Earthquakes
Lesson Guide

Overview: Students identify where earthquakes occur, how energy moves from an earthquake, and consider what type of soil is best to build on for stability during an earthquake.

Learning Objectives: Students learn what an earthquake is, basics of where they occur and how their energy travels, what type of soils are more optimal to build on for earthquake-stable buildings, and how to conduct an experiment. Students conduct an experiment to determine which soils amplify side-to-side shaking during an earthquake. This is likely most appropriate for K-6 (but make sure to adjust guiding questions and facts appropriately).

Materials:
(1) One to two trays of jello (make the night before)
(2) Play-doh
(3) Grape nuts with water, or pebbles
(4) Sand (or a corn-starch mixture)
(5) Toothpicks or short straws
(6) Marshmallows (or dots)
(7) Pie trays

Setup:
(1) Put out “soil” materials in trays
(2) Put marshmallows in bowl
(3) Maps on table (one for every one to two students)

Earthquakes Lesson Plan

Introduction: Introduce volunteers, say what we do.

Invitation: Some sort of question to engage students: What have you all learned about so far in other parts of the camp? What’s your favorite ___?

Context: Give some context for earthquakes.

(1) Show the map of earthquakes that have happened over the last 5 years. Describe what the colors/circle size means.
(2) Question: Where do most earthquakes occur? (Along plate borders)
(3) What is a plate? Describe that the earth’s lithosphere (or just say crust …) is divided into plates, and that these plates move and interact.

In depth: Questions to pose to students:
What’s an earthquake? Earthquakes occur due to a sudden release of energy in the Earth’s crust.

How can you feel an earthquake far away from its source? This energy travels in the form of seismic waves from the earthquake source the where we feel it on the earth’s surface.

How does the energy from an earthquake propagate? There are multiple types of seismic waves including both body waves that travel through the interior of the earth, and surface waves, which propagate along Earth’s surface. Surface waves are usually larger that body waves and are hence more destructive. Seismic deformation is elastic, which means that the medium that the waves travel through returns to its original state after the wave passes through. Today we will focus on how the two types of body waves, primary (P) and secondary (S) waves, propagate. In particular, we will discuss the difference between the direction a wave propagates and how the wave moves individual particles.

Exploration:

Activity #1: How do waves travel? What is the difference between P and S waves?  
Goal: to see how the energy from an earthquake propagates outward.

1) Tell students to get in groups. Distribute slinky and tell students to stretch the slinky with one student holding each end.

2) For P wave propagation (travel), have one student cup his/her hand over the end of the slinky and hit that hand with the fist of the other hand. This will create a compressional disturbance (Figure 1).

3) For S wave propagation (travel), have one student move his/her hand quickly up and down or side to side (Figure 2).
Discussion/Questions:

1. Get into groups and discuss. What is the difference between the direction of travel and the direction of particle motion? For P waves, particle motion is in the direction of travel and for S waves, particle motion is perpendicular to the direction of travel (See diagrams in Handout).

2. What happens to the slinky after the wave passes through? It returns to its original position after the energy passes through, representing how waves travel through an elastic medium (internal forces oppose deformation and return the material to its original position).

3. Which type of wave moves faster? Students can usually see that the P wave moves faster visually, but it may also be instructive to use a stopwatch to determine the time it takes for the P or S wave to move from one end of the slinky to the other and back (the slinky must be held at a constant length for a direct comparison between the P and S wave.

Activity #2: What type of soil amplifies side-to-side shaking during earthquakes?

Goal: This project involves building a simple shake table and testing the stability of marshmallow buildings on different types of soil: (1) bedrock (play dough), (2) gravel (grape nuts), (3) alluvium (grape nuts with water), (4) sand (a sort of corn-starch mixture), (5) liquid within sand (jello). We will test building by shaking them for about 20 seconds on each material and recording the destruction.

1) Have students construct their buildings. Encourage them to build two-story high, and maybe make a drawing of what they could look like on the board.
2) After the buildings are constructed, put them on the pans of Jell-O and shake them. Notice how wobbly they are.
3) Give the students back their buildings and have them rebuild them to make them more stable. How can this be done? (Suggest using cross bracing (create diagonals) (Fig. 2b) or a tapered structure (upper stories are smaller)
4) Test the new buildings on the Jell-O and note that they are more stable. This demonstrates how engineering is important in earthquake prone areas.
5) Place buildings on other materials and shake them.

Questions/Discussion:

Take turns with these experiments, depending. Groups discuss questions:

1. Which material is the most stable to build on? Why? Should be bedrock.

2. Which material is the worst to build on? Why? Should be the stuff that doesn’t have lots of cohesion.

3. How did you make your buildings stronger?

Reflection

What did we learn?

1. Earthquakes occur along plate boundaries from a release of energy.
(2) Energy from an earthquake travels outward from its source via two kinds of waves, P waves and S waves.
(3) Firm material is better to build on for earthquake risk, whereas material that is loose is not ideal to build on.

**Final Questions from Students**