ROCK AND ROLL

Grade Level: 4th Grade
Presented by: Diane C. Moses, Travis Elementary School, San Antonio, TX
Length of Unit: Seven Lessons

1. ABSTRACT

Designed to complement textbook curriculum, this unit uses simulations and models to investigate convection currents moving crustal plates, earthquakes and volcanoes. Students observe currents and the movement of floating objects resulting from convection, then relate this to the movement of crustal plates. Earthquakes are simulated and damage to models representing buildings is recorded and analyzed. Using a model of a seismograph, the intensity of simulated earthquakes is recorded. Finally, after volcanic action is demonstrated, students compare the results of cooling a model of lava quickly or slowly, and apply their results to physical properties observed in igneous rocks.

2. OVERVIEW

A. Major concepts: the crust of the earth consists of plates that move upon the mantle; volcanoes and earthquakes change the shape of the land and affect human structures, and igneous rocks are formed from magma and lava and their properties depend upon how they are formed.

2. *Core Knowledge Sequence* includes movement of crustal plates, earthquakes, volcanoes, and formation and characteristics of igneous rock.

3. Skill taught is the use of models; skills used by students include observing, collecting and analyzing data, comparing and contrasting, making inferences and drawing conclusions.

III. BACKGROUND KNOWLEDGE

3. Geological time is difficult for elementary students to understand and most elementary students are unable to visit the site of an earthquake or volcano, so models and simulations are used to help students develop a conceptual base. I recommend Gunter, Estes & Schwab=s *Instruction: A Models Approach* (1995) to develop questioning strategies and teaching models around the use of these simulations. Models, however, can be misleading and their strengths and weaknesses must be identified for the student; for example, the traditional use of vinegar, baking soda, and red food color to simulate a volcanic eruption may totally mislead an elementary student since it deals with a chemical reaction and has no relationship to the pushing up of magma through the earth=s crust. For background information, any high school or college geology textbook covers the content, or consult *Ranger Rick=s NatureScope, Geology: The Active Earth* (Braus, 1988) or AIMS= *Primarily Earth* (Hoover & Mercier, 1996).

4. The concepts of the layers of the earth, volcanoes and geysers, and the formation and characteristics of different kinds of rocks was introduced to students in the *Core Knowledge Sequence* in first grade, however these concepts should be reintroduced and earthquakes should be introduced before these models are used.

IV. RESOURCES

See each lesson for materials which will be needed.

V. LESSONS

Lesson One: Movement of Crustal Plates, Convection

A. *Daily Objective:* Students will be able to explain why the earth=s crustal plates move.
   1. *Lesson Content:* Students observe a model showing convection currents and the resulting movement of objects floating on top of the model, then relate this to the movement of melted rock in the earth=s mantle to infer what makes the earth=s crustal plates move.
   2. *Concept Objective:* Crustal plates move over melted rock in the earth=s mantle.
   3. *Skill Objective:* Use models to observe and make inferences related to the real world

B. *Materials:* Clear plastic shoe box or Pyrex glass container, water, heat source (burner, candle, heating pad), kitchen plastic bag filled with ice, red food color, blue food color, wood chips.

3. *Prepare background notes:* none.
4. *Key vocabulary:* crust, mantle, core, plate, convection
5. *Procedures/Activities:* Set up the shoe box so that one end rests on the heat source and the other rests on the bag of ice; fill the box with water. Review the layers of the earth. Explain to the students that they will be watching a model that shows what happens inside the earth due to the movement of melted rock in the mantle. Add a few drops of red food color at the end of the box over the heat source, and a few drops of blue food color at the end of the box over the ice. Float the wood chips in the center of the shoe box. Allow students to observe the movement of the water and wood chips, and list their observations. Brainstorm possible explanations for the movement of the wood chips. Extend the lesson by having students cut out the shapes of the continents and placing them together as one large land mass (Wiebe, pp. 17-24), or constructing motion booklets (Devito & Krockover, pp.196-8).
6. *Evaluation/Assessment:* See Lesson Two.
7. *Standardized Test/State Test Connections:* none

Lesson Two: Movement of Crustal Plates, Cupcake Geology

8. *Daily Objective:* Students will be able to infer why a single area on the earth=s crust may contain a variety of different rocks and minerals.
   1. *Lesson Content:* Students observe a model of the earth=s crust, and take core samples below the surface.
   2. *Concept Objective:* Convection currents cause some rocks and minerals to ascend and others to descend in the earth=s crust causing variation in the characteristics metamorphic and igneous rocks found in a specific area of the earth=s crust.
   3. *Skill Objective:* Use models to observe, make inferences, and draw conclusions about geological phenomena
9. *Materials:* 1 box of white cake mix prepared and separated into three bowls, red, yellow, and green food color, various added ingredients (chopped nuts, chocolate mini-morsels, crushed cinnamon candies, chopped raisins or currents, and cake decorations such as

Amixed decors@ and gold or silver Adragees@), foil covered cupcake liners, white frosting, clear plastic straws

10. *Prepare background notes:* none
11. *Key vocabulary:* Same as Lesson one
12. *Procedures/Activities:* The night before the lesson, prepare the cake mix and divide it into three bowls. Color the mix in one bowl red, in another bowl yellow, and leave the third white. To each bowl add two or three different additional ingredients, such as crushed cinnamon candies and chopped nuts to the red, Amixed decors@ and mini-morsels to the yellow, and currents and silver Adragees@ to the white. Layer in the cupcake liners with the red on the bottom, yellow in the middle, and white on the top. Bake according to directions and let cool. Color the frosting green, and frost the cupcakes when cool.
    1. Explain the steps made during preparation of the cupcakes and order layers were placed in the liners before heat was applied. (You may note that a Amountain@ was formed in the middle of each model when heated.)
    2. Explain students will act as geologists to take Acore samples@ from their models of the earth=s crust, pass out straws and demonstrate how to insert straw and remove the Acore sample@ from the straw by squeezing it from the empty end towards the sample.
    3. Allow students time to take their Acore samples@ and record their observations.
13. *Evaluation/Assessment:* Students should record their observations and explain why they think the layers changed position, relating this model to Lesson One. Ask students to write down what conclusions can be drawn about the composition of the materials in the earth=s crust based on these models.
14. *Standardized Test/State Test Connections:* none

Lesson Three: Earthquake Damage

15. *Daily Objective:* Students will use a model to simulate the energy from an earthquake traveling through the earth.
    1. *Lesson Content:* Students simulate an earthquake on their model, and observe the effects on Asugar cube@ model buildings.
    1. *Concept Objective:* The energy from an earthquake travels through the earth=s crust to the surface where it may cause damage.
    2. *Skills Objective:* Use models to observe, gather data, and draw conclusions about geological phenomena

B. *Materials:* For each pair of students: one paper carton box top marked with grid 5 cm apart with vertical lines numbered 1st, 2nd, 3rd, 4th, and 5th, and horizontal lines marked A, B, C, D, and E, 20 sugar cubes, Appendix A activity sheet.
3. *Prepare background notes:* none
4. *Key vocabulary:* earthquake, fault, epicenter
5. *Procedures/Activities:*
    1. Have students describe what they think an earthquake feels like.
    2. Demonstrate how plates pressing against each other at a fault suddenly release energy and slip quickly, creating an earthquake by pressing your hands against each other while moving them in opposite directions; students will imitate.
    3. Ask students where they think the earthquake is strongest, on the earth=s surface just

above where the slipping took place (the epicenter), or further away where the energy has had a greater chance to wave up and down.

4. Pass out materials and explain procedures.
5. Act as facilitator help students form their hypotheses, gather data, and draw conclusions.

6. *Evaluation/Assessment:* Use student activity sheets to assess their ability to make observations, gather data, and draw conclusions.
7. *Standardized Test/State Test Connections:* none

Lesson Four: Earthquake Strength and Duration

1. *Daily Objective:* Students will use a model to investigate the relationship between the strength of the earthquake and the damage caused.

1. *Lesson Content:* Students simulate an earthquake on their model, and observe the effects on Asugar cube@ model buildings.
2. *Concept Objective:* The amount of energy released by an earthquake traveling through the earth=s crust to the surface directly affects the amount of damage it may cause.
3. *Skills Objective:* Use models to observe, gather data, and draw conclusions about geological phenomena.

B. *Materials:* For each pair of students: one paper carton box top marked with grid 5 cm apart with vertical lines numbered 1^{st}, 2^{nd}, 3^{rd}, 4^{th}, and 5^{th}, and horizontal lines marked A, B, C, D, and E, 20 sugar cubes, Appendix B activity sheet.

C. *Prepare background notes:* none

4. *Key vocabulary:* earthquake, fault, epicenter
5. *Procedures/Activities:*
    1. Ask students if they think the force and duration of an earthquake greatly affects the damage it causes.
    2. Pass out the materials and explain the procedures. Be sure to explain that the hard taps should not be so hard as to damage the box lids.
    3. Act as a facilitator to help students form their hypotheses, gather data, and draw conclusions.
6. *Evaluation/Assessment:* Use student activity sheets to assess their ability to make observations, gather data, and draw conclusions.
7. *Standardized Test/State Test Connections:* none

Lesson 5: Building Design and Earthquake Damage

A. *Daily Objective:* Students will use a model to investigate the relationship between the design of a building and the damage caused.

1. *Lesson Content:* Students simulate an earthquake on their model, and observe the effects on Asugar cube@ model buildings which are designed differently.
1. *Concept Objective:* The design of a building directly affects the amount of damage caused by an earthquake.
2. *Skills Objective:* Use models to observe, gather data, and draw conclusions about the structural damage caused by earthquakes.

B. *Materials:* For each pair of students: one paper carton box top marked with 5 cm apart

vertical lines numbered 1st, 2nd, 3rd, 4th, and 5th, and horizontal lines marked A, B, C, D, and E; 6 sugar cubes and 2 bouillon cubes, and Appendix C activity sheet.

C. *Prepare background notes:* none

4. Key *vocabulary:* earthquake, fault, epicenter

5. *Procedures/Activities:*

1. Ask students which they think will exhibit more damage, a building that is heavier on the bottom or a building that is heavier on the top.
2. Pass out the materials and explain the procedures. Be sure to explain that the taps on the box lids should all be of equal strength.
3. Act as a facilitator to help students form their hypotheses, gather data, and draw conclusions.

6. *Evaluation/Assessment:* Use student activity sheets to assess their ability to make observations, gather data, and draw conclusions.

7. *Standardized Test/State Test Connections:* none

Lesson Six: Seismograph and Richter Scale

A. *Daily Objective:* Students will be able to describe how scientists measure earthquakes.

1. *Lesson Content:* Students will Acreate an earthquake@ by shaking a table back and forth and observe the resulting lines traced on their seismograph model.
2. Concept Objective: A seismograph records varying amplitudes of seismic waves, and from the records scientists can estimate the energy that was released by an earthquake using the Richter Scale.
3. *Skill Objective:* Make observations, record data, make inferences, and draw conclusions based on data

2. *Materials:* Frame or support for suspended weight, 1-kg or larger mass weight with fine felt tip pen attached, string, 2 x 4 wood base with four 2-1/2" nails hammed into the wood **2** " form a 2" x 6" rectangle 2" high, one liter plastic bottle half filled with water, sheets of plain white or graph paper 5" x 11"

3. *Prepare background notes:* none

4. *Key vocabulary:* Seismograph, seismogram, pendulum, Richter Scale

5. *Procedures/Activities:* The teacher should construct the seismograph prior to the lesson. Wrap a plain piece of paper around the bottle and place it on the base so that the paper does not come in contact with the heads of the nails and the suspended felt tip pen just touches the top of the bottle. Place the seismograph on an empty student desk or table.

1. Explain to students that a seismograph is based on the principle of a pendulum; although the desk will move, the inertia of the weight suspended above the pendulum will keep it from moving allowing the motion of the table to be recorded.
2. Demonstrate how to record data by steadying the weight and having a student slowly rotate the bottle, then ask students to hit the table while the bottle is being slowly turned again. Emphasize that the table legs should never leave the floor because the instrument is not designed to measure vertical movement, and that the weight should never sway like a pendulum. Discard the paper.
3. Student partners or groups should be allowed to record data from the seismograph and post their seismograms on a classroom bulletin board.

6. *Evaluation/Assessment:* Select students to study the seismograms and put them in order from least to greatest amplitude. Lead a class discussion about what can be learned from their data, and about how scientists rate the intensity of earthquakes on a scale of 1 to 10 with each whole number increase indicating a magnitude of 10 times the lower number.
7. *Standardized Test/State Test Connections:* none

Lesson Seven: Volcanoes & Lava

A. *Daily Objective:* Students will be able to relate the differences between types of igneous rocks and the way they were cooled.
   1. *Lesson Content:* Students observe a model of a volcano and then observe physical properties of fudge that is cooled quickly, at room temperature, and slowly.
   2. *Content Objective:* The characteristics of igneous rocks are determined by their source material and how they are formed.
   3. *Skill Objective:* Make observations, compare and contrast, make inferences, and draw conclusions
2. *Materials:* hot plate, pot, large metal funnel, small piece of modeling clay, water, kitchen spoon, measuring spoons, wide shallow bowl filled with ice, 2 small pie tins greased with butter, 2/3 cup water, 2 cups sugar, 1/4 tsp. salt, 6 tbsp. cocoa, 2 tsp. vanilla, hand lenses, samples of igneous rocks (such as granite, basalt, obsidian, and pumice)
3. *Prepare background notes:* none
4. *Key vocabulary:* magma, lava, igneous rocks, crystals
5. *Procedures/Activities:*
   1. Add 1-1/2" to 2" of water in the pan. Loosely cover the open spout of the funnel with the very thin layer of modeling clay and place the inverted funnel in the pan. Turn on the heat, and have students observe what happens. Empty and cool the pot.
   2. Instruct students about safety around a stove.
   3. Have students mix the water, sugar, salt, cocoa, and vanilla in the pot.
   4. Allow only one student at a time to heat the mixture while stirring constantly; boil for three minutes.
   5. Turn off the hot plate. Place one pie tin on the ice in an area where it will not be disturbed, then pour 1/3 of the mixture into it. Place the second pie tin next to the one on ice, and pour another 1/3 of the mixture into it. Leave the remaining 1/3 of the mixture in the pot and replace it on the burner.
   6. When all mixtures are cooled, students should hand lenses to observe the cooled mixtures for similarities and differences, and compare them with examples of igneous rocks.
6. *Evaluation/Assessment:* Students should record their observations, and relate them to the rock samples to explain which samples they think were cooled quickly, at a moderate temperature, and slowly.
7. *Standardized Test/State Test Connections:* To compare and contrast the fudge mixtures students may make a Venn diagram showing how they are alike and different.

VI. CULMINATING ACTIVITY

None

VII. HANDOUTS/WORKSHEETS

See Appendix.

VIII. BIBLIOGRAPHY

A. Braus, Judy, ed., *Ranger Rick=s NatureScope*, AGeology: The Active Earth.@ Washington, D.C.: National Wildlife Federation, 1988.

2. DeVito, Alfred, and Gerald H. Krockover, *Creative Sciencing*. Boston: Little, Brown & Company, 1980, ISBN 0-316-181617

3. Gunter, Mary Alice, Thomas H. Estes, and Jan Schwab, *Instruction: A Models Approach*, 2nd edition. Boston: Allyn and Bacon, 1995, ISBN 0-205-16018-2

4. Hoover, Evalyn, and Sheryl Mercier, *Primarily Earth.* Fresno, CA: AIMS Education Foundation, 1996, ISBN 1-881431-63-0.

5. Lind, Karen K., ed., *Water, Stones, & Fossil Bones*. Washington, D.C.: National Science Teachers Association, 1991, ISBN 0-87355-101-x

6. Weibe, Ann, ed., *Finding Your Bearings*. Fresno, CA: AIMS Education Foundation, 1990.

Appendix A

Investigating Earthquake Damage

1. Question: What is the relationship of the location of the earthquake to the damage which results?

2. Hypothesis: _____

_____

3. Procedure:

A. Turn the empty box upside down. Look at the vertical and horizontal lines 5 cm apart on the grid. Each line is a street in a city. Vertical lines are 1st Ave., 2nd Ave., 3rd Ave., 4th Ave., and 5th Ave. Horizontal lines are A St., B St., C St., D St., and E St.

B. To find out how the energy from an earthquake travels through the Earth and what damage it causes to buildings, build 4 sugar cube skyscrapers 5 cubes tall. Build them on the corners of A and 1st, B and 2nd, C and 3rd, and D and 4th.

C. Make an earthquake by tapping with the eraser end of a pencil on the box lid at the corner of E and 5th. This is the epicenter of your earthquake. Continue tapping until at least one cube from each skyscraper has fallen.

4. Data Collection:

Order of Fall	Location	Distance from Quake	Description of Damage
1st			
2nd			
3rd			
4th			

5. Conclusion: _____

_____

_____

_____

Appendix B

Earthquake Strength and Duration

1. Question: What is the relationship of the strength of the earthquake to the damage that results?

2. Hypothesis: _____

_____

3. Procedure: Use the materials and "skyscrapers" from Activity 1 to see how many hard vibrations it takes to knock at least one cube from each building; then repeat to see how many soft vibrations it takes to cause the same amount of damage.

4. Data Collection:

Hard Taps

Location	Number of Taps	Distance from Quake	Description of Damage
A & 1st		cm	
B & 2nd		cm	
C & 3rd		cm	
D & 4th		cm	

Soft Taps

Location	Number of Taps	Distance from Quake	Description of Damage
A & 1st		cm	
B & 2nd		cm	
C & 3rd		cm	

D & 4th		cm	

Appendix B

5. Conclusion: W hat is the relationship between the amount of damage caused by an earthquake and its strength and duration?

_____

_____

_____

_____

Appendix C

Building Design and Earthquake Damage

1. Problem: What is the effect of the design of the building on the amount of damage done during an earthquake?

2. Hypothesis:_____

_____

_____

3. Procedure:
   1. Build one skyscraper on the corner of A and 2nd by stacking three sugar cubes on top of a bouillon cube. Build another skyscraper on the corner of A and 4th by stacking a bouillon cube on top of three sugar cubes.
   2. Create an earthquake by tapping at the corner of C and 3rd until at least one cube falls. Stop, then record your results.
   3. Repeat this activity 2 times, making sure to tap the box the same way each time.

4. Data Collection: Complete the chart to describe damage to both buildings during each trial.

Trial Number	A & 2nd (bouillon cube on bottom)	A & 4th (bouillon cube on top)
1		
2		
3		

5. Conclusion: What is the effect of the design of the building on the amount of damage done during an earthquake?

_____

_____

_____