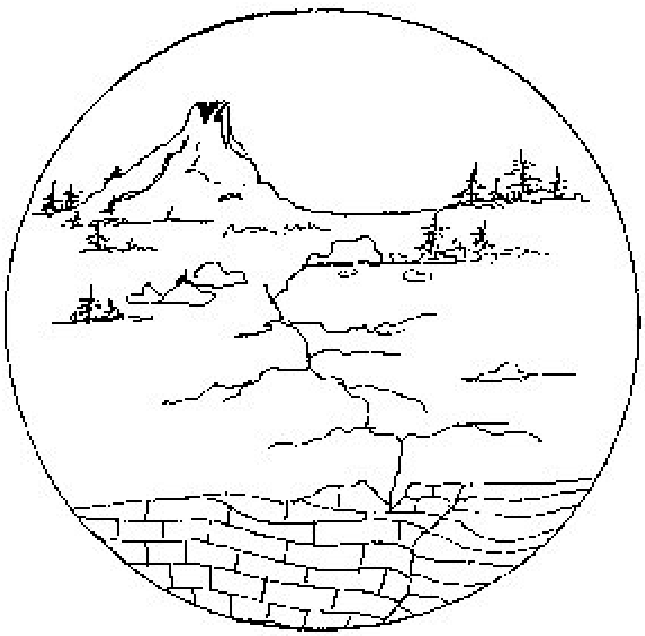
Plate Tectonic Cycle

Earth's Moving Force

FOURTH GRADE

HAZARDS



1 WEEK
LESSON PLANS AND
ACTIVITIES

PLATE TECTONIC CYCLE
OVERVIEW OF FOURTH GRADE

VOLCANOES

WEEK 1.
PRE: *Comparing different structures of volcanoes.*
LAB: *Modeling three types of volcanoes.*
POST: *Illustrating a volcanic eruption.*

EARTHQUAKES

WEEK 2.
PRE: *Comparing the Richter and Mercalli scales of earthquake measurement.*
LAB: *Testing how different shapes react during an earthquake.*
POST: *Describing a seismogram.*

PLATE TECTONICS

WEEK 3.
PRE: *Distinguishing the different layers of the Earth.*
LAB: *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.*
LAB: *Comparing structural damage caused by earthquakes.*
POST: *Contrasting the Richter and Mercalli scales.*

PLATE TECTONIC CYCLE - HAZARDS (4)

PRE LAB

Students predict structural damage during an earthquake.

OBJECTIVES:

1. Exploring structural damage caused by earthquakes.
2. Discovering that structures can be built to resist shaking from an earthquake.

VOCABULARY:

intensity
magnitude
structure
structure damage

Fault break, Turkey

MATERIALS:

world map
doll house
Earthquake Slideshow
Internet

BACKGROUND:

Different types of building materials respond differently to the shaking caused by seismic waves. Materials such as brick and stone break easily during an earthquake. The mortar that typically holds these materials together shakes loose; it has little strength. Brick, stone and mortar structures are very unsuitable dwellings for "earthquake country." In addition, non-bearing walls of bricks or stone are extremely dangerous because they are not structurally part of a house. Wood and steel are much better at withstanding seismic waves. Both of these materials flex as the earth shakes.

Weak materials can be reinforced to make them relatively safe. Reinforcing structures with a steel frame, or driving beams through a structure will help support it during shaking.

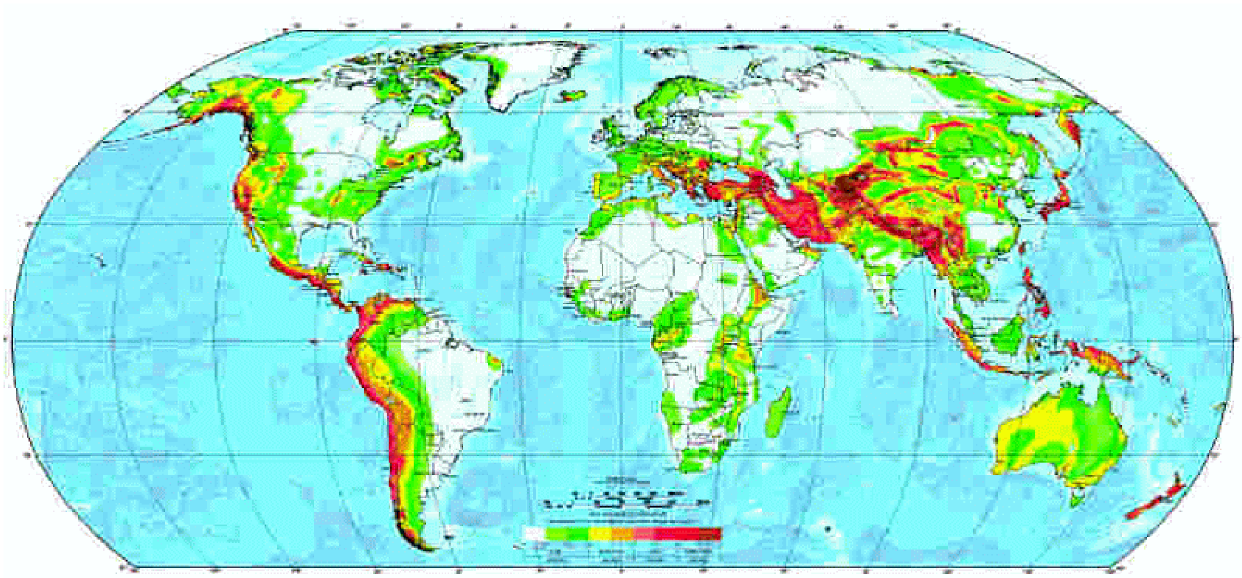
PROCEDURE:

1. Draw the chart on the different structures and how they react in an earthquake on the board. Have the students predict how each material will react to the shaking in a moderate earthquake. The answers are written in the diagram, but make the students think before you give them the answers.

	TYPE	PREDICT HOW MATERIAL WILL REACT IN AN EARTHQUAKE
A	WOOD BUILDING	very good
B	STEEL BUILDING	good
C	BRICK BUILDING	poor, especially if not reinforced
D	STONE BUILDING	poor
E	ADOBE BUILDING	poor
F	GRASS HUT	good (if roof is attached)

2. Discuss how these structures may be reinforced. If you have the doll house, you may want to discuss ways to reinforce structures inside the house. Go over each room. If you are unfamiliar with reinforcing techniques, the Association of Bay Area Governments website, http://www.abag.ca.gov/bayarea/eqmaps/fixit/fixit.html, has excellent, up-to-date information.

3. Use a world map and go over areas that are prone to disasters caused by earthquake. Point out the area around the Pacific especially from Alaska to Indonesia region; west coast of United States, and Andes Mountains. Areas around the India-China border is also active in earthquakes. Excellent slides are also available from the National Oceanographic and Atmospheric Administration (NOAA) at the website: http://www.ngdc.noaa.gov/seg/fliers/se-0801.shtml.



Red-browns are areas of highest earthquake risk. From Global Seismic Hazard Assessment Program.

PLATE TECTONIC CYCLE - HAZARDS (4)

LAB

> Students build earthquake resistant structures.

OBJECTIVES:

1. Comparing structural damage caused by earthquakes.
2. Designing structures that can withstand earthquakes.

VOCABULARY:

damage
disaster
intensity
magnitude
structural damage


Collapsed buildings, Peru

MATERIALS:

toys
Earthquake Slideshow
Shaker Boards (marbles, large plastic container lids, wooden boards)

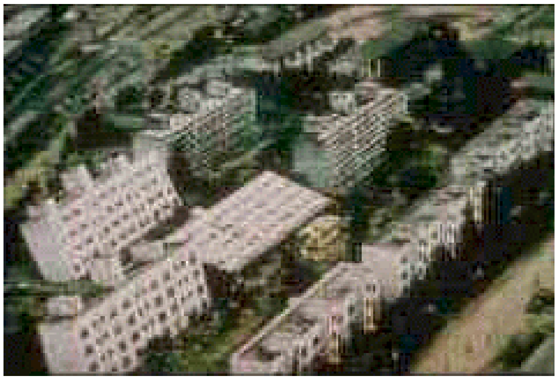
BACKGROUND:

It sometimes does not matter the intensity of the earthquake, but how the structures can withstand the force of the shaking. Sometimes landslides or tsunami's caused by the energy destroys an area. Below are some examples of such disasters.


Alaska, 1964

The southern Alaskan earthquake on March 27, 1964 had a 8.3 magnitude. It caused severe damage due to landsliding and from a large tsunami wave that hit the area. Many homes and businesses were damaged because the structures could not withstand the mass movement.

A moderate earthquake (5.5) in Peru in 1962 caused complete damage to villages. The unreinforced adobe and wood structures could not withstand the shaking. The intensity of the earthquake was not great, but the damage was.



Japan, 1984

On June 16, 1984 a large earthquake was felt in the Nigata region. Large buildings collapsed due to the shaking. In some areas the ground was unstable and caused buildings to tumble. A 6.4 earthquake in San Fernando Valley region, just north of Los Angles, caused major damage to hospitals, homes, and freeways. After this earthquake, California created strict laws so builders would make earthquake resistant buildings.

In September, 1985, two large earthquakes (8.1 and 7.3) paralyzed Mexico City. Residents had no clean water for weeks. Large buildings collapsed, and people were trapped. Mexico did not use reinforced concrete structures, which could not take the intense shaking.

Hospital, San Fernando, California, 1971

Mexico City, 1985

PROCEDURE:

1. In this exercise, students experiment with structures. They design and build models composed of different types of materials on shaker tables, and then simulate earthquakes of various strengths to test their designs.

2. If necessary, gather the materials to make shaker boards before lab. Boards should be about 12 x 18 inches (or longer than they are wide), with at least 3/4 inch thickness.

a. Place the marbles in a plastic top that you might get in a coffee can. The marbles will act as ball-bearings in the experiment.

b. Balance the shaker board on top of the marbles. This completes the shaker table.

3. Demonstrate how the shaker board works to the class. When it is "jolted", it simulates the movement of the Earth's surface (an earthquake). The "earthquake" creates energy that moves along the surface of the shaker table as waves. Control the intensity by how fast you shake the board. Demonstrate to students that a strong earthquake occurs when you shake quickly; a weak earthquake occurs when you shake it less violently; a moderate earthquake occurs when you shake it somewhere in between. On the lab worksheet, "slow-long" means to move the board in the long direction slowly (this is relative). "Quick-long" refers means moving the board in the long direction quickly. This will illustrate that intensities B and D (both quick) represent a high number on the Richter Scale while A and C represent a low Richter number.

4. Using a different building block set at each station, have the students build an "earthquake proof" structure. Next, have them place different "real life" models in and outside their structures. Test the models using the four intensities and have students record their results.

5. Have students discuss their results. Have them analyze why some students recorded different amounts of damage. They should realize that the building materials are an important factor. In addition, their structures lack foundations which in general will make them less stable than real buildings.

6. You can extent this lab very easily by having the students redesign their structure to try and make it more resistant. You may want to go over more resistant shapes that the students learned in a previous lab. You may also want to describe the different types of reinforcement of structures.

PLATE TECTONIC CYCLE - HAZARDS (4) LAB

PROBLEM: Can buildings be constructed to withstand earthquakes?

PREDICTION: ____

EXERCISE I. Examine the slides of the disasters caused during the following earthquakes. Record what happened and the intensities of each earthquake.

	LOCATION	MAGNITUDE	DESCRIBE DAMAGE
1.	Anchorage, Alaska		
2.	Los Angeles, Calif.		
3.	Mexico City, Mexico		
4.	Nigata, Japan		
5.	Peru		

EXERCISE II. You previously did an exercise on different earthquake intensities. Let's use the same directions you used in the previous exercise to see what will cause harm in different situations. Each table will have different "real life" models to place within the different types of structures. Create a situation where people can be found outside and inside. Shake the table and see what happens. After testing the models we will talk about the different disasters.

TYPE OF BUILDING MATERIAL:___________________________

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

CONCLUSION: How can you design your structure to withstand a moderate earthquake?
____

PLATE TECTONIC CYCLE - HAZARDS (4)

POST LAB

Students evaluate the Modified Mercalli and Richter Scales.

OBJECTIVES:

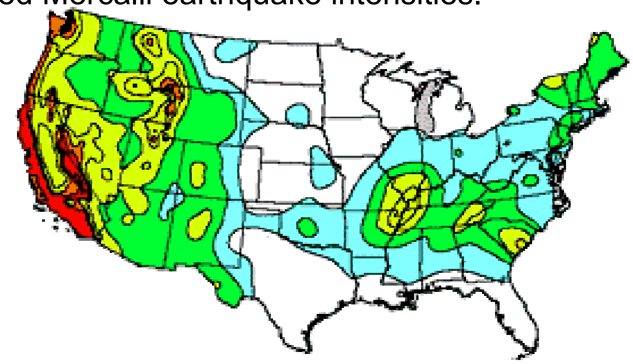
1. Comparing the Richter and Modified Mercalli scales.
2. Distinguishing the Richter and Modified Mercalli earthquake intensities.

VOCABULARY:

Modified Mercalli Scale
Richter Scale

MATERIALS:

worksheet



Earthquake risk in United States. Reds and yellows are highest risk, blue and white are least.

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). Seismologists use several methods to measure the intensity of an earthquake. This post lab focuses on two such scale.

First, 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 height (amplitude) of the waves produced by the earthquake. The Richter Scale is an absolute scale; wherever an earthquake is recorded, it will measure the same on the Richter Scale.

Second, the Modified Mercalli scales measures how people feel and react to the shaking of an earthquake. It is a relative scale, because people experience different amounts of shaking in different places. It is based on a series of key responses such as people awakening, the movement of furniture, and damage to structures. In general, the further one is from the epicenter of an earthquake, the less shaking is experienced. When an earthquake occurs, it is important for a student to have a way to interpret the size of the event. Learning the Modified Mercalli scale can give students this ability. It is sufficient to distinguish between small, moderate, or large earthquakes. This knowledge can help a student determine a course of action during and after the shaking.

PROCEDURE:

1. Using the worksheet, review the Modified Mercalli and Richter Scales with the students. Compare the two scales. If you live in an earthquake prone area, you may wish to have your students recall earthquakes that they have experienced. Ask them what Modified Mercalli scale rating they would give it.

2. Have the students complete the worksheet. They are asked to predict the Modified Mercalli and Richter Scale magnitudes for a series of earthquake descriptions.

ANSWERS:

1. IV - moderate: 4.3-4.8
2. X - disastrous; 7-7.3
3. II - feeble; 3.5-4.2
4. VI - very strong; 5.5-6.1
5. VIII - destructive; 6.2-6.9

Mercalli scale = measures intensity compared to human terms
Richter scale = strength of earthquake due to ground motion

PLATE TECTONIC CYCLE - HAZARDS (4)

POST LAB

DIRECTIONS: Determine the Modified Mercalli Scale intensity and Richter magnitude of each of described earthquakes. Use the tables on the next page to guide your answers.

1. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing cars may rock slightly. The vibration feels similar to the passing of a truck.

MERCALLI______________ RICHTER______________

2. Damage is negligible in buildings of good design and construction: slight to moderate in well-built ordinary structures; considerable damage in poorly build or badly designed structures; some chimneys broken.

MERCALLI______________ RICHTER______________

3. Not felt except by a very few under especially favorable conditions.

MERCALLI______________ RICHTER______________

4. Felt by all, many frightened. Some heavy furniture is moved; a few instances or fallen plaster. Damage slight.

MERCALLI______________ RICHTER______________

5. Damage slight in specially designed structures; considerable damage in ordinary substantial building with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.

MERCALLI______________ RICHTER______________

6. Define the Mercalli Intensity Scale: _______________________________________

____

7. Define the Richter Magnitude Scale: ______________________________________

____

PLATE TECTONIC CYCLE - HAZARDS (4) - POST LAB

Scale of Earthquake Intensities with Approximately Corresponding Magnitudes

MERCALLI INTENSITY	DESCRIPTION	RICHTER MAGNITUDE
I.	*INSTRUMENTAL*: detected only by seismographs	**3.5**
II.	*FEEBLE*: noticed only by sensitive people	**4.2**
III.	*SLIGHT*: like the vibrations due to a passing train; felt by people at rest, especially on upper floors	**4.3**
IV.	*MODERATE*: felt by people while walking; rocking of loose objects, including standing houses	**4.8**
V.	*RATHER STRONG*: felt generally; most sleepers are awakened and bells ring	**4.9 - 5.4**
VI.	*STRONG*: trees sway and all suspended objects swing; damage by overturning and falling of loose objects	**5.5 - 6.0**
VII.	*VERY STRONG*: general alarm; walls crack; plaster falls	**6.1**
VIII.	*DESTRUCTIVE*: car drivers seriously disturbed; masonry fissured; chimneys fall; poorly constructed buildings damaged	**6.2**
IX	*RUINOUS*: some houses collapse where ground begins to crack, and pipes break open	**6.9**
X	*DISASTROUS*: ground cracks badly; many buildings destroyed and railway lines bent; landslides on steep slopes	**7.0 - 7.3**
XI	*VERY DISASTROUS*: few buildings remain standing; bridges destroyed; all services (railways, pipes and cables) out of action; great landslides and floods	**7.4 - 8.1**
XII	*CATASTROPHIC*: total destruction; objects thrown into air; ground rises and falls in waves	**> 8.1**