LAB EXERCISE – GLACIERS

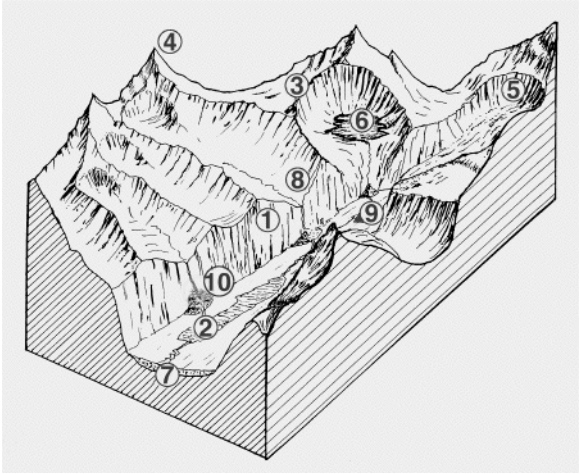
Introduction

A ***glacier*** is a long-lasting mass of ice which flow downhill under its own weight. Glaciers can be seen today in high mountain areas of every continent but Australia as well as in the extreme north and south polar regions. Glaciers are active agents of erosion, transportation, and deposition of sediments. Glaciers were much more widespread in the past than they are at present. Large masses of ice from the last great glacial period have modified and molded great stretches of the landscape in what are now temperate zones.

Glaciers form in regions where the annual snowfall exceeds the annual melting. Alpine (valley) glaciers form above the snowline in high mountainous areas, in some instances even very close to the earth's equator. Continental glaciers are great seas of ice which have formed in polar regions and periodically in the past have spread far toward the equator and covered areas of continental size.

Alpine Glaciation

Alpine (valley) glaciation modifies the landscape drastically cutting U-shaped valleys and leaving sharp ragged ridges and peaks. The stream-cut mountainous areas are characterized by V-shaped stream valleys, overlapping spurs, and rounded hills. Valley glaciers develop from accumulating snow fields in the high peaks and flow down the stream valleys. Major glaciers, therefore, have a network of tributaries which follow the older river drainage system.

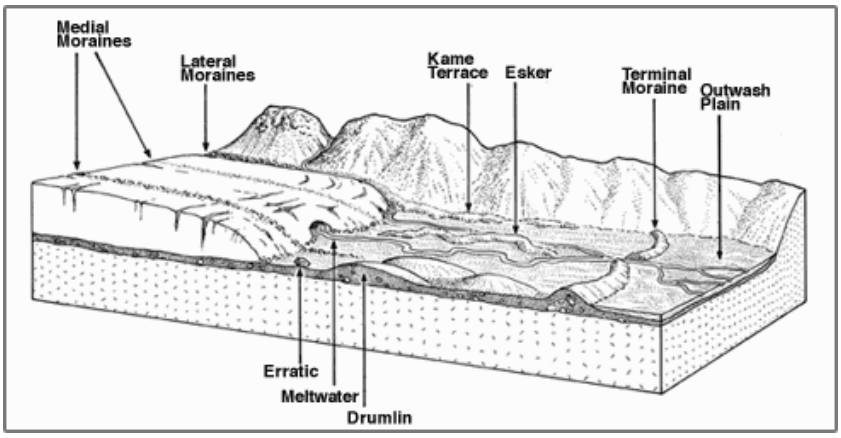


Glacial erosion tends to produce sharp, angular geomorphic features. Most of these landforms have French names because they were originally studied in the Alps of Europe. Bowl-shaped depressions called *cirques* ⑤ develop at the heads of valleys. Where several cirques merge, a sharp angular peak called a *horn* ④ is produced. The divides between glacial valleys are carved into sharp ridges called *arêtes* ③. Valleys which have been glaciated are typically straight and U-shaped in cross section ⑦. Major glacial valleys are deep with truncated *spurs* ①. Glacial tributaries form *hanging valleys* ⑧, which enter high on the side of the main valley. A lake, left in a cirque after the glacier has melted is called a *tarn* ⑥. Glaciated valleys sometimes decend like stairsteps with each level being fairly flat and containing a lake; these are called *pater noster lakes.* Rock debris deposited at the base, sides and lower end (terminus) of a glacier forms *moraine*. Moraine deposits are very poorly sorted.

Continental Glaciation

Even though large-scale continental glaciation in North America ended prior to the beginning of written history, geologists have been able to demonstrate that at least four and as many as seven major glacial advances occurred during the last million years. The last major ice sheet in North

America disappeared approximately 10,000 years ago. Today, major contintental glarciers are found only in Antarctica and Greenland. The unique erosional and depositional features that they create are found in Northern Europe and North America and enable us to determine the nature and extent of past continental glaciation. Terminal moraines mark the margins of the ice. Ground moraine is deposited beneath the glacier and may be locally shaped into streamlined hills called *drumlins.* Melt water from the ice deposits an *outwash plain* consisting of stratified gravels, sands and silts (drift) deposited by braided streams flowing from the glacier. Sinuous ridges called *eskers* result from sediment deposited on the floor of former ice tunnels. Ice blocks which break off from the glacier or are left behind as the glacier recedes and become surrounded by sediment produce *kettles* when they melt away. Large rocks left behind by the ice are called *erratics*.



Procedure

Please observe the following aerial photos and topographic maps which illustrate glacial features and then answer the following questions.

Questions

Mt. Rainier, Washington (map #104, photo #9)

1. Notice the well-developed radial drainage in th[i]s area. There are more glaciers on this peak than on any other in the continental U.S. In the photo, why are the upper parts of the glaciers quite white while the lower parts of the larger glaciers are darker in color?

2. What features can you see in the photo of this peak which suggest its geologic origin?

Crillon Glacier, Alaska (photo #47)

3. About how many medial moraines are present in the upper part of the main branch of this glacier?

   Explain the origin of these medial moraines.

4. Why is the ice so much darker near the downstream terminus of the glacier than it is farther upstream?

5. What evidence do you see that this glacier is still moving rather than being stagnant ice?

6. A smaller glacier is present in the upper left part of the photos. Why doesn't this small glacier join the main glacier?

   Did it ever join the main glacier?_____What will this tributary valley be called if the ice melts away entirely?

Mt. Tom, California (map #19)

7. Give the elevation of Mt. Tom to the nearest foot.

8. Locate Four Gables in the lower left-hand part of this map. Notice that a number of the contour lines immediately north of Four Gables are shown in a blue color. What does this represent?

   What is the elevation of Four Gables?

9. Notice the shape and steepness of the slopes of Four Gables. What is the name of the erosional feature represented by Four Gables?

10. Locate the Upper Horton Lakes about 1 mile east of Four Gables. Notice that the Upper Horton Lakes lie in a large amphitheater-like basin at the head of Magee Creek. What is the name given to this large amphitheater at the head of Horton Creek?

    What is the name given to lakes like the Upper Horton Lakes?

11. Locate Horton Lake in the northeast quarter of Sec. 27, 17S, R. 30 E. Horton Creek flows almost due east out of this lake. What evidence indicates that a glacier once occupied Horton Creek in the area immediately downstream below Horton Lake?

    Estimate the lower limit of the extent of this glacier down Horton Creek. What was the elevation of the terminus of this glacier?

How did you determine how far the glacier descended down Horton Creek?

12. Pine Creek flows northeast out of the mountains in the central part of the map. Notice that Pine Creek has also been glaciated. Estimate the lowest elevation to which the glacier extended down Pine Creek.

    How were you able to determine how far the glacier extended down Pine Creek?

13. How can you explain the large difference in the elevations of the terminations of the Horton Creek vs. Pine Creek glaciers?

14. Steelhead Lake lies in the northwest quarter of Sec. 32, T. 7 S, R. 30 E. Notice that the creek flowing out of Steelhead Lake flows through several large lakes. In the following spaces, give the approximate elevations of Steelhead Lake and of the three lower lakes below Steelhead Lake.

    _____ _____ _____
    _____ _____ _____ _____

15. The course of a glaciated valley is often marked by a series of rock basins, which are probably formed by plucking in the areas where the bedrock is more closely jointed. As time passes, the rock basins may fill up with water, producing a string of lakes such as those we see below Steelhead Lake. They are sometimes referred to as *pater noster* lakes because they resemble a string of blue Rosary beads.

Lee Vining California (photo #15)

19. Some of you have driven up Lee Vining Canyon on your way across Tioga Pass into Yosemite. From the highway (and in the photo) you can see a well-developed hanging valley entering Lee Vining Canyon from the south. Was there more than one stage of glaciation in this area? _____ If so, how many main stages occurred?

    How do you know (hint: examine the lateral moraines)?

    Is there any evidence that Mono Lake (in the northeast corner) was ever deeper than it is now?