Activity: Ground Temperature Investigation

Instructor Background

Objective

Students will investigate how the temperature below Earth's surface stays more stable than air temperature and explain how this principle is used in geothermal heating and cooling.

Materials

- soil thermometer or probe thermometers
- skewers or popsicle sticks
- rulers
- stopwatch
- map of school grounds
- clipboards (optional)
- access to outdoor tap (optional)

NGSS

DCI: Earth's Materials and Systems; Natural Resources
SEP: Planning and Carrying Out Investigations; Analyzing and Interpreting Data
CCC: Energy and Matter; Stability and Change

SDGs

7: Affordable and clean energy
9: Industry, innovation, and infrastructure

A soil thermometer. Credit: Vera. FoodandGarden/Stock. Adobe.com

Credit: *Depends on selected image – the one above is from ESW 2023 Calendar - April

Steps

1. **Introductory Discussion:** Begin by asking, "What are some times or places when you've noticed big differences in temperature?" Encourage students to share examples related to time (e.g., day vs. night, summer vs. winter) and location (e.g., sun vs. shade, grass vs. pavement). Guide the conversation toward how temperature can vary not only with time but also across different surfaces and environments. Explain that in this investigation, students will explore how temperature changes in different locations around them, and not just on the surface, but also below the ground.

2. **Pick Areas of Interest:** Work with students to choose 3–6 different outdoor locations to test surface and shallow subsurface temperatures. Example sites could include grass in sunlight, grass in shade, in a garden bed near plants, in soil near a wall. Ask students to write a prediction about which areas will be hottest and coolest at the surface and below the ground.

3. **Plan the Investigation:** Have student groups develop a procedure using the available materials to determine temperature differences of their areas of interest. Have groups get their procedure approved before carrying it out. It is recommended that when taking temperatures, students hold the thermometer in place for at least 30 seconds and take multiple readings.

4. **Carry Out the Investigation:** Have students carry out their approved procedure, ensuring they record their data and take observations.

5. **Analyze and Discuss:** Back inside, ask students to calculate the average temperature for each site and compare differences. Optionally, have students graph their data. Ask:

- How did the subsurface temperature compare to the air or surface? Which was more stable?
- Why do you think the ground below changes less than the air?
- How might the experiment differ if we collected the data at night? In the summer versus spring? Deeper in the ground?

6. **Connect to Geothermal:** Sketch or show a geothermal gradient graph, such as **this one from BC Campus's Physical Geology**, or a graph of oil and gas well data like **the one on page 10 of SMU's Geothermal Laboratory**. Just a few meters down, the ground stays the same temperature all year. But if we drilled far below the surface, temperatures could be hot enough to make steam that could be used to generate electricity.

7. **Extension:** Measure the temperature of water from an outdoor tap (after running it for 30 seconds). This often reflects the stable underground temperature of buried water pipes, similar to shallow geothermal systems. How does this water temperature compare to the air and soil readings? What does this suggest about the temperature deeper underground?