GLACIERS AND FEEDBACK (Part I)

GRADE Grade 8

PART 1 of 3

TOPICS Climate change, glaciers, water cycle

CURRICULAR CONNECTIONS

Grade 8 Science

Unit E – Freshwater and Saltwater Systems

2. Investigate and interpret linkages among landforms, water and climate
   - Identify evidence of glacial action, and analyze factors affecting the growth and attrition of glaciers and polar ice caps
4. Analyze human impacts on aquatic systems; and identify the roles of science and technology in addressing related questions, problems and issues
   - Illustrate the role of scientific research in monitoring environments and supporting development of appropriate environmental technologies
   - Provide examples of problems that cannot be solved using scientific and technological knowledge alone

KEEP WATCHING

National Geographic has produced a series of educational resources called about climate change called *Climate 101*. These resources include a video about the different types of glaciers and the way they form (Run Time – 4:06), available at bit.ly/2JmeoQ9 or by searching for *"National Geographic Climate 101 Glaciers."*

OVERVIEW

In this introductory lesson on glaciers, students will learn about how glaciers form and transform over time through a number of hands-on activities. Students will also gain an appreciation for the diverse and important roles that glaciers play in the lives of people around the world, including residents and visitors to the Bow Valley.

OBJECTIVES

- Students will understand how glaciers are formed
- Students will understand the important environmental, sociocultural and economic role of glaciers for different communities

KEY TERMS

- **Alpine glacier** – a glacier that is formed among mountains and moves slowly downwards through valleys
- **Firn** – granular snow, especially on the upper part of a glacier, where it has not yet been compressed into ice
- **Ice sheet** – permanent layer of ice covering a broad expanse of land (greater than 50 000 km^2)

GUIDING QUESTIONS

- How does snow change over time to form glaciers?
- Why are glaciers important to residents of and visitors to the Bow Valley?

BACKGROUND ESSAY

Glaciers are formed over hundreds or thousands of years when more snow accumulates in the winter than melts in the summer. Each year, additional layers of snow bury and compress the previous layers. Over time, light snowflakes are transformed into round ice pellets that resemble sugar. As the weight of the additional snow continues to compress the underlying ice pellets, pockets of air are squeezed out and the ice increases in density. The snowpack needs to grow to about 50 metres thick before these ice pellets – called **firn** – are fused into a solid mass of ice. For most glaciers, the process of formation takes more than one hundred years. Whether a glacier retreats or advances depends upon the amount of snow accumulation, evaporation or melt.

When enough snow and ice accumulate, gravity and the weight of the glacier are enough to cause it to flow very slowly downhill. Sometimes a glacier slides over a thin layer of water between the base of the glacier and the rock that lies beneath it. This thin layer of water may be the result of pressure from the weight of the glacier ice or from water that makes its way through cracks in the ice. This water layer makes it easier for the glacier to move across the land, much like a slow moving river. While it might not be apparent to the naked eye, glaciers are incredibly dynamic and are constantly changing.

There are two types of glaciers: **alpine glaciers** and **ice sheets**. Alpine glaciers form on mountainsides and are very slowly pulled down valleys by the force of gravity. Ice sheets on the other hand are not limited to mountainous areas and exceed 50 000 km^2. They form broad domes and travel outward from their centres.

DURATION 15-20 minutes

MATERIALS

- Large marshmallows
- Jar
- Cardboard disc to fit inside jar
- Small weights

ACTIVITY – GLACIAL PRESSURE

In this simulation of glacial formation, students will recreate the formation of a glacier using marshmallows and weights.

1. Place 5 or 6 large marshmallows inside a jar. Place a cardboard disc of slightly smaller diameter than the jar on top of the marshmallows.

2. Place a weight on top of the disc and observe what happens to the marshmallows. Incrementally add additional weight and observe the effects.

3. Discuss with the students what happened when weight was added to the marshmallows. Some prompting questions to consider:
   - Is there evidence that the marshmallows spread outward?
   - Is there evidence that the marshmallows adhere to one another when they are compressed? How does this compare to snow?
   - What would have happened if the sides of the jar were not there to contain the marshmallows?
   - If the marshmallows were snow, what form would they have assumed as a result of the pressure that was applied to them?
   - Does this experiment more closely resemble the formation of an alpine glacier or an ice sheet? Why?
   - What forces cause a glacier to move? (gravity, mass)

This activity has been adapted from "Glacial Pressure" from TeacherVision. View the original lesson plan at www.teachervision.com/science/glacial-pressure.

KEEP READING

For a map of the distribution of Canada's glaciers, visit bit.ly/2WOZAlg or by searching for *"NRCAN Distribution of Freshwater – Glaciers and Icefields."*

BACKGROUND ESSAY

Outside of the massive ice sheets in Greenland and Antarctica, Canada has more glacial cover than any other nation on Earth. Glaciers cover an estimated 2% of Canada's landmass. About a quarter of these glaciers are located in mountainous areas in Western Canada.

So why are alpine glaciers important to people? Around the world, an estimated 1.9 billion people live downstream of mountain glaciers and rely on them for freshwater resources. For this reason, mountains are sometimes called the "water towers of the world." Glacial meltwater and runoff contribute to water flow downstream, thus affecting the availability of freshwater resources for ecosystems, human consumption, crop irrigation and hydropower generation. Glacial

meltwater acts as a buffer in dry, hot years when there is not a lot of snowfall or rainfall. Glaciers essentially work like a bank account for downstream areas during hot summers when water is scarce.

In addition to the freshwater resources that glaciers provide to downstream users and ecosystems, glaciers in Western Canada are also important for social and cultural reasons. Glaciated mountains have long attracted mountaineers and tourists from all over the world and continue to do so today. Many of the first Europeans to visit the Bow Valley did so in pursuit of mountain climbing, an endeavour that frequently required crossing glaciers. Every year hundreds of thousands of people flock to the Icefields Parkway in Banff and Jasper National Parks to gaze upon the glaciated peaks that line the highway.

DURATION 30-45 minutes

MATERIALS

- Snow shovel, preferably with a flat blade
- Magnifying glass
- Black laminated index card

ACTIVITY – SNOWPACK ANALYSIS

While the formation of glaciers takes place over many years, students can investigate how snow changes shape, texture and density over a shorter time scale by looking at a snow profile. A snowpack is made up of different layers that are created each time it snows. The layers are impacted by the weather, changes in pressure and temperature. These are the same processes that create glaciers, albeit over a longer period of time and at a much larger scale.

1. Dig a pit in the snow that extends to the ground. The pit should be dug so that the wall that you will be investigating is as near to vertical as possible (Figure 1). Make predictions about how the grains of snow might differ in shape or texture through the snowpack. How does the density of the snowpack change as you get closer to the ground? Test density by making a fist and trying to gently push it into the wall of the pit. If you are unable to penetrate the wall with a fist, try pushing four gloved fingers straight in, followed by one finger, the sharp end of a pencil, and finally a sharp blade such as the edge of a shovel or index card.

2. Ask students to view the snow grains under a magnifying glass by placing some of the grains onto a black laminated card. *Avoid touching the grains with bare skin as body heat may transform or melt the grains.*

3. Have students sketch the different snow grains that they have seen. How do the grains on the surface compare to those in the middle or close to the ground? What comparisons can be drawn between the snow pit and the transformation that snow in a glacier undergoes over time? How do they differ from one another?

4. Ask students to visualize filling a container with the different snow grains that they have observed. Which would have more air between the grains?

KEEP READING

There are many fantastic resources for studying features of the snowpack like snow grain metamorphism, grain form and snowpack density (also called snow hardness) that have been developed by avalanche forecasters. Understanding the water that is bound up in snowpack is a great way to teach about future water supplies, natural resource issues and climate change.

The National Snow & Ice Data Center is a great place to start learning more about the characteristics of snow and ice. Resources are available at nsidc.org/cryosphere/snow.

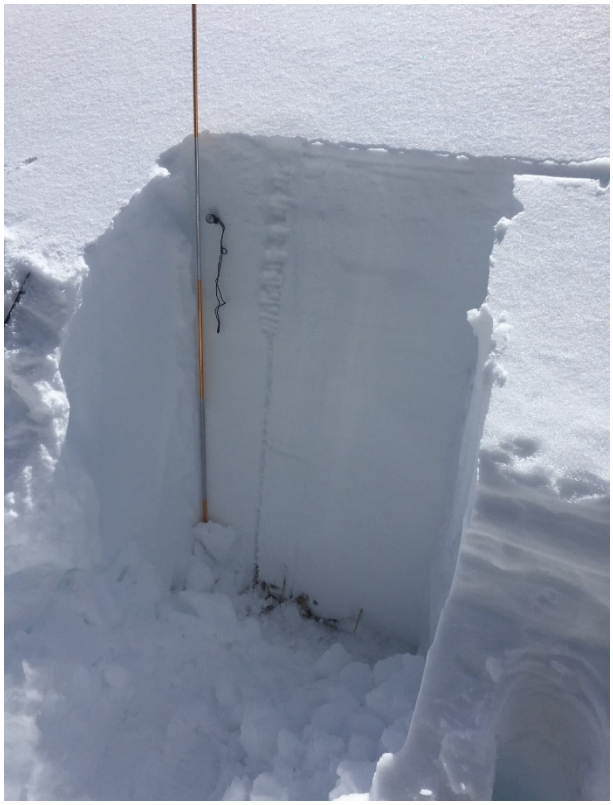

Figure 1: Snow pit (Source - Bridgeport Avalanche Center)

REFERENCES

Jurt, C., Brugger, J., Dunbar, K. W., Milch, K., & Orlove, B. (2015). *Cultural values of glaciers.* (pp. 90-106) Cambridge University Press.

National Snow & Ice Data Center. (2020). *All About Glaciers.* Accessed 28 March 2020. nsidc.org/cryosphere/glaciers.