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Defining an Earthquake

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An earthquake is a natural phenomenon like rain. Earthquakes have occurred for billions of years. Descriptions as old as recorded history show the significant effects they have had on people's lives. Long before there were scientific theories for the cause of earthquakes, people around the world created folklore to explain them. In simple terms, earthquakes are caused by the constant motion of Earth's surface. This motion creates buildup and releases energy stored in rocks at and near the Earth's surface. Earthquakes are the sudden, rapid shaking of the Earth as this energy is released.

> At half-past two o'clock of a moonlit morning in March, I was awakened by a tremendous earthquake, and though I had never before enjoyed a storm of this sort, the strange, thrilling motion could not be mistaken . Both glad and frightened, [I shouted]: "A noble earthquake! A noble earthquake!" feeling sure that I was going to learn something.
>
> *John Muir, 1872*

Defining an Earthquake

An earthquake is a natural occurrence, like rain. Earthquakes affect almost every part of the Earth and like rain they can be either mild or catastrophic. Over the course of geological time, earthquakes, floods, and other natural events have helped to shape the surface of our planet.

An earthquake may last only a few seconds, but the processes that cause earthquakes have operated within the Earth for millions and millions of years. Until very recently, the cause of earthquakes was an unsolved mystery. It was the subject of fanciful folklore and equally fanciful learned speculation by peoples throughout the world.

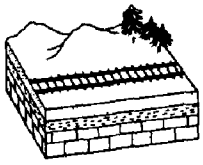
> In a legend from Siberian Kamchatka, a god named Tuli drives an Earth-laden sled pulled by flea-infested dogs. When the dogs stop to scratch, the Earth shakes.
>
> ***
>
> Some say the Earth was fevrous [feverish] and did shake.
>
> Shakespeare, Macbeth, III

In the mid-1960s, many scientific observations and explanations of earthquakes came together in the theory of plate tectonics. We'll be exploring that subject in later units. In this unit we consider both scientific and popular explanations for the phenomenon and look at the patterns of earthquake occurrence worldwide.

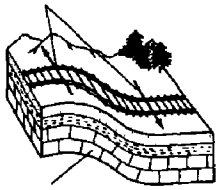
An Earthquake Is . . .

An earthquake is a sudden, rapid shaking of the Earth caused by the release of energy stored in rocks. This is a brief definition which students of all ages can master. A full definition of the term, however, would need to include a good deal more information.

Students may be surprised that we speak of rocks and rock layers, because in many places the rock material of the Earth's crust is covered by accumulations of sand or soil. Remind them that even beneath the sediment in river valleys, plains, and beach areas, some kind of rock is always present.

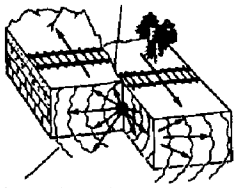


Pressure Direction



Deformed Rocks

Fault



Earthquake Waves

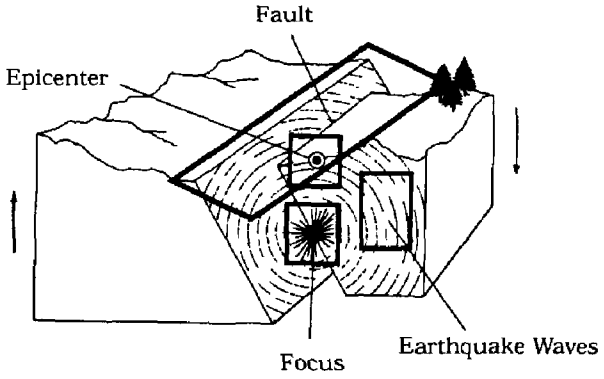
Earthquake shaking may cause loss of life and destruction of property. In a strong earthquake the ground shakes violently. Buildings may fall or sink into the soil. Rocks and soil may move downhill at a rapid rate. Such landslides can bury houses and people.

Folklore and Scientific Theory

Because strong earthquakes have such disastrous effects, it is not surprising that people have always looked for ways to explain their origin. We find many nonscientific explanations of earthquakes in the folklore of civilizations around the world. We call these traditional narratives earthquake *legends*. Some of them are still being told today.

What we have learned in recent years, however, largely from the study of earthquakes, is that the Earth around us is not static, like a stage set for a play. The Earth's rock layer is broken into large pieces. These pieces are in slow but constant motion. They may slide by smoothly and almost imperceptibly.

From time to time, the pieces may lock together, and energy that accumulates between the pieces may be suddenly released. This sudden release of energy, like the snapping of a rubber band that has been stretched too far, is what we call *elastic rebound*. Energy is released and travels through the Earth in the form of waves. People on the surface of the Earth experience an earthquake.



Earthquake Epicenters

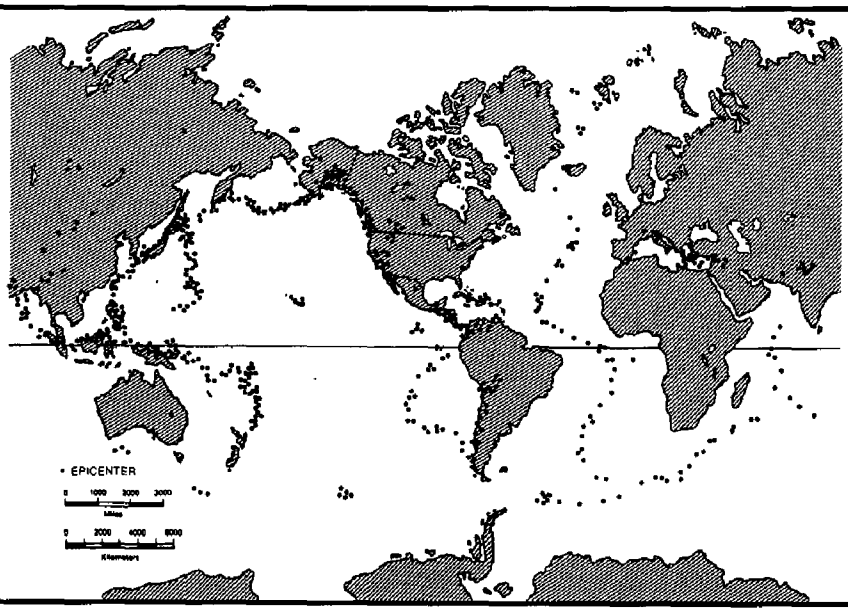
The *epicenter* of an earthquake is the place on the Earth's surface directly above the focus (or *hypocenter*), the place inside the Earth where the quake originates. Earthquake foci are usually somewhere between the surface and 100 km in depth. In some areas, however, foci may be as deep as 700 km.

Even a glance at an earthquake epicenter map shows that most earthquakes have occurred in certain well-defined regions of the Earth. Because these regions tend to be relatively long and narrow, they are sometimes referred to as earthquake *belts*.

One large belt of epicenters runs through the Mediterranean Sea, Asia Minor, the Himalayan mountains, and into the eastern Indian Ocean. A second large belt runs northward through the western Pacific Ocean, the Japanese islands, the Aleutian islands, and the west coasts of North and South America. The longest belt of earthquake epicenters runs through the central regions of most ocean basins. The world epicenter map also shows some shorter belts of epicenters.

Chances are, even if your school is far from any earthquake epicenter, your students already have some ideas about earthquakes and what causes them. In the lessons that follow, you will invite them to tell you what they think.

Master 7, World Map with Epicenters. The dots represent earthquakes with magnitudes ≥ 5 0 recorded from 1980-1990 by the National Earthquake Information Center, USGS.



What Is an Earthquake?

Content Concepts

1. An earthquake is a sudden, rapid shaking of the Earth caused by the release of energy stored in rocks.

2. Legends are traditional narrative explanations of natural phenomena that evolve when scientific explanations are not available

Vocabulary

earthquake
legends

Objectives

Students will
—describe personal experiences with earthquakes.
—construct an earthquake model.
—observe effects of a simulated earthquake
—define the term *legend,* and listen to a legend.
—suggest possible causes of earthquakes.
—write and illustrate original legends.
—draw pictures to illustrate their ideas about the Earth's interior.

Assessment

Restate The Turtle Tale. Draw or tell three imaginative, non-scientific explanations for Earth movement.

Learning Links

Language Arts: Writing a description of a demonstration (older students), sharing ideas about the possible causes of earthquakes, building vocabulary, listening to a legend, creating an original legend

Art: Illustrating the legends, expressing ideas about the Earth's interior in drawing, contributing to a mural

Social Studies: Observing the effects of a simulated earthquake on model buildings, predicting the effects on people's lives, discussing a Native American legend, locating San Gabriel on a U.S. map

Activity One: Tremble Here, Tremble There

Materials for the teacher
- A small table or desk that moves easily

Materials for each small group of students
- A shallow box partially filled with sand or soil
- An assortment of paper plates, cups, and small boxes that can be stacked to represent a building.

Procedure

1. Introduce the topic with a class discussion based on the following questions:

   What does the word *quake* mean?

   What do we mean when we say people are "quaking in their boots"? (Invite students to imitate a person trembling.)

   Have you ever been on a bridge when it shook from heavy traffic, or near the railroad tracks when a train passed over? (Invite students to demonstrate shaking and vibrating.) What do you suppose is happening to the Earth when there is an earthquake?

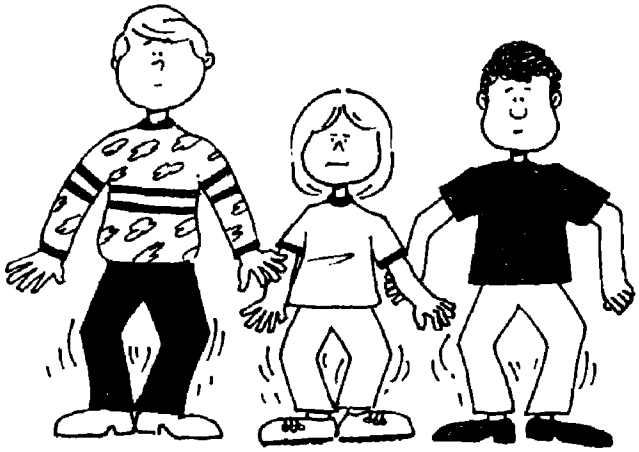
   Has anyone here ever felt an earthquake? (Allow students time to express their observations and feelings.)

earth • quake

An earthquake is a sudden, rapid shaking of the Earth caused by the release of energy stored in rocks.

leg • ends

Legends are traditional narrative explanations of natural phenomena that evolve when scientific explanations are not available.



2. Tell students they are going to make a model to demonstrate what happens during an earthquake. Follow these steps.

a. Invite a small group of students to pile plates, cups, and small boxes on top of each other in the filled box to form a tall structure. (Either have enough materials for each group to construct one model, or have the groups take turns.)

b. Place the large box on the cart, table, or desk.

c. Shake the cart, table, or desk until the structure topples.

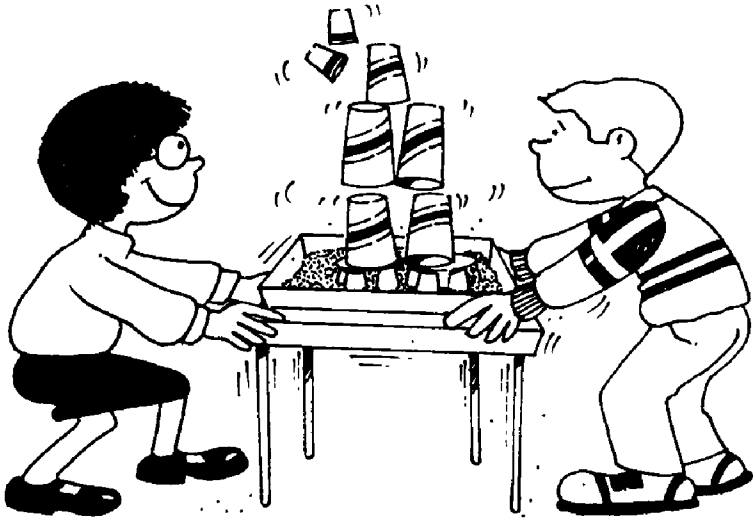
d. Ask the students to comment on what they see

What does the sand or soil represent? (the Earth)

What do the plates, cups, and boxes represent? (a tall building)

What moves? (the Earth and the building)

What happens to the building? (various degrees of damage)



Children will enjoy simulating various levels of force and observing the results

Activity Two: Tremors and Turtles

Materials for the teacher
- Master 1a, U.S. Map
- Master 2, The Turtle Tale

Materials for each student
- 2 small (6") paper plates
- 1 straw
- Green construction paper
- Handout from Master 3, Turtle Tale Pop-Up Puppet
- Scissors
- Markers or crayons
- Stapler

Teacher Take Note: **See the Appendix, Earthquake Legends, for more tremor tales from around the world.**

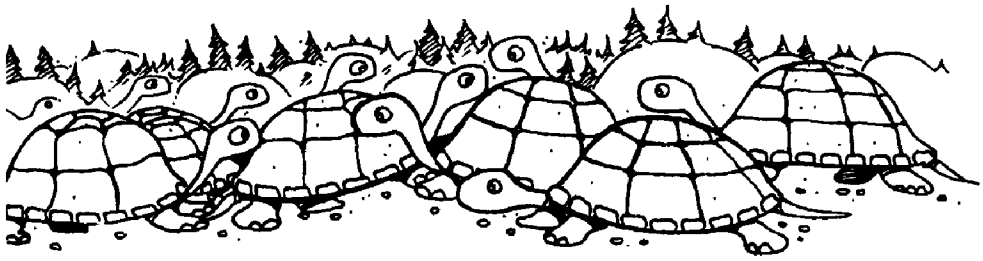
Procedure

1. Discuss the origin of legends.

   How can we understand about earthquakes? (from science)

   Yes, but earthquakes have been happening for a long time, and we have only been studying them with scientific instruments for a short time. How do you suppose people explained them before that? (with stories)

   These stories are called legends.



Master 1a, U.S. Map. San Gabriel is marked with an asterisk (*)

Teacher Take Note: Encourage older students to design their own puppets. Younger students may enjoy the turtle dot-to-dot exercise. (Master 4)

2. Point out the San Gabriel Valley on a U.S. map. (Indicate the southwestern part of California, in the neighborhood of Los Angeles—see map.)

3. Introduce the story on Master 2, The Turtle Tale, and read it aloud. This is a story that was told by a group of Native Americans who lived where earthquakes are common, in the San Gabriel Valley. People call them the *Gabrielinos* (Ga • bree • uh • leé • nos).

4. Discuss the story.

Did you enjoy the story? Why or why not?

Do you think the story is true? Why or why not? (Students will give a variety of reasons why it is not: Turtles are not that big Turtles are not that strong. Turtles can't talk.)

Why do you think the Indians developed this story? (When an earthquake or any other frightening event occurs, people want to understand what causes it. Understanding helps them to be less afraid)

Have you ever asked an older person to explain something that frightened you, and felt better afterwards?

5. Have students make a Turtle Tale Pop-Up Puppet. Distribute Master 3 (pattern) to students and give these instructions:

Staple plates together top to top creating a rounded shell for the turtle

Copy pattern onto green construction paper.

Cut out 4 feet, 1 head, and 1 tail.

Attach feet onto shell (paper plates).

Staple tail to one end of the straw and the head to the other.

Slip straw between plates at a space between staples.

Decorate the shell.

Pull the tail to make the head go into the shell. Push the tail to make it come out again.

6. Have students act out the legend of the Turtle Tale with their puppets. You will need seven students to portray the turtles and one for the Great Spirit. Students can mime the action and dialogue as the teacher reads aloud.

Activity Three: Earth Mural

Materials for the teacher
- A large roll of paper for the mural

Materials for each small group of students
- Drawing paper and crayons or oil pastels
- Scissors

Procedure

1. Ask each student to draw a large circle representing the Earth and draw a picture of what there might be inside to make it move. Help students dictate or write explanations that match their drawings.

2. Create a class mural by directing the students to cut out their drawings and paste them to a large piece of paper. The explanations students have written or dictated may be displayed beside the drawings.

3. Share all the student stories and the legends. Accept all ideas without evaluation. End the lesson without providing any further information as to the actual causes of earthquakes (Direct curious students to children's encyclopedias and other classroom or library reference materials When the discussion resumes in the next lesson, you will find that students have gained some information on their own.

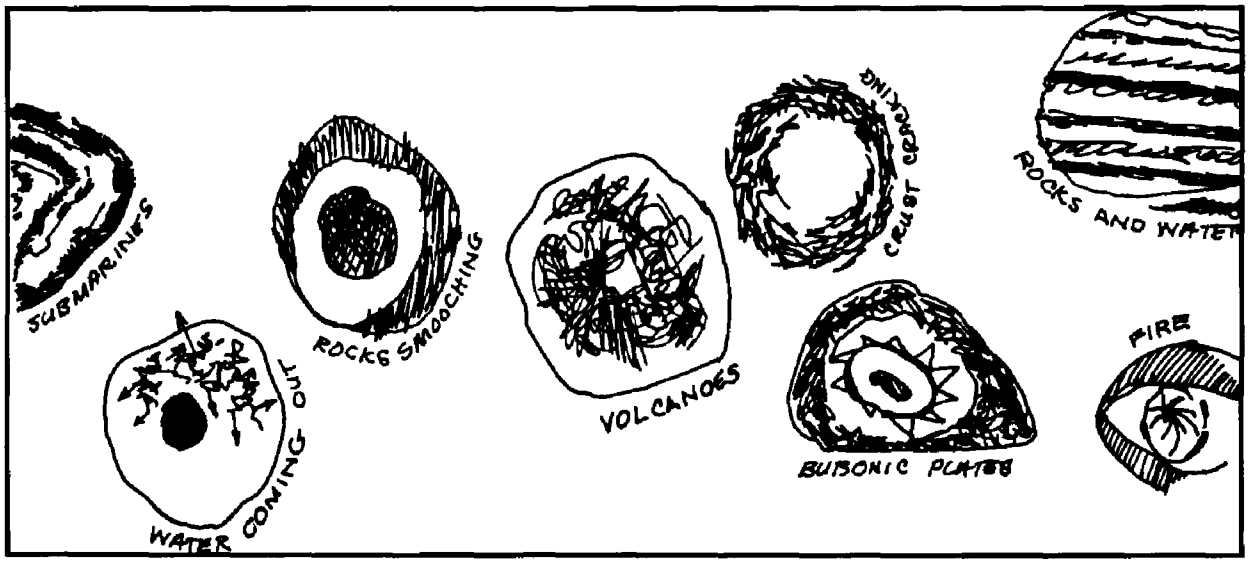
Extensions

1. Ask students to create their own legends to explain earthquakes. Have them dictate, draw, or write their stories.

2. Act out the original legends with paper bag puppets. Provide lunch bags and art materials. Give the students time to make their puppets and rehearse before the final presentation.

3. Ask the children to describe an imaginary journey to the center of the Earth. What might they find there that could cause earthquakes?

One group of first graders made these drawings of the Earth's insides



People Explain Earthquakes

Content Concepts

1. An earthquake is a sudden, rapid shaking of the Earth caused by the release of energy stored in rocks.

2. Legends are traditional narrative explanations of natural phenomena that evolve when scientific explanations are not available.

3. Earthquake energy is released in the form of waves.

Vocabulary

earthquake
legend
culture

Objectives

Students will
—describe personal experiences with earthquakes.
—write and illustrate a paragraph about what they think causes earthquakes.
—read and illustrate earthquake legends.
—locate the cultures that developed the various legends on a world map.
—compare these locations to the major areas of earthquake activity around the world.
—state what scientists now believe is the cause of earthquakes.
—observe the effects of a simulated earthquake

Learning Links

Language Arts: Class discussion, writing expository paragraphs, sharing ideas

Social Studies: Locating countries on the world map

Art: Illustrating students' earthquake theories, illustrating legends

Assessment

Explain or draw a picture of what scientists believe is the cause of earthquakes.

Activity One: Earthquake Experiences

Materials for the teacher
- Magazine or newspaper accounts of earthquakes, or books, slides, movies, and other media dealing with the subject

Materials for the students
- Drawing paper
- Crayons or markers
- Tape

Procedure

1. Begin a discussion by asking students what they think an earthquake is. List responses on the board.

2. Ask if any of your students has ever experienced an earthquake. Invite those who have to share their experiences with the class.

3. If the students do not have much personal experience to draw on, use some of the resources suggested above to provide a basis for the unit You may also want to invite someone who has experienced an earthquake to visit the class

4. Distribute paper and art supplies. Ask the students to make drawings illustrating what they think causes earthquakes. They may write paragraphs to accompany the pictures and combine them as a display for the wall or bulletin board. Volunteers can present their ideas to the class. Make no comments about the correctness of their ideas at this point.

earth • quake

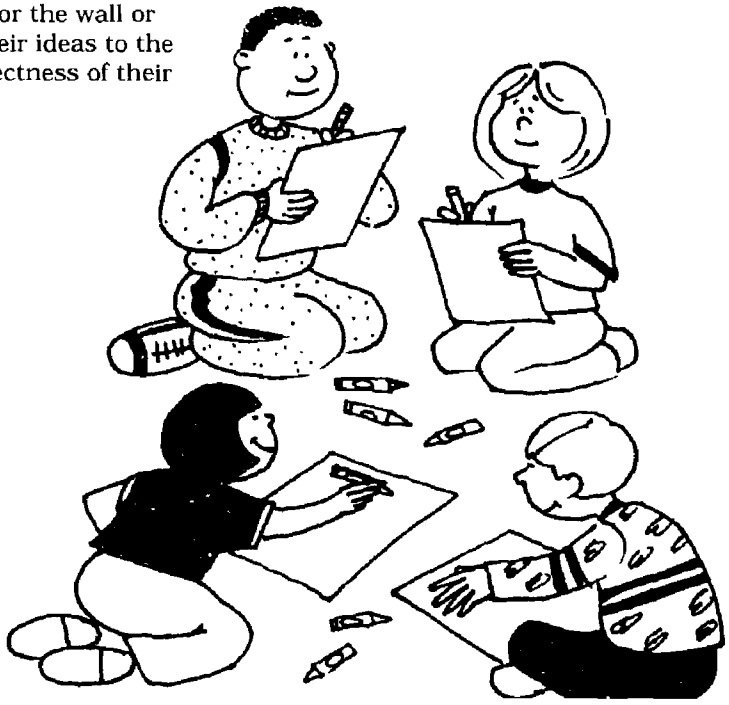
An earthquake is a sudden, rapid shaking of the Earth caused by the release of energy stored in rocks.

leg • ends

Legends are traditional narrative explanations of natural phenomena which evolve when scientific explanations are not available.

cul • ture

A culture is the special way of life common to a group of people.



Activity Two: Earthquake Legends

Teacher Take Note: Some of these legends come from parts of the world where quakes do not occur frequently. An earthquake is a highly dramatic, memorable event. Some cultures may have borrowed oral traditions based on events outside their own geographic region. Others may have carried legends with them as they migrated from one part of the globe to another. Be prepared to find a less than exact correlation between legends and earthquake activity.

Materials for the teacher
- Large wall map of the world, or transparency made from Master 5, World Map
- Tape or pins
- Colored yarn
- Transparency made from Master 6, World Map with Legend Sites
- Transparency made from Master 7, World Map with Epicenters
- Overhead projector

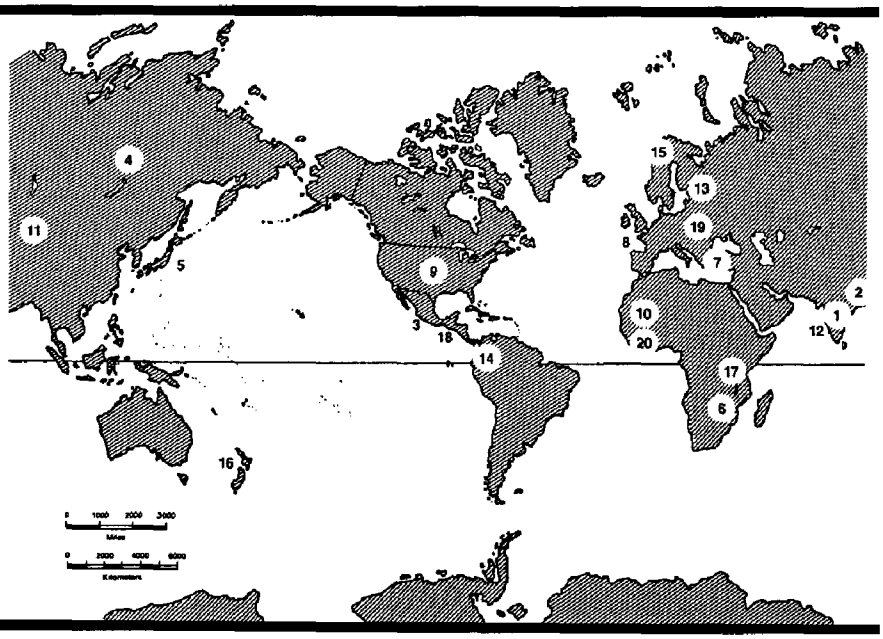
Materials for each student
- Booklet of earthquake legends (See Appendix)
- Large sheets of drawing paper
- Crayons or markers

Procedure

1. Explain that earthquakes have been happening on Earth for millions of years. Scientists have understood what causes them for less than 50 years. People who experienced earthquakes developed traditional explanations that suited their *culture*, or way of life. We call these explanations *legends*.

Master 6, World Map with Legend Sites

Earthquake Legend Sites Key
1. India
2. Assam, between Bangladesh and China
3. Mexico
4. Siberia
5. Japan
6. Mozambique
7. Greece
8. Belgium
9. Tennessee USA
10. West Africa
11. Mongolia
12. India
13. Latvia
14. Colombia
15. Scandinavia
16. New Zealand
17. East Africa
18. Central America
19. Romania
20. West Africa



2. Distribute art materials and copies of the legends to every student. Divide the students into groups and have each group illustrate one of the legends. Label each illustration with the name of the culture or the region of the world it comes from.

3. On a world map, locate the region where each legend originated. (See Master 6. How you approach this part of the activity depends on your students' geography background.)

4. Make a wall display by having students place their illustrations on the wall surrounding the world map Use the yarn and pins or tape to connect each illustration of a legend to the appropriate spot on the map.

5. Ask each group to read or recount their legend, and tell why they think it does or does not explain earthquakes. You may need to start the groups off by asking such questions as these, for the first story:

Are elephants big enough to hold up the world?

Could an elephant stand on a turtle without crushing it?

Did the early Hindus imagine ordinary animals in this story, or magical ones?

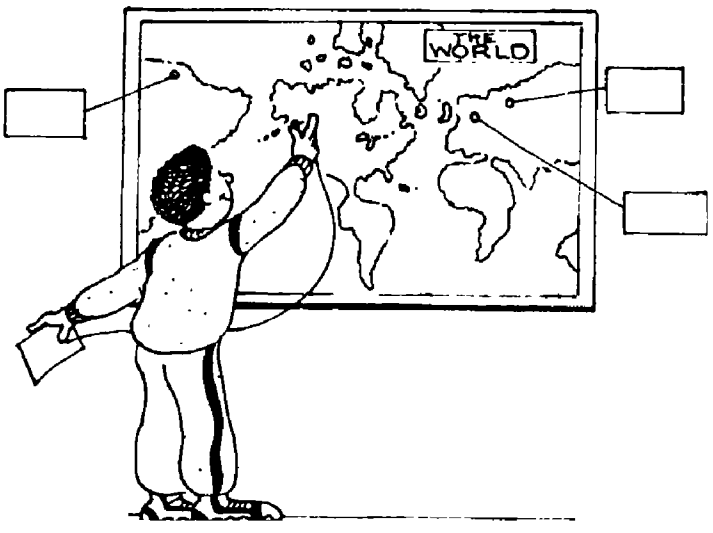
Do you think there are any such magical animals?

6. Project the transparency of Master 7, World Map with Epicenters. Explain that each dot shows a place where an earthquake has occurred. You may want to highlight the areas of greatest earthquake activity. Ask students if they can see a relationship between these areas and the places where the legends originated.

Teacher Take Note: **You may want to read all the legends with the students before they begin to draw.**

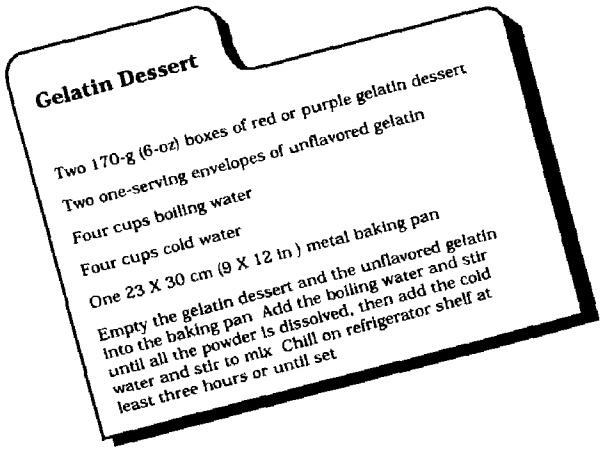
Legend Book Assembly

Copy the pages (each one has two legends) for the legend book in sequence. Be sure to copy page 2 on the back of the cover page. Repeat this process for the rest of the pages. Fold and staple in the center to form a booklet.



Activity Three: Tasty Quake

Materials for the teacher
- One pan of prepared gelatin dessert (see recipe)
- A fist-sized rock
- Silicone putty or "flubber" (see recipe)
- 25 coffee stirrers -- 5" (13 cm) plastic
- Scissors
- Ruler

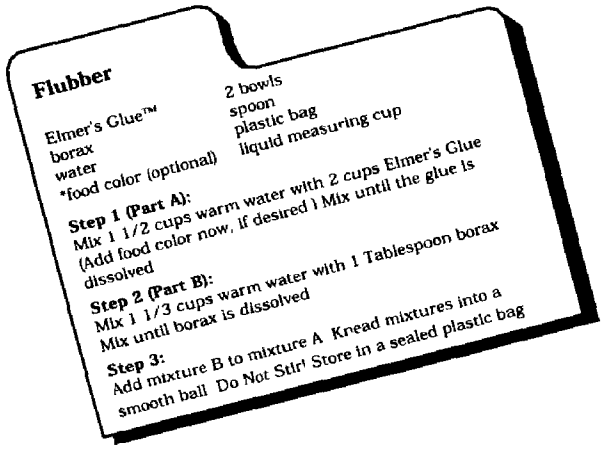


Gelatin Dessert

Two 170-g (6-oz) boxes of red or purple gelatin dessert
Two one-serving envelopes of unflavored gelatin
Four cups boiling water
Four cups cold water
One 23 X 30 cm (9 X 12 in) metal baking pan

Empty the gelatin dessert and the unflavored gelatin into the baking pan. Add the boiling water and stir until all the powder is dissolved, then add the cold water and stir to mix. Chill on refrigerator shelf at least three hours or until set

Teacher Take Note: This recipe has been carefully tested. To transmit waves that can be seen easily, the pan *must* be metal, and it *must* be full nearly to the top with the gelatin mixture.



Flubber

Elmer's Glue™ — 2 bowls
borax — spoon
water — plastic bag
*food color (optional) — liquid measuring cup

Step 1 (Part A):
Mix 1 1/2 cups warm water with 2 cups Elmer's Glue (Add food color now, if desired) Mix until the glue is dissolved

Step 2 (Part B):
Mix 1 1/3 cups warm water with 1 Tablespoon borax Mix until borax is dissolved

Step 3:
Add mixture B to mixture A. Knead mixtures into a smooth ball. Do Not Stir! Store in a sealed plastic bag

Teacher Take Note: To get the best results follow the instructions for mixing ingredients in two separate bowls before combining all ingredients. Students should not eat the flubber. Students should wash their hands after handling the mixture.

Procedure

1. Prepare gelatin dessert in advance and refrigerate These ingredients will make one pan. Prepare more if you wish to have several small groups performing the demonstration simultaneously.

2. Write the definition of an earthquake on the board.

3. Explain that under the soil there are rock layers. These layers are under stress because of activity within the Earth.

4. Explain that when these rocks are under extreme stress they react more like a plastic material, such as silicone putty, than like the hard rock we see above the ground. (Show rock and putty.)

5. Demonstrate with silicone putty (or flubber), or distribute several lumps so that each small group can do the activity for themselves. (The putty will be difficult to break if it has been warmed by too much handling, so work quickly)

a. First, stretch the putty slowly to show how rocks react to slow twisting and pulling

b. Next, shape it back into a ball and give it a sharp tug with both hands. The putty will snap into two pieces.

c. Explain that this reaction is similar to what happens during an earthquake.

6. Explain that when rocks break in this sudden way energy is released in the form of waves. We can simulate this release of energy by watching what happens to a pan of gelatin.

7. Gently tap the side of the pan of gelatin, while holding the pan firmly with the other hand. Students should be able to see the waves traveling through the gelatin. Compare the gelatin to the ground, the tap of your hand to the rock breaking, and the waves in the gelatin to earthquake waves.

8. Ask the students to predict what happens when you tap the pan with more force. Tap the pan harder. Is their prediction confirmed? Repeat these two steps several times, and be sure that all the students have a chance to see the waves.

9. Coffee stirrers can be used to further enhance student observation of wave action. In the gelatin, insert to the bottom of the pan, four rows of stirrers parallel to the short side of the pan. (Place each row approximately 1.5" (4 cm) apart. Place each stirrer approximately 1.25" (3 cm) apart.)

10. Repeat steps 7 and 8 above (tap pan at side opposite the stirrers).

11. Ask students to compare their observations of waves in gelatin with and without stirrers. (The stirrers magnify the wave action, allowing greater visibility.) Discuss possible results of wave action on buildings (point out that stirrers could represent buildings). Ask how stirrers reacted to different amounts of force used in tapping the pan.

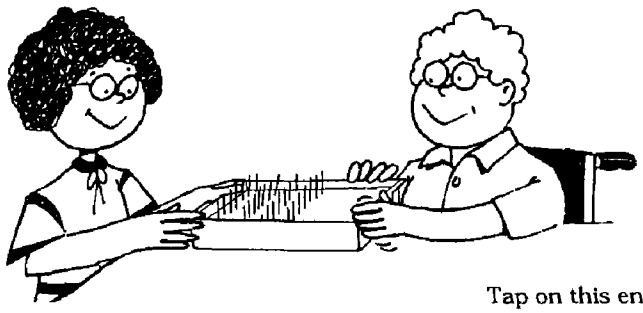
Extensions

1. Students could act out the legends with a few simple props.

2. Students could survey other students in the school to learn what they think causes earthquakes. Responses can be tabulated on the board or on butcher paper taped to the wall and become the basis for a class discussion.

3. In an area where earthquakes do not occur frequently, students could survey adults in the community to find out how many of them have experienced earthquakes. Small groups could divide responsibility for a set number of interviews such as ten per group and graph their results. No two students may interview the same person.

4. Instead of illustrating the legends on large sheets of paper, students may draw a small symbol for each legend, cut it out, and pin it directly onto a large wall map at the correct location. The Japanese legend, for example, could be represented by a fish.



Tap on this end

Energy Waves Cause Earthquakes

Vocabulary

earthquake
legend
stored energy (potential energy)
earthquake waves (seismic waves)
fault
fault creep
focus
epicenter

Learning Links

Language Arts: Discussing, oral reading, note taking, following directions

Social Studies: Map reading, correlating different types of maps, discussing effects and explanations of earthquakes in past and present societies

Math: Using map scale to measure distances

Art: Creating signs, illustrating activity

Content Concepts

1. Earthquakes result from the buildup and release of energy stored in rocks.

2. Earthquakes occur over much of the world, including the United States.

3. Various societies have produced earthquake legends to explain these natural occurrences.

Objectives

Students will
—watch one demonstration and participate in one activity on elastic rebound, and apply the principle to earthquake activity.
—demonstrate the phenomenon of fault creep, and distinguish it from earthquake activity.
—list some events that occur during an earthquake.
—locate their own state on an outline map of the United States.
—determine from the study of epicenter maps if their local area and state have experienced earthquakes.
—read and discuss earthquake legends.
—locate the place where each legend originated on an outline map of the world

Assessment

Describe (write and/or draw) an event which releases energy and relate the results of that energy release.

Activity One: A Wet Wave Experience

Materials for the teacher

- Transparency made from Master 8, Elastic Rebound
- Overhead projector
- Strip of 1/16" wood lath the size of a ruler, or a 1/4" dried stick about 1' (30 cm) long.
- Sink or basin large enough to hold wood
- Water to fill basin
- Goggle

Procedure

1. Gather students around sink or basin filled almost to the top with water.

2. Hold the wood completely under water With one hand on each end, bend it slowly until it breaks.

3. Ask students to describe what they see: jerky movement of the water and waves radiating out from the breaking point.

4. Explain that energy was transferred to the stick by the hand movements, stored as potential energy until the stick broke, and then transferred to the water This concept of buildup and release of energy in rocks is called elastic rebound theory.

5. Direct students to make a drawing of the demonstration in their notebooks.

6. Ask students to explain how the demonstration relates to an earthquake.

7. Project transparency of Master 8, Elastic Rebound, and use it to illustrate that when pressure from within the Earth is exerted on rocks, they bend and store energy until they reach a certain point, like the wood.

The stored or potential energy is released, in the form of waves, in an event we call an *earthquake*. The breaking point is the focus of the earthquake. Help students to relate this explanation to the demonstration.

fo • cus

The focus is the place where an earthquake starts.

ep • i • cen • ter

The epicenter is the point on the Earth's surface directly above the focus.

fault

A fault is a crack in rock or soil along which earthquake movement has taken place.

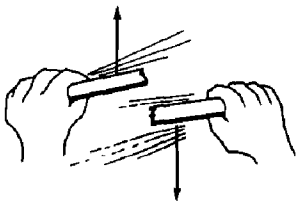
earth • quake waves

Earthquake waves, or seismic waves, are waves caused by the release of energy in the Earth's rocks during an earthquake.

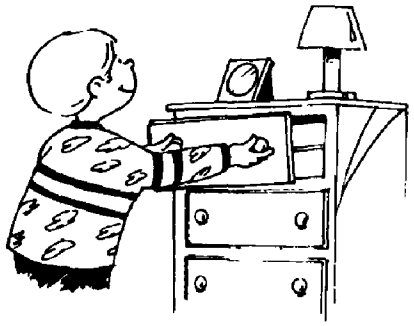
Elastic Rebound

Original position

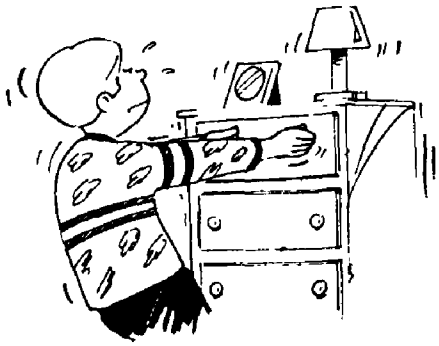
Buildup of potential energy



Breaking stick produces energy release



Smooth surface slides easily



A sticky drawer opens with a jerky movement

Activity Two: It's Your Fault

Materials for the teacher
- Transparency made from Master 9, Dresser Drawers
- Transparency made from Master 10a, Earthquake Terms
- Overhead projector

Materials for each student
- A sign saying either Block A or Block B (Students can make them and letter them neatly.)
- String or tape for affixing sign

Procedure

1. Project the transparency made from Master 9, and explain that the pieces of Earth's crust often move past each other as smoothly as our dresser drawers move. Project Master 10a, and point out the *fault* on the Earth's surface.

2. Label the area to the left of the fault Block A and that to its right, Block B. Explain to students that they are going to demonstrate what happens when pieces of the Earth's crust move.

3. Take the students to a location in or outside the classroom where they will not hit anything but the floor if they fall.

4. Ask them to form into groups of 8 to 10 students, and divide each group into equal halves. (The teacher can participate if necessary to even the groups.)

5. Line up two groups of students facing each other, and explain that each line represents a block of Earth. The area between the two lines represents a fault.

6. Students should stretch out their arms, from both sides of the "fault," so that each is lightly touching the palms of a student on the other side.

7. Instruct students on both sides of each fault to shuffle smoothly to the students' right, keeping their palms extended. (The two lines will move in opposite directions, and students will slowly change partners.) Explain that this simulates *fault creep* movement.

8. Line the groups up as before, but this time have them lock fingers across the fault. Again instruct them to move to the right by slow steps, but keep them moving past the point where they can hold on easily Just before they have to let go or fall, call out "earthquake!" Ask students to drop hands and stand up straight. The sudden release of energy should cause them to stumble and fall into one another. Explain that this activity simulates an earthquake.

9. Compare and contrast the two events in a class discussion, referring to the Dresser Drawers (Master 9) and Earthquake Terms (Master 10a) transparencies. Be sure that students understand the difference between the smooth movement that simulated fault creep and the buildup and sudden release of stress that caused them to stumble in the second demonstration. According to the theory of elastic rebound, it is this buildup and release of stress that causes earthquakes.

Activity Three: Visual Vocabulary

Materials for the teacher
- Movie clip, video clip, slides, filmstrip, or written eyewitness account(s) of earthquakes
- Transparency made from Master 10a, Earthquake Terms
- Overhead projector

Materials for each student
- Student handout made from Master 10b, Earthquake Terms Worksheet
- Colored pencils

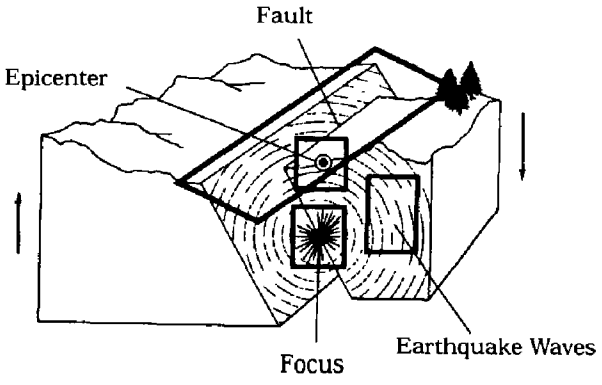
Procedure

1. Ask any class members who have experienced an earthquake to describe that event to the class.

2. Use one of the media listed above (movie clip, video, etc) to give the class some common vicarious earthquake experiences.

3. Brainstorm to create a class list of things that happen during an earthquake (rumbling noises, swaying trees, etc.) on the board or an overhead.

4. Project Master 10a, and go over the definitions of *focus, epicenter, fault,* and *earthquake waves.* Instruct students to fill in the definitions on Master 10b, Earthquake Terms Worksheet, then shade over each one in a different color: the first in red, the second in blue, the third in yellow, and the fourth in green. Finally, ask them to color the part of the diagram that each definition refers to in the same color as the definition.



Master 10a. earthquake terms

Activity Four: Local Legends

Materials for the teacher
- Standard classroom wall map of the world, or a transparency made from Master 5, World Map
- Transparency of Master 11, U S. Map with Epicenters
- Transparency made from Master 7, World Map with Epicenters
- Booklet of earthquake legends (See Appendix.)
- Optional· Epicenter map of your state or area (obtain from state geological survey, U.S. Geological Survey or local college geology department)

Materials for each student
- Booklet of legends
- Worksheets made from Master 11, U.S. Map with Epicenters

Procedure

1. Using transparencies and/or student copies of the U.S. Map with Epicenters. Master 11, ask students these questions·

   According to this map, which of the states experience a lot of earthquakes?

   Which states experience very few or no earthquakes?

   Where is our state on this map?

   According to the map, does our state experience a small, medium, or large number of earthquakes?

   People in states without epicenters, as shown on this map, may still experience earthquakes How can this be? (Both seismographs and the human senses can register the effects of distant earthquakes, especially large ones Also, this map only records quakes over a certain intensity. Some states may have quakes below those levels.)

2. Show students how to use the map scale on the U.S Map with Epicenters to measure the distance from where they live to the nearest epicenter on the map. Use a local or state map if available.

Extensions

1. If you live in an area that has ever been affected by an earthquake, check your local library for microfilm copies of old newspapers describing the event. On August 31, 1886, for example, the effects of the Charleston, South Carolina earthquake were felt in most of the states east of the Mississippi and south of New York state.

2. Current documentation on seismic activity can be obtained through the Internet at http://earthquake.usgs.gov

Teacher Take Note: The terms *intensity* and *magnitude* will be discussed in later chapters.

3. Write the definition of *legend* on the board, and invite students to recount some legends they may have heard.

4. Have students read some of the earthquake legends out loud in class. Locate the origin of each on the world map before moving on the next.

5. Project the transparency of Master 7, World Map with Epicenters, and ask students if they see any correlation between the origins of the legends and the density of earthquake epicenters. (See Unit I, Level 2, Activity Two.)

6. Discuss with students:

Why did these legends develop? (Emphasize that they were creative attempts to explain frightening and puzzling natural occurrences.)

What real facts do these legends contain or reflect? (Siberia: that human beings and animals are interdependent; New Zealand: that the Earth is like a living organism; Romania· that human decency upholds the social world; Mexico: that the evil in the world is hard to understand; etc.)

leg • ends

Legends are traditional narrative explanations of natural phenomena which evolve when scientific explanations are not available.

Master 6, World Map with Legend Sites

Earthquake Legend Sites Key

1. India
2. Assam, between Bangladesh and China
3. Mexico
4. Siberia
5. Japan
6. Mozambique
7. Greece
8. Belgium
9. Tennessee USA
10. West Africa
11. Mongolia
12. India
13. Latvia
14. Colombia
15. Scandinavia
16. New Zealand
17. East Africa
18. Central America
19. Romania
20. West Africa