Temperatures also decrease with height, so there are glaciers in the high mountain ranges on Earth, even on the equator (e.g. the summit of Mt Kilimanjaro). The last places in the UK where glacial ice was found are in the Scottish Highlands, but there are no permanent snow patches at the moment. There are also remnant glaciers in high mountain areas such as the European Alps.

- Suggested Film
- Glaciers

Section 2: Changing Landscapes

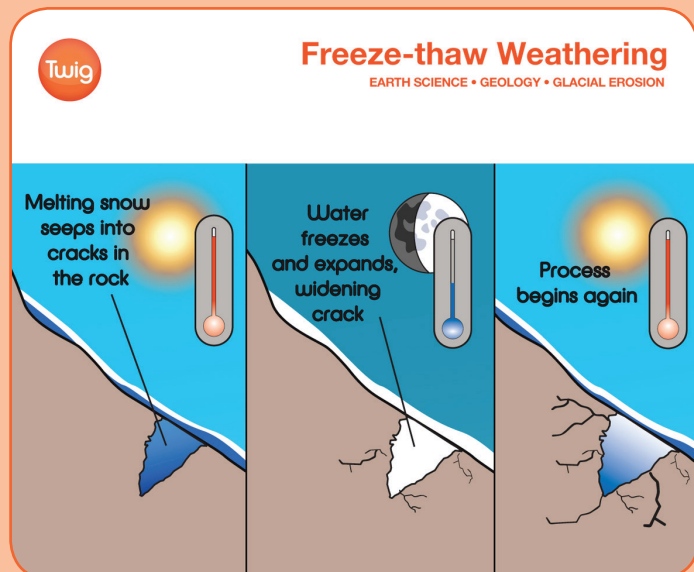
• How does ice cause weathering and erosion?

Ice mainly causes erosion via movement and by the process of freeze-thaw weathering. Freeze-thaw weathering occurs when water (from rainfall or melting snow and ice) seeps into a crack or hole in the rock, turns to ice and expands. This expansion increases pressure and as a result widens the crack. The process of melting and re-freezing of ice repeats until the rock breaks and shatters.

Glacial plucking involves the removal of fragments of bedrock by moving ice, and is probably the most effective way in which glaciers erode. These fragments can then be frozen into the glacier, and as the glacier moves, these fragments cause abrasion on the surface of the rock underneath, causing further erosion.

Ice wedging is an important process in glaciated areas, as it helps loosen rocks beneath the glacier, and so contributes to plucking and abrasion. It also produces loose rocks in topography above the glacier, which can fall onto the glacier and be transported away by the moving ice.

DIAGRAM 02:





Rocks are slowly worn away through freeze-thaw weathering, as water freezes in cracks and holes, widening the gaps, and eventually forcing them apart

- Suggested Film
 - Weathering

• How do glaciers change the landscape?

Ice can shape the landscape in several ways. Where a sheet of ice advances, it can act like sandpaper and smooth away the landscape. It can also act like a chisel and cut large grooves in the land. Glaciers carve the landscape into a U-shaped valley, which is characterised by steep sides and a flat bottom.

Glaciers can reach the sea, and carve out deep, steep-sided inlets called fjords. These are particularly common in Norway where they have resulted in significant tourist interest, as well as providing sheltered harbours for large boats, and the construction of floating oil rigs.

The material carried by glaciers can both smooth rocks and scratch them. Glaciologists use these scratches to retrace the path that the ice took as it moved out of the mountains during glacial periods. They also look for the piles of material (moraine) that marks the front edge of the advancing ice.

Ice can also protect a landscape by covering it completely. The mountains in Antarctica have been hidden for thousands of years by the ice sheets that cover them.



Yosemite's deep u-shaped valleys were carved out by glaciers

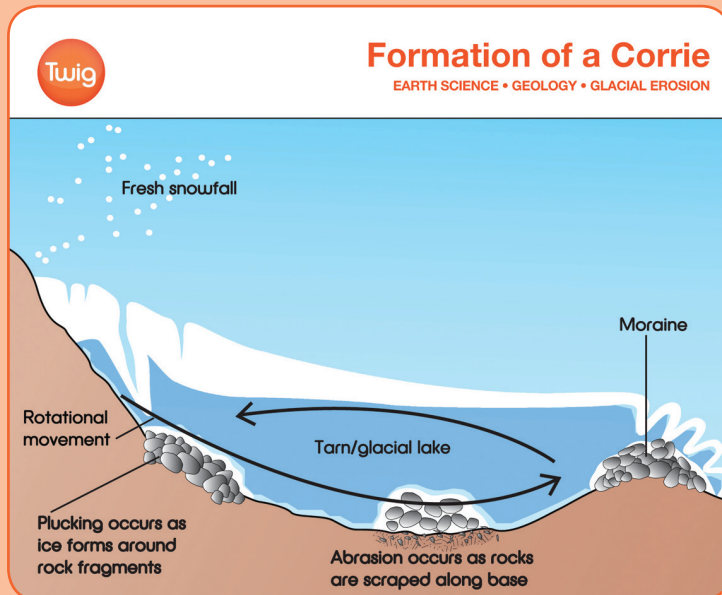
- Suggested Films
 - Weathering
 - Yosemite's Valleys

• What is a corrie?

A corrie, also called a cirque or cwm, is a round hollow found in the side of a mountain, caused by the erosion of a glacier.

A corrie forms when layers of snow accumulate in a hollow, often on the more shaded and colder side of the mountain where snow doesn't melt as quickly. The snow is compressed, due to the increased pressure caused by many layers of snow, and it eventually turns to ice. The hollow is deepened and widened through the processes of glacial erosion and by the movement of ice downhill under gravity. When the corrie ice melts, a small lake may be left behind, known as a tarn.

DIAGRAM 03:



Extension Question

Q2. What is meant by albedo?

Albedo refers to how reflective a surface is. A dark colour will absorb more heat, and reflect less. Ice is generally lighter than the surrounding rock, and as a result it tends to reflect solar radiation and stay intact once it forms. Stones or other material landing on the surface may cause it to melt faster. Dark stones sitting on the ice are often heated so that they melt down into the ice, leaving a hole at the surface.

Section 3: Glaciers and People

- Why is glacier melting a problem?

Glacier data reveals that ice is melting more rapidly today than has ever previously been the case, and this glacial melting supports evidence of our warming climate. Glacial melting does not mean that the glaciers are retreating (as in going backwards up the hill), but that they are losing ice from the front faster than it can be replaced from the back.

Large populations rely on glacier-fed rivers for a number of activities, including washing, drinking, crop irrigation and hydroelectric power.

Glaciers are responsible for ensuring that billions of people have fresh water, therefore melting would result in huge water shortages in drier areas that experience little rainfall. There are communities in Pakistan and the Andes that rely on meltwater from glaciers for their water supply, and La Paz in Bolivia relies on glaciers for its drinking water.

Rapid glacier melting can increase sea levels and burst the walls of glacial lakes to cause extensive flooding of the surrounding area. This can result in damage to homes and infrastructure, landslides and loss of farmland.

Extension Question

Q3. How can glacier melting be reduced?

Effort is being made to save some of the world's glaciers, and one of the most interesting is taking place in Peru. Peruvian inventor, Eduardo Gold came up with a plan to paint a mountain white in an attempt to reduce the rate of melting. The science behind this is that the white paint will change the albedo of the area, and might have an effect on the rate at which the glacier on the Chalon Sombrero peak disappears. Glaciers have also been wrapped in plastic to try to reduce melting.

• What benefits can glaciers bring to people?



Glacial valleys attract tourists for a number of activities, including skiing and walking

Glaciers have sculpted the landscape into spectacular scenery, and glacial valleys attract tourists from all over the world for skiing, climbing and hill walking activities. Developments are built in the surrounding areas to provide services for the tourists, which bring wealth to the local people.

The steep sides of glacial valleys make them suitable locations for damming, which can generate hydroelectric power and provide drinking water.

Glaciers also break up the rocks they travel over, which makes quarrying and extraction of resources from these areas easier.

• Will glaciers soon become a thing of the past?

There are still plenty of large ice masses on Earth. In particular, the ice sheet of Antarctica that has a range of glaciers carrying ice out from the centre of the continent, which are unlikely to melt in the near future.

However, scientists have suggested that a number of smaller glaciers are likely to disappear by 2030, or earlier in some cases. It has long been understood that ice has retreated throughout warmer periods of Earth's history, but this process is occurring today at a rapid rate. Time-lapse photography clearly shows the rate of decline in the amount of ice found at various locations. It is difficult to predict the long-term future of the Earth's ice masses, and scientists are still in disagreement about this.



75% of Earth's fresh water is frozen in glaciers. If melted, sea levels would rise by 70 metres

• Suggested Film

- State of the Greenland Ice Sheet

• Quizzes

Weathering

Basic

• Rock is not worn away by which of the following?

- A – wind
- B – cloud
- C – water
- D – sand

• Which of the following is not a type of weathering?

- A – physical
- B – biological
- C – fiscal
- D – chemical

• Rainwater is naturally

- A – acidic
- B – slightly alkali
- C – neutral
- D – strongly alkali

Advanced

• Rainwater is naturally acidic because it has absorbed

- A – oxygen
- B – nitrogen dioxide
- C – hydrogen
- D – carbon dioxide

• The removal of rocky material is known as

- A – erosion
- B – mineralisation
- C – crystallisation
- D – eruption

• Breakdown of rocks into smaller pieces is known as

- A – swash
- B – mineralisation
- C – weathering
- D – petrification

• Which does not cause physical weathering?

- A – roots
- B – sponges
- C – driftwood
- D – sea urchins

Glaciers

Basic

• Glaciers are often said to be rivers of

- A – frozen ice
- B – rock
- C – sand
- D – weathered rock

• Glaciers today can be found

- A – only in Antarctica and the Arctic
- B – on all continents except Africa
- C – on all continents
- D – only in Antarctica

• Marks on rocks, scratched out by glaciers are called

- A – striations
- B – scars
- C – incisions
- D – ruffles

• Glaciers are predominantly made up of

- A – rock
- B – frozen water
- C – sea water
- D – sand

Advanced

• How much of the world's fresh water is held up in glaciers?

- A – a quarter
- B – a half
- C – a tiny fraction
- D – three-quarters

• Ice freezing in holes in the rock and forcing it apart is known as

- A – freeze-thaw weathering
- B – insolation weathering
- C – onion skin weathering
- D – crystallisation weathering

• The ice beneath the glacier freezing to the Earth's surface and pulling away chunks of material is known as

- A – striating
- B – basal picking
- C – plucking
- D – basal lift

• The ice beneath the glacier using material to scratch the Earth's surface is known as

- A – basal cut
- B – basal attrition
- C – abrasion
- D – striation

• Answers

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