Plate Tectonic Cycle

Earth's Moving Force

SIXTH GRADE

HAZARDS

1 WEEK
LESSON PLANS AND
ACTIVITIES

PLATE TECTONIC CYCLE
OVERVIEW OF SIXTH GRADE

VOLCANOES

WEEK 1.
PRE: *Comparing the structure of different types of volcanoes.*
LAB: *Plotting 3 different types of volcanoes on a globe.*
POST: *Researching where volcanoes occur around the world.*

EARTHQUAKES

WEEK 2.
PRE: *Comparing energy waves from earthquakes.*
LAB: *Experimenting with energy waves through different substances.*
POST: *Observing fault movements.*

PLATE TECTONICS

WEEK 3.
PRE: *Locating different plates.*
LAB: *Illustrating the difficulty in defining and counting plates.*
POST: *Observing the movement of the Earth's crust.*

HAZARDS

WEEK 4.
PRE: *Comparing earthquakes in Alaska and Hawaii.*
LAB: *Designing structures that withstand different earthquake intensities.*
POST: *Comparing earthquake dangers in different areas.*

PLATE TECTONIC CYCLE - HAZARDS (6)

PRE LAB

Students compare earthquakes using the Modified Mercalli Scale.

OBJECTIVES:

1. Comparing earthquakes in Alaska and Hawaii.
2. Exploring the Modified Mercalli Scale.

VOCABULARY:

converge
Mercalli Scale

MATERIALS:

worksheet
map with Pacific "Ring of Fire"

Earthquake rupture along a fault line

BACKGROUND:

Hawaii and Alaska both have volcanoes and earthquakes. The active Hawaiian volcanoes and earthquakes are concentrated on the big island of Hawaii. Volcanic activity decreases progressively with each island further to the northwest in the chain. The age of the volcanoes increases in the same direction. Hawaii is not on a plate boundary, but in the middle of the Pacific Plate.

The Hawaiian volcanoes are not explained by plate tectonics, but as "a hotspot." A hotspot is a relatively stationary plume, or rising column, of magma in the Earth's mantle, below the plates. When this rising plume strikes the bottom of the Pacific Plate, its melts its way through it. Some of this magma erupts, building the Hawaiian Islands. New volcanoes form as the plate keeps moving over the hotspot. This is why the volcanoes get older to the northwest; they formed in the past, when that part of the plate was over the hotspot. They have since been moved away.

The southern part of Alaska has volcanoes because it is at the converging plate boundary between the Pacific Plate and the North American Plate. At this boundary, the Pacific Plate is subducting into the mantle. As it subducts, it melts, generating magma that rises to form the volcanoes. Large earthquakes occur as the plate subducts. The volcanoes and earthquakes caused in Alaska are thus explained by the theory of plate tectonics.

In this exercise, the students will use the Modified Mercalli Scale to determine whether Hawaii or Alaska has stronger earthquakes. They will learn that Alaska has bigger earthquakes. This is because it is at a converging plate boundary, whereas Hawaii is not.

PROCEDURE:

1. Have the students examine map with earthquakes and volcanoes plotted on the map. Have them compare where the Hawaiian Islands and Alaska fit into the global pattern of earthquake activity. They should realize that Hawaii is more isolated, where Alaska is part of a larger zone called the Pacific "Ring of Fire."

2. Have the students complete the worksheet.

ANSWERS:

1. Which state had the most earthquakes? *ALASKA*
2. Which state had the strongest earthquakes? *ALASKA*

3. Color in red those areas that you feel are very dangerous and hazardous places to live. Why are those areas so dangerous?

The most hazardous and dangerous areas are found in Alaska. Those areas are dangerous because they lie along a converging plate boundary.

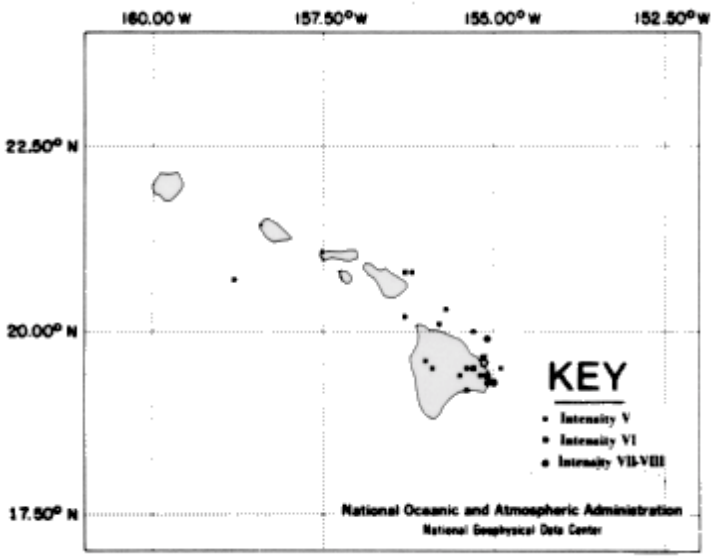
PLATE TECTONIC CYCLE - HAZARDS (6) PRE LAB

Examine the maps of Alaska and Hawaii. These maps show Modified Mercalli Scale intensities of earthquakes that occurred between the years of 1971-1980. The higher the intensity of the earthquake, the stronger it was.

1. Which state had the most earthquakes? _____

2. Which had the strongest earthquakes?
_____
_____

3. Color in red the areas you think would be the most hazardous to live in. Why are these areas dangerous?
_____
_____
_____
_____



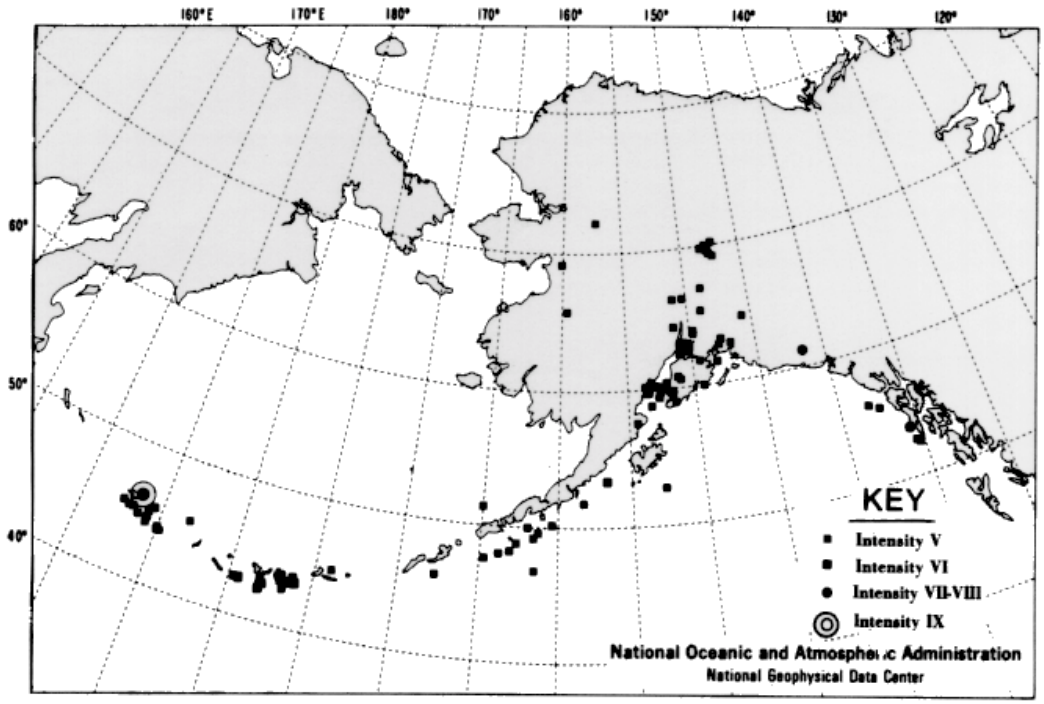


PLATE TECTONIC CYCLE - HAZARDS (6)

LAB

Students build earthquake resistant structures.

OBJECTIVES:

1. Exploring damage created by earthquakes.
2. Designing structures that can withstand different earthquake intensities.

VOCABULARY:

Modified Mercalli Scale
Richter Scale

MATERIALS:

worksheet
Plate Tectonic Cycle - Hazards (6)
Earthquake Slideshow
shaker tables
small building toys

Building collapse triggered by seismic waves

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 because it is not strong. 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.

Architects and engineers can also design and construct buildings that can withstand intense ground shaking. For example, designs that are broader at the base than at the top or homes that are not more than two stories high survive earthquakes fairly well. Ornate pillars or facades (fake fronts) on a home do not survive shaking well. Engineers need to consider the rigidity of the building material. The material should be able to bend or flex without damage in an earthquake. For instance, wood bends but brick and mortar does not. Engineers need to reinforce brick masonry by putting steel beams through the structures. Many buildings were built prior to strict earthquake codes, so in many places such reinforcement is necessary. Bracing a structure is an alternative way to prevent

damage. Engineers and architects can make structures earthquake resistant, but they cannot make them earthquake proof. If you are unfamiliar with reinforcing techniques or want to learn more, the Association of Bay Area Governments website has excellent, up-to-date information (www.abag.ca.gov/bayarea/eqmaps/fixit/fixit.html).

PROCEDURE:

1. If necessary, gather the materials to make shaker boards before lab. You require a flat board about 3/4 inch thick with a length longer than its width (12 x 18 inches). Here are directions for assembling them:

a. Place the marbles in the plastic top. 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.

2. Set up stations with shaker tables and building materials. Toys can include Lincoln Logs, Legos, Slinky building toys, or any other building toys that students can bring in from home.

3. Discuss with students that the hazards of an earthquake are directly related to the magnitude of seismic waves. Have the class make a list of earthquake damage on the board. It should include such school and home damage as unreinforced masonry, bookshelves that are not secured, or houses that are not bolted to their foundations. Explain that some hazards can be avoided by taking precautions before an earthquake occurs.

4. Show the class the images of building damage caused by earthquakes from the Earthquake Slideshows.

5. 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.

6. Have the students complete the lab, following the worksheet. Emphasize trying to improve their building structures to prevent damage.

You may want them to design a structure and shake it once, before you discuss how

you can reinforce the structure. If you talk about it before they build the first structure their structures will tend to have those features that you discuss already in them. The objective of this lesson is for them to see that a dramatic change in the strength of a structure that they have reinforced. You make want to have double stick velcro available, so students can secure their foundations to the shaker board. This exercise has become to known as "Save the Baby."

7. Discuss different real building materials and their relative resistance to earthquakes. The students should be aware that most structures have foundations, unlike the models they are using. You may want to highlight the structures that were the most resistant.

PLATE TECTONIC CYCLE - HAZARDS (6) LAB

PROBLEM: What types of damage can be caused by an earthquake?
PREDICTION:_____
PROCEDURE:

Use the following intensities on the Shaker Boards:

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

Build a structure that you feel can withstand an earthquake. Test the different intensities described above. Test A, B, C, and then D. If the structure falls down during one intensity rebuild it the same way and test the other intensities. Redesign structure and retest only those intensities in which the original design failed.

Type of building material:_____

INTENSITY	DRAW STRUCTURE AND STATE THE DAMAGE THAT OCCURRED
A RECORD ANY CHANGES MADE:	
B RECORD ANY CHANGES MADE:	
C RECORD ANY CHANGES MADE:	
D RECORD ANY CHANGES MADE:	

CONCLUSION: Can structures be designed to withstand different earthquake intensities? How?_____
_____

PLATE TECTONIC CYCLE - HAZARDS (6)

POST LAB

Students write an essay evaluating the safety of their homes.

OBJECTIVES:

1. Analyzing what to do in case of an earthquake.
2. Preparing for an earthquake.

VOCABULARY:

disaster
earthquake hazard

MATERIALS:

worksheet

Earthquake damage to homes in Peru.

BACKGROUND:

There are no rules which can eliminate all earthquake danger. However, damage and injury can be greatly reduced by following common sense. The following excerpt is from a U.S. Geological Survey publication, which can help direct your students on what to do after an earthquake.

* Check for injuries to your family, to those around you, and others in your neighborhood. Do not attempt to move seriously injured persons unless they are in immediate danger of further injury.
* Check for fires or fire hazards.
* Wear shoes in all areas near debris or broken glass.
* Check utility lines and appliances for damage. If gas leaks exist, shut off the main gas valve. Shut off electrical power if there is damage to your house wiring. Report damage to the appropriate utility companies and follow their instructions. Do not use matches, lighters, or open-flame appliances until you are sure that there are no gas leaks. Do not operate electrical switches or appliances if gas leaks are suspected.
* Avoid downed power lines or objects touched by the downed wires.
* Immediately clean up spilled medicines, drugs, and other potentially harmful materials.
* Obtain emergency water from water heaters, toilets tanks, melted ice cubes, and canned vegetables if the water is off.
* Check to see that sewage lines are intact before permitting continued flushing of toilets.
* Do not eat or drink anything from open containers near shattered glass. Liquids

may be strained through a clean handkerchief or cloth if danger of glass contamination exists.

* Check you freezer and plan meals to use foods which will spoil quickly if the power is shut off.

* Use outdoor charcoal broilers for emergency use.

* Do not use your telephone except for genuine emergency calls. Turn on your radio for damage reports and information.

* Check your chimney over its entire length for cracks and damage, particularly in the attic and at the roof line. Unnoticed damage can lead to a fire. The initial check should be made from a distance. Approach chimneys with caution.

* Check closets and storage shelf areas. Open closet and cupboard doors carefully and watch for objects falling from shelves.

* Do not spread rumors. They often do great harm after disasters.

* Do not go sightseeing, particularly in beach and waterfront areas, where seismic sea waves may strike. Keep the streets clear for passage of emergency vehicles.

* Be prepared for additional earthquake shocks called "aftershocks." Although most of these are smaller than the main shock, some many be large enough to cause additional damage.

* Respond to requests for help from police, fire fighters, civil defense, and relief organizations, but do not go into damaged areas unless your help has been requested. Cooperate fully with public safety officials. In some areas, you may be arrested for getting in the way of disaster operations.

PROCEDURE:

1. Read the list of post earthquake actions to the class.

2. Have the students write an essay, as a homework assignment, on what they would do at home after a big earthquake. You might want to give them the lead sentence, "It was a hot, blistering day when the big earthquake occurred. I was home..."

3. Have the students read their essays. Have them discuss whether good procedures were followed. Do not just give the students your evaluation, but have other students analyze the logic. This helps to reinforce the logic of responding to a disaster.

4. Please remember that the answers may vary for different situations. Students should be taught to THINK about the hazards and react accordingly...not to just "duck" and "cover."

PLATE TECTONIC CYCLE - HAZARDS (6) POST

Write an essay with the following lead sentence.

"It was a hot, blistering day when the big earthquake occurred. I was home..."