

Overview:

In this lesson, students explore the active layer above permafrost and investigate various factors on the insulation value of the active layer. (NOTE: This lesson will require more than one class period.)

Objectives:

The student will:

- define conduction;
- identify the control and variable in an experiment; and
- complete an experiment to determine the effects of snow cover, vegetation, and/or soil moisture content on the insulation value of permafrost.

BSSD Standards Addressed:

Science

- SC 03.02 Brainstorms & formulates hypothesis based on questions and investigations.
- SC 03.03 Asks questions about classmates' science work.
- SC 03.05 Follows the procedures of scientific process with guidance.
- SC 03.07 Identifies variables, control groups, reliability, & validity.
- SC 03.09 Records, collects and explains data.
- SC 04.02 Formulates multiple hypothesis based on investigations and questions.
- SC 04.07 Design experiments with a control group and a single variable.
- SC 04.08 Conduct student designed experiments with a control group and a single variable.
- SC 04.09 Records, collects, and analyzes relevant data.

GLEs Addressed:

Science

- [5-8] 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.
- [5] SA1.2 The student demonstrates an understanding of the processes of science by using quantitative and qualitative observations to create inferences and predictions.
- [6] SA1.2 The student demonstrates an understanding of the processes of science by collaborating to design and conduct simple repeatable investigations.
- [7] SA1.2 The student demonstrates an understanding of the processes of science by collaborating to design and conduct simple repeatable investigations, in order to record, analyze (i.e., range, mean, median, mode), interpret data, and present findings.
- [6] SD3.2 The student demonstrates an understanding of cycles influenced by energy from the sun and by Earth's position and motion in our solar system by identifying that energy transfer is affected by surface conditions (e.g., snow cover, asphalt, vegetation) and that this affects weather.
- [6-7] SE2.2 The student demonstrates an understanding that solving problems involves different ways of thinking by comparing the student's work to the work of peers in order to identify multiple paths that can be used to investigate a question or problem.
- [8] SE2.2 The student demonstrates an understanding that solving problems involves different ways of thinking by comparing the student's work to the work of peers in order to identify multiple paths that can be used to investigate and evaluate potential solutions to a question or problem.

Whole Picture:

The active layer is the portion of the ground that freezes every winter and thaws during spring and summer. Places as far south as Texas have active layers in their soil that freeze each winter, but Alaska has a thick active layer that often sits above permafrost. The active layer in Interior Alaska, near Fairbanks for example, can be two-to-five feet thick. That means you might be able to easily dig a four-foot hole in Fairbanks soil in late August, at the time of maximum thawing of the active layer, but in early May, even when air temperatures are above freezing, the active layer is still frozen, and a shovel can't penetrate the frozen ground beyond a few inches. The farther north a person travels, the thinner the active layer is (because permafrost is so close to the surface). On Alaska's North Slope, for example, where the permafrost is up to 2,000-feet deep, summer temperatures are so cool, the soil only thaws one foot down, where permafrost starts.

Scientists measure the active layer with a frost tube, a plastic tube filled with colored liquid and inserted into a drilled hole in the ground. The liquid in the tube freezes along with the cold front of frozen soil in the fall, as cold air temperatures slowly penetrate the ground. With a frost tube, students can check the frozen ground's progress throughout the fall and winter, and its thawing in spring and summer.

Vocabulary:

control – a standard of comparison for checking or verifying the results of an experiment

variable – the part of an experiment that is likely to change

Materials:

- OVERHEAD: "Permafrost Distribution"
- STUDENT WORKSHEET: "Keep It Active"

Other materials will vary based on students' experiment design and are likely to include:

- Heat lamp with bulb
- Disposable (plastic or styrofoam) cups
- Soil
- Thermometers
- Water
- Moss or other vegetation
- Snow or snow substitute

NOTE: Insulating materials used in the student-designed experiment will vary based on students' experimental design and will need to be furnished by the school or furnished by the student.

Activity Procedure:

1. Show the OVERHEAD: "Permafrost Distribution." Explain the image on the bottom is extracted from the satellite image above, with areas of permafrost in blue. Briefly review the difference between continuous and discontinuous permafrost. Ask students why they think one area has permafrost and another does not. Discuss the differences in the areas marked on the photo: vegetation, slope (north or south), snow cover, etc. Ask students what else might be different that they can't see in the picture (*soil moisture content, soil type*). Record students' answers on the board.
2. Remind students there is a layer of soil above permafrost called the active layer, that thaws and freezes; if it warms up enough, permafrost will thaw, but the active layer keeps the permafrost cool enough to stay frozen all year, even through the Arctic summer.
3. Explain the active layer acts as insulation for the permafrost, slowing heat transfer through the soil. Snow cover, vegetation, and soil moisture content all affect the rate heat is transferred through the soil. Divide students into small groups. Instruct each group to choose a factor they would like to investigate.

4. Distribute the STUDENT WORKSHEET: “Keep It Active,” and lead students through the creation of their experiment. Discuss the terms **control** and **variable** (described under Vocabulary, above) and explain how they are related to scientific experimentation.
5. Remind students an experiment is an investigation in which only one variable is changed. Each group should design a controlled experiment with only one variable being tested. Verify groups have designed a valid experiment before distributing materials.
6. After groups have performed their experiment, discuss results. Did one factor appear to have a greater effect on heat transfer than another? If so, which factors? If two groups tested the same factor, how did their results differ? How did their experiment designs differ? How might that have affected their results?

Answers:

- 1-12. Answers will vary.
13. Heat conduction is the transfer of thermal energy, or heat, through a substance.
14. Two of the following: vegetation, snow cover, and/or soil moisture content.
15. Answers will vary but should show understanding of the concept that heat can travel through the active layer to the permafrost and raise the temperature or cause thawing of the permafrost.

Rubric

Lab Report. Use this rubric to assess students’ performance, and/or allow students to assess their own performance completing the a lab report provided on the STUDENT WORKSHEET: “Keep It Active.”

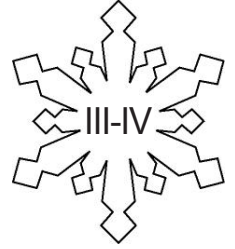
Performance Measure	Self	Teacher
1. My hypothesis makes sense and is related to the background information.		
2. My materials list includes everything needed for the lab and includes quantities for each material.		
3. My procedure is in the correct order and clearly describes what is needed so that I or other students could repeat the lab exactly.		
4. Where appropriate, I have included diagrams in my procedure to help others understand what needs to be done.		
5. My measurements are correct and include the correct units.		
6. My data is placed in a table or chart that is clearly labeled.		
7. My observations include everything I saw, felt, heard, or smelled (no inferences).		
8. My conclusion explains whether or not the hypothesis was proved and how it was supported by the data.		
9. I have explained how I would change the lab to improve the accuracy of my results.		

Name: _____

Keep It Active

Student Worksheet (page 1 of 4)

Levels



Testable Question:

Does snow cover, vegetation, or soil moisture content have an impact on heat transfer through the soil?

Background Information:

Heat conduction is the transfer of thermal energy, or heat, through a substance. Conduction is influenced by the properties of a material. For example, a Styrofoam cup has a slower conduction rate than a plastic cup.

The active layer above permafrost, like all materials, conducts heat. Heat is typically conducted from the air through the soil. However, sometimes buildings that are erected directly on the soil will conduct heat to the soil surface.

The properties of the soil, including soil moisture content, affect the rate at which heat is conducted. The presence of snow or vegetation on top of the permafrost will also affect the rate at which heat is conducted, as if there is another layer of insulation to the soil.

Hypothesis:

1. If _____ (factor),
2. is _____ (increased or decreased),
3. then heat transfer through the soil will be _____ (increased or decreased),
4. because _____
_____.

Experiment:

5. Materials: List all materials needed for your lab. Be sure to list amounts/units needed.

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Name: _____

Keep It Active

Student Worksheet (page 3 of 4)

Data:

9. On a separate sheet of paper create a chart of your data. Be sure to indicate units. Write your observations below.

Analysis:

10. On a separate sheet of paper, graph your data. Be sure to title and label your graph and indicate units.

Conclusion:

11. Were you able to support your hypothesis? What evidence do you have that supports or refutes your hypothesis?

12. If you were to conduct this experiment again, how would you change your procedure or data collection? Why?

Name: _____

Keep It Active

Student Worksheet (page 4 of 4)

Questions:

13. What is conduction?

14. Name two factors that influence active layer conduction.

15. How does the conduction of heat through the active layer affect permafrost?
