

FINDING PERMAFROST

Overview:

Students will become familiar with four of the ways permafrost is observed: surface observation, aerial view, satellite imagery and underground studies. Students will locate permafrost features in their own community using Google Maps.

Objectives:

The student will:

- identify four methods used to identify areas underlain with permafrost;
- identify four permafrost zones present in Alaska; and
- locate local permafrost features using Google Maps or GoogleEarth.

Targeted Alaska Grade Level Expectations:

Science

- [9] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.
- [10] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring, and communicating.
- [9] SE1.1 The student demonstrates an understanding of how to integrate scientific knowledge and technology to address problems by recognizing that the value of any given technology may be different for different groups of people and at different points in time (e.g., different uses of snow machines in different regions of Alaska).
- [10] SE1.1 The student demonstrates an understanding of how to integrate scientific knowledge and technology to address problems by identifying that progress in science and invention is highly interrelated to what else is happening in society.

Vocabulary:

continuous permafrost – geographic areas in which permafrost occurs everywhere beneath the exposed land surface; mean annual soil surface temperatures are typically below -5° Celsius

borehole – a hole that is drilled into the earth for exploratory purposes or to extract a core; a permafrost borehole is dug into frozen soil to monitor temperatures at different depths

discontinuous permafrost – permafrost occurring in some areas beneath the exposed land surface throughout a geographic region where other areas are free of permafrost; a geographic area in which 50-90 percent of land is underlain with permafrost

drunken forest – trees leaning in random directions caused by thawing permafrost

frost tube – device for measuring the depth of freeze or thaw

GoogleEarth – a virtual-globe program that shows Earth by the superimposition of images obtained from satellite imagery, aerial photography and GIS over a 3-D globe

ice wedge polygons – polygonal-shaped features often delineated with a furrow or crack; the result of ice wedges; vegetation is frequently concentrated in the furrow and helps emphasize the pattern

pingo – a perennial frost mound consisting of a core of massive ice with soil and vegetation cover

satellite – an object launched to orbit Earth or another celestial body; used for research, communications, weather information, and navigation

sporadic permafrost – a geographic region in which some areas have permafrost and some do not; a geographic area in which 10-50 percent of land is underlain with permafrost

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thermokarst – a geographic area characterized by an irregular land surface, with bogs, pits, and other depressions, formed as ice-rich permafrost thaws

Whole Picture:

Determining the location and extent of permafrost can be difficult, especially in areas with heavy vegetation growth. A deep active layer can mask underlying frozen ground. Scientists have been mapping permafrost since the mid-20th century. In the Northern Hemisphere, most permafrost occurs between the latitudes of 60° N and 68° N, because the greatest amount of land area is there.

From the National Snow and Ice Data Center: “Determining the location and extent of permafrost is often difficult. The historical approach has been to assume that ground temperature equals the overlying air temperature, but ground and air temperatures usually differ. Even in areas where the mean annual air temperature is below freezing, permafrost may not exist. Land under glaciers, rivers, and streams is often free of permafrost, despite freezing air temperatures at the surface” (Williams and Smith, 1989).

“Proximity to large water bodies tends to reduce temperature extremes, which affects the distribution of permafrost. Scandinavia and Iceland, for instance, have relatively little permafrost (Williams and Smith, 1989). Snow cover can play a varying role in the formation or survival of permafrost. In areas of continuous permafrost, seasonal snow cover can lead to warmer ground temperatures, while in areas of discontinuous or sporadic permafrost, the absence of snow cover can contribute to permafrost formation” (Zhang, 2005).

Language Links:

The local dialect for these words may differ from the examples provided. Share the words with students to build fluency in local terms related to weather. Include local words in songs, stories and games when possible.

English	Gwich'in	Denaakk'e	Lower Tanana	Deg Xinag	Your Language
Water	Chuu	Too	Tu	Te	
Melt/ It's melting	Naaghwan/ neeyahkwaii	Ghaan	Nghan	Ntidlighanh	
Freeze/ It's freezing	Datan	Ggaats	Ethdetenh		
Ice	Łuu	Ten	Tenh	Tinh	

Materials:

- Access to the Internet on student computers
- MULTIMEDIA: “Permafrost or No Permafrost, That is the Question” on the UNITE US website (uniteusforclimate.org)
- STUDENT WORKSHEET: “Take Note”
- STUDENT WORKSHEET: “In My Own Back Yard”
- STUDENT WORKSHEET: “Show What You Know”
- STUDENT WORKSHEET: “The Ground Was Frozen Then”
- SUPPLEMENTAL STUDENT WORKSHEET: “Put it to Rhyme”

Activity Preparation:

1. Review MULTIMEDIA: “Permafrost or No Permafrost, That is the Question” on the UNITE US website (uniteusforclimate.org) and bookmark as necessary.
2. Review STUDENT WORKSHEET: “In My Own Back Yard” to become familiar with Google Maps and the steps students will take to access the information. Bookmark sites as necessary.



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Activity Procedure:

1. Hand out STUDENT WORKSHEET: "Take Note," and explain students will be accessing a multimedia tutorial about where permafrost is found. Scientists have mapped the locations of permafrost globally, though most permafrost is in the Arctic. Scientists locate permafrost in many different ways. Ask students to access MULTIMEDIA: "Permafrost or No Permafrost, That is the Question" on the UNITE US website (uniteusforclimate.org). Ask students to take notes throughout the activity and complete the extension questions.
2. Hand out STUDENT WORKSHEET: "In My Own Back Yard." Ask students to access Google Maps on the Internet. Student will be looking up their own community using the Satellite view in Google Maps. (Students can also complete the activity using GoogleEarth, if it is available.) Work through steps 1 through 4 together to ensure students are able to access the imagery needed. Ask students to complete the remainder of the worksheet.
3. As a class, review information from the multimedia and from Google Maps. Use the following questions as prompts, if needed:
 - a. If permafrost is completely underground, how can it be detected from the air?
 - b. What are clues that an area is underlain with permafrost?
 - c. What part of the state has continuous permafrost?
 - d. What part of the state has discontinuous permafrost? Sporadic?
 - e. What kind of permafrost is in this community?
 - f. Are there areas of the state that are permafrost free? Where?
 - g. What are some ways that scientists study permafrost?
 - h. What are some visible permafrost features in the Arctic?
4. Hand out STUDENT WORKSHEET: "Show What You Know" and ask students to complete.
5. Hand out STUDENT WORKSHEET: "The Ground Was Frozen Then" for students to complete as homework. Remind students of the final project, which requires film clips, and suggest students film interviews with Elders.

Ideas for Filming:

NOTE: Students will complete a short film about permafrost for the final project associated with this UNITE US unit. Each lesson leading to the final project contains ideas about what students might film as they compile clips. Students are not limited to the list and are encouraged to use their imagination and creativity when filming.

-  Access the Climate Change Resources section on the UNITE US website and download clips taken inside the US Army Corp of Engineers Cold Regions Research and Engineering Laboratory Permafrost Tunnel. Narrate over the clips, explaining the kinds of things that can be seen inside the tunnel, then add the clip to personal projects.
-  After completing the lesson, ask students to film peers performing a piece written using SUPPLEMENTAL STUDENT WORKSHEET: "Put it to Rhyme."

Extension Idea(s):

1. Visit the US Army Corp of Engineers Cold Regions Research and Engineering Laboratory Permafrost Tunnel website at <http://permafrosttunnel.crrel.usace.army.mil/>. Research how the tunnel was excavated and how it continues to be preserved with a cooling system.
2. Allow students to access GoogleEarth. Ask them to locate various places around Alaska such as their own community, specific rivers, and visible permafrost features.

Answers:

STUDENT WORKSHEET: Take Note

Answers will vary but should exhibit an effort to note key concepts.

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STUDENT WORKSHEET: In My Own Backyard

- 1– 4. Teacher observation will determine if students are completing tasks.
5. Answers will vary.
6. Answers will vary but will likely indicate thermokarst lakes and/or thermokarst terrain.
7. North Slope (northern part of the state)
8. There are some thermokarst features visible as far as the Alaska Peninsula.
9. The ice-wedge polygons appear to be between 50 feet and 100 feet in width.

STUDENT WORKSHEET: Show What You Know

1. Arctic
2. continuous, discontinuous, sporadic, and isolated
3. Answers will vary but should indicate that building on permafrost without taking precautions will result in permafrost thaw and degradation, damaging the structure.
4. Two of the following: tunnel, borehole, or frost tube. If students give other reasonable answers based on prior knowledge, teacher's discretion determines validity.
5. a. permafrost temperatures at various depths
6. Four of the following: thermokarst terrain, thermokarst lakes, ice-wedge polygons, pingos, drunken forest, buckled roads, damaged buildings, thaw slump, river bank failure, lake bank failure. If students give other reasonable answers based on prior knowledge, teacher's discretion determines validity.
7. Satellite images help scientists see permafrost terrain and monitor changes over time.

STUDENT WORKSHEET: The Ground Was Frozen Then

Answers will vary.

NAME: _____
TAKE NOTE

Directions: Use this sheet to take notes as you view the MULTIMEDIA: "Permafrost or No Permafrost, That is the Question" on the UNITE US website: (uniteusforclimate.org). Write at least one key concept for each of the four headings below then answer the extension question.

Clues on the surface

Extension: What permafrost "clues" have you seen in your community? _____

View from the air

Extension: Have you ever flown over permafrost landforms? What did you see? _____

NAME: _____
TAKE NOTE

As seen from space

Extension: What changes over time would you like to see monitored in your community? _____

Under the ground

Extension: Does your community have a borehole or frost tube, or a permafrost cellar? Describe how it is used.

NAME: _____
IN MY OWN BACK YARD

Directions: Find your community using Google Maps. Locate and describe visible permafrost features.

1. Open Google Maps by entering the following URL (<http://maps.google.com>).
2. In the upper right-hand corner of the map area, find the button labeled Satellite. Click this button.



3. In the search box at the top, enter the name of your city, town or village followed by a comma, then Alaska. (i.e. Fairbanks, Alaska) Press enter or click on Search Maps.
4. Practice moving around the map (see the box to the right) to view the area, then proceed with the worksheet.
5. What is the name of your community?

6. What permafrost features are visible using the satellite view in Google Maps? Circle all that apply. (Note: If you cannot find permafrost features in your community, search for Fairbanks, Minto or Barrow and answer accordingly.)

- | | |
|---------------------|--------------------|
| thermokarst lakes | ice wedge polygons |
| thermokarst terrain | thaw slump |
| river bank failure | lake bank failure |

7. Use the navigation tools to explore other areas of the state. In what area of the state are thermokarst lakes most prevalent?

8. About how far south can you still find thermokarst lakes on the map?

9. Find Deadhorse, Alaska on the map. Zoom in very close and explore until you have found visible ice wedge polygons. Find the scale located at the bottom of the screen and zoom in until it reads 100ft (feet) or 30m (meters). The ice-wedge polygons around Deadhorse are typical of those found on the North Slope. What is the average width of ice-wedge polygons?

Moving Around on the Map

A common way to move is by using the “hand” icon controlled by the mouse. Hold down the button to “grab” the map then move the mouse to move the map. You can also use the navigation controls in the upper left of the map.

Move the zoom slider towards the + sign to zoom in.

To zoom back out move the slider towards the – sign.

If Street View is available in your community, drag the orange person to the street and Google Maps will show you the street view.



Hint: This activity can be even more dynamic using GoogleEarth, if the tool is available.

NAME: _____

SHOW WHAT YOU KNOW

1. Permafrost is found primarily in the _____.
2. The four types of permafrost found in the Arctic are:
 - A. _____
 - B. _____
 - C. _____
 - D. _____
3. Why is it important to know if an area is underlain with permafrost before building a road or a building?

4. Name two ways that scientists study permafrost below the surface.
 - A. _____
 - B. _____
5. Over the course of a year, borehole sensors measure:
 - A. permafrost temperatures at various depths
 - B. the mineral and water content of soil
 - C. volcanic and seismic activity
 - D. the rate of decay of organic material
6. Name four permafrost features you would likely see if you were to fly over the North Slope and Interior of Alaska.
 - A. _____
 - B. _____
 - C. _____
 - D. _____
7. How can satellite images help scientists find and study permafrost? _____

NAME: _____

THE GROUND WAS FROZEN THEN

1. Read the following narrative by Athabascan Elder Robert Charlie:

Our people have always used permafrost for storage of food. The method used was to build a birch bark basket out of the oldest birch tree that had a thick, heavy bark. You pattern it into a 3x4 feet square container, enough to hold food and berries and white fish. Then you dig down to where the ground is frozen, and even a foot into the frozen ground, for storage.

Another significant use of permafrost areas is water. When we were out hunting in higher elevations, where water could be hard to find, we would find a spot where the ground was wet and chop away the tundra to make a hole. Soon you would notice very cold water seep upward from the permafrost.

2. Interview a local Elder or culture bearer in your community about the traditional use of permafrost. Write your questions and their answers below. You might ask questions such as:

What do you remember about the use of frozen ground in the past?

Was frozen ground an important part of traditional ways?

What was permafrost called in our language?

3. Does your community still use ground with permafrost? Explain.
