

**Glaciers Lab - Part I**

<http://scidiv.bcc.ctc.edu/gj/forms/lab11/lab11.ncl> & <http://scidiv.bcc.ctc.edu/rv/online101/labs/week10LabNotes.html>

**The maps that you will need for this part of the lab are LISTED BELOW. Be sure to ZOOM in. ☺**

In **Part A** you will be examining some of the glacier-related features found at the terminus of a modern glacier near Cordova, Alaska (called the Scott Glacier). In **Part B** you will use a topographic map of Cowlitz Glacier on Mt. Rainier, Washington, to measure the equilibrium line of a glacier and see how we can use glacial deposits from 150 years ago to study climate change. Note that the link will show you the lower half of Cowlitz Glacier (the large glacier in the top left-hand corner of the map – it's not labeled) and the region in front of the glacier. This is the area you will need to look at to answer most of the questions. To see the upper half of the glacier (which you will need to do to answer Q.#5a), click on the green arrow in the upper left-hand corner of the map. Do the opposite to return to the original map. If you can't read the writing on the map, you can zoom in by changing the map scale (on the left side of the screen under "View Scale") from 1:100,000 to 1,50,000.

The basic concept of **Part B** is that glaciers act like giant thermometers – they get larger when it is cold and smaller when it is warm. (They also make good "rain gauges", telling us something about past precipitation. Glaciers also leave distinctive sediments and landforms behind when they melt back. Therefore, we know how big they were in the past. It is as if you had an old-fashioned thermometer (the kind filled with mercury or red fluid) that left a mark at its highest temperature for that day. You could look at the thermometer at night and read the current temperature, and furthermore, the mark left during the day would also tell you how much hotter it was earlier. The "mark" we will use is that glacier's **equilibrium line** – the line that separates the zone of accumulation from the zone of ablation.

Geologists have shown, by monitoring modern glaciers, that the **elevation of the equilibrium line** is closely related to climate (average annual temperature and precipitation). The lab exercise describes how to measure the modern equilibrium line of Cowlitz Glacier, as well as where the equilibrium line was 150 years ago. From this information you can determine how much the temperature has changed over the past 150 years.

### **A. Scott Glacier, Cordova, Alaska - Alpine glacier depositional features**

Topo map: <http://terraserver-usa.com/image.aspx?T=2&S=14&Z=6&X=184&Y=2100&W=2>

Satellite image: <http://www.multimap.com/maps/?&t=1&map=60.69611,-145.17694|13|4&loc=US:60.69611:-145.17694:13#map=60.62303,-145.36766|12|8&loc=US:60.69611:-145.17694:13>

1.
  - a. What symbol does the map use to represent debris on the surface of the glacier?
  - b. The lower region of the glacier covered with rock debris is the zone of ablation. Most deposition occurs here. Why is no debris apparent on the upper reaches of the glacier?
  
2.
  - a. In what compass direction is the Scott Glacier flowing? Towards the \_\_\_\_\_.
  - b. When a glacier is retreating, does the ice itself flow back toward its source? Explain briefly what happens.
  
3.
  - a. The rock debris which forms long linear streaks on the glacier are called lateral or medial moraines, depending on their location. How do lateral moraines form?
  - b. Explain how a medial moraine forms. (Hint: This is a two-stage process.)

4.
  - a. What would you call the stream-channel pattern illustrated by the river flowing away from the terminus of the Scott Glacier?
  - b. The formation of this type of drainage pattern is dependent on the variable discharge and high sediment load of the river. The volume of water flowing down a glacial river changes from morning to night, and from season to season, and this change affects the amount of sediment the river can carry. What do we call the water-deposited sediments located in front of the glacier? (I'm looking for the specific name when they are associated with a glacier.)
  - c. How do ice-deposited and water-deposited sediments physically differ from one another? (This difference is crucial for identifying glacially formed features.)

**B. Cowlitz Glacier, Mount Rainier, Washington - Glaciers and climate change**

Topo map: <http://teraserver-usa.com/image.aspx?T=2&S=12&Z=10&X=750&Y=6481&W=3>

Aerial photo: <http://teraserver-usa.com/image.aspx?T=1&S=12&Z=10&X=750&Y=6481&W=3>

5.
  - a. What is the elevation at the head (the very beginning) of Cowlitz Glacier? \_\_\_\_\_ feet
  - b. What is the elevation at the terminus (bottom) of Cowlitz Glacier? \_\_\_\_\_ feet
  - c. What is the *approximate* **equilibrium line altitude (ELA)** for Cowlitz Glacier? (Average the two; it's not a bad approximation.) *Show your work below.* \_\_\_\_\_ feet elevation today
  
6.
  - a. Assume that the farthest extent of the brown dots on the map in the Cowlitz River Valley (in front of Cowlitz Glacier) mark the former position of Cowlitz Glacier (they are an end moraine). Measure the *horizontal distance* (in feet) from that end moraine to the *modern* terminus of the Cowlitz Glacier (note the scale at the bottom of the map). \_\_\_\_\_ feet
  - b. If you were to visit this end moraine you would find that it is now covered with a forest. Using dendrochronology you could determine that the end moraine formed 150 years ago (during the end of what is often called the **Little Ice Age**). Basically, you'd find that the oldest tree growing on the moraine is less than 150 years old. Before 150 years ago the moraine was covered with a glacier, so no trees could grow on it until the glacier retreated. Using the horizontal distance you determined above in Q.#6a., calculate the *retreat speed* of the glacier over the last 150 years. *Show your work below.* \_\_\_\_\_ feet per year
  - c. Now calculate the ELA for Cowlitz Glacier when it was at its extended position 150 years ago:
    - i) What was the elevation at the head of Cowlitz Glacier (in feet)? (Assume that this was the same as today (i.e., the same as answer #5a.)) \_\_\_\_\_ feet
    - ii) What was the elevation of the terminus of Cowlitz Glacier 150 yrs ago (in feet)? (Measure the elevation of the end moraine we looked at in #6a.) \_\_\_\_\_ feet
    - iii) What was the approximate equilibrium line altitude for Cowlitz Glacier 150 yrs ago? *Show your work.* \_\_\_\_\_ feet elevation 150 years ago

- d. What was the *change* in equilibrium line altitude between the glacier 150 yrs ago (answer #6c) and today (answer #5c)? \_\_\_\_\_ feet
- e. It has been shown that a 1000-foot change in equilibrium line altitude corresponds to a 2°C change in temperature. Based on this information and your answer to Q.#6d, **how much has the temperature in this region changed in the last 150 years?**

## Glaciers Lab – Part II

These questions are from: <http://webspace.ship.edu/cjwolt/geology/lab-glac.htm>

The maps and photographs that you will need are LINKED at that website. Be sure to **zoom in**.

### A. Mt. Rainier, Washington.

1. Notice the extensive network of glaciers on Mt. Rainier. What does this tell you about the local climate of this high-elevation alpine area?
2. Locate Kautz Creek, which flows southwest away from Kautz Glacier in the southwestern portion of the map. What is the shape of the valley occupied by Kautz Creek?
3. What does this tell you about the geologic forces responsible for shaping this valley? What stream type is Kautz Creek?
4. What explains this type of stream, in relation to the glacial source of water and sediments at the head of the watershed?

### B. Chief Mountain, Montana.

5. Notice the many lakes in this high alpine landscape. How did many of these lakes – such as Iceberg Lake, Helen Lake, and Sue Lake – form?
6. What type of feature is “The Garden Wall” and how did it form?
7. Locate and describe a horn on this map. How would you describe the shape of the valley occupied by the Belly River?

**C. Holy Cross, Colorado.**

8. **Draw a topographic profile** across the Lake Fork valley, extending from the top of Sugar Loaf Mountain perpendicularly across the valley to the 10,750' contour line on the north side. (*Be neat and exact – use graph paper.*)
9. How was this valley formed?
10. Do you think the valley bottom is bedrock or some kind of sediment? *Explain your answer.*
11. If sediment were there, what kind would be present where your profile crosses the valley bottom?
12. What landscape clues are present that provide information on these sediment questions?
13. Explain the differences in the formation of Timberline and Turquoise Lakes.

**D. Catskill, New York.**

14. This area was subjected to continental glaciation, with the maximum ice extent reached approximately 15,000 years ago. How would you describe the hills in the eastern part of this map (Cross Hill, Roundtop, Little Roundtop)?
15. What do they and other characteristics shown on the map indicate about the direction of ice flow?

**E. Jackson, Michigan.**

16. This area is completely covered with a terminal moraine produced by continental glaciation. How has this affected the local hydrology?
17. Name two kettles shown on the map.
18. How would you describe "Blue Ridge" in the north-central portion of the map?