Plate Tectonic Cycle

Earth's Moving Force

THIRD GRADE

EARTHQUAKES

1 WEEK
LESSON PLANS AND
ACTIVITIES

PLATE TECTONIC CYCLE
OVERVIEW OF THIRD GRADE

VOLCANOES

WEEK 1.
PRE: *Explaining why there are many types of volcanic rocks.*
LAB: *Comparing rocks from different volcanoes.*
POST: *Learning that volcanoes produce different types of rocks.*

EARTHQUAKES

WEEK 2.
PRE: *Discovering that earthquakes produce energy.*
LAB: Observ*ing different energy experiments.*
POST: *Learning that pressure inside the Earth causes earthquakes.*

PLATE TECTONICS

WEEK 3.
PRE: *Dividing the earth into layers.*
LAB: *Discovering how the Earth's crust creates plates.*
POST: *Explaining how plates have moved through time.*

HAZARDS

WEEK 4.
PRE: *Discussing different volcanic hazards.*
LAB: *Exploring different types of volcanoes during an eruption.*
POST: *Learning about historical eruptions.*

PLATE TECTONIC CYCLE - EARTHQUAKES (3)

PRE LAB

Students compare seismograms from the San Francisco Bay area.

OBJECTIVES:

1. Discovering that earthquakes produce energy.
2. Analyzing how energy waves travel through the Earth.

VOCABULARY:

earthquake
energy waves
frequency
intensity
magnitude
seismogram

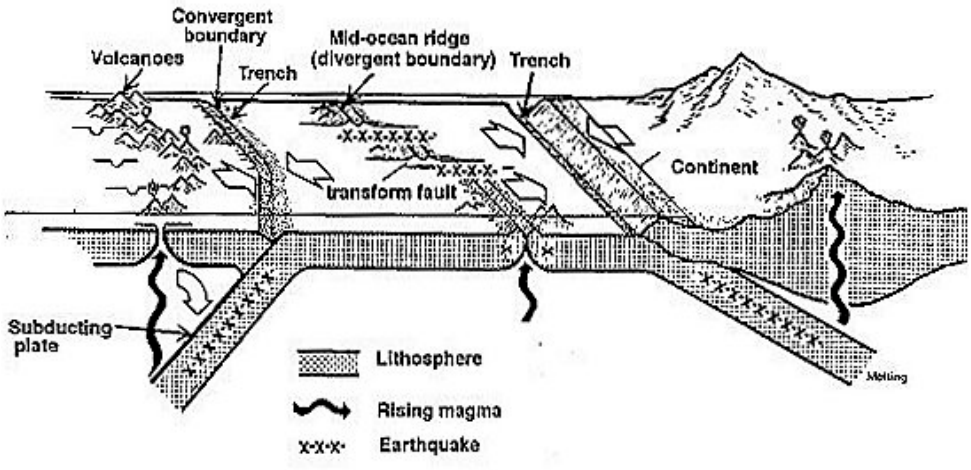

Coalinga, California

MATERIALS:

worksheet
map of United States

BACKGROUND:

Earthquakes and volcanoes are related. Earthquakes can occur without volcanoes, but volcanoes cannot occur without earthquakes. Volcanic activity triggers earthquakes. The ground shakes as magma moves upwards within the crust. Both of these events always create stress within rocks.



Earthquakes can occur without volcanic activity, because stress can be applied to the Earth's plates in other ways. For example, at converging plate boundaries, the force of the two plates coming together causes many earthquakes. All large, devastating earthquakes are associated with plate boundary stresses.

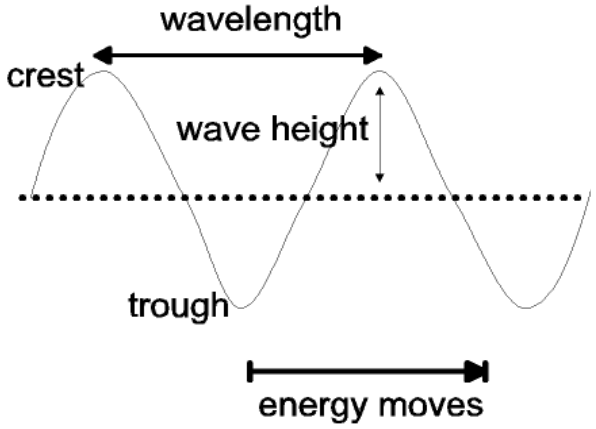
The diagram of plate movements shows the correspondence between earthquakes and rising magma, as well as earthquakes caused by plate motion alone. Note that the moving plates cause both earthquakes and volcanoes in the first place. Many small earthquakes also occur within the volcanoes on the map; they are too small to be shown.

In the Pre Lab exercise, students will explore how seismic energy travels through the Earth, and learn that the resulting shaking feels different in different locations.

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.

Energy is produced when an earthquake occurs. This energy is released in the form of seismic waves. These waves travel throughout the entire Earth. Waves transmit energy between different points. There are many kinds of waves, seismic waves are a type of physical wave. Waves have several parts, as shown in the picture below. In the picture, the dotted line represents the undisturbed surface, and the wave is moving left to right. The crest is the high point of a wave. The trough is the low point. The wavelength is the distance between adjacent crests (or troughs). The wave height is the vertical distance from the undisturbed surface to the wave crest. In general, the bigger the waves, the more energy they carry. Larger waves will be steeper, i.e., have a different shape, than smaller, less energetic waves of the same wavelength. If wavelength stays the same, but the energy increases, wave height increases as well.

The energy released during an earthquake causes the ground to shake. If you are



close to the epicenter of an earthquake, the shaking is more severe than if you were farther away. This change occurs for many reasons. Most important, seismic energy dissipates as it travels through rocks, due to friction and other effects. In addition, the different types of seismic waves travel at different speeds. This means that close to the epicenter of an earthquake, all the waves arrive at about the same time, and the ground

shakes very hard for a short period of time. Further from the epicenter, the fastest waves arrive ahead of the slower waves. This spreading out of energy makes the shaking is less intense.

The seismic waves generated by an earthquake can be recorded and measured on a seismograph. The record produced by a seismograph is called a seismogram.

PROCEDURE:

1. Explain how earthquakes and volcanoes are interrelated.

2. Explain how seismic waves are created. Explain how waves travel through the Earth. Draw the picture above on the parts of the wave on the board. Explain how wave shape changes as wave energy changes. Make sure the students understand that the greater the height of a wave, the more intense the wave is. You may wish to ask the students the following questions:

What happens with more energy? Bigger waves are formed.
Will the intensity of shaking increase? Yes.
Will the shape of the waves change? Yes.
What happens with less energy? The wave height decreases**.**

3. Explain that scientists use machines called seismographs to measure seismic waves. Tell the class that these machines produce charts called seismograms, that show the frequency and magnitude of the energy waves produced by earthquakes. Show them the seismogram in the presentation below. Current seismograms for the United States are available at the U. S. Geological Survey website:

http://quake.wr.usgs.gov/QUAKES/CURRENT/index.html

4. On a map of the United States, show the class the location of San Francisco.

5. Have the students complete the worksheet. The students should realize that the energy from a single earthquake can feel different at different locations.

Answers: 1. five; 2.for an overall understanding of how an earthquake effects a regional area; 3.C and F; 4. A and E; 5. A 16.6, B 18.1, C 11.3, D 16.2, E 22.3, F 18.3

PLATE TECTONIC CYCLE - EARTHQUAKES (3)

PRE LAB

An earthquake occurred 6 kilometers below the surface of the earth, just south of the San Francisco Bay, as shown in Figure 1.

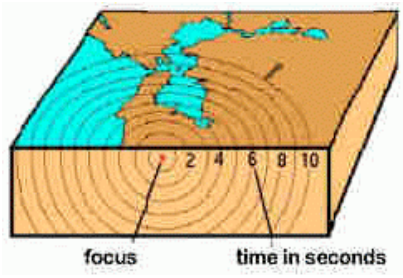


Figure 1

The energy released radiates outwards from the focus.

Seismograms record how the energy affects different areas. Figure 2 shows seismograms from different locations around the Bay area that recorded the earthquake. Look at the information from the seismograms locations in figure 2 and answer the questions below.

1. How many seismograph locations are shown? _____
2. Why are they spread out and not all in the same place?

_____

3. Which location felt the earthquake first? _____ Which location felt the earthquake last? _____
4. Which area had more energy recorded? _____ Which location had the least_____
5. When did the first wave hit each of the areas (seconds after the earthquake).

A _____, B _____, C _____, D _____,
E _____, F _____

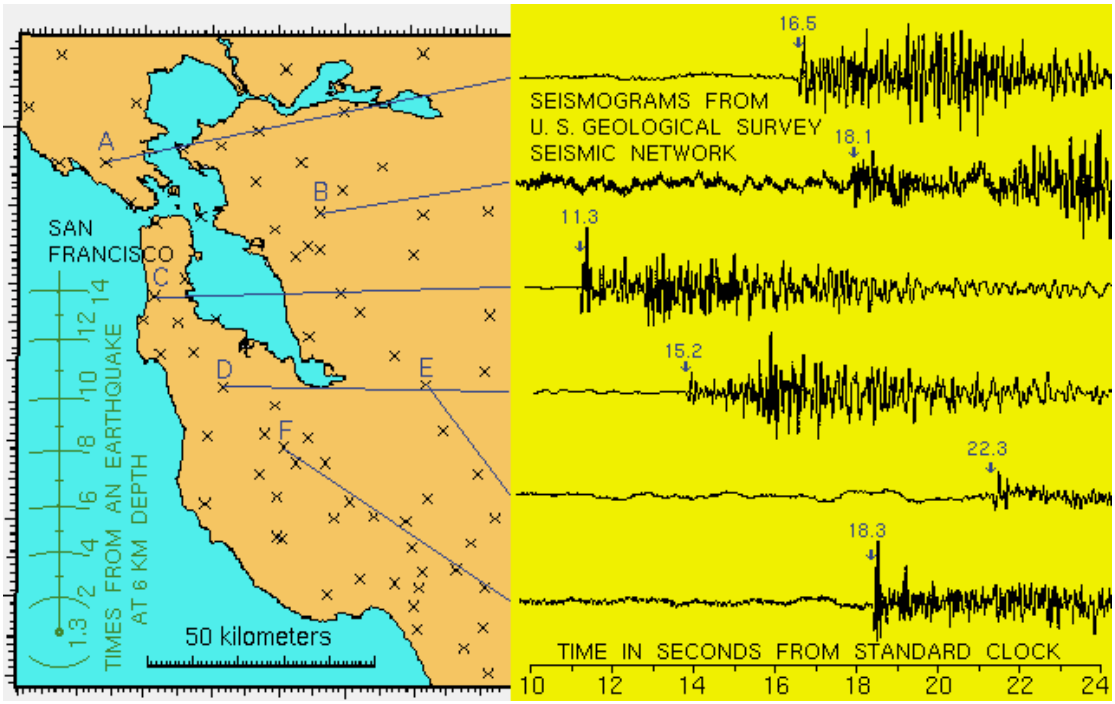


Figure 2.

PLATE TECTONIC CYCLE - EARTHQUAKES (3)

LAB

Students observe how waves move through different substances.

OBJECTIVES:

1. Discovering why an earthquake causes damage.
2. Observing different energy experiments.

VOCABULARY:

earthquake
energy wave
tsunami

MATERIALS:

tape of 1964 Alaskan Earthquake (if available)
margarine tubs
teaspoons
oil
water
aluminum foil

San Fernando, California 1971

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. Your students need to understand that 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. As described in the Pre Lab, this energy travels in the form of waves.

The seismic waves generated by an earthquake can be recorded and measured on a seismograph. The record produced by a seismograph is called a seismogram. The interpretation of the waves provides seismologists with a way of "seeing" into the inside of the Earth. The waves produced by earthquakes travel through the Earth and bounce off different features of the Earth's interior. The patterns they form after bouncing off these features can be used to create images of the interior.

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 and are recorded on the seismogram first. Secondary waves are recorded second, and is shown as a sharp increase on the seismogram. Other waves like Raleigh waves, Love waves, and over 200 different types of waves are recorded afterwards.

PROCEDURE:

1. Ask the students to predict what causes damage during an earthquake before showing the beginning of the 1964 Alaskan Earthquake video. Write their comments on the board or on the screen if you are using a projector. Use a chart similar to the one below.

WHAT CAUSES EARTHQUAKES?		
PREDICTION	AFTER FILM	AFTER LAB

2. After you show the video, ask the students the same question, and again record their responses. (You may want to selectively reshow portions of the tape). See if their responses have changed.

3. You may want to demonstrate the lab before the students begin their investigation, so that the students have an idea of what "gently" means. The goal of the lab is for the students to observe how the waves that they generate change as more energy is applied. Explain that the water waves they are creating are a type of energy wave, and are analogous to a real type of earthquake wave.

Alaska Earthquake, Government Hill School

4. After the students finish the lab, ask them again what causes damage during an earthquake. Record their answers on the diagram. Hopefully they will now see that energy transmitted by waves during an earthquake is what causes damage to buildings and structures. The shaking of the ground can also cause disasters such as landslides, tsunamis (due to crustal movement under the ocean), and building collapse. You might want to remind the students that the release of stress inside the earth is what causes

earthquakes.

5. Discuss with the class any earthquake-caused damage that they have seen in the newspaper or on television. Ask them if they have ever seen damage in person or if they know of anybody that was affected by damage during an earthquake.

Answers:

1. Tap the sides of the tub gently. What are you creating in the tub?
   SMALL WAVES (BE SURE TO ILLUSTRATE WHAT SMALL WAVES ARE)
2. Tap the sides a little harder. Does the pattern change? How?
   THE WAVES GET HIGHER AND FORM MORE CLOSELY TOGETHER
3. Float a flattened piece of foil in the tub. Tap gently. What happens?
   IT GOES UP AND DOWN AS THE ENERGY AFFECTS THE FOIL
4. Tap a little harder on the outside. Does it still float?
   YES (MAKE SURE STUDENTS DON'T TAP THE TUB TOO HARD)
5. With the teaspoon, tap the water directly. Can you cause the foil to sink without touching the foil and without spilling any water?
   LET STUDENTS EXPERIMENT BY HITTING THE SIDES; IT CAN BE DONE
6. Take the foil out. Put 1 teaspoon of oil on the water. Tap the sides gently. What happens?
   THE OIL GOES UP AND DOWN
7. Tap the sides a little harder. What happens?
   THE OIL WILL BREAK UP

PLATE TECTONIC CYCLE - EARTHQUAKES (3) LAB

PROBLEM: Why do earthquakes cause damage?

PREDICTION:_____

_____

MATERIALS: margarine tubs, teaspoons, oil, water, aluminum foil

PROCEDURE: Fill the margarine tubs 1/2 full of water

1. Gently tap the sides of the tub. What are you creating in the tub?
_____

2. Tap the sides a little harder. Does the pattern change? How?
_____

3. Float a flattened piece of foil in the tub. Tap gently. What happens?
_____

4. Tap a little harder on the outside. Does it still float?
_____

5. With the teaspoon, tap the water directly. Can you cause the foil to sink without touching the foil and without spilling any water? _____

6. Take the foil out. Put 1 teaspoon of oil on the water. Tap the sides gently. What happens? _____

7. Tap the sides a little harder. What happens?

_____

8. Fill in the blank letter in the sentence below.

WHEN THE STRESSES IN THE EARTH BREAK THE CRUST THEY SEND OUT
W _ _ _ _.

CONCLUSION:

What causes some of the damage during an earthquake?
_____
_____

PLATE TECTONIC CYCLE - EARTHQUAKES (3)

POST LAB

Students create a myth about the causes of earthquakes.

OBJECTIVES:

1. Learning that pressure inside the Earth causes earthquakes.
2. Exploring how a myth can be composed of some truths.

VOCABULARY:

earthquakes
pressure

MATERIALS:

worksheet
jell-O (optional)

Damage to a freeway, 1989 Loma Prieta earthquake, Oakland, California

BACKGROUND:

The students have learned that earthquakes emit energy in the form of seismic waves. These seismic waves travel through the Earth, rocks, water, buildings and almost any other substance or structure. We experience shaking during an earthquake because we are surrounded by these substances or structures.

Understanding how the release of energy causes so much damage is difficult. People who do not have a scientific background may not fully realize how the Earth could cause such disasters. When people do not know the facts, many times they develop their own stories or myths of why such an event may happen. Myths are usually based on a little accurate information, and much exaggeration.

PROCEDURE:

1. You may want to reinforce the concepts students explored in lab with a jell-O demonstration. Demonstrate the travel of energy waves by tapping the side of a slab of jell-O (any color will do). Vary the strength of your taps to show the class how different amounts of energy change the amount of shaking.

2. The students have seen that the movement of the Earth's crust causes earthquakes. They now know that earthquakes produce energy in the form of waves. A common question that comes up, both with children and adults, is "why does the Earth's surface crack during an earthquake?" A full explanation of this is difficult, especially if no

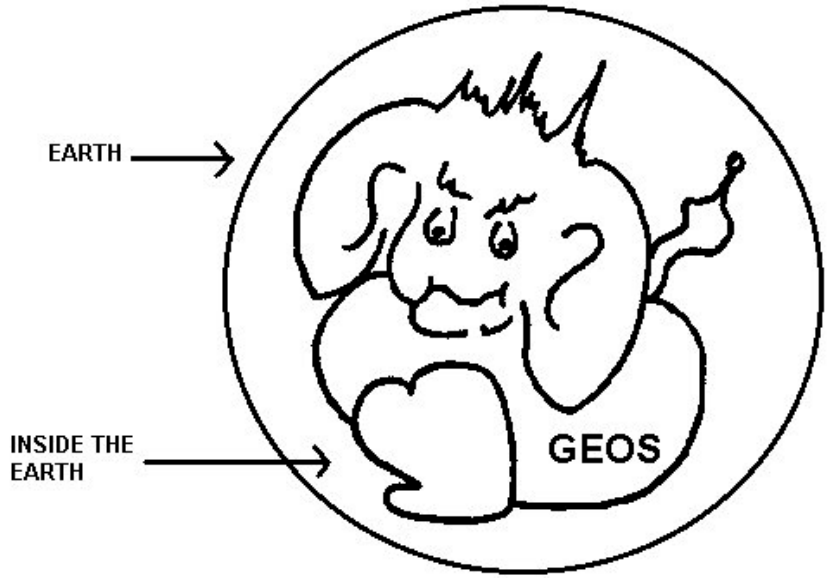
one in the discussion has a scientific background. In ancient times, people would create myths to try and explain what was actually happening. In this exercise, the students will write their own myth to explain the cracking and shaking of the Earth caused by earthquakes.

3. The Geos Myth activity can help illustrate how the Earth's surface breaks due to pressure. Emphasize with the students that they are going to create a myth that is based on some scientific information, but is not necessarily true. Explain that this kind of explanation was common in ancient times, before the development of modern science.

4. Read the introduction of the worksheet to the class. It is included below as a presentation, along with the image of Geos.

5. After you are sure the students understand the reading, have them write their own myth. Have them try to use information from the previous labs. Point out that they are to be creative. Explain that myths sometimes contain some truth, but myths are not always true. The main point that the students should develop in their storyline is that pressure building up inside the Earth causes earthquakes. If Geos can become liquid, then the cracks in the Earth can also become volcanoes and Geos can escape. Note that the cracking of the Earth can signify earthquakes as well as volcanoes.

PLATE TECTONIC CYCLE - EARTHQUAKES (3) POST LAB



There is a friendly monster inside the Earth. Geos wants to get out, but he does not want to hurt any living creature on Earth. How can he get out without hurting anyone? Geos can change to any shape that he wants. He can become liquid or change into energy.

_____

_____

_____

_____

_____

_____

_____

_____

_____