The Characteristics of Glaciers on the Move

These activities help demonstrate the changing nature of glaciers. Glaciers, without much stress have great plasticity and will flow as we expect a glacier to flow. Add high stress such as a sudden jolt or pull and the mass experiences brittle failure, which is what happens when a crevasse opens up or an iceberg breaks off. As you vary the surface and incline, you can observe the way a glacier behaves in nature. If the temperature of the ice changes the flow of the ice will change, too.

Glaciers move in the same direction as gravity dictates. They move forward or retreat backward depending on what is happening in the environment. As long as a glacier accumulates more snow than it loses, it will move forward. When it loses more than it gains, it will begin retreating. If a glacier is retreating, it is losing ice mass.

Different forces may cause a glacier to move. Glaciers like the interior ice sheet in Antarctica move in part because of *internal deformation*. Gravity pulls down on the ice causing great pressure. As the ice sheet sits on land, the pull tends to spread it out from the center. This spread happens because of changes to the ice crystals as the pressure causes the changes in the crystals.

The West Antarctic Ice Sheet provides a good example of *basal sliding*. This occurs when water is under the base of the ice. This water might be there due to melting, rain water, meltwater that has worked its way through the glacier, or other melting. The melting point of ice under the pressure of a glacier is actually lower than the normal 32° F. As the ice thickens and mass increases, the melting point lowers. The layer of water under the ice reduces friction and invites the ice to slide faster downhill. Basal sliding causes a glacier to move ten times faster than a glacier moving due to internal deformation. The land surface under the glacier determines the speed also. When a glacier is on wet, soft earth, it moves much like when it is on a layer of water.

Environmental factors can indeed impact glaciers. However, it is important to remember that not all glaciers are the same. The glaciers in Antarctica are polar glaciers. The glaciers in North America are temperate glaciers. They are so named by their locations, obviously. More importantly they are influenced by the local climate. A temperate glacier is much warmer than a polar glacier. They are still frozen, but respond faster to environmental changes. A long-term change of a few degrees in the Antarctic where the average temperature is well below freezing won't be as significant as a few degrees change in our latitudes. It takes time for something as massive as the Antarctic ice sheets in that freezing environment to change.

Teacher Notes on the lessons and material preparation:

Activity: ***Glacier Goo***

1. This is a super connection to the chemistry of making a chemical change. If you are working with chemistry prior to this, make up the recipe as a class experiment and keep it until you need it. The glacier goo will keep for a few months. Just work the water back into the mix before using.
2. You will need 3 colors for one of the experiments. You will need 2 of the colors for the others.
3. For the experiments, each group should have a fresh set of the goo samples. For example, at the pipe station each group should start with a new set of the samples: a refrigerated piece and a room temperature piece. (If the samples are re-used by subsequent groups, the temperatures will not hold and the results would be invalid.)

Activity: ***How does a glacier travel down a mountain?***

1. This could be done as a class demonstration with one mountain. It is effective as a station along with one or more of the other activities, again requiring one mountain. There may be toy or model mountains available in your area or through science catalogs. They are usually difficult to find and rather pricey. Another option is to make one out of papier mache. The advantage with a homemade mountain is the ability to create the formations on the mountain that you wish to emphasize. If the class is studying land formations, even in earlier units, groups could make the papier mache mountains and use them for this activity. The mountain needs to be tall enough to allow the glaciers to demonstrate their natural movement. For the purpose of developing this lesson, the mountain was approximately 18” tall and had a base of about 2’. It worked well since this allowed several different slopes for experimenting.
2. Each group testing on the mountain needs a set of 2 goo samples: one refrigerated and one room temperature. The refrigerated goo will most resemble the behavior of temperate glaciers (speeded up considerably!).

Activity: ***How does temperature affect the speed of a glacier?***

1. Two sets of glacier goo are needed for each group testing: refrigerated and room temperature.

2. 4” PVC pipe is inexpensive and available at any local hardware store. Ask to have the pipe cut in half lengthwise. This does not have to be exact, it can be cut “freehand.” Many places will do this free of charge for a school project. A one-foot length of pipe works fine. Cut in half, you have the two pieces needed for comparison.
3. A range of time from 5 to 10 minutes will render results for comparison.

Activity: ***What are the characteristics of Glacier Goo at different temperatures?***

1. Three different colors and temperatures of goo are needed for this activity. Besides the refrigerated and room temperature samples, also provide one that is nearly frozen.
2. Have the students take the temperature of each sample before starting any other exploring.
3. Be sure to conduct any tests on the samples that intend to show effects dependent on temperature before any other activities. The kids love to handle and manipulate this stuff. The temperature differences will be lost relatively quickly as it is held.

Additional notes:

1. Another good lesson to go along with these hands-on activities is to teach the parts of glacier. This would give the students the vocabulary to use while doing the other activities. See the web references for a good site to get both a graphic and the vocabulary.
2. Finding the rate of flow in the pipe activity is difficult since the number is so small. Help the students realize that the rate must be less than 1cm per second. If they realize that in just one minute at 1cm per second it would travel 60cm, they will see how impossible that is. They have to be careful which number they use as the divisor!

Web references:

http://nsidc.org/glaciers/
http://www.asf.alaska.edu:2222/anatomy/anatomy_begin.html (good graphic to use in teaching the parts of a glacier)
http://www.pbs.org/wgbh/nova/everest/earth/glacier.html
http://www.pbs.org/edens/patagonia/tglacier.htm (a lesson on making a glacier)
http://www.glacier.rice.edu/land/5_whatisaglacier.html
http://www.glacier.rice.edu/land/5_icemovement.html
http://www.glacier.rice.edu/land/5_glaciersandtheir2.html#anchor88262