Glacial Erosion and Deposition

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CONCEPT 1

Glacial Erosion and Deposition

Lesson Objectives

- Discuss the different erosional features formed by alpine glaciers.
- Describe the processes by which glaciers change the underlying rocks.
- Discuss the particles deposited by glaciers as they advance and recede.
- Describe the landforms created by glacial deposits.

Vocabulary

- alpine (valley) glacier
- continental glacier
- end moraine
- glacial erratic
- glacial striations
- glacial till
- glaciers
- ground moraine
- hanging valley
- lateral moraine
- medial moraine
- moraine
- plucking
- terminal moraine
- varve

Introduction

Glaciers cover about 10% of the land surface near Earth's poles and they are also found in high mountains. During the Ice Ages, glaciers covered as much as 30% of Earth. Around 600 to 800 million years ago, geologists think that almost all of the Earth was covered in snow and ice. Scientists use the evidence of erosion and deposition left by glaciers to do a kind of detective work to figure out where the ice once was.

Formation and Movement of Glaciers

Glaciers are solid ice that move extremely slowly along the land surface (**Figure** 1.1). Glacial ice erodes and shapes the underlying rocks. Glaciers also deposit sediments in characteristic landforms. The two types of glaciers are:

- **Continental glaciers** are large ice sheets that cover relatively flat ground. These glaciers flow outward from where the greatest amount of snow and ice accumulate.
- **Alpine** or **valley glaciers** flow downhill through mountains along existing valleys.

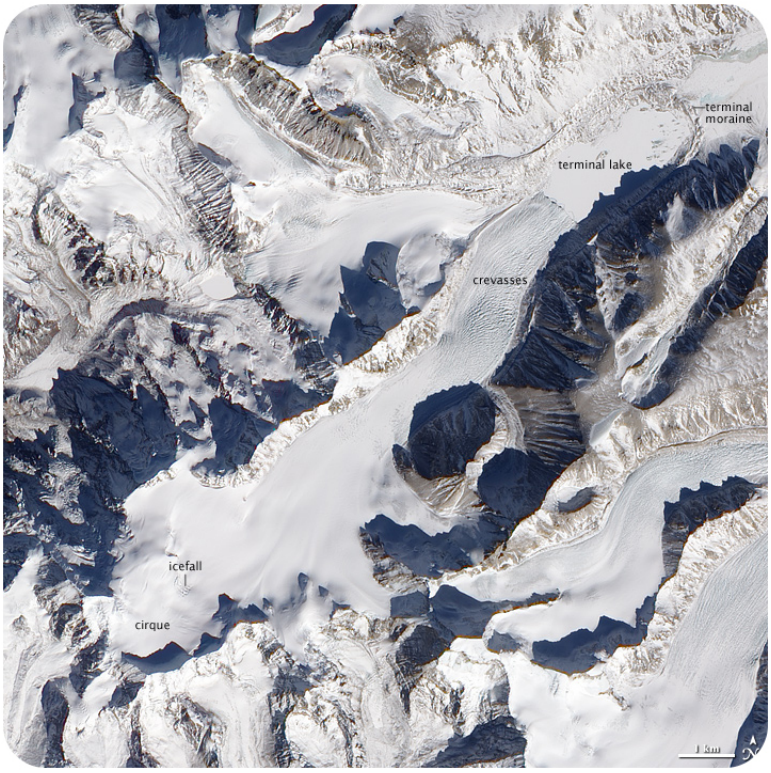

FIGURE 1.1

A satellite image of glaciers in the Himalaya with some features labeled.

Glacial Erosion

Glaciers erode the underlying rock by abrasion and **plucking.** Glacial meltwater seeps into cracks of the underlying rock, the water freezes and pushes pieces of rock outward. The rock is then plucked out and carried away by the flowing ice of the moving glacier (**Figure** 1.2). With the weight of the ice over them, these rocks can scratch deeply into the underlying bedrock making long, parallel grooves in the bedrock, called **glacial striations.**

Mountain glaciers leave behind unique erosional features. When a glacier cuts through a 'V' shaped river valley, the glacier pucks rocks from the sides and bottom. This widens the valley and steepens the walls, making a 'U' shaped valley (**Figure** 1.3).

Smaller tributary glaciers, like tributary streams, flow into the main glacier in their own shallower 'U' shaped valleys. A **hanging valley** forms where the main glacier cuts off a tributary glacier and creates a cliff. Streams plunge over the cliff to create waterfalls (**Figure** 1.4).

Up high on a mountain, where a glacier originates, rocks are pulled away from valley walls. Some of the resulting erosional features are shown: (**Figure** 1.5), and (**Figure** 1.6).

FIGURE 1.2

Glacial striations point the direction a glacier has gone.

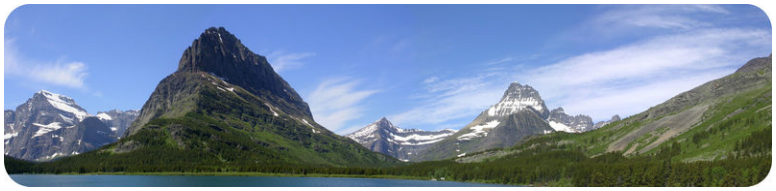

FIGURE 1.3

A U shaped valley in Glacier National Park.

FIGURE 1.4

Yosemite Valley is known for waterfalls that plunge from hanging valleys.

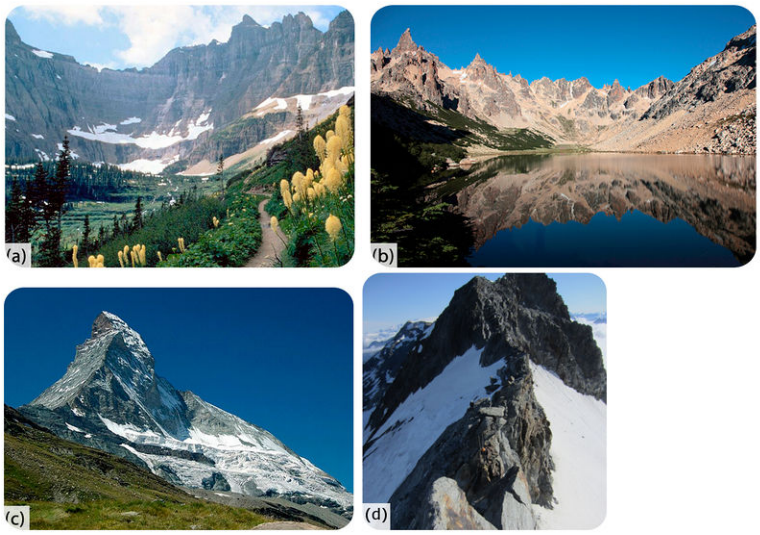

FIGURE 1.5

(a) A bowl-shaped cirque in Glacier National Park was carved by glaciers. (b) A high altitude lake, called a tarn, forms from meltwater trapped in the cirque. (c) Several cirques from glaciers flowing in different directions from a mountain peak, leave behind a sharp sided horn, like the Matterhorn in Switzerland. (d) When glaciers move down opposite sides of a mountain, a sharp edged ridge, called an arête, forms between them.

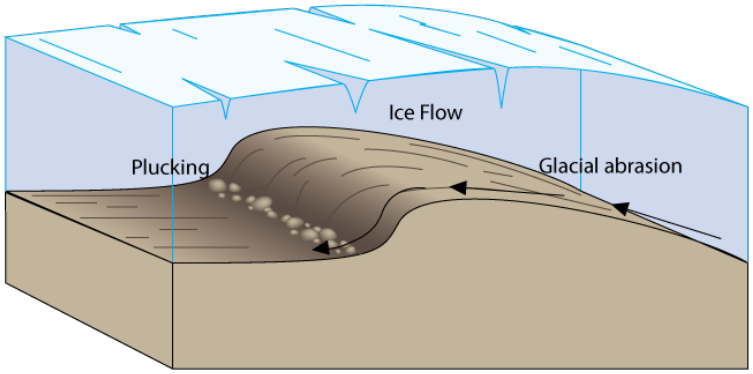

FIGURE 1.6

A roche moutonée forms where a glacier smooths the uphill side of the bedrock and plucks away rock from the downslope side.

Depositional Features of Glaciers

As glaciers flow, mechanical weathering loosens rock on the valley walls, which falls as debris on the glacier. Glaciers can carry rock of any size, from giant boulders to silt (**Figure** 1.7). These rocks can be carried for many kilometers for many years. These rocks with a different rock type or origin from the surrounding bedrock are **glacial erratics**. Melting glaciers deposit all the big and small bits of rocky material they are carrying in a pile. These unsorted deposits of rock are called **glacial till**.

Glacial till is found in different types of deposits. Linear rock deposits are called **moraines.** Geologists study moraines to figure out how far glaciers extended and how long it took them to melt away. Moraines are named by their location relative to the glacier:

- **Lateral moraines** form at the edges of the glacier as material drops onto the glacier from erosion of the valley walls.
- **Medial moraines** form where the lateral moraines of two tributary glaciers join together in the middle of a larger glacier (**Figure** 1.8).

FIGURE 1.7

A large boulder dropped by a glacier is a glacial erratic.

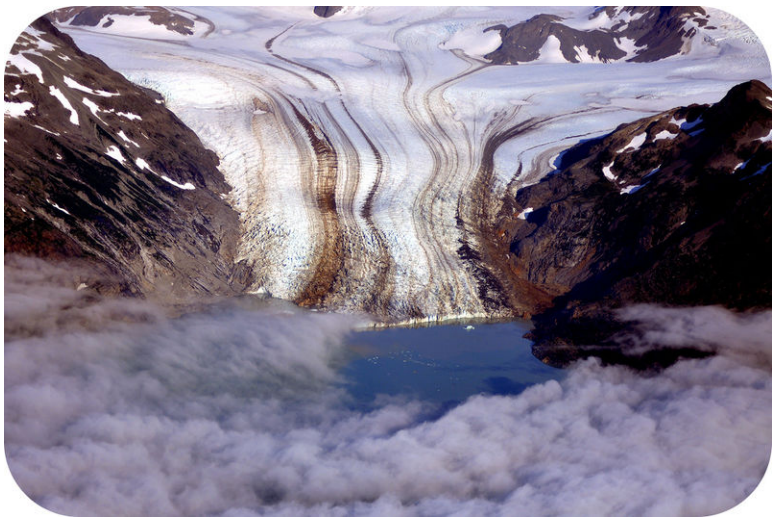

FIGURE 1.8

The long, dark lines are medial and lateral moraines.

- Sediment from underneath the glacier becomes a **ground moraine** after the glacier melts. Ground moraine contributes to the fertile transported soils in many regions.
- **Terminal moraines** are long ridges of till left at the furthest point the glacier reached.
- **End moraines** are deposited where the glacier stopped for a long enough period to create a rocky ridge as it retreated. Long Island in New York is formed by two end moraines.

FIGURE 1.9

(a) An esker is a winding ridge of sand and gravel deposited under a glacier by a stream of meltwater. (b) A drumlin is an asymmetrical hill made of sediments that points in the direction the ice moved. Usually drumlins are found in groups called drumlin fields.

While glaciers dump unsorted sediments, glacial meltwater can sort and re-transport the sediments (**Figure** 1.9). As water moves through unsorted glacial till, it leaves behind the larger particles and takes away the smaller bits of sand and silt. (**Figure** 1.10).

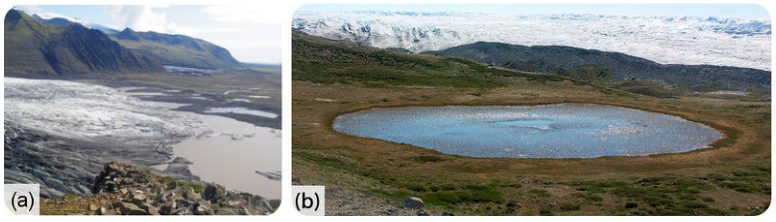

FIGURE 1.10

(a) A sorted deposit of sand and smaller particles is stratified drift. A broad area of stratified drift from meltwater over broad region is an outwash plain. (b) Kettle lakes form as blocks of ice in glacial till melt.

- Try to pick out some of the glacial features seen in this Glacier National Park video: http://www.visitmt.com/national_parks/glacier/video_series/part_3.htm.

Several types of stratified deposits form in glacial regions but are not formed directly by the ice. **Varves** form where lakes are covered by ice in the winter. Dark, fine-grained clays sink to the bottom in winter but melting ice in spring brings running water that deposits lighter colored sands. Each alternating dark/light layer represents one year of deposits. If during a year, a glacier accumulates more ice than melts away, the glacier advances downhill. If a glacier melts more than it accumulates over a year, it is retreating (**Figure** 1.11).

Lesson Summary

- The movement of ice in the form of glaciers has transformed our mountainous land surfaces with its tremendous power of erosion.
- U-shaped valleys, hanging valleys, cirques, horns, and aretes are features sculpted by ice.

FIGURE 1.11

Grinnell Glacier in Glacier National Park has been retreating over the past 70 years.

- The eroded material is later deposited as large glacial erratics, in moraines, stratified drift, outwash plains, and drumlins.
- Varves are a very useful yearly deposit that forms in glacial lakes.

Review Questions

1. How much of the Earth's land surface is covered by glaciers today? Where are they found?
2. What are the two types of glaciers and how are they different from each other?
3. What is the shape of a valley that has been eroded by rivers? How does a glacier change that shape and what does it become?
4. What two different features form as smaller side glaciers join the central main glacier?
5. How do glaciers erode the surrounding rocks?
6. Name the erosional features that are formed by glaciers high in the mountains and describe how they form.
7. Describe the different types of moraines formed by glaciers.
8. Describe the difference between glacial till and stratified drift. Give an example of how each type of deposit forms.
9. Name and describe the two asymmetrical hill shaped landforms created by glaciers.

Further Reading / Supplemental Links

- Glacial landforms illustrated: http://www.uwsp.edu/geo/faculty/lemke/alpine_glacial_glossary/glossary.html

Points to Consider

- What features would you look for to determine if glaciers had ever been present?
- If glaciers had never formed, how would soil in Midwestern North America be different?
- Can the process of erosion produce landforms that are beautiful?

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