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Title: When Permafrost Is Not
Topic: Melting of Permafrost
Completion Time: About a week
Permission: N/A
Grade Level: Middle School & Up

Overview:
The students will bury ice (frozen in various shapes such as flat slabs, wedges, & lumps) at varying depths and under the various substrates and vegetation covers.

The students will record the ambient temperature and how long it takes the various ice shapes with the various coverings to melt. Students will observe and record results.

The students will then raise the ambient temperature by placing a light bulb over the permafrost and then repeat the project. The students will also put a model house or objects that will conduct heat as a house would on the permafrost models. Once again the students will observe and record the results.

Objectives:

I. The students will learn what permafrost is.
II. They will understand that temperature impacts the melting of permafrost.
III. The will understand that different ground covers insulate differently.
IV. They will gain a better understanding of why it is challenging to build on permafrost.

Materials:

I. A Large Tub or Stream Table
   Note: The students in my classes have constructed a model of a drainage in a 2' by 3' tub that has mountains, valleys, and plateaus sculpted out of styrofoam.
II. Ice
   a. Flat ice (freeze in ziplocks) to represent a layer of ice.
   b. Wedge shaped ice (freeze in pan at angle) to represent permafrost on a slope.
   c. Irregular, lumpy shaped ice to represent permafrost situated in a valley trapped on the sides by bed rock.
III. Various Substrates
   a. Large gravel
   b. Silica sand
   c. Potting soil
IV. Vegetation
   a. Mosses & lichens
   b. Grasses
   c. Leaves & twigs

V. Foam (e.g., 1/8 sheets for insulation)
VI. Metal Model of a House (about 3" square in this case). Note: the house could be anything that has significant weight and conducts heat.
VII. Lamp with Extendable Arm

Lesson Preparation:
Prior to starting the experimental part of the lesson, the students will need to know what permafrost is and why it is important to them. The classes I will be doing this lesson with are Applied Technology / Construction Design. I will discuss how permafrost affects building in the arctic. The experiments will give students a chance to see how different conditions, i.e. adding heat to the ambient temperature, can affect the permafrost.

The ice needs to be made ahead of time. Lay ziplocks with about an inch of water in them flat in the freezer to make nice slabs of ice. Partially fill pans and prop up one end to make wedges. Fill ziplocks partially with water, then put them in a bowl with rocks stuffed around them to produce some nice lumpy ice.

Procedure:
I. Discussion
    a. Define permafrost
    b. Importance to us
    c. What changes or affects permafrost
        i. Climate Change
            1. Temperatures
            2. Ground Coverings
        ii. Development
            1. Roads
            2. Structures
II. Permafrost Simulation: Substrate Control
    a. Bury identical ice slabs under different substrates (Wksh: Ice Types B & C).
    b. Leave identical ice slabs out (not buried) for comparison (Wksh: Ice A).
    c. Observe & Record
III. Permafrost Simulation: Heat
    a. Bury identical ice slabs under different substrates.
    b. Leave identical ice slabs out (not buried) for comparison.
    c. Add heat using the extendable lamp.
    d. Observe & Record
IV. Permafrost Simulation: Heat with Man Made Features
    a. Bury identical ice slabs under different substrates.
    b. Leave identical ice slabs out (not buried) for comparison.
    c. Add heat using the extendable lamp.
    d. Add man made features

i. Put the wedge shaped piece of ice on a slope (as it is in nature) and cut a road along the down slope side of the wedge.
ii. Put the metal houses on permafrost slabs. One with very little ground cover and one with the foam pad.

e. Observe & Record

V. Students apply the knowledge used in this lesson to a larger project in designing man made developments.

Extension:

Additional Activities Could Include

I. Freeze damp soil slabs and wedges to replicate permafrost as a comparison to pure ice in the above experiment.

II. Variation for testing the effects of building heat on permafrost.
   a. Replicate the heat produced by a building by using small battery powered candles or tea lights placed on top of the permafrost.
   b. Vary the insulation around the individual candles.

III. Tunnels Under Permafrost
   a. Use pipes to make tunnels, light (heat) the tunnels with small lights and experiment with various materials as insulation.

IV. Changing Climate Conditions
   a. Simulate rainfall in varying amounts and with varying temperatures.

Resources:

Alaska Building Science Network. www.akbuildingsciencenetwork.org/programs/education/course-options/.

"Climate and Land Use." USGS. www.usps.gov/climate_landuse/.

"Climate Change." US Forest Service. www.fs.fed.us/climatechange/.

Cold Climate Housing Research Center. www.cchrc.org.

"NOAA Helps the Construction Sector Build for a Changing Climate." NOAA. www.noaa.gov/climate or www.noaa.gov/pdf/526_igorjuliakarl20100916.pdf.

"A Student's Guide to Global Climate Change: Thawing Permafrost." EPA. www.epa.gov/climatestudnets/impacts/signs/permafrost.html.

Assessment:

I. Students will be given a short quiz on the terms used in this project.

II. Students will be divided into teams and each team assigned a development project, e.g. build a road & gas station, build a military installation, or design a national park.
   a. The teams will design and model projects that will have to work around the challenge of building in permafrost country. They will also need to address other challenges not covered in this lesson, such as watersheds and wildlife corridors.

Author/Credits: Original.

Science Education Standards:

National Science Education Standards

HS Weather and Climate: Earth Materials and Systems: ESS2.A

HS Weather and Climate: Weather and Climate: ESS2.D

Science and Engineering Practices: Developing and Using Models: HS-ESS2-4

Crosscutting Concept: Stability and Change: ES-ESS3-5

Alaska Content Standards

Science and Technology: E1, E3

Science as Inquiry and Process: A1, A2

Concepts of Earth Science: D2

Permafrost Simulation

Variable: _____

Estimated Remaining Volume (Percent) or Weight of Ice

Date & Time	Unburied Slab A	Unburied Wedge A	Unburied Irregular A	Buried Slab B	Buried Wedge B	Buried Irregular B	Buried Slab C	Buried Wedge C	Buried Irregular C
Note Substrate & Vegetation	N/A	N/A	N/A						