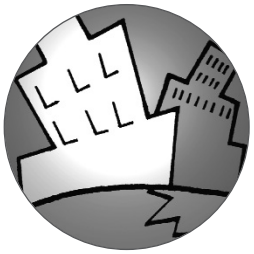


Earthquakes
3–5

Earthquake Science

LESSON PLAN 3

Dynamic Planet

Children will understand the causes of earthquakes when they grasp the dynamics of constantly moving plates.

Key Terms and Concepts

continental crust
convergent
convergent plates
divergent
divergent plates
earthquake
elasticity
epicenter
fault
oceanic crust
plate tectonics
lateral
lithosphere
magma
mantle
Ring of Fire
seafloor spreading
strike-slip
subduction
tectonic plate

Purposes

To help the students understand why earthquakes occur in certain places

To help the students understand what happens to the earth's crust when plates diverge and converge

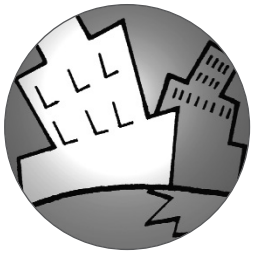
Objectives

The students will—

- Use a world map to hypothesize where earthquakes occur.
- Use *Epicenters Around the World, Map of the Earth's Plates* and *Map of Plate Movements* to compare actual earthquake epicenters with the plates of the earth and their movements.
- Observe and respond to classroom demonstrations of plate movement: divergent, convergent and lateral.
- Create a color key to identify the different plates and their movements on *Map of the Earth's Plates*.
- Use *Map of the Earth's Plates* and a world map to identify features and events caused by the movement of the earth's plates. (Linking Across the Curriculum)
- Use a world seismicity map to identify earthquakes and answer relevant questions. (Linking Across the Curriculum)
- Use demonstrations, *Forming Faults*, and modeling to create and describe three types of faults, their movement and effects.
- Write stories to describe the travels of a tiny sea fossil that began life on the ocean floor and ended up in the mountains of Alaska. (Linking Across the Curriculum)

American Red Cross

Visit the American Red Cross Web site at *www.redcross.org/disaster/masters*



Earthquakes 3–5

LESSON PLAN 3

Dynamic Planet

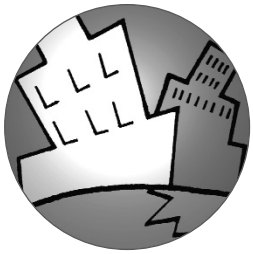
Activities

"Where Does the Earth Quake?"

"What Causes Earthquakes?"

American Red Cross

Visit the American Red Cross Web site at *www.redcross.org/disaster/masters*



Earthquakes 3–5

LESSON PLAN 3

Dynamic Planet

Materials

- World map or globe
- Push pins or small, clear "sticky" notes, possibly in the shape of arrows
- *Epicenters Around the World,* 1 copy per student
- *Map of the Earth's Plates*, 1 copy per group
- *Map of Plate Movements*, 1 copy per group
- Markers, 3 different colors per group

American Red Cross

Visit the American Red Cross Web site at *www.redcross.org/disaster/masters*

"Where Does the Earth Quake?"

SET UP 15 minutes **CONDUCT** 1 or 2 class sessions

Science: Earth Science; Social Studies: Geography

TEACHING NOTE To complete the activity as a whole group, using an overheard projector, make transparencies from *Epicenters Around the World* and *Map of the Earth's Plates.*

1. As a whole class, have the students use the world map or globe to point out where they believe earthquakes occur. If possible, place push pins or sticky arrows at each point.

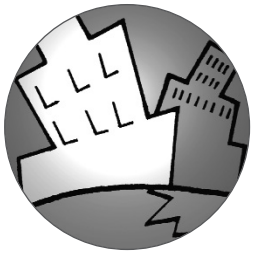
2. Distribute *Epicenters Around the World* to the students. They will compare their suggestions to actual areas of seismic activity. What surprised them the most? What areas were the most obvious to them? Why?

3. Next, divide the class into small groups and distribute *Map of the Earth's Plates* to each. After comparing this map with *Epicenters Around the World*, question them about what they have discovered. (Most earthquakes occur directly along plate boundaries.)

4. Finally, distribute *Map of Plate Movements* to each group. Demonstrate for the class each type of plate movement shown by the arrows on the activity sheet. Ask two students to come to the front of the class.

   Divergent Plate Movement: The two students will stand facing each other, arms out and with palms touching. As they back away from each other, direct the groups' attention to the *Map of Plate Movements*. Where is this kind of plate movement occurring? (Plates are moving apart on the floor of the Atlantic and Pacific Oceans.) Ask students what might happen as plates move away from each other. (Melted rock, or magma, will rise from the upper mantle to fill the spaces—seafloor spreading.)

   Convergent Plate Movement: Two students will stand facing each other, a few feet apart, hands out. Slowly, they will approach each other until their fingertips touch, the hands of one person rising and the other's descending, as they continue to move closer and closer. Next, have the groups use *Map of Plate Movements* to identify where this type of plate movement is occurring. (Convergent plate movement is occurring along the western coast of South America; between South America and Antarctica; and around the Ring of Fire. Notable exceptions are the western coast of North America; the active area between Africa, Asia and Europe; and the north Atlantic, between Greenland and Europe.)



Earthquakes 3–5

LESSON PLAN 3

Dynamic Planet

Ask students what might happen if the plates push together? (The colliding plates will trigger earthquakes. Mountains may form near the plate boundaries, and subduction—one plate pushing down under the other—will occur. The plate that is forced under dips into the earth's magma and melts to become part of the magma.)

Lateral Plate Movement: Two students will stand facing each other (not directly in front of one another). When they each walk forward they brush shoulders as they pass each other. Have the groups use the *Map of Plate Movements* to identify where this type of movement is presently occurring. (Along the San Andreas Fault where the Pacific and North Atlantic plates meet in North America.) Ask the students: What might happen during lateral plate movement? (As the plates move, bump and settle, earthquakes will occur.)

Wrap-Up

Have the groups transfer the arrows from *Map of Plate Movements* to *Map of the Earth's Plates*.

To identify the two types of plates, continental or oceanic, and the three types of movement, have the students create a color key. Using the key, have them identify the correct color for each plate on *Map of the Earth's Plates* and then draw the correct color arrows to show the movement for each of the plates using the information from *Map of Plate Movements*.

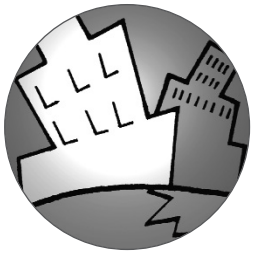
TEACHING NOTE If the students have completed Lesson 2, they will be able to discuss how the density of the plates—continental plates are denser than oceanic plates—will affect the movement of the plates.

Based on what they've learned, students will select different plate boundaries and write possible scenarios for the future. For example:

- At the juncture of the Pacific Plate and the Nazca Plate, new crust will develop as the plates diverge.
- The Andes Mountains will continue to rise, and the crust of the Nazca Plate will plunge into the magma where the South American and Nazca Plates converge.
- The Pacific and North American Plates will continue to collide and scrape as they move laterally, one to the north, while the other remains relatively still.

American Red Cross

Visit the American Red Cross Web site at *www.redcross.org/disaster/masters*



Earthquakes 3–5

LESSON PLAN 3

Dynamic Planet

American Red Cross

Visit the American Red Cross Web site at *www.redcross.org/disaster/masters*

Linking Across the Curriculum

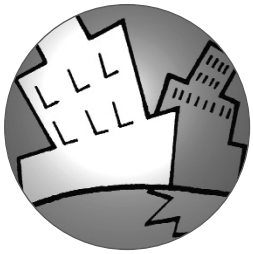
Social Studies: Geography; Science: Earth Science

Using a map of the world and *Map of Earth's Plates*, have the students identify features or events that have been caused by the movement of the earth's plates. For example: the volcanic islands that form Hawaii; the tsunami in the Indian Ocean; and the Himalaya Mountains, the earth's newest and tallest mountains, which were formed as the Australian-Indian Plate converged with the Eurasian Plate.

Social Studies: Geography; Science: Earth Science

Use the World Seismicity Map from the U.S. Geological Survey at *http://earthquake.usgs.gov/regional/world/seismicity/* to identify earthquakes. Use what you know about plate tectonics to answer and explain the following questions:

- What is the Ring of Fire? Where is it? Why do you think it is called the Ring of Fire?
- Are there other areas of the earth's surface where there are many earthquakes? Explain.
- Are there areas with relatively few earthquakes? Why?



Earthquakes 3–5

LESSON PLAN 3

Dynamic Planet

Materials

- 1 large rubber band
- Stack of books

For each of 5 groups:

- Modeling clay in 3 colors
- Rolling pin or dowel
- Ruler
- *Forming Faults,* 1 copy per group

American Red Cross

Visit the American Red Cross Web site at *www.redcross.org/disaster/masters*

"What Causes Earthquakes?"

SET UP 30 minutes **CONDUCT** 60 minutes

Science: Earth Science and Physical Science

1. Ask the students to try to snap their fingers. Can they explain why the sound occurs? (Before you snap, you push your fingers together and sideways. Because you are pushing them together, friction prevents them from moving to the side. When you push sideways hard enough to overcome the friction, your fingers move suddenly, releasing energy in the form of sound waves that travel from your fingers to your ears.) Tell the students that they will use this concept as they examine faults in the earth's crust and how they release energy.

2. Hold up the large rubber band and ask the students—
   - What would happen to this rubber band if I were to stretch it, stretch it some more and keep stretching it? (It would finally break.)
   - What if I were to put the rubber band around this pile of books? (It will stretch to the shape of the books.)
   - What will happen to the rubber band if I stretch it out and then let go of one end? (It will snap back.)
   - What will happen to the stretched rubber band if it is gently and slowly placed back on the table? (It should return to its original shape.)

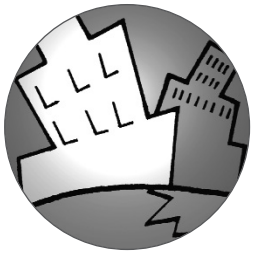
3. Ask the students to talk about why the rubber band behaves this way. (Answers will vary, but must include the concept of elasticity—bending and stretching when force is applied and returning to its original shape when force is released.)

4. Have the students describe other things they know that have elasticity. (Answers may include—elastic waistbands, clothing with Lycra, bedsprings, melted cheese and play putty.)
   The students probably won't describe rocks, but explain that rocks also have elasticity. When force is applied or released, rocks will bend or stretch under stress, but at a certain point they will break. When massive pieces of rock are pushed or pulled as the mantle pushes the crust, the pressure builds until it rips apart the rocks, creating an earthquake. The plane, or surface, where the rocks are torn is called a fault.

5. Divide the class into five small groups. Distribute *Forming Faults* and clay, a rolling pin and a ruler to each group. Have the students follow the directions on the activity sheet to model three kinds of fault.

Wrap-Up

When the students have completed the activity sheet, invite them to compare their observations in a class discussion.



Earthquakes 3–5

LESSON PLAN 3

Dynamic Planet

American Red Cross

Visit the American Red Cross Web site at *www.redcross.org/disaster/masters*

- What are the differences in the three types of fault they have modeled? (The movements and the angles of the faults.)
- How would the appearance of the ground change after a quake at each of the three types of fault? (In a strike-slip fault, the land on either side of the fault would shift, but not drop. In a normal fault, the two sides of the fault would separate—one rising and one falling. In a thrust fault, the angle is so sharp that the lower side of the fault would be covered by the higher side of the fault.)

Incorporated Research Institutions of Seismology (IRIS) has an excellent animation called Fault Motion at *http://www.iris.edu/gifs/animations/faults.htm*. Use it as a presentation for the whole class or have the groups refer to it on their own to compare their understanding about faults and the changing earth's crust with the animations.

- If the blocks had rough edges, what would have happened when they slid together? (There would have been a much jerkier motion—pressure would build and quakes would have occurred at every "bump.")

Linking Across the Curriculum

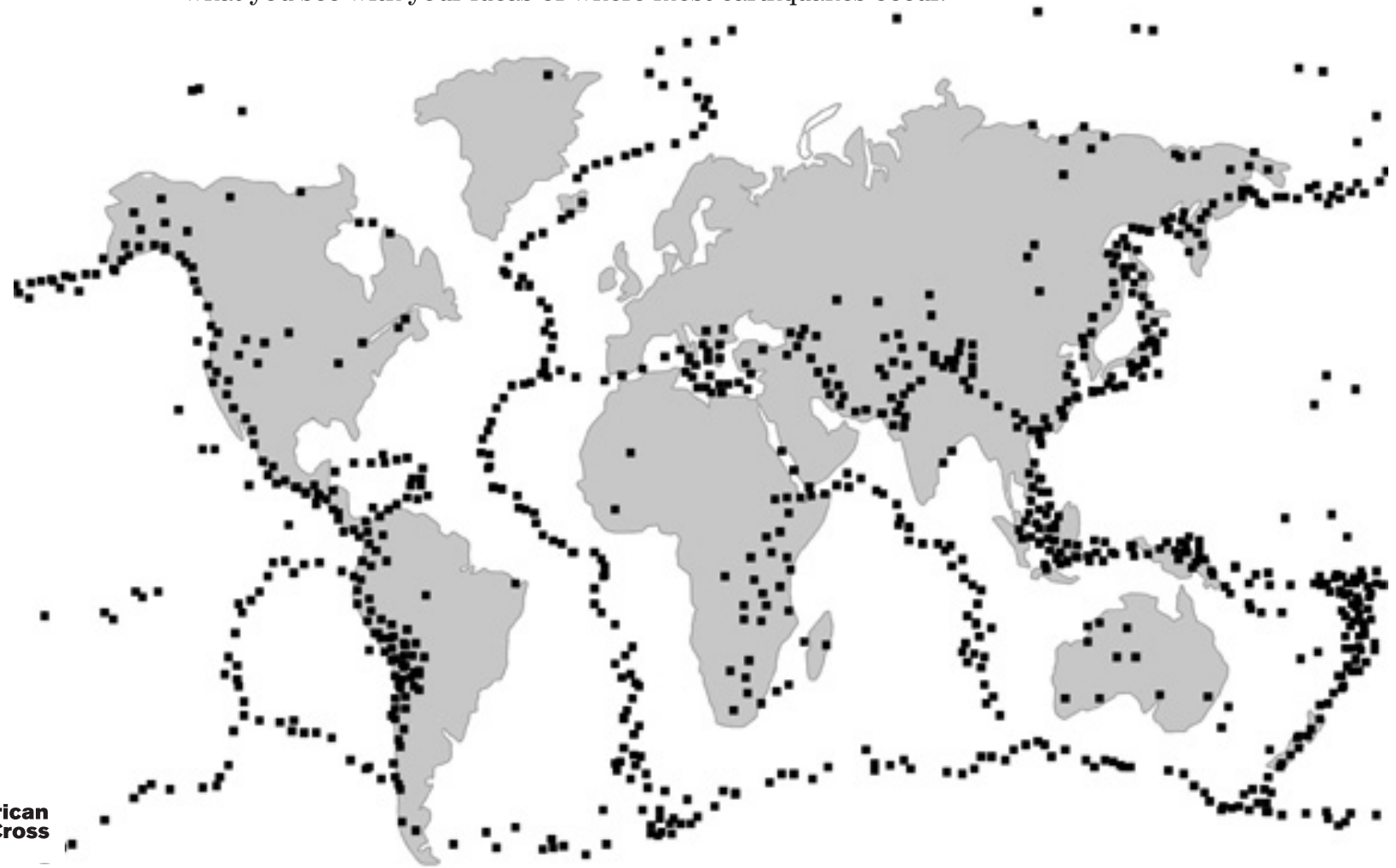
Language Arts: Writing; Science: Earth Science

Adventurers in the Rocky Mountains have found tiny shells and other sea fossils. Challenge the students to write a story about a sea creature that dies and falls to the ocean floor and ends up as the discovery of a hiker in the mountains of Alaska. What plates would have carried it to its mountain destination? What events may have moved it from place to place? Students should base their stories on information from Lessons 2 and 3.

Epicenters Around the World

Name _____

Directions: This is a map of the epicenters of earthquakes that have occurred around the world. Compare what you see with your ideas of where most earthquakes occur.



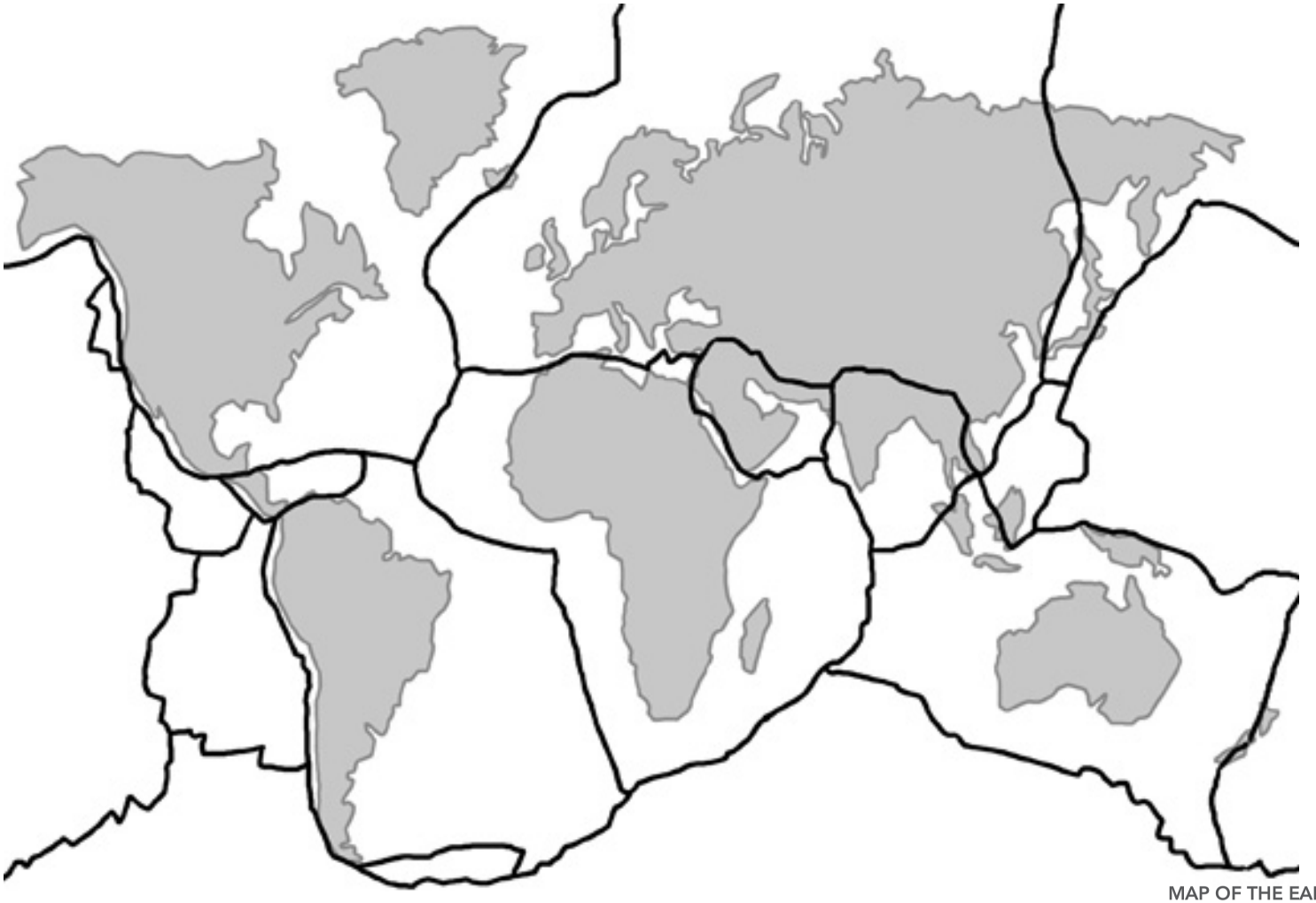
American Red Cross

Visit the American Red Cross Web site at *www.redcross.org/disaster/masters*

Map of the Earth's Plates

Name _____

Directions: This is a map of the earth's 12 major plates. Many scientists identify even smaller plate boundaries, dividing the earth into 20 plates. Compare these plate boundaries with the earthquake epicenters found on *Epicenters Around the World*. Discuss how this information supports plate tectonics and the continuous motion of the earth.



American Red Cross

Visit the American Red Cross Web site at *www.redcross.org/disaster/masters*

Map of Plate Movements

Name _____

Directions: The earth's plates are constantly moving because of the convection currents within the magma. The movement is very slow, about 1 to 2 inches (2.5 to 5 centimeters) per year, or about as fast as your fingernails grow.

The arrows on the plates shown on this map illustrate the direction in which each plate moves. Plates may converge (come together), diverge (pull away from each other) or move laterally (side to side).

Create a color code to identify the types of plate (oceanic or continental) and the type of boundary movement represented by the arrows. Redraw these arrows, using your color code, on *Map of the Earth's Plates* to identify movement and plates by name and discuss the effects on the earth's crust.

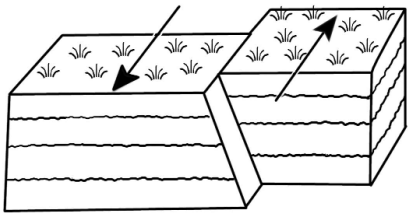
American Red Cross

Forming Faults

Name _____

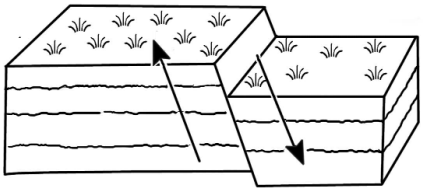
Faults are places in the earth where the rocks are broken and the rocks on one side have moved in some direction (up, down or sideways) relative to the rocks on the other side. The boundaries between plates are faults, and there are other areas in the earth's crust that have faults as well. These faults, or cracks, are formed because of the tremendous pressure created by the movement of the crust on top of the mantle.

Earth's plates are so big that they move a little bit at a time, usually only a section at a time. Even these little movements can release large amounts of energy. Some plates have fracture zones, areas of many faults fairly close to the edge of the plate. Some plates have weak areas with faults far from the boundary.

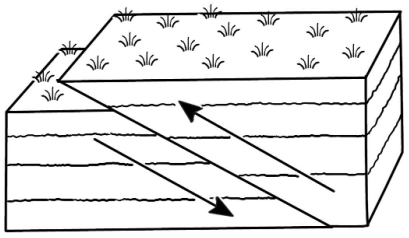


There are three basic kinds of faults:

- **Strike-slip fault** (sideways movement): The fault is vertical or nearly vertical. One side of the fault moves sideways past the other. This movement is also described as lateral or transform.



- **Normal fault** (down movement): The fault plane is angled, and one side moves down and away from the other side.



- **Thrust fault** (up movement): The fault plane is angled, and one side slides up over the other.

American Red Cross

Forming Faults

Materials:

- Modeling clay, 3 colors
- Rolling pin
- Ruler

Directions:

Use the clay and a rolling pin to create blocks of rock or sections of the earth's crust. Use three colors of clay to show layers of different types of rock. Use a ruler to slice through the clay to show the fault. Move one side of your clay block to model each of the three major types of fault movement. Then answer these questions:

1. What motions did you use to demonstrate each kind of fault?

_____

_____

_____

2. What would you expect the ground to look like after an earthquake on each kind of fault?

_____

_____

_____

American Red Cross