

Glaciology Resources

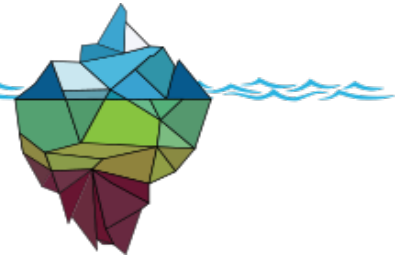
Thank you for taking interest in our series of glaciology resources titled “The Power of Ice”.

This resource pack was developed in partnership with Prof. Doug Benn of the School of Geography and Sustainable Development, University of St Andrews.

These resources were made as part of the NERC-NSF research projects: Calving Laws for Ice Sheet Models (CALISMO) and Disintegration of Marine Ice Sheets: Novel Optimized Simulations (DOMINOS) – International Thwaites Glacier Collaboration.

Special thanks is also due to Robert Jones and Bethany Hudd who wrote all materials. The development of this resource would not have been possible without the generous support of the GeoBus sponsors, which we gratefully acknowledge.





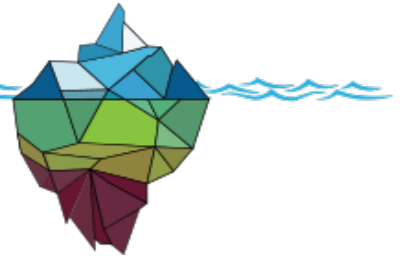
Glacier Dynamics – Glacier Goo Teacher Notes

<i>Activity Title:</i>	Glacier Dynamics; Glacier Goo.
<i>Target Age Group:</i>	Scottish S1 – S4 (approximately 12 – 16 years).
<i>Preparation:</i>	Collect materials, download associated PowerPoint.
<i>Activity Description:</i>	The focus of this activity is to identify and observe the different mechanisms of flow and the rates of flow associated with each of these.
<i>Time:</i>	10-15mins introduction/preparation, 25mins activity, 10mins reflection. Total: 45 - 50mins.
<i>Learning Outcomes:</i>	<ul style="list-style-type: none">- Understand the different mechanisms of glacier flow.- Understand the different rates of flow associated with each mechanism.- Think critically to predict the order of flow speeds.- Observe evidence of the differences in flow type and speed through a 'glacier goo' activity.
<i>Group Size:</i>	This activity may be done as a whole class or in small groups – groups of around 4 usually work best

BACKGROUND

How fast or slow a glacier moves largely depends on the bed that it is flowing over. This exercise tests different bed conditions – rough, smooth, wet, steep and shallow – and compares how a glacier flows. Using different colours of goo shows the frictional effects the surrounding bed has on the glacier, causing the inner-ice region to flow faster than the ice touching the valley sides.





INGREDIENTS

Bed Materials:

- **5 smooth "beds"** that the glacier can flow over, to simulate a valley. Gutter pipe works best, but something flat like a baking tray also works.
- **Sand Paper** (to simulate a rough bed)
- **Water** (to simulate a wet bed)
- **Stopwatch**

Goo Materials:

- **480ml White Glue**
- **2 heaped teaspoons of Borax powder** (a detergent powder, can be purchased on Amazon if not in homeware store)
- **Mixing Bowl**
- **Measuring Jug**
- **Spoon**
- **Two trays**
- **Blue Food Colouring**

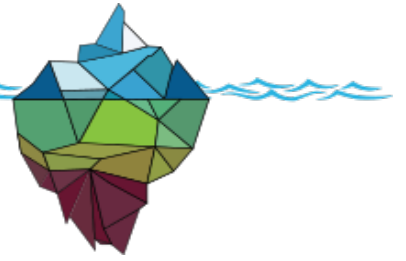
You can either use the quantities above to make one large batch of a single colour or divide the ingredients in half to make 2 colours (ideally you want 2 colours e.g. one white and one blue to highlight velocity profiles of glacial movement more easily).

METHOD

To make the white batch of goo:

1. Empty 240ml of White Glue into a Mixing Bowl
2. Measure 120ml of warm water in a jug and add 1 heaped teaspoon of Borax to the water. Mix thoroughly (it is ok if there is some residual powder left over)
3. Add the Borax solution to the glue bit by bit, mixing the glue as it is added (you should begin to feel long strands of molecules start to be formed)
4. Ditch the spoon and use your hands to mix whilst you continue to add the Borax solution until the goo feels like putty (you should be able to roll it on the table like dough)
5. Add more warm water or borax solution as required if it is not the correct consistency





To make the blue batch of goo:

1. Add ~10 drops of food colouring to the glue mixture before adding the Borax solution and continue as above.

Once both batches of goo are made, combine them by folding the large pieces together until you get swirls of blue and white goo.



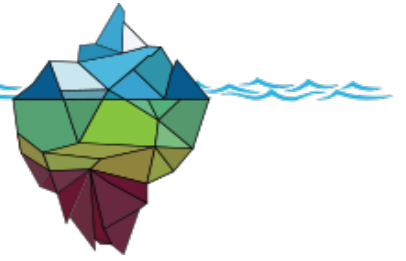
ACTIVITY

Once done, set up the five stations (representing the five mechanisms of glacier flow) as follows:

1. To simulate a 'rough' bed, take 1 piece of drainage pipe and some sandpaper and line (+ secure) the sandpaper down the length of the pipe.
2. To create a 'smooth' bed, simply take a piece of drainage pipe and leave it as it is.
3. For the 'steep bed', the same procedure should be followed, although this time the drainage pipe should be positioned at a relatively steep angle.
4. The 'shallow' bed condition also requires some plain drainage pipe but this time the angle should be much less steep.
5. To simulate a wet bed, take one piece of drainage pipe and line it with water or oil.

When all the stations have been set up, the students should briefly discuss and note down which bed they expect the goo to flow fastest on, and which they expect to be the slowest.





Then, to run the experiment:

1. Place the goo at the top of each bit of drainage pipe (hold in position so the whole mass does not move, and rather, the goo stretches (as a glacier would)).
2. Observe and record the time it takes for the goo to get to the bottom under each basal condition.

Once completed for all 5 conditions, the results should be discussed in terms of frictional effects (refer back to slides).



Glacier goo, with lines of food colouring, flowing over a smooth bed.



Glacier goo flowing over the rough sandpaper.

VARIATIONS

Instead of using two layers of goo, small flags (made from cocktail sticks and pieces of paper) can be stuck into the goo in a straight line. They will show the movement of the goo and where it is flowing fast or slow.

A line of food colouring can also be drawn onto the goo at the beginning of the experiment with a paintbrush (see pictures above) to show the flow movement.

A time-lapse video is useful to review the process – have one pupil from each group use their phone to do this.



