

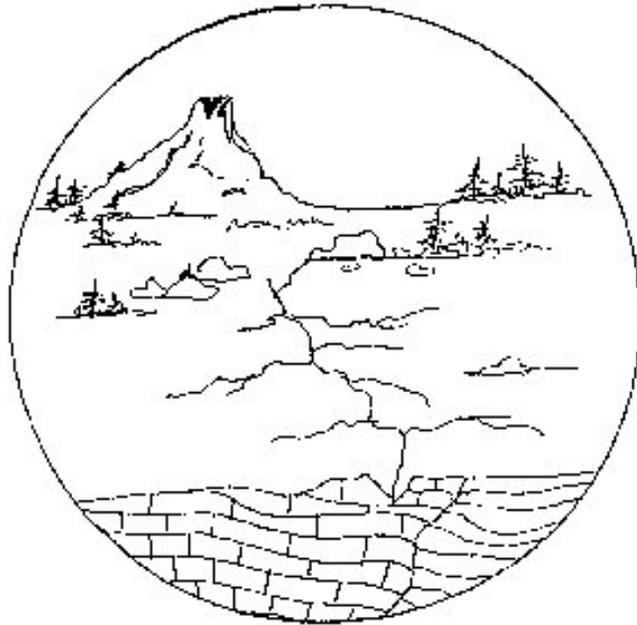


Plate Tectonic Cycle

Earth's Moving Force

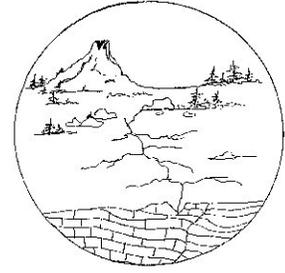


FOURTH GRADE EARTHQUAKES



1 WEEK
LESSON PLANS AND
ACTIVITIES

PLATE TECTONIC CYCLE OVERVIEW OF FOURTH GRADE



VOLCANOES

WEEK 1.

PRE: *Comparing different structures of volcanoes.*

DURING: *Modeling three types of volcanoes.*

POST: *Illustrating a volcanic eruption.*

EARTHQUAKES

WEEK 2.

PRE: *Comparing the Richter and Mercalli scales of earthquake measurement.*

DURING: *Testing how different shapes react during an earthquake.*

POST: *Describing a seismogram.*

PLATE TECTONICS

WEEK 3.

PRE: *Distinguishing the different layers of the Earth.*

DURING: *Observing the effects caused by plate movements.*

POST: *Exploring the reason for earthquakes and volcanoes.*

HAZARDS

WEEK 4.

PRE: *Exploring about structural damage caused during an earthquake.*

DURING: *Comparing structural damage caused by earthquakes.*

POST: *Contrasting the Richter and Mercalli scales.*

PLATE TECTONIC CYCLE - EARTHQUAKES (4)

PRE LAB

Students look at damage from seismic waves.

OBJECTIVES:

1. Exploring how we can measure an earthquake.
2. Comparing the Richter and Mercalli scales.

VOCABULARY:

epicenter
focus
intensity
liquefaction
Modified Mercalli Scale
Richter Scale
seismic wave

MATERIALS:

worksheet



Buildings damaged in Japan

BACKGROUND:

Earthquakes are caused when stress within the crust of the Earth builds up, causing an area of rock to "snap" along a fault. This breaking causes a release of energy. This energy is measured by how much "shaking" occurs. The shaking can vary in its intensity. Some earthquakes shake everything (high intensity), and others are not felt at all (low intensity). In these labs, we introduce two ways to measure this shaking: the Richter scale and the Modified Mercalli scale. The Richter scale is a mathematical measurement of the intensity of the ground shaking, as measured on a seismograph. It is actually a measurement of the size of the waves produced by the earthquake. The Modified Mercalli scale measures how people feel and react to the shaking.

Seismic waves radiate outward from the focus (point at which the earthquake starts). These waves cause damage in some areas and but not in others. Many factors effect damage. One of the most fundamental is distance: seismic energy is lost as waves travel through the Earth, so the further you are from the epicenter of an earthquake, the less shaking you will likely feel. Another important factor is the type of ground through which the waves travel. For instance, if the waves shake sand particles, the energy will tend to make the particles "settle." This may cause the Earth's surface to sink; large movements can occur, damaging human structures. In contrast, if the wave past through

hard, solid rock, no settling occurs, and the movement will be less. Basically, the more tightly bound a material is, the less it will settle in response to seismic waves.

PROCEDURE:

1. Explain the meaning of intensity, epicenter, and focus to the class. Explain that energy waves (seismic waves) are emitted from the focus (just like when you throw a pebble into the water and waves are emitted from the point of impact). Discuss how the strength of a substance affects how much it settles.

2. Have the students complete the worksheet.

3. Answers:

1. 2 and 3

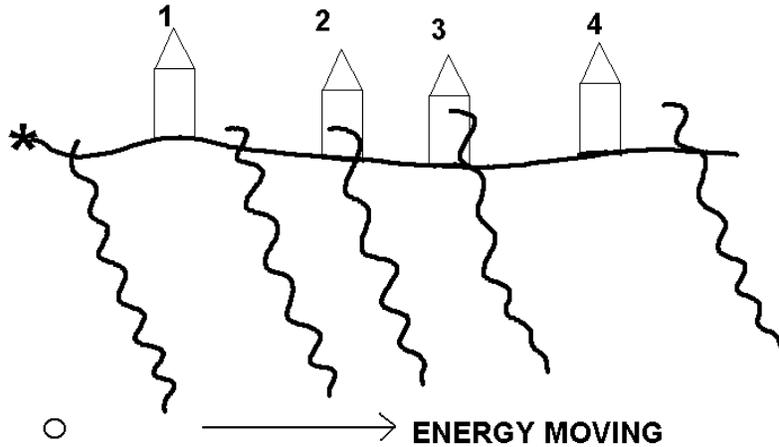
2. The seismic waves go through these homes. Homes #1 and #4 are not affected by the waves.

3. House #4, because the intensity of an earthquake is felt less, the farther it is from the epicenter.

4. B, because when the ground shakes it will not collapse.

**PLATE TECTONIC CYCLE - EARTHQUAKES (4)
PRE LAB**

LABEL THE FOCUS AND EPICENTER.

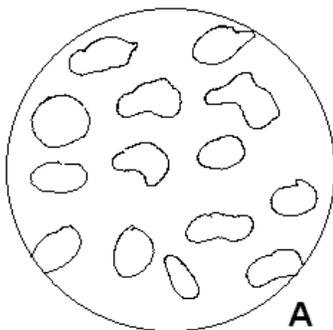


1. Which homes will feel the most intensity? _____

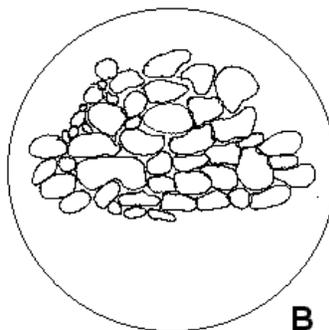
2. Why? _____

3. Which house feels the intensity the least? Why? _____

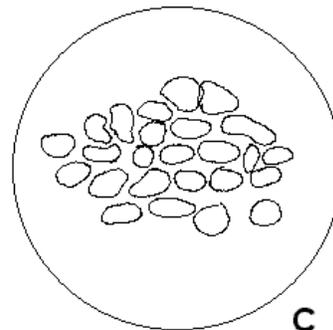
4. The following picture is an enlarged view of three different types of soil. Which one do you think would "resist" shaking the most? Why?



A



B



C

PLATE TECTONIC CYCLE - EARTHQUAKES (4)

LAB

Students determine the damage caused by seismic waves.

OBJECTIVES:

1. Comparing the relative differences between high and low intensity earthquakes.
2. Testing how different shapes react during an earthquake.

VOCABULARY:

intensity
Mercalli Scale
not resistant
resistant
Richter Scale
semi-resistant

MATERIALS:

Shaker Boards
marbles
large plastic container lids
Styrofoam cups
building sets



San Francisco, 1906

BACKGROUND:

As discussed in the Pre Lab, the damage caused by earthquakes is dependent on the intensity of the earthquake and the type of ground a structure is built on. A third factor is the materials used in a building's construction. In earthquake country, unreinforced building materials like brick are not suitable, because these structures are weak. It takes little energy to cause the mortar to break loose, causing the building to collapse. Materials like wood are much more resistant to earthquake shaking, because these structures are flexible. A seismic wave can easily pass through a wood structure with little breakage.

Another factor in determining resistance to earthquake damage is the shape of a building. Students will see in this exercise that a shape with a large base and a smaller top (like a pyramid) is the most resistant of high structures. A cylinder or high standing rectangle is not resistant to shaking.

This lab illustrates the intensities of different earthquakes by having the students experiment with different shapes on the shaker boards. Because we cannot accurately simulate the Richter or the Modified Mercalli scales, the students will make their own relative scales, which they will name it after themselves. The key concept is that the

harder the shaking the higher the intensity and magnitude of the earthquake.

PROCEDURE:

1. Explain the factors that contribute to earthquake damage. Emphasize that the shape and construction of a building are important factors.

2. Have the students work in groups of four. For Exercise I, each group will construct a simple shaker table. Each group will need a shaker board, a handful of marbles, a plastic container lid, and toy blocks or their equivalent. Have the students place the marbles in the plastic top. The marbles will act as ball-bearings in the experiment. Next, have them balance the shaker board on top of the marbles. This completes the shaker table. The board should be about 12 to 18 inches in length and at least $\frac{1}{2}$ inch thick.

3. Explain that for each type of motion, the same student will perform the shaking for all four building shapes. Have the students record their names next to their type of motion on the worksheet. Have the students practice the different types of motion before they conduct the experiments. "Slow-long motion" means to move the board in the long direction slowly. "Quick-long motion" means moving the board in the long direction quickly. "Slow-short" and "quick-short" mean slow and fast motions in the short direction, respectively. As much as possible, try and get the groups to move the boards similar amounts and speeds.

4. Instruct the students to build 4 differently shaped structures (i.e., rectangle, triangle, sphere, cylinder) on their tables. Have each student "shake" the table at their assigned intensity. The students should record if the shapes are resistant (do not fall), semi-resistant (does not fall easily), or not resistant (falls immediately). Their conclusions may vary because of the shape(s) they test, as well as how the students move the boards.

5. During the experiment, the students should quickly realize that intensities B and D (both quick) represent a high number on the student's scale, while A and C represent a low number.

6. In Exercise II, the students try to stack 3 Styrofoam cups so that they will resist a slow-long earthquake. They can put the cups up or down. They may have trouble drawing the cups. Help them by suggesting an easy way to draw the cups: cup up; cup down; side view (cup up); side view (cup down); top view (cup up); two view (cup down).

7. Remember that the relative shaking of the boards is dependent on the student. It is important for students to recognize the relative nature of quantifying an earthquake. The Richter Scale is a mathematical representation of the intensity of an earthquake, but your students cannot simulate this.

PLATE TECTONIC CYCLE - EARTHQUAKES (4) LAB

PROBLEM: What happens to buildings on the Earth's surface during an earthquake?

PREDICTION: _____

PROCEDURE: You will conduct two experiments to study how different structures withstand simulated earthquake waves. Follow the directions given for each exercises below.

EXERCISE I. MATERIALS: different building block shapes, shaker boards, marbles, plastic container lids, toy blocks or building set

1. Construct a shaker table according to your teacher's directions.
2. Each person in your group will shake the table a different way. Write the last name of the person who shakes the board in front of each intensity. Practice each shake 5 times before you do the experiment.

- A. slow-long board (low intensity)
- B. quick-long board (high intensity)
- C. slow-side board (low intensity)
- D. quick-side board (high intensity)

3. Using the blocks or toys, build for differently shaped buildings on the table, one at a time. By shaking the table, determine how each shape resists each of the shaking motions. Use the following code:

R = resistant (falls down after 10 seconds or more)

S = semi resistant (falls down after 3-10 seconds)

N = not resistant (falls down quickly)

DRAW SHAPE	A	B	C	D

EXERCISE II. Arrange 3 styrofoam cups on the table in an arrangement that will withstand Shaking Intensity A. Draw your arrangement below. The cups may be placed up or down.

CONCLUSION: Which shapes and structures are most resistant to different intensities of earthquakes? _____

PLATE TECTONIC CYCLE - EARTHQUAKES (4)

POST LAB

Students learn to read seismograms.

OBJECTIVES:

1. Describing a seismogram.
2. Comparing a seismogram with a seismograph.

VOCABULARY:

primary wave
secondary wave
seismogram
seismograph

MATERIALS:

worksheet
Internet



BACKGROUND:

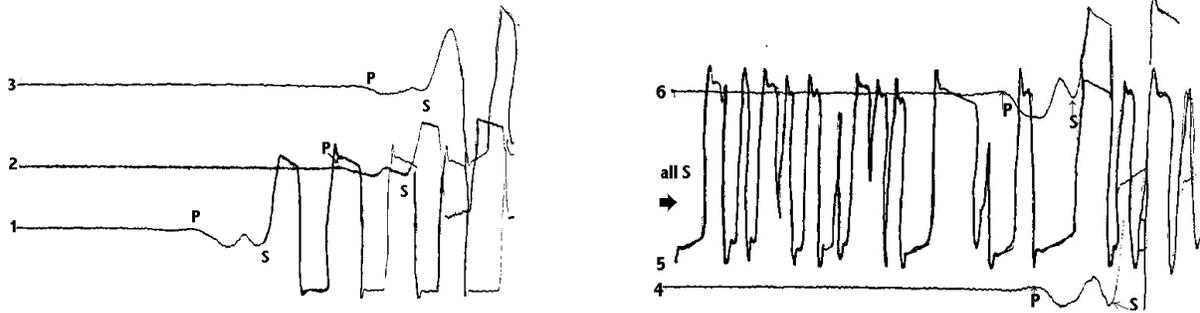
Earthquakes are caused by the sudden movement and fracturing of rock masses along preexisting faults. A fault is a broken surface within the Earth's crust. The point on the fault at which the displacement begins is called the focus of the earthquake. The point on the surface of the earth directly above the focus is the epicenter. An earthquake happens in rocks that have been stressed. This stress is stored until the strength of the rock is exceeded. The actual break (the earthquake) then releases the energy. Again, this energy travels in the form of waves.

Seismograms record the energy emitted by seismic or earthquake waves. Seismograms are created by machines called seismographs. Seismograms are used by seismologists (scientists who study earthquakes) to mathematically describe the magnitude of an earthquake. Seismologists have established a worldwide network of seismographic stations. They are especially concentrated in areas of active earthquakes.

When an earthquake occurs, data from the seismographs feeds into a major research center, where the seismograms are analyzed. This analysis determines where the earthquake occurred, and determines its magnitude. Major earthquake data centers in the United States include Menlo Park and Los Angeles, both in California, and Boulder, Colorado.

Earthquakes generate many different types of seismic waves. Two major types are P (push/pull; compressional, or primary) and S (shear or secondary). P-waves are faster

than S-waves, hence their names. Seismograms will record P-wave arrivals before S-wave arrivals.



PROCEDURE:

1. The worksheet shows a copy of six real seismograms recorded at different seismographs near Mammoth Lake, California. Notice that different locations did not record the seismic waves at the same time, because they were different distances from the epicenter. The lowest two lines on the seismogram indicate time. This is used by seismologists to determine the distance of the seismograph from the earthquake epicenter.

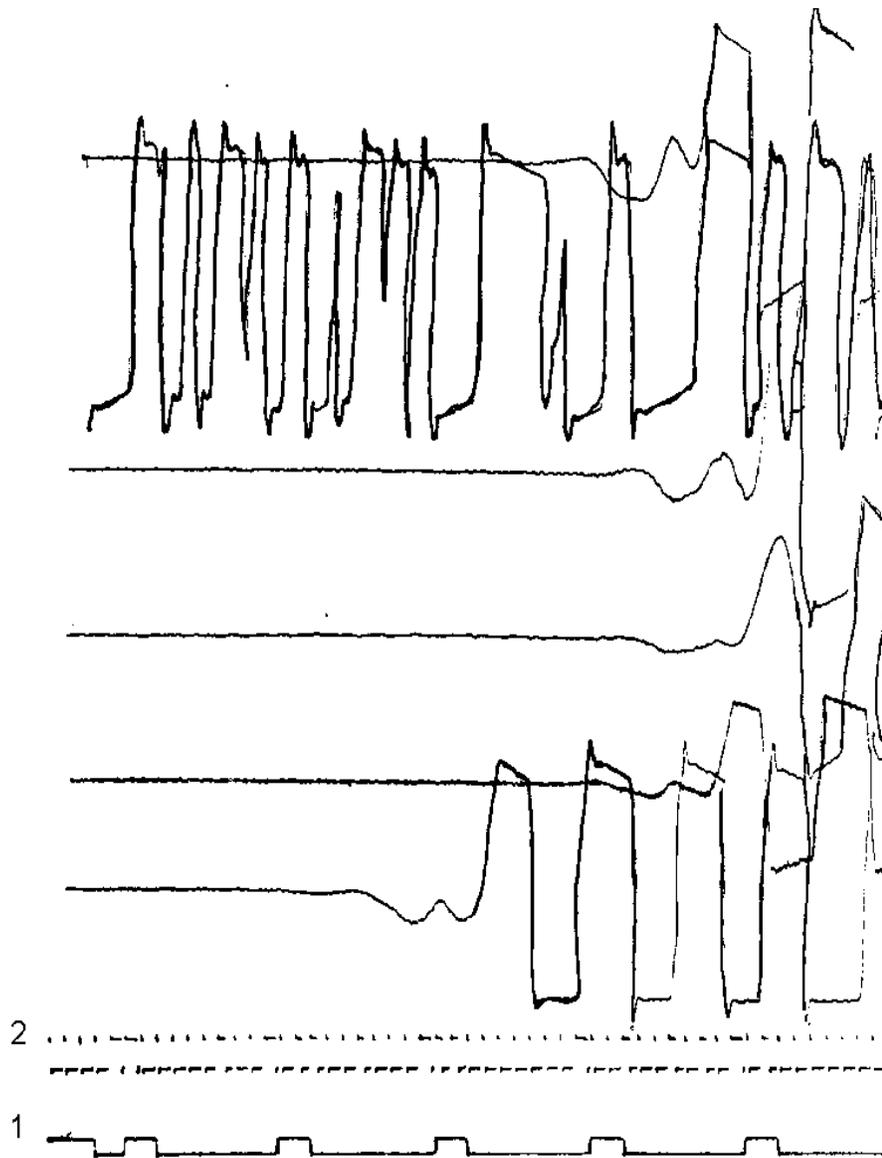
2. Explain P-waves and S-waves to the class. Emphasize that P-waves are faster than S-waves, and will be recorded first on a seismogram.

Answers: 1) 6; 2) look on seismogram above; 3) time.

3. Instruct the students to find other seismograms on the Internet. Seismologists make extensive use of the Internet to post data derived from earthquakes. The U. S. Geological Survey maintains an excellent website that has real-time earthquake data for the whole United States, at <http://quake.wr.usgs.gov/QUAKES/CURRENT/index.html>. It also has good links to other earthquake information.

PLATE TECTONIC CYCLE - EARTHQUAKES (4)

POST LAB



These seismograms show an approximately a 3.0 magnitude (Richter Scale) earthquake near Mammoth Lakes, California

1. How many seismograph stations are shown? _____
2. Place a P where the primary wave starts at each station.
Place an S where the secondary wave starts at each station.
3. What do the lines labeled 1 and 2 represent? _____