Lesson 4: Plate Motions & Faults

As observed in Lesson 3, at low pressures and temperatures rock is a brittle material that will fail by fracture if the stresses become sufficiently large. When a lateral displacement takes place on a fracture, the break is referred to as a fault. Earthquakes are associated with displacements on faults. In this lesson, students learn about the different kinds of faults produced by different kinds of plate motions discussed in Lesson 2, and their relation to earthquakes.

This activity is designed for one 1-hour class period.
This activity is modified from a lesson owned by Integrated Teaching and Learning Program (College of Engineering, University of Colorado, Boulder).

Materials

A soft ball of dough
Small amounts of flour
Strips of cardboards (1 per group)
Colored pencils
Scissors
A copy of Handout No. 4 (1 per student)

Introduction

1. Remind students of lessons learned from Lesson 3. Have a student define Stress and Strain.

2. Explain that there are three kinds of stress: compression, tension, and shear. Give them an example they can relate to. Ask students to predict what happens to a ball of pizza dough when they squeeze it between both hands. Then hand a student a soft ball of dough and ask the student to show what happens (you might want to dust the student's hands with small amounts of flour prior to touching the dough to avoid stickiness). The dough becomes squeezed into less space. Tell students they have compressed the dough. This stress is call compression. It changes the shape of the dough by shortening it. Ask students to predict what happens if they stretch the dough. Invite a student to demonstrate this. The dough becomes thinner and longer. The stress applied by students is called tension. It changes the shape of the dough by lengthening it. To demonstrate the third kind of stress, ask two students to stand next to each other, holding on to the ball of dough. One student should face the blackboard, while the other should face the rest of the students in the class. Ask students to predict what happens to the dough if both students start to walk. The dough is sheared and may eventually become torn apart into two pieces. This is called shear stress.

3. Ask students what kind of plate motion results in compression in rocks, what kind produces tension in rocks, and what kind shears rocks. Students should use the information acquired in Lesson 2 and from playing with the dough to answer these

questions. Explain to students that different kinds of plate motions produce different kinds of stress, and different kinds of stress produce different kinds of strain (deformation) in rocks. Convergent plate motion results in compression in rocks, Divergent plate motion produces tension in rocks, and transform plate motion shears rocks. This should be easy to understand after experimenting with the dough. The dough is the rock in this experiment.

4. Remind students of what they learned in Lesson 3: The outer part of the Earth is relatively cold, and when it is stressed it tends to break (like breaking a piece of cold silly putty). Explain to your students that these breaks or fractures, across which displacement occurs, are called faults. Tell them there are different kinds of faults (strike-slip, normal, and reverse faults). If you have pictures of faults and fault ruptures, now is a good time to share them with your students. Tell your students they are going to build models of the above faults in this lesson.

Procedures

1. Divide your students into three groups (Group 1, 2, and 3). Hand each group one strip of cardboard, one pair of scissors, and colored pencils.

2. In Group 1, instruct one student to color a road with several houses along it on their piece of the cardboard. This piece represents a bird's eye view of the Earth's surface from above. Then, ask one student to make a vertical line from a point at the center of the cardboard. The line should split the cardboard in two, and should cut across the colored road. Instruct a student to cut along this line. See Figure 1.

In Group 2, instruct one student to color horizontal layers of rocks on their piece of cardboard (you might want to show your students a picture of a mountainside with layers in it). This piece of cardboard represents a cross-section of the Earth (analogous to cutting a cake and observing the internal layers). Students should mark a point at the center of the cardboard, and draw a line at a 45^{o} angle to the rock layers, from the center point to the outside edge of the cardboard, splitting the cardboard in two. Ask them to cut along this line. See Figure 2.

Give students in Group 3 the same instruction as the ones given to Group 2. Also, see Figure 2.

3. Meet individually with each group. Explain to the students in Group 1 that they have produced a model of a strike-slip fault where one block of rock slides past another horizontally (Figure 3). Ask them to show you this motion using their cardboards. Ask them what happens to the road cut by the fault. Ask them what kind of stress results in this type of fault (compression, tension, or shear). Ask them near what plate boundary (convergent, divergent, and transform) one can expect to see this kind of fault. Explain to them that earth scientists distinguish between two types of strike-slip faults, based on the relative movement of one side of the fault with respect to the other. If they stand facing

the fault, they can say it is a left-lateral strike-slip fault if the block on the far side slipped to their left, and that is a right-lateral fault if the block on the far side slipped to their right.

Explain to students in Group 2 that they have created a model of a normal fault. The fault is marked by the cut in the cardboard. In a normal fault, the rock above the fault plane moves down the slope of the fault (Figure 4). Ask a student to demonstrate this using the cardboard. Remind them that the cardboards represent a cross-section of the Earth. It might help if they hold the cardboards perpendicular to the surface of their table, and imagine looking at a mountainside across a road that cuts through it. Ask them what kind of stress results in this type of fault. Ask them near what plate boundary one can expect to see this kind of fault.

Explain to students in Group 3 that they have produced a model of a reverse fault. The fault is marked by the cut in the cardboard. In a reverse fault, the rock above the fault moves up the slope of the fault (Figure 5). Then ask them the same questions as the ones used in Group 1 and 2. Mention to the students that thrust faults are reverse faults that develop at a very shallow angle.

4. Invite one student from each group to give a brief report to the class on the fault motion discussed in their groups. Each student presenter must demonstrate the sense of motion on their faults using their cardboards, name the stress that creates them, and name the plate motion that may contribute to their formation.

5. Allow students to exchange their fault models. It is encouraged to allow each student try all of the models. Hand each student a copy of Handout No. 4. Ask them to complete and turn in the handout by the end of lesson.

6. Finish this lesson by explaining to the students that earthquakes occur on faults. Strike-slip earthquakes occur on strike-slip faults, normal earthquakes occur on normal faults, and thrust earthquakes occur on thrust or reverse faults. When an earthquake occurs on one of these faults, the rock on one side of the fault slips with respect to the other, just as what they observed when experimenting with their fault models. Ask students to turn in their handouts.

Figure 1: Bird's eye view of the Earth's surface

Figure 2: A cross-section of the Earth

Figure 3: Cardboard representation of a strike- slip fault

Figure 4: Cardboard representation of a normal fault

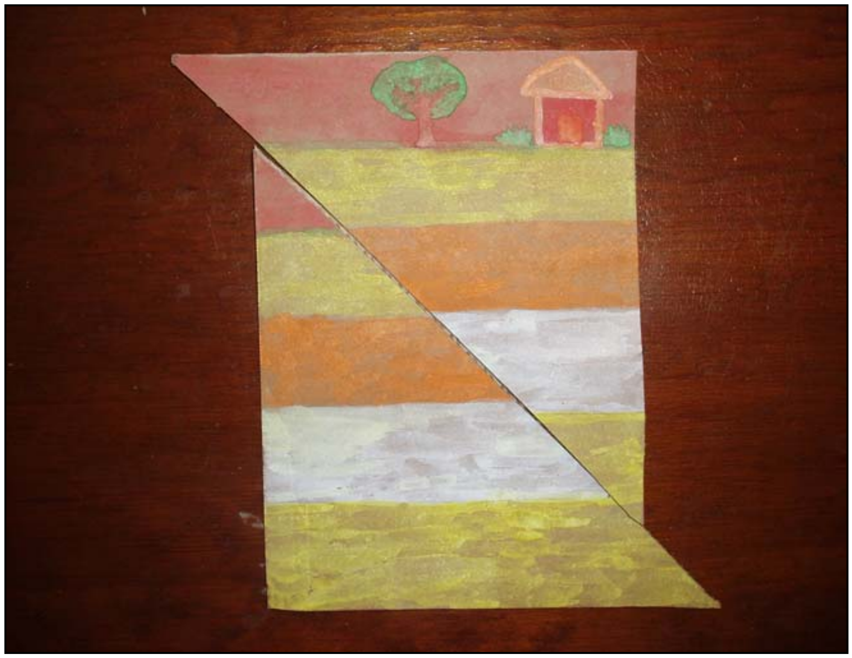

Figure 5: Cardboard representation of a reverse fault

Handout No. 4 Name: ______________

This is a chart for comparing fault types to stress and strain and plate boundary types. This chart was adapted from materials produced by the American Geological Institute.

Cardboard Representation	Has the crust **Shortened?** **Lengthened?** **Neither?**	Was the stress: **Shear?** **Compression?** **Tension?**	Fault Type	Is the plate boundary type: **Divergent?** **Convergent?** **Transform?**
			**Strike-Slip fault**	
			**Normal fault**	
			**Reverse fault**	

ANSWER KEY

Handout No. 4 Name: ______________

This is a chart for comparing fault types to stress and strain and plate boundary types. This chart was adapted from materials produced by the American Geological Institute.

Cardboard Representation	Has the crust **Shortened? Lengthened? Neither?**	Was the stress: **Shear? Compression? Tension?**	Fault Type	Is the plate boundary type: **Divergent? Convergent? Transform?**
	Neither	Shear	**Strike-Slip fault**	Transform
	Lengthened	Tension	**Normal fault**	Divergent
	Shortened	Compression	**Reverse fault**	Convergent