

As Cold as Ice

Glacial Theory

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Grade Level	6th – 8th Grade	**Time Frame**	3-4 class period(s)
		Duration	160 minutes

Essential Question

Overarching: What is the Nature of Science? Secondary: How can scientists use evidence to form plausible scientific theories and how do those theories change over time?

Summary

Students will examine evidence for glacial theory and other competing theories of the early 1800s. Students will read field journal excerpts from geologists as well as analyze the data collected from early Alpine expeditions.

Snapshot

Engage

Students are given a scenario in which they have to make inferences from the evidence at hand and propose plausible theories using the Claims, Evidence, Reasoning (CER) model to explain what occurred.

Explore

Students participate in a simulation showing glacial movement and its results. Students view a real glacier flow time-lapse video over a 5-year period.

Explain

Students create a T-Chart explaining the similarities and the differences in their glacier model and real glacier movements. Students examine the evidence for modern day Glacial Theory.

Extend

Students investigate original glacial evidence from the 1830's. Students "travel" along with Louis Agassiz on one of his field expeditions into the Alps. Students play the role of William Buckland, a Geologist in the early 1800's, who was unsure about glacial theory. Students analyze the competing theories (glacial theory, diluvial theory, and drift theory) and test them against the available evidence at hand.

Evaluate

Students write a speech to the British Association for the Advancement of Science to explain why they either support or reject Glacial Theory and cite the evidence for or against the theory.

Standards

Next Generation Science Standards (Grades 6, 7, 8)

MS-ESS2-1: Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.
MS-ESS2-2: Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

Oklahoma Academic Standards (6th Grade)

6.LS1.3 : Use an argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
6.LS1.8 : Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

Attachments

- 1838 Alpine Expedition Log—As Cold as Ice - Spanish.docx
- 1838 Alpine Expedition Log—As Cold as Ice - Spanish.pdf
- 1838 Alpine Expedition Log—As Cold as Ice.docx
- 1838 Alpine Expedition Log—As Cold as Ice.pdf
- Agassiz Buckland Bios—As Cold as Ice - Spanish.docx
- Agassiz Buckland Bios—As Cold as Ice - Spanish.pdf
- Agassiz Buckland Bios—As Cold as Ice.docx
- Agassiz Buckland Bios—As Cold as Ice.pdf
- Alpine Expedition Map—As Cold as Ice - Spanish.docx
- Alpine Expedition Map—As Cold as Ice - Spanish.pdf
- Alpine Expedition Map—As Cold as Ice.docx
- Alpine Expedition Map—As Cold as Ice.pdf
- Diluvial Drift Theory Teacher Handout—As Cold as Ice - Spanish.docx
- Diluvial Drift Theory Teacher Handout—As Cold as Ice - Spanish.pdf
- Diluvial Drift Theory Teacher Handout—As Cold as Ice.docx
- Diluvial Drift Theory Teacher Handout—As Cold as Ice.pdf
- Footprints Tricky Tracks Data Sheet—As Cold as Ice - Spanish.docx
- Footprints Tricky Tracks Data Sheet—As Cold as Ice - Spanish.pdf
- Footprints Tricky Tracks Data Sheet—As Cold as Ice.docx
- Footprints Tricky Tracks Data Sheet—As Cold as Ice.pdf
- GAK Recipe—As Cold as Ice - Spanish.docx
- GAK Recipe—As Cold as Ice - Spanish.pdf
- GAK Recipe—As Cold as Ice.docx
- GAK Recipe—As Cold as Ice.pdf
- Glacier Data Sheet—As Cold as Ice - Spanish.docx
- Glacier Data Sheet—As Cold as Ice - Spanish.pdf
- Glacier Data Sheet—As Cold as Ice.docx
- Glacier Data Sheet—As Cold as Ice.pdf
- Speech Argumentative Essay Rubric—As Cold as Ice - Spanish.docx
- Speech Argumentative Essay Rubric—As Cold as Ice - Spanish.pdf
- Speech Argumentative Essay Rubric—As Cold as Ice.docx
- Speech Argumentative Essay Rubric—As Cold as Ice.pdf
- Study Site A—As Cold as Ice.pdf
- Study Site B—As Cold as Ice.pdf
- Study Site C—As Cold as Ice.pdf
- Study Site D—As Cold as Ice.pdf
- THE CASE OF THE MISSING MEATBALL—As Cold as Ice - Spanish.docx

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- THE CASE OF THE MISSING MEATBALL—As Cold as Ice.docx
- THE CASE OF THE MISSING MEATBALL—As Cold as Ice.pdf
- Tricky Tracks Handout Version—As Cold as Ice - Spanish.docx
- Tricky Tracks Handout Version—As Cold as Ice - Spanish.pdf
- Tricky Tracks Handout Version—As Cold as Ice.docx
- Tricky Tracks Handout Version—As Cold as Ice.pdf
- Tricky Tracks Slides—As Cold as Ice.pptx

Materials

- Tricky Tracks Slides
- Case of the Missing Meatball handout (one per student)
- Fossil Footprints handout (one per student or class set)
- GAK (Follow attached instructions for making GAK, makes 3 cups) (1/2 cup – cup per group)
- Paper towel tubes (one per group or one per class if done as demo)
- Foil (to line tubes, one per group)
- Small gravel (aquarium gravel works well, about 10-20 pieces of gravel per group)
- Food coloring (enough to dye GAK)
- Black marker (one per group)
- (optional) iPad or other tablet with time-lapse app
- Speech/Essay Rubric (1 per student)

Engage

Give students the **Case of the Missing Meatball** handout and have them write a Claim, Evidence, Reasoning (CER) statement for the scenario.

Teacher's Note

This is an optional guided activity to introduce the students to the idea of observation and inference. This can be used to refer back to through the lesson if needed.

Tell students you are going to show them a series of pictures that tell a story. Explain that they will be making some observations about the pictures and using their observations to make some inferences. Show students the first panel of the footprints (use either the **Tricky Track slides** or **Tricky Tracks** student handouts). Have the students write down some observations.

Sample Student Responses

- One looks like it's going faster.
- They are moving closer together.

Show students the second panel of the footprints picture. Allow students time to record their observations.

Sample Student Responses

- The creatures are interacting with each other.

Show students the third panel and completed picture with all three panels.Have the students record their observations

Sample Student Responses

- Only one set of footprints remain.

Now ask students to talk with an Elbow Partner to discuss what possible scenarios could account for their observations. Have students write a CER statement for the scenario they think is most likely to have occurred. The students DO NOT have to have the same scenario as other students; there are multiple scenarios that can explain the footprints.

Sample Student Responses

- Claim 1: Two creatures got into a fight. One ate the other and left.
- Claim 2: The creatures came at different times to a waterhole to get a drink. One was a bird and flew away.

Explore

Assign students into groups of 2-4 depending on your available materials. Prepare the GAK ahead of time according to the attached instructions. (Option: If possible students can make the GAK themselves as part of the lesson.)

Teacher's Note

This simulation can be done in each group or as a class demonstration depending on your classroom needs.

Cut the paper towel tube in half lengthwise so that you have two "open channels." These will serve as our valley for our glaciers to travel down.



Paper Towel Tube Valley

Cover the channels with foil; this will keep the GAK from sticking to the valley. (Note: As a differentiation you can have groups create obstacles with balls of tape stuck to the cardboard. These would simulate rock and boulder outcroppings.)



Foil Wrapped Paper Towel Tube Valley

Have the students use a marker to draw lines in the bottom of the valley. The marks should be about 1-2 cm apart. These marks will help the students to measure and detect the movement of their GAK glacier.



1cm Marks in Valley Trough

Use books or a cardboard box to prop up one end of the "valley" so that it will have a gentle slope. (Note: As a differentiation you could have different groups experiment to see how the angle of the slope affects the flow rate of the GAK glacier.) Have each group take equal amounts of the two different colors of GAK and layer like a stack of coins.



GAK Glacier Layers

Have students put about 10-15 pieces of aquarium gravel in their GAK glacier, these will represent boulders that get moved hundreds of miles by glacial flows. Tell students they will place their layered GAK at the top of the valley, "open channel".

Make sure they note the time or use a stopwatch to record how long the glacier takes to flow. Once they have noted the time they can release their GAK glacier and watch it flow. (Note: Depending on the consistency of the GAK, room temperature, slope of the valley, etc. this could take 30-45 minutes to occur.)

Optional Technology Integration

If the technology is available you can also use a camera, smartphone, or tablet with an app similar to Lapseit™ to make a time-lapse video of the glacier movement. Two sample time-lapse videos are included with the lesson.

When the students have completed the simulation have them record the time it took the glacier to reach the bottom of the valley. Instruct students to calculate the flow rate or speed by dividing the distance it traveled (the length of the valley) by the time it took to reach the bottom.

Example:

- Distance = 30cm
- Time = 45 min 25 sec (2725 seconds)
- Flow rate(Speed) = 30cm/2725 secFlow rate(Speed)= 0.011cm/sec or 0.011 centimeters per second

Point out to students that this is extremely slow. Ask them if they would have been able to notice a difference in their glacier if they only looked at it two times about 10 seconds apart, and if they only looked at it in the beginning and the end. Show students one of these clips showing real glaciers flowing. Tell students that this time-lapse video was created over a 5 year period.

Explain

Instruct students to create a T-Chart for the similarities and differences between the simulation and the real glacial flow.

Similarities	Differences
Both took a long time to flow. Both had striations in the glacier. Both moved rocks, gravel and boulders.	The real glacier took a lot longer to flow. The real glacier is more solid than our Gak glacier.

Sample T-Chart

Have students share their responses in a class discussion. As they share begin to point out common features of glaciers that relate to their observations. You can do this by asking leading questions about their observation. You can also create a word list or word wall for the terms related to glaciers. As you discuss, point out the key terms and have the students write their own definition for each term in their science journal.

Glaciers move large boulders, rocks, and gravel, what would all this rock material do to the valley surface underneath the glacier?

Sample Student Responses

Scratch the ground and rocks underneath it. These scratches are called abrasion.

What will happen over a long period of time if the glacier continues to scratch the ground?

Sample Student Responses

It will grind or carve the valley down deeper.

Teacher's Note

Explain to students that as glaciers do this they leave behind a typical "U" shape valley. This shape is called the Glacial Trough.

The glaciers moved very slowly, what is causing them to move at all?

Sample Student Responses

Gravity is pulling them down the valley slope.

What caused the striations (stripes) in the glacier?

Sample Student Responses

The different layers ran down the valley creating the stripes/striations.

What do you think the different layers of GAK represented on a real glacier?

Sample Student Responses

Different layers of ice.

What would happen to all of the material the glacier moved down the valley? Where will it end up?

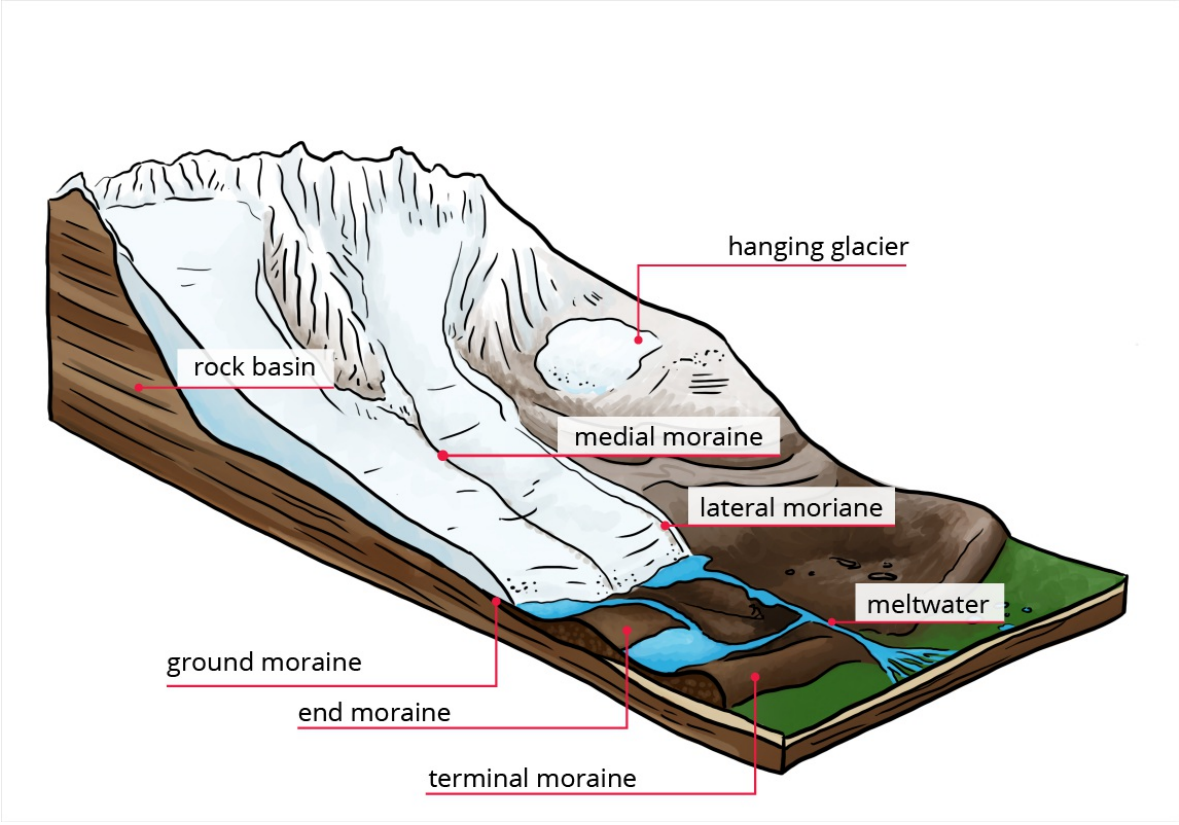
Sample Student Responses

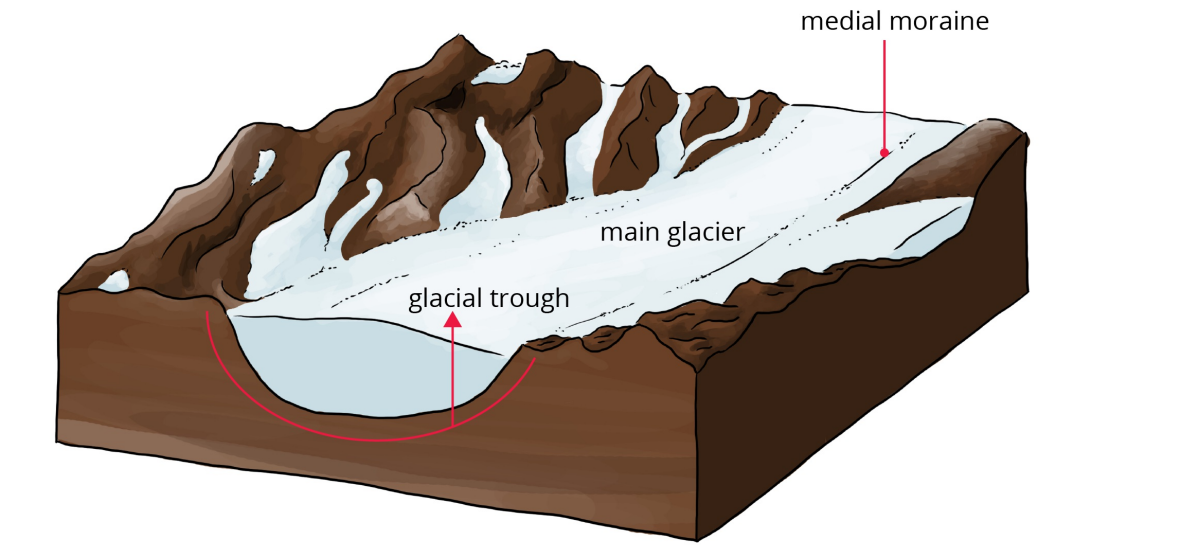
At the end or bottom of the valley

Teacher's Note

This earthen material, rocks, gravel, dirt and boulders, which is left at the bottom and sides of the valley, is called moraine (earthen material) and has a different name depending on its location terminal moraine, end moraine, and lateral moraine.

At this point show the students a diagram of a glacier and a glacial valley. Make sure to identify the features of the glacier and the key features it leaves behind in the valley.





Glacier Diagram 2

The key features to point out include:

- Moraine Types
- Lateral moraine
- End moraine
- Medial moraine
- Ground Moraine
- Glacial Trough

Extend

Place students in groups of 2-4. Explain that they will be looking at original evidence and field journal notes from Louis Agassiz and William Buckland from their expeditions into the Alps, Scotland, and England in the early to mid 1800s. They will be walking in the shoes of the scientist explorers who began to piece together the evidence for glacial theory.

Explain to students the two theories (diluvial theory and drift theory) that were most prevalent at the time and were later displaced due to the mounting evidence and support for glacial theory.

Teacher's Note

Teacher Handouts are attached giving a brief description of diluvial and drift theory.

Give students copies of the attached **Agassiz and Buckland Biographies**. Have them read the bios using an analytical reading strategy such as thinking notes or Why-Lighting. Once they have read the bios lead a discussion about the two men and the timeframe (use the background information about diluvial and drift theory to assist). This discussion will set the stage for the significance of their historical expedition.

Tell students that they are going to go on an expedition into the Alps with Louis Agassiz and play the part of William Buckland who is skeptical of Agassiz's Glacier theory. Hand out the attached **Alpine Expedition Map** and explain to students they will be visiting the same sites Agassiz and Buckland visited in 1838.

Inform them that as they visit each site they will be presented with evidence. Explain that they must document, write down, their observations in the attached **1838 Expedition Log** handout.

Teacher's Note

Included with the lesson are 4 sets of site evidence (SITE A, B, C, D). Each set includes original sketches from Agassiz's expedition as well as some modern day pictures. You can have each site be a station that a group will rotate through and "visit" or you can give each group all 4 site sets at once.

Have students make inferences from their observations.

Observations Should include:

- Scratches in the rocks
- Polished surfaces
- Soil and gravel piles (moraines)

Sample Inference:

- Glaciers carrying boulders and gravel scratched the surface of the rocks.

Evaluate

Inform students they will be writing a speech/argumentative essay addressed to the British Association for the Advancement of Science of the early 1800s much like William Buckland did in support of Glacial theory.

Teacher's Note

In November of 1840, William Buckland, who had previously been a strong supporter of the Diluvial Theory and opponent of Glacial Theory, presented a paper outlining his support for glacial theory. After direct fieldwork with Louis Agassiz in the Alps he started to revise his ideas and eventually shifted his support from Diluvial Theory to Glacial Theory.

Have students write an argumentative essay/speech in support of glacial theory. Tell them to be sure to use evidence from the text in support of their claims. Give students a copy of the rubric and explain to them what you will be looking for in the speech/essay.

Teacher's Note

This could be done in partnership with your English teacher at your school.

Possible Differentiations

Give students only one study site or provide observations and inferences for students ahead of time. Provide a vocabulary list for students to use in their observations and inferences as well as their speech.

Resources

- K20 Center. (n.d.). Claim, Evidence, Reasoning (CER). Strategies. https://learn.k20center.ou.edu/strategy/156
- K20 Center. (n.d.). Elbow Partners. Strategies. https://learn.k20center.ou.edu/strategy/116
- K20 Center. (n.d.). T-Chart. Strategies. https://learn.k20center.ou.edu/strategy/86
- K20 Center. (n.d.). Why-Lighting. Strategies. https://learn.k20center.ou.edu/strategy/128
- University of Oklahoma History of Science Collection