

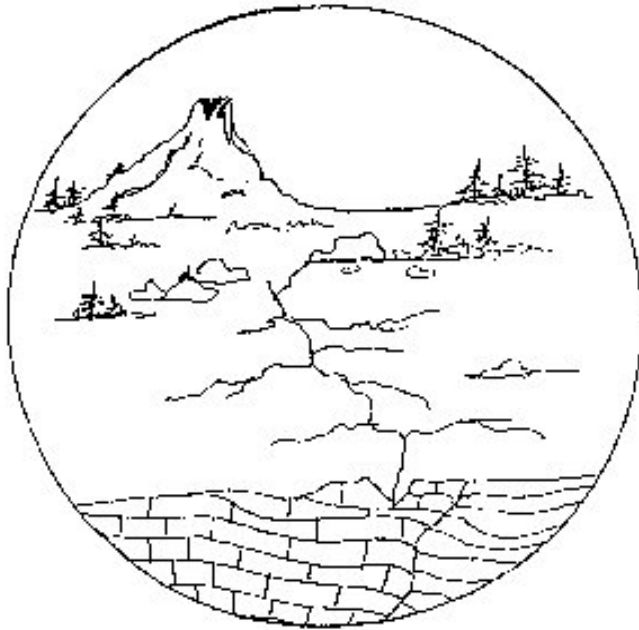


Plate Tectonic Cycle

Earth's Moving Force

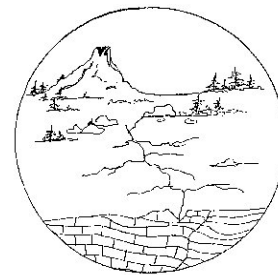


FIFTH GRADE EARTHQUAKES



1 WEEK
LESSON PLANS AND
ACTIVITIES

PLATE TECTONIC CYCLE OVERVIEW OF FIFTH GRADE



VOLCANOES

WEEK 1.

PRE: *Exploring the rocks produced by volcanoes.*

LAB: *Comparing igneous rocks.*

POST: *Critiquing books on volcanoes for their scientific content.*

EARTHQUAKES

WEEK 2.

PRE: *Analyzing the types of waves produced by earthquakes.*

LAB: *Interpreting seismograms with associated damages.*

POST: *Analyzing earthquakes around the world.*

PLATE TECTONICS

WEEK 3.

PRE: *Investigating the patterns produced by volcanoes and earthquakes.*

LAB: *Testing models of crustal movement.*

POST: *Defining plate boundaries.*

HAZARDS

WEEK 4.

PRE: *Comparing volcanic and earthquake hazards.*

LAB: *Determining what type of viscous mixtures can cause the most damage.*

POST: *Exploring earthquakes that are associated with volcanoes.*

PLATE TECTONIC CYCLE - EARTHQUAKES (5)

PRE LAB

Students learn about P and S waves.

OBJECTIVES:

1. Analyzing the type of waves produced by earthquakes.
2. Comparing S and P waves recorded on a seismogram.

VOCABULARY:

earthquake "event"
lithosphere
primary wave
secondary wave
seismic waves
seismogram

MATERIALS:

slinky
rope



Ground rupture caused by an earthquake

BACKGROUND:

Earthquakes and volcanoes are evidence for plate tectonics. Earthquakes are caused when energy is released as the lithosphere (crust and upper mantle) of the Earth moves. Energy is emitted in the form of waves. There are different types of waves, some move faster, slower, sideways, or up and down. A seismograph records these waves on a seismogram. When an earthquake is recorded it is called an earthquake "event."

There are two types of waves you will discuss with the students, P and S waves. P waves or primary waves, are the first waves that the seismogram records. The P wave is the "fast" wave and can be called a push-pull wave, because it moves by contracting and expanding along a horizontal path. A P-wave travels through a material as a compressional force. For example, when you speak, your voice compresses a volume of air. One of the properties of air (and just about any other material) is that it resists being compressed into a smaller volume. When your voice compresses the air, it resists by pushing against neighboring volumes of air. These volumes then resist compression, and they push back against their neighbors. This generates a wave of compression that travels through all the volumes of air

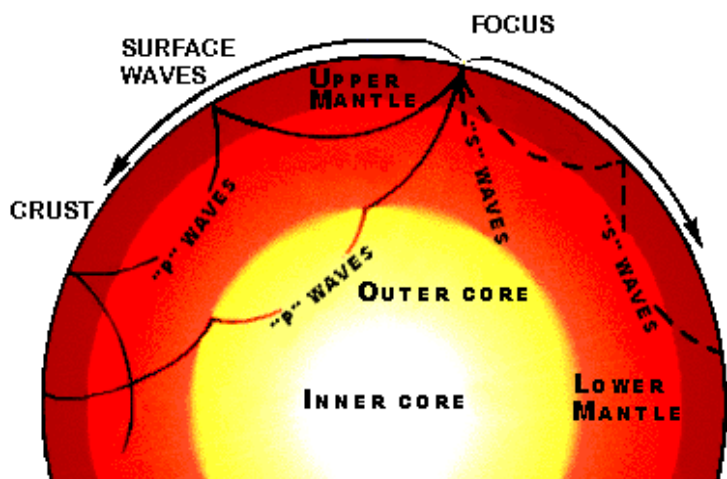


between your mouth and the person hearing you. The S waves or shear waves, are the second wave to be recorded because it is slower than the P wave.

PROCEDURE:

1. Review the divisions of inside the Earth. Earthquakes occur in the upper part of the crust and mantle. Earthquakes release energy in the form of waves.

2. Demonstrate P- and S-wave motion to the class. P-waves can be demonstrated with a slinky. Pull the slinky apart and then pull in about 6 coils. Let them go. The wave will oscillate through the slinky, alternately compressing and expanding the coils.



3. The S wave can be shown by using a rope attached to a wall. Hold onto the rope and move your wrist up and down. This whipping motion will generate S-waves. The motion will be up and down as the energy goes through the rope. Although you can demonstrate both types of wave with a slinky, we have found that students can distinguish the two types of waves more readily if you use different materials. If you cannot attach a rope to your classroom walls, try this demonstration with two people.

4. Draw a P and S wave on the board as illustrated below. Make sure the students understand how to identify them. In addition, explain that the greater the height of the lines on the seismogram, the larger the earthquake. This holds true unless a seismograph is located very close to the epicenter of the earthquake. This causes the wave height to be exaggerated.

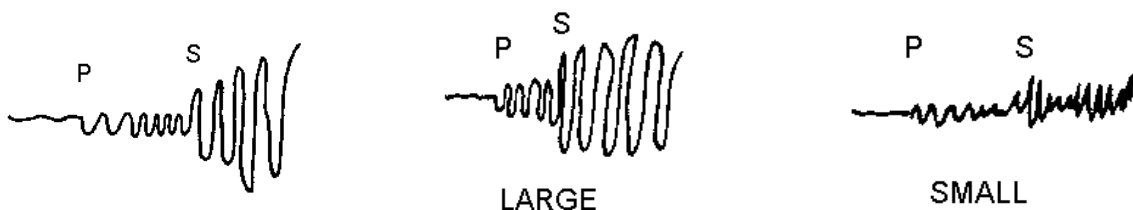


PLATE TECTONIC CYCLE - EARTHQUAKES (5)

LAB

Students analyze seismograms.

OBJECTIVES:

1. Interpreting seismograms and their associated damage.
2. Predicting damage by looking at a seismogram.

VOCABULARY:

epicenter
P wave
S wave
seismogram
seismic waves

MATERIALS:

seismogram sheet
Earthquake damage images
United States placemats



Alaska, 1964

BACKGROUND:

Damage caused by earthquakes varies depending on many factors. In order to predict what the damage may occur, many factors must be considered. These include:

1. Intensity of the earthquake
2. Distance from the focus
3. Type of soil/rock buildings are built on
4. Type of material the building is composed of
5. Probability of a landslides if in a mountainous area
6. Probability of tsunami (large ocean waves) if near a coastline

If a city is close to the epicenter of a large earthquake (6.0 or above on the Richter scale) it may have significant damage. The damage may be substantial if the buildings are not reinforced. Brick buildings are more prone to “fall” apart. In addition, if the city is situated on unconsolidated soil or landfill, damage will likely be greater, because these materials settle and/or liquify during earthquakes.

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. The energy released by earthquakes travels through the Earth as seismic waves.

Scientists have developed many scales to measure the intensity of earthquakes. Two common ones are the Richter Scale and Modified Mercalli Scale. The Richter Scale measures the size of the waves produced by the earthquake, hence the energy it releases. The Richter Scale is absolute, so the same Richter magnitude wherever they measure the earthquake. The Modified Mercalli Scale describes what a person feels during an earthquake. This scale is relative because it changes depending on how far you are away from the epicenter, and how much damage occurs around you.

P-waves and S-waves are easily distinguishable on a seismogram. P-waves are faster than S-waves, so the first shaking recorded by the seismogram is always due to P-waves. When S-waves arrive, their energy combines with the P-waves to amplify the shaking. This makes the waves bigger, and the shaking stronger. The first arrival of S-waves is thus marked by a distinct increase in the size of the waves on the seismogram.

PROCEDURE:

1. Review and discuss the concept that volcanoes and earthquakes provide data for understanding the movement of the lithosphere, as explained by the theory of plate tectonics.

2. Show the class images of earthquake damage. You can use slides or transparencies, or the presentation below. We recommend showing the students the pictures before they complete the lab, so they can understand the damage earthquakes can cause. Explain that damage in urban areas depends on many factors.

If you wish to customize or create your own presentation, here are several websites that have good earthquake damage information:

<http://www.uidaho.edu/igs/nisn/nisnpics.html>

Earthquake damage in Idaho. Good, simple descriptions of damage and location.

<http://www.sfmuseum.org/1906/06.html> and <http://quake.wr.usgs.gov/more/1906/>

Damage from the San Francisco earthquake in 1906. A link to photographs is towards the bottom of the each page.

<http://www.ngdc.noaa.gov/seg/mainmeta.shtml>

An outstanding but huge collection of images of the effects of natural hazards, including earthquakes, volcanoes and tsunamis.

3. Review the Richter Scale and the Modified Mercalli Scale with the class.

4. Introduce the assignment to the students. Explain that interpreting the seismograms and describing potential earthquake damage both require imagination. The point is not to get the “right” answers, but to speculate on what might happen. This is a prediction, after all!

As a class, you may want to have the students find the geographic locations of the seismograms on the worksheet. Use the United States placemats. Try to get the students to locate cities near the epicenters that might be effected by the earthquakes.

5. Select a few students to read one or more of their answers to the rest of the class. The class should conclude that according to the seismogram, the San Fernando Valley earthquake appears to be the most intense and would probably cause the most damage.

Here is an example of a student response:

Seismogram 1. The earthquake was probably a sharp quake. Maybe a 5 or 6 on the Richter scale. However, conditions in the ocean created a large tsunami (or tidal wave) and it caused major destruction along the coast. Downtown Anchorage was not affected, except for small items thrown from shelves.

PLATE TECTONIC CYCLE - EARTHQUAKES (5) - LAB

IMAGES OF EARTHQUAKE DAMAGE



Tsunami effects in Hawaii, 1960 - note bent parking meters!



Tsunami damage in Indonesia, 1996



Ground rupture in Northridge, California



Collapse of freeway, Oakland, California
1989



2001, Ahmedabad, India
7.9 quake

PLATE TECTONIC CYCLE - EARTHQUAKES (5) LAB

PROBLEM: How can a seismogram tell you the intensity of an earthquake?

PREDICTION: _____

EXERCISE I. Examine the seismograms on the next pages. Label them with a “P” and an “S” where you think the first P (primary wave) and S (secondary wave) waves occur.

EXERCISE II. Each seismogram records a different earthquake. Using a U.S. placemat find the appropriate areas of each earthquake. Examine where each seismogram was recorded. Assuming that this was near the epicenter of the earthquake, describe the seismogram: does it record a small, moderate, or large earthquake? Does the shaking happen all at once, or is it spread out? In addition, describe the kinds of damage that may have happened at the epicenter.

	DESCRIPTION OF DAMAGE
seismogram 1. location: intensity:	
seismogram 2. location: intensity:	
seismogram 3. location: intensity:	
seismogram 4. location: intensity:	

CONCLUSION: Can scientists predict the types of damage that may happen during an earthquake? How? _____

PLATE TECTONIC CYCLE - EARTHQUAKES (5)

LAB

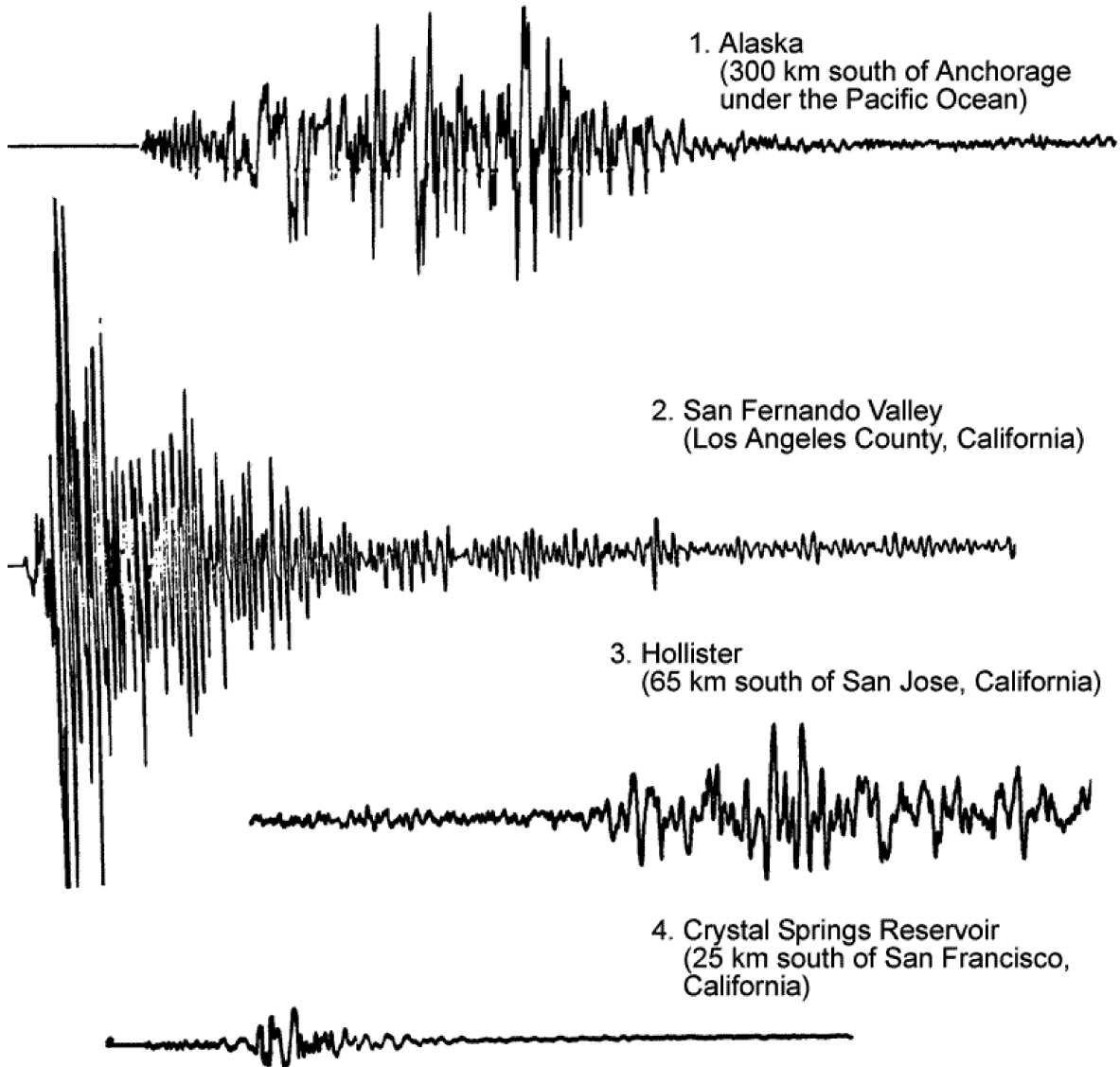


PLATE TECTONIC CYCLE - EARTHQUAKES (5)

POST LAB

OBJECTIVES:

1. Analyzing earthquakes around the world.
2. Predicting future earthquake by looking at data.

VOCABULARY:

earthquakes
Mercalli Scale
Richter Scale

MATERIALS:

worksheet
relief map of the world

Students use a worksheet to identify global patterns in the occurrence of earthquakes.



San Fernando, 1971

BACKGROUND:

Earthquakes have occurred for as long as the Earth has had a solid crust. They will continue until the Earth turns into a solid rock. Our great grandchildren will have to live with the possibilities of earthquakes. Students should realize that earthquakes generally recur in the same locations. It is reasonable to assume that if one earthquake strikes an area, there will probably be more.

Earthquakes are caused by stresses from plate movement. Most earthquakes thus occur at plate boundaries, where pieces of the lithosphere converge, diverge, or slide past each other. This is also true for most volcano related earthquakes, as most volcanoes form at plate boundaries as well. In particular, earthquakes and volcanoes are very common along the “Ring of Fire”, the belt of converging plate boundaries that circles the Pacific Ocean.



Japan.

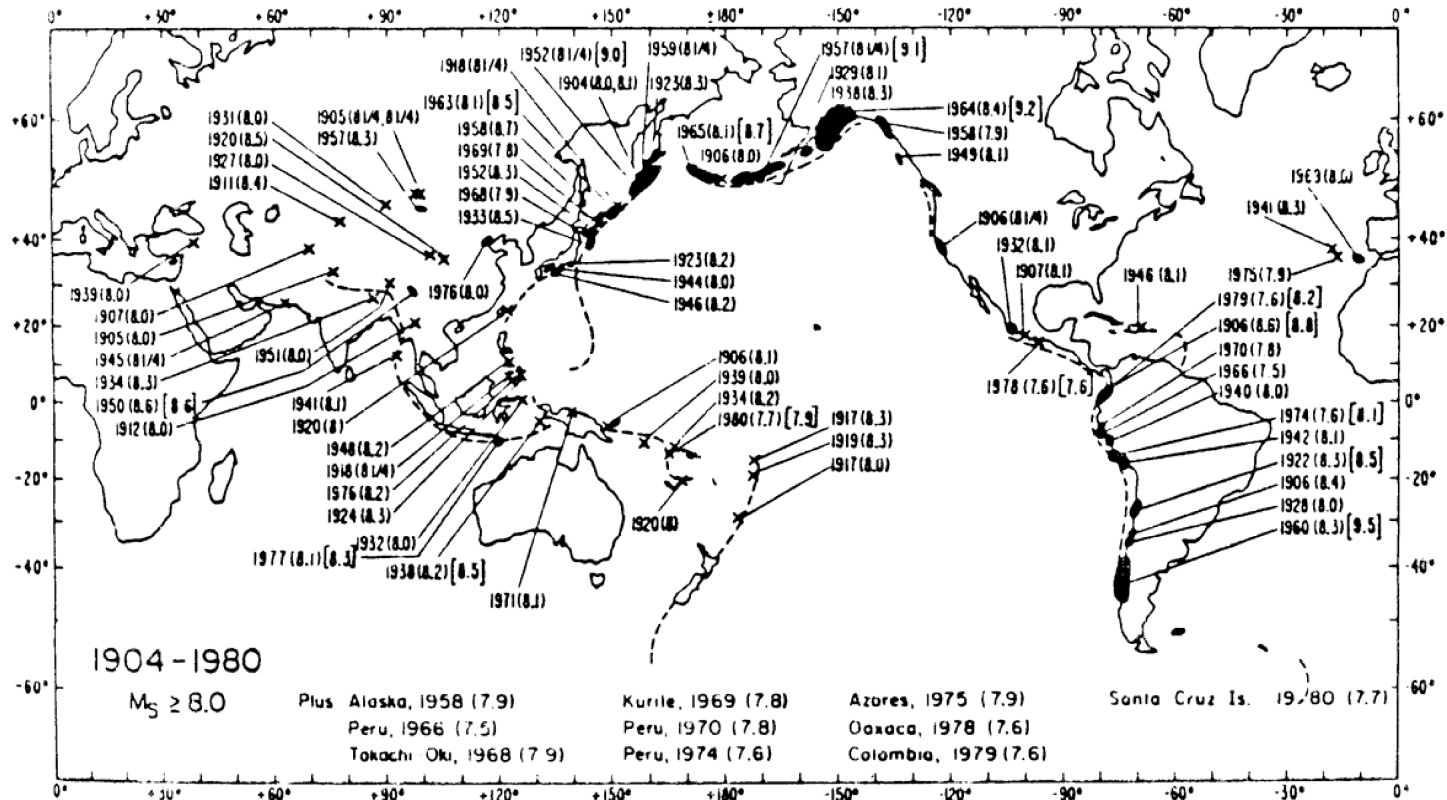
PROCEDURE:

1. Explain to the class that earthquakes tend to recur in the same areas, and that these areas are usually at or near plate boundaries. Explain the map on the worksheet to the class. This global map shows all the large earthquakes that occurred between 1904 and 1980. The Richter Scale magnitude of each earthquake is listed for each event.
2. Have the students complete the worksheet. You may want the students to trace the general area where large earthquakes have historically occurred. This looks particularly dramatic with a colored pencil or pen. You may want to trace along with the class.
3. Ask the students if these areas will have earthquakes again. The answer is yes, because where plates meet there will be stress until they stop moving.
4. Instruct the students to write about the areas that are free from earthquakes, and to explain why no earthquakes occur there.
5. If you have a relief map of the world, point out that the areas that have many earthquakes often have high mountains: these are either volcanoes or compressional mountain ranges. The latter form at converging plate boundaries.

ANSWERS:

1. Many earthquakes have occurred along the rim of the Pacific Ocean, especially in the following areas: Southern Alaska, Japan, and Chile. The area between China and India also has had many large earthquakes (This is the Himalaya Mountains, a compressional mountain range).
2. Large earthquakes are not likely to occur in Australia, the eastern coast of North America and South America, and in the interior of Africa.

PLATE TECTONIC CYCLE - EARTHQUAKES (5) POST LAB



1. Past earthquakes give us clues to where future earthquakes will happen. Using the map, list the areas where earthquakes are most likely to occur.

2. List the areas where large earthquakes are not likely to occur.
