Lab 9
Glaciers

Materials Needed:

4 oz white school glue	½ Tbs Borax	Two cups	Food coloring
PVC chutes	Blocks	Ice	Warm water
Dry erase marker	Timer	Drinking straw	

GLACIERS:

Glaciers start to form when winter snow to able to survive a summer without melting and begins to accumulate year after year. The snow crystals become rounded, more densely packed (less air bubbles), and eventually evolves into **firn** then **glacial ice**. Glaciers are massive, long-lasting, moving masses of compacted snow and ice. There are two types of glaciers.

Alpine Glaciers occur at all latitudes at high elevations, i.e. in the mountains. The word Alpine comes from the Alps, a high mountain range in Europe that has been glacially carved.

> Mountains tops tend to be colder and wetter than the adjacent lowlands and, near to the summit, get deep snowfalls in winter with short, cool summers. An alpine glacier forms when the amount of snow that falls exceeds the amount that melts during the warm season. These types of glaciers exist on every continent.
>
> Alpine glaciers form at the peaks and, constrained in valleys, flow downward towards the lowlands. Their growth depends on the temperature in the region as well as the amount of precipitation.

Continental glaciers, or *ice sheets*, form at all elevation at high latitudes, i.e. in polar regions, where winters are so cold and summers so short that glaciers can cover most of the land, regardless of elevation. A continental glacier covers 50,000 km^2 or more and spreads outward under its weight.

> There are two continental glaciers on Earth today, in Greenland and Antarctica. Together they hold 99% of Earth's ice and ¾ of its freshwater.

MOVEMENT:

The rate of glacier movement varies with three factors; slope steepness, precipitation, and air temperature. Glaciers can move by two mechanisms: basal slip and plastic flow.

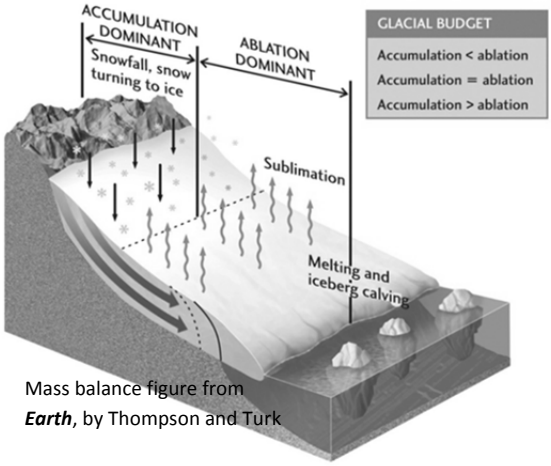
Basal slip means that the entire glacier is sliding over the bedrock. Water will accelerate the rate of slip.

Plastic flow means that the ice is moving as a viscous fluid. The surface of a glacier remains brittle and breaks into large cracks called *crevasse*. Below about 40 m, the ice flows plastically with the center moving faster than the edges and bottom, due to friction from the valley floor and walls.

MASS BALANCE:

The *Zone of Accumulation* is the high elevation portion of the glacier where snowfall accumulates faster than it melts. This is where the glacier is covered with snow year round.

The *Zone of Ablation* is lower into the valley and where more snow is melting than is falling. This is where the snow cover is only seasonal and, when the snow melts, the hard glacial ice, broken into crevasses, is exposed.



Mass balance figure from ***Earth***, by Thompson and Turk

The *snow line* is the boundary between the two zones and will shift from year to year depending on the weather.

BASIC GLACIAL FEATURES AND DEPOSITS:

As glaciers move down a mountain side they scour the bottom and sides of the constraining valley and create a *U-shaped valley*. The *terminus* is, simply, where the glacier terminates or ends.


Terminus at Canon Ford, Canada


Axel Heiburg, Canada

mound around the bottom the Axel Heiburg glacier, in the picture above, is a terminal or end moraine.

Till deposited on the lateral edges of a glacier are lateral moraines. As glaciers from different valleys merge, their lateral moraines merge to become medial moraines.

Drift is all rock or sediment transported and deposited by a glacier with *till* being the drift that is deposited directly by the glacial ice.

Moraines are mounds or ridges of till that are usually deposited at the glacial terminus. The


Yukon, Canada

MAKING A GLACIER!

So, under steady pressure, ice will bend and flow and, under sudden stress, it will break, very much like silly putty!

MAKING GLACIAL GAK

- Combine 4 oz of warm water and 4 oz of glue in one cup
    - Add food coloring to glue and stir in. Make whatever color glacier you want!
- Combine 1.2 tablespoon of borax and 2 oz of warm water in the second cup
    - Stir until your borax is dissolved
- Slowly pour your borax mixture into your glue cup and then pour them back and forth between the cups. As it solidifies, take it out of the cup and kneed it with your hands.

1. Get a feel for the properties of the gak. Stretch it slowly. Pull on it quickly. How does it behave?

- Prop up one end of your PVC pipe chute so the glacier will be able to flow downhill
    - Record the angle of the slope
- Place your entire "glacier" at the top of the chute and use a dry erase marker to mark the position of the front end of the glacier (the terminus)
- Set a timer for five minutes, then record the new terminus for your glacier
    - Measure total movement on the left side, the right side, and the center and determine the rate of flow for each (distance/time)
- Repeat increasing your slope angle.

Run	Angle	Left flow rate	Center flow rate	Right flow rate
1				
2				

2. How does slope steepness affect the rate of flow?

- Place your glacier in a cup and sit in an ice bath for five minutes (no ice in the cup, keep your gak dry!)
- Set up your chute again using one of your previous angles and remark the terminus of the glacier.
- Set your timer for five minutes, and then record the new terminus of your glacier and determine your rate of flow for each portion

Run	Angle	Left flow rate	Center flow rate	Right flow rate
1				
2				
3				

copy data for runs 1 and 2 over from previous page

3. How does temperature affect the rate of flow of your glacier?

- Set up the experiment again (use one of your previous slope angles and make sure to record it) marking the terminus of the glacier.
- Set your timer for 5 minutes.
- Poke the plastic drinking straw through the glacier as close to the top of the glacier as possible.
- Add ~5ml of water through the straw to simulate meltwater seeping down through the glacier.

4. How do you think the glacier will flow compared to the first time you ran the experiment?

- Measure the distance the glacier traveled from start to finish at the center, the left side, and the right side of the glacier.
- Determine the rate of flow now that you added water, and record your results.

Run	Angle	Left flow rate	Center flow rate	Right flow rate
4				

5. What causes glaciers to flow?

6. When your glacier started to flow, what shape did the front of the glacier make?

7. What part of the glacier flows the fastest? Why?

8. Describe the difference in flow rates before and after you added water. Why does the flow rate change?