

# Changing Earth

**Grade Level or Special Area:** Fourth Grade

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**Length of Unit:** Nine lessons (twelve 40-minute sessions)

## I. ABSTRACT

This unit is an inquiry based approach to understanding the planet and the forces that shape the land as detailed in the *Core Knowledge Sequence*. It uses the scientific method to investigate the planet. Students will study data collected from earthquakes and volcanoes, uncover the secrets of Earth's interior, understand how landforms are created and changed due to the infrastructure of the Earth, and study the theories that have helped man to understand the Earth. Students will create models, research topics, and use the scientific method to help them learn more about their planet.

## II. OVERVIEW

### A. Concept Objectives

1. Students will understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
2. Students will know and understand the processes and interactions of Earth's systems.
3. Students will understand that science involves a particular way of knowing and understand common connections among scientific disciplines.

### B. Content from the *Core Knowledge Sequence* (pg. 105)

1. Science: Geology: The Earth and Its Changes: The Earth's Layers
  - a. Crust, mantle, core (outer and inner core)
  - b. Movement of crustal plates
  - c. Earthquakes
    - i. Faults, San Andreas fault
    - ii. Measuring intensity: seismograph and Richter scale
    - iii. Tsunamis (also called tidal waves)
  - d. Volcanoes
    - i. Magma
    - ii. Lava and lava flow
    - iii. Active, dormant or extinct
  - e. Hot springs and geysers: Old Faithful (in Yellowstone National Park)
  - f. Theories of how the continents and oceans were formed: Pangaea and continental drift
2. Scientific Method (not from the *Core Knowledge Sequence*)
  - a. Question
  - b. Hypothesis
  - c. Procedure
  - d. Results
  - e. Conclusion

### C. Skill Objectives

1. Students will explain the importance of the scientific method.
2. Students will explain how earthquakes have helped scientists gather information about Earth's interior.
3. Students will describe how volcanoes help scientists learn about Earth's interior.
4. Students will tell how scientific ideas are used to explain previous observations.
5. Students will identify causes of natural forces that change Earth's surface.

6. Students will discuss patterns to the changes in the Earth's surface.
7. Students will use observations to answer questions.
8. Students will describe how natural processes (convection) shape Earth's surface.
9. Students will recognize patterns that shape the Earth's surface.
10. Students will create a model of the Earth's layers with appropriate labels.
11. Students will identify major features of the Earth's layers.
12. Students will explain the relationship between the continental drift theory, the plate tectonics theory, and convection currents.
13. Students will compare results with their prediction and answer the question they set out to answer.

### III. BACKGROUND KNOWLEDGE

- A. For Teachers
  1. Sattler, H.R. *Our Patchwork Planet: The Story of Plate Tectonics*
  2. Van Rose, S. *Earth*
  3. Olien, B. *The Changing Earth*
- B. For Students
  1. Grade 1: Earth

### IV. RESOURCES

- A. O'Brien-Palmer, M. *How the Earth Works: 60 Fun Activities for Exploring Volcanoes, Fossils, Earthquakes, and More*. Chicago, Illinois: Chicago Review Press, Incorporated, 2002. 1556524420.
- B. Nicolson, C.P. *Volcano!* Tonawanda, New York: Kids Can Press, 2001. 1553373545.
- C. Silver, D.M. and Wynne P.J. *The Amazing Earth Model Book: Easy-to-Make, Hands-on Models That Teach*. New York, New York: Scholastic Inc., 1997. 0590930893.
- D. Blobaum, C. *Geology Rocks!: 50 Hands-on Activities to Explore the Earth*. Charlotte, Vermont: Williamson Publishing Co. 1885593295.
- E. Young, R.M. *Hands-On Minds-On Science: Geology*. Westminster, California: Teacher Created materials, Inc., 1994. 1557346410.

### V. LESSONS

#### Lesson One: What's Going On? (one 40-minute session)

- A. *Daily Objectives*
  1. Concept Objective(s)
    - a. Students will understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
    - b. Students will know and understand the processes and interactions of Earth's systems.
    - c. Students will understand that science involves a particular way of knowing and understand common connections among scientific disciplines.
  2. Lesson Content
    - a. Scientific Method
      - i. Question
      - ii. Hypothesis
      - iii. Procedure
    3. Skill Objective(s)
      - a. Students will explain the importance of the scientific method.
- B. *Materials*
  1. Appendix A – Earth Trivia (one copy for teacher)

2. Science Journal – one per student
- C. *Key Vocabulary*
1. Geology – the study of the Earth and how it changes over time
  2. Scientific Method – a step by step process of investigating a question; the steps are question, hypothesis, procedure, results, and conclusion
  3. Hypothesis – an educated guess to a question you are trying to answer
  4. Procedure – the specific plan for investigating a question
- D. *Procedures/Activities*
1. Divide the class into two even teams. Play “Earth Trivia” (Appendix A) to activate students’ prior knowledge about the Earth. Take turns, giving each team a chance to discuss the answer before electing one student to give the answer. If a question is answered incorrectly, the opposing team has one opportunity to answer the question for an extra point. The game then resumes as usual. Teams can earn points by giving a correct answer, or for showing respect for the opposing team.
  2. When the trivia game is over, explain to students that we are beginning a new unit of study called Geology, which is the study of the Earth and how it changes over time. Have students brainstorm possible topics we might study during this unit. Tell them that we will be using the scientific method to learn about the Earth. We will begin with a question, form a hypothesis, figure out our procedure, examine our results, then form a conclusion. Explain to the students that our focus question for this unit is to figure out why our planet has certain features, such as mountains, earthquakes, and volcanoes. Write the focus question on the board as the students copy it into their journal.
  3. Introduce the term hypothesis. Tell students that a hypothesis is an educated guess to a question that you are trying to answer. Ask students to share possible hypotheses for the focus question. Write different ideas on the board as the students suggest them. Ask the students to write their own hypothesis in their journal.
  4. Next have the students think about possible, realistic ways to go about finding the answer to the focus question. As students suggest ideas write them on the board. (You may need to lead with some examples, or redirect students’ focus to the topics being covered.) From the list of ideas written on the board, draft a final list that will serve as the procedure for the investigation. Explain that the procedure tells the specific things you will do while investigating a question. A sample is given below.
    - a. Study what happens during and earthquake
    - b. Study volcanoes
    - c. Observe the locations of volcanoes and earthquakes
    - d. Research what other scientists have already learned
    - e. Simulate the causes of earthquakes and volcanoes
  5. Have the students copy the finalized procedure into their journals. They will also need to add the words geology, scientific method, hypothesis, and procedure (with definitions) into their journals.
- E. *Assessment/Evaluation*
1. In their journals students will answer the following question in complete sentences.
    - a. What are the advantages to following the scientific method when doing an investigation? (steps are easy to follow, other scientists follow the same procedure, you won’t leave out an important step, makes scientific research consistent).

## **Lesson Two: Quakin' and Shakin' (two 40-minute sessions)**

### **A. Daily Objectives**

1. Concept Objective(s)
  - a. Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
  - b. Students know and understand the processes and interactions of Earth's systems.
  - c. Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.
2. Lesson Content
  - a. Earthquakes
    - i. Faults
    - ii. Measuring intensity: seismograph and Richter Scale
    - iii. Tsunamis (also called tidal waves)
3. Skill Objective(s)
  - a. Students will explain how earthquakes have helped scientists gather information about Earth's interior.

### **B. Materials**

1. *Hands-On Minds-On Science: Geology*, Teacher Created Materials, Inc.
2. 2' length of string – one for every three students
3. Marker (any color) – one for every three students
4. Masking tape – one roll
5. Blank paper – one for every three students
6. Science journal – one per student
7. Appendix B-1 (made into transparency)
8. Appendix B-2 (made into transparency)
9. Appendix B-3 (made into transparency)

### **C. Key Vocabulary**

1. Earthquake – created when sudden movements in the Earth's surface cause the ground to shake
2. Tsunami – huge waves caused by earthquakes under the ocean
3. Seismograph – an instrument used to detect and record earthquake waves
4. Richter Scale – developed by Charles Richter to measure the intensity of earthquake waves
5. Primary waves (p-waves) – earthquake waves that pass through the Earth and are the first to be detected
6. Secondary waves (s-waves) – earthquake waves that will not pass through liquid and are the second waves to be detected

### **D. Procedures/Activities**

1. Explain to students that we are beginning to follow the procedure that has been previously set. The science journals will be used to record important information throughout the investigation. The first step of the procedure is to take a closer look at earthquakes. Read aloud "Earthquake Legends" *Hands-On Minds-On Science: Geology*. Teacher Created Materials, Inc., pg. 40. Discuss with students the previous ideas that people held about the cause of earthquakes. Ask students what an earthquake is and what happens during one (the ground shakes, buildings and bridges may collapse, the ground cracks). Tell students that an earthquake is caused by sudden movements in the Earth's surface that make the ground shake. Ask students to predict what may happen when an earthquake occurs under the

ocean, then explain what a tsunami is. Have the students add the terms earthquake and tsunami (with definitions) into their science journals.

2. Divide the students into groups of three. Each group will need a length of string, marker, a blank sheet of paper, and two pieces of masking tape. Each group of students will need to use one desk and one chair. Instruct the students to carefully place the chair on top of the desk. Tape a piece of blank paper on the desk directly beneath the chair. Have the students tie one end of the string to the marker, securing it with a piece of tape. Tape the other end of the string to the bottom of the chair making sure that the tip of the marker barely touches the paper. Two students will steady the chair so it doesn't fall off while the third group member gently shakes the desk. The marker should detect and record the movement of the desk.
3. After the activity, explain to students that they made an instrument that detects and records earthquakes. Inform the students that these instruments are called seismographs and they are located all around the world. Introduce students to the Richter Scale and point out that while a seismograph detects and records earthquakes, the Richter Scale is used by scientists to measure the intensity of earthquakes. Earthquakes are given a number between 0 and 9, with anything above a 6 being very dangerous. Have students add the terms seismograph and Richter Scale (with definitions) to their science journals.
4. Say that geologists have studied earthquake waves and have learned some very useful information about them. Use a transparency of Appendix B-1 to show the Earth. Point out the area where an earthquake happened. Add the first overlay (Appendix B-2) that shows the path of the primary waves. Tell students that Geologists learned that these waves slow down when they pass through liquid, and speed up when they go through a solid. Point out to students the areas where the speed of the shockwaves changed, and have students add the word (primary waves) and its definition into their journals. Add the second overlay (Appendix B-3) which shows the path of the secondary waves. Explain that secondary waves cannot pass through liquid and point out where secondary waves stopped on their way through the Earth. Have the students add secondary waves (and definition) into their journals. Ask students to study the diagram and think about what possible clues this gives us about the Earth's interior (there are different layers, the third layer is liquid).

E. *Assessment/Evaluation*

1. Question students orally:
  - a. What are p-waves? (first waves to be detected, pass through the Earth)
  - b. What are s-waves? (second waves to be detected, can't pass through liquid)
  - c. What are seismographs? (instruments used to detect and record earthquakes)
2. In their science journals, have students write two to three sentences in response to the following question:
  - a. What do s and p-waves reveal about the Earth's interior? (it is made of layers and one of them is liquid)

**Lesson Three: Volcano! (two 40-minute sessions)**

A. *Daily Objectives*

1. Concept Objective(s)
  - a. Students will understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.

- b. Students will know and understand the processes and interactions of Earth's systems.
      - c. Students will understand that science involves a particular way of knowing and understand common connections among scientific disciplines.
    - 2. Lesson Content
      - a. Volcanoes
        - i. Magma
        - ii. Lava and lava flow
        - iii. Active, dormant or extinct
      - b. Hot springs and geysers: Old Faithful (in Yellowstone National Park)
    - 3. Skill Objective(s)
      - a. Students will describe how volcanoes help scientists learn about Earth's interior.
- B. *Materials*
  - 1. Science journal – one per student
  - 2. *The Amazing Earth Model Book*, pages 21-30-copy pages 25 and 30 (one per student)
  - 3. Scissors (one per student)
  - 4. Glue (one per student)
  - 5. Coloring utensils (one per student)
  - 6. Transparent tape – one roll
- C. *Key Vocabulary*
  - 1. Volcano – an opening in the Earth's crust from which hot, melted rock and ash explodes
  - 2. Crater – the mouth or opening of the volcano
  - 3. Magma – hot melted rock under the Earth's surface
  - 4. Vent – opening through which magma reaches the mouth of the volcano
  - 5. Magma chamber – chamber under the volcano where magma collects
  - 6. Lava – hot melted rock that has spilled out onto the Earth's surface
- D. *Procedures/Activities*
  - 1. Review terms and skills from previous lessons. What is an earthquake? (sudden movements on the Earth's surface that causes the ground to shake) What is a seismograph? (instrument used to detect and record earthquakes) What is the Richter Scale? (scale used to measure the intensity of an earthquake) How do earthquakes help us learn about the Earth's interior? (p-waves change speed as they go through different materials, s-waves stop at the liquid mantle)
  - 2. Ask students what we call an opening in the Earth that spills out hot, molten rock (volcano). Have students add the diagram of a volcano into their science journal. Use *The Amazing Earth Model Book*, pages 21-30 for copies of the diagram and instructions of how to put it together. Students will color it, cut it out, assemble it, then glue it into their science notebooks. Have students add the terms volcano, crater, magma, vent, magma chamber and lava (with definitions) into their notebook. Have the students label these areas on their diagram.
  - 3. Point out to students that sometimes magma slowly oozes out onto the Earth's surface without a huge eruption. Geologists call this a lava flow.
  - 4. Explain that scientists classify volcanoes in three ways, dormant, active, and extinct. Volcanoes that erupt on a regular basis are classified as active. A volcano that is quiet for many years is said to be dormant (asleep). Volcanoes that will probably not erupt again are called extinct.

5. Ask students to raise hands if they've ever seen Old Faithful, a geyser in Yellowstone National Park. Ask a couple of volunteers to describe what they saw (a jet of steam and water erupting from the ground). Tell students that a geyser is similar to a volcano. In this case, water seeps into the ground where it is heated by magma that is near to the Earth's surface. The super-heated water expands and rises, shooting out of an opening in the ground in a column of water and steam. Similar to a geyser is a hot springs. The same thing happens, but instead of an eruption, the water trickles steadily out of the ground. It would be similar to what geologists call a lava flow.
  6. Ask students to think about what clues volcanoes can give us. Point out that magma, which is hot, liquid rock, comes from a volcano. What does this tell us about what may be inside the Earth?
- E. *Assessment/Evaluation*
1. In their journals, students will answer the following question in a complete sentence.
    - a. What clues do volcanoes give us about the interior of the Earth? (magma comes from a volcano so it must be hot enough to melt rocks)

**Lesson Four: Where do Earthquakes and Volcanoes Occur? (one 40-minute session)**

- A. *Daily Objectives*
1. Concept Objective(s)
    - a. Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
    - b. Students know and understand the processes and interactions of Earth's systems.
    - c. Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.
  2. Lesson Content
    - a. Movement of crustal plates
    - b. Earthquakes
      - i. Faults, San Andreas Fault
  3. Skill Objective(s)
    - a. Students will describe how scientific ideas are used to explain previous observations.
- B. *Materials*
1. Appendix C-1 (made into transparency)
  2. Appendix C-2 (made into transparency)
  3. One red transparency pen
  4. Science journal – one per student
- C. *Key Vocabulary*
1. Theory – an idea or opinion that is based on reasoning and observation
  2. Plate tectonics theory – the theory that the Earth's surface is broken into large slabs, or plates, that are constantly moving
  3. Fault – a crack in the Earth's surface, usually where two plates meet
- D. *Procedures/Activities*
1. Before the lesson make overheads of Appendices C-1 and C-2. On Appendix C-2, use a red transparency pen to go over the dots showing where earthquakes and volcanoes have occurred.
  2. Review previous lessons. What is an earthquake? (sudden movements in Earth's surface cause the ground to move) What do earthquake waves tell us about the

- Earth's interior? (made of layers, one of them is liquid) What do volcanoes reveal about the Earth's interior? (it is very hot, rocks can melt and form magma)
3. After reviewing the clues that have been gathered from earthquakes and volcanoes, use the overhead projector to show the students Appendix C-1. Explain that the red dots show where an earthquake or volcano has occurred. Allow the students time to study the map and look for clues. Ask for students to share observations. (the dots make lines, the locations seem to be concentrated together)
  4. Explain that geologists have made the same kinds of observations, and believe that where there are patterns of earthquakes and volcanoes there is a break in the Earth's surface. Based on observation, research, and reasoning, geologists came up with a theory to explain this. Add Appendix C-2 to the overhead. Explain that the new lines indicate where geologists believe these cracks lay. This theory is called the plate tectonics theory. Have students add the terms theory and plate tectonics theory (with definitions) to their journal.
  5. Point out the concentration of earthquakes on the West Coast of the United States. Ask students what they know about the area (state of California, they have earthquakes there). Tell students that geologists call the cracks in the Earth's surface faults, and a well-known fault, the San Andreas Fault, is located in California. Have students add the term fault (with definition) to their journals.
- E. *Assessment/Evaluation*
1. In their journals, students will answer the following question in complete sentences.
    - a. What is the plate tectonics theory, and what facts and information helped geologists come up with it? (theory that the Earth's surface is broken into large plates, scientists noticed that earthquakes and volcanoes lined up along the edges of these plates)

**Lesson Five: Cracked Crust (one 40 minute session)**

- A. *Daily Objectives*
1. Concept Objective(s)
    - a. Students will understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
    - b. Students will know and understand the processes and interactions of Earth's systems.
    - c. Students will understand that science involves a particular way of knowing and understand common connections among scientific disciplines.
  2. Lesson Content
    - a. Movement of crustal plates
  3. Skill Objective(s)
    - a. Students will identify causes of natural forces that change Earth's surface.
    - b. Students will discuss patterns to the changes in the Earth's surface.
- B. *Materials*
1. Science journal – one per student
  2. Appendix D – one per student
  3. Appendix E – answer key for teacher
  4. Two whole graham crackers per student
  5. One wax paper square per student
  6. Cake frosting – one container for approximately 24 students

7. Water containers (8 oz. cups) –one for every two students
  8. Paper towels
- C. *Key Vocabulary*  
None
- D. *Procedures/Activities*
1. Begin by reviewing information from previous lessons. How would you describe the interior of the Earth? (made of layers, some liquid, some solid) How many layers does the Earth have? (about four) What is the plate tectonics theory? (Earth's surface broken into plates) What is a fault? (crack in Earth's surface)
  2. Review what a fault is and their connection to earthquakes and volcanoes (break in the Earth's surface, earthquakes and volcanoes occur along faults). These are areas where geologist can learn a lot about the Earth and the forces that shape it.
  3. Explain to students that we will be doing an activity that will help us visualize what happens at fault lines. Give students Appendix D and hand out materials. Read through the investigations together and demonstrate how to do the investigations before students begin.
- E. *Assessment/Evaluation*
1. Collect the students' Cracked Crust worksheets. Use Appendix E to assess their understanding. Return this to the students as soon as possible and have them staple it into their journal.
  2. Questions students over lesson material
    - a. What is a fault? (break in Earth's crust)
    - b. What is the Plate Tectonics Theory? (Earth's crust is broken into moving plates or slabs)
    - c. What are some ways that the movement of plates affect Earth's surface? (mountains are formed, causes earthquakes or volcanoes)

**Lesson Six: Convection Currents (one 40-minute session)**

- A. *Daily Objectives*
1. Concept Objective(s)
    - a. Students will understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
    - b. Students will know and understand the processes and interactions of Earth's systems.
    - c. Students will understand that science involves a particular way of knowing and understand common connections among scientific disciplines.
  2. Lesson Content
    - a. Movement of crustal plates
  3. Skill Objective(s)
    1. Students will use observations to answer questions.
    2. Students will describe how natural processes (convection) shape Earth's surface.
    3. Students will recognize patterns that shape the Earth's surface.
- C. *Materials*
1. Appendix F – demonstration procedure (for teacher)
  2. Glass or Pyrex baking dish
  3. Aquarium heater
  4. Ice in a seal-able plastic bag (quart size)
  5. Water
  6. Red and blue food coloring

7. Masking tape (one roll)
  8. Decorative bark chips
  9. Appendix G – for teacher
  10. Science journal – one per student
  11. Coloring utensils – for each student
- C. *Key Vocabulary*
1. Convection currents – the movement of heated magma in the Earth that moves Earth’s plates
- D. *Procedures/Activities*
1. Begin with a review of previous lesson content. Is the Earth’s crust one solid piece? (no) What is a fault? (break in Earth’s crust) What can happen at fault lines? (land shifts building mountains, causes earthquakes and volcanoes) What is the plate tectonics theory? (crust divided into slabs which move) What have earthquakes and volcanoes revealed about the Earth? (Earth has layers, very hot, some magma beneath the surface)
  2. Refer back to the “Cracked Crust” investigation when we looked at what happens when Earth’s plates move. Ask students to share ideas with the class about why the plates move. You may need to remind students about what a volcano tells about what lies beneath the Earth’s surface.
  3. Use Appendix F to demonstrate how convection currents in the mantle are responsible for the movement of Earth’s plates. Continually relate the demonstration to what is happening below the Earth’s crust. What does the water represent? (magma below Earth’s surface) What happens to magma as it is heated? (it rises) What happens to magma when it moves away from the heat source and cools? (it sinks down) What do the bark chips on top of the water represent? (Earth’s plates) What effect does the moving magma below the surface have on the bark chips? (it causes them to move and bump into each other)
  4. Add convection current and its definition to the science journals. Draw a diagram of convection currents in the mantle and how they affect the Earth’s plates (use Appendix I as example). Have students draw the diagram in their own notebooks, adding color to the finished products.
- E. *Assessment/Evaluation*
1. In their own words, students will write three-four sentences describing heated magma affects the Earth’s plates. This should go directly under their diagram in their science journal (the magma rises and pushes against the Earth’s plates causing them to bump into each other, as the magma rises away from the heat source it cools and sinks).

**Lesson Seven: Earth Model (two 40-minute sessions)**

- A. *Daily Objectives*
1. Concept Objective(s)
    - a. Students will understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
    - b. Students will know and understand the processes and interactions of Earth’s systems.
  2. Lesson Content
    - a. Crust, mantle, core (outer and inner core)
  3. Skill Objective(s)
    - a. Students will create a model of the Earth’s layers with appropriate labels.
    - b. Students will identify major features of the Earth’s layers.

B. *Materials*

1. One 3” Styrofoam ball for every two students
2. Tempera paint – blue, green, brown, orange, red
3. Paint brushes
4. Paper towels
5. Straight pins – four per student
6. Scratch paper – cut into small strips
7. 8 oz. cup – one for every two students
8. Black markers (fine tip)
9. Appendix H – made into overhead
10. Appendix I – one per student
11. Appendix J – one per student
12. Scissors – one per student
13. Glue – one per student
14. Coloring utensils –per student
15. Science journal – one per student
16. Knife – with serrated edge
17. Appendix K – one per student

C. *Key Vocabulary*

1. Crust – the outer layer that is mostly rock and varies in thickness from 3 to 34 miles thick
2. Mantle – the thickest layer, it is 1800 miles thick and is mostly made of rock with some magma
3. Outer Core – this layer is completely liquid and is made of iron and nickel
4. Inner core – this layer is composed of solid iron and nickel and is about 7,200 degrees Fahrenheit

D. *Procedures/Activities*

1. Day One: Before the lesson, gather the Styrofoam balls and paint them blue. Allow them to dry thoroughly before the students begin working on them.
2. Begin the lesson by reviewing the previous lesson(s). What is geology? (study of the Earth and how it changes) How do geologists learn about the inside of the Earth? (gather information from earthquakes and volcanoes) How many layers does the Earth have? (four layers) What do we already know about Earth’s layers? (third layer is completely liquid, there is magma in the layer below the surface)
3. Explain to students that in this activity they will be learning more about the individual layers of the Earth. Have the students group themselves into pairs. Give each pair a straight pin and strip of scratch paper. Have the students write their names on the paper then pin it onto their ball. The students will be divided into three groups. The following explains what each group will do and the students will rotate to the stations.
  - a. Station 1:
    - i. Materials: green paint, paint brushes, paper towels
    - ii. At this station students will paint the continents on their model. Review how many continents there are and where they are located. Have an example of a ball already painted at the station for students to refer to. Students set their model (with names still attached) on a paper cup and set in a safe place to dry. When students finish this station then move to Station 2.

- b. Station 2:
  - i. Materials: overhead diagram (Appendix H), student diagram (Appendix I), scissors, glue, coloring utensils, science notebook.
  - ii. Students will copy information onto their diagrams, color them appropriately, then cut and paste the diagram into their science notebook. They will move to Station 3 when they finish.
- c. Station 3:
  - i. Materials: scissors, templates (Appendix J)
  - ii. Students will cut out the templates they will use to mark the Earth's layers, and they will cut out the flags they will use for labeling. They should put their cut out copies into the cup they use to hold their model as it dries. When they finish they should move to Station 1.
- 4. Day Two: Before the lesson cut the models into halves (or hemispheres), being careful to keep them together so students can find them easily.
- 5. The students will need to team up with their partners and retrieve their Earth models from the previous day. Using the templates and a black marker, students will need to position them on their model and trace the lines for the boundaries of the layers. If some groups have not finished the activities from the previous day (diagrams or templates) they will need to finish before they continue with their models.
- 6. After layers have been drawn on the models some students can begin painting their layers. Paint the inner core brown, the outer core orange, and the mantle red. The crust is so thin that it is represented by the thin layer of blue paint around the exterior of the model.
- 7. Next, students need to take the flags that they cut out with their template (these should be in their cup). On each flag, students need to write the layer name and one fact about that layer. Make sure that students write their name on the opposite side of their flags.
- 8. Using straight pins, students attach their correct flag to the correct layer of the Earth and set aside to dry. Again, be sure that students have their names on their flags.
- E. *Assessment/Evaluation*
  - 1. Use checklist to assess student models (Appendix K).

**Lesson Eight: Continental Drift and Pangaea (one 40-minute session)**

- A. *Daily Objectives*
  - 1. Concept Objective(s)
    - a. Students will understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
    - b. Students will know and understand the processes and interactions of Earth's systems.
    - c. Students will understand that science involves a particular way of knowing and understand common connections among scientific disciplines.
  - 2. Lesson Content
    - a. Theories of how the continents and oceans were formed: Pangaea and continental drift.
  - 3. Skill Objective(s)
    - a. Students will explain the relationship between the continental drift theory, the plate tectonics theory, and convection currents.

- B. *Materials*
1. Appendix L – Jigsaw Puzzle (one per student)
  2. Scissors – (one per student)
  3. Glue – (one per student)
  4. Science journal – (one per student)
- C. *Key Vocabulary*
1. Continental drift theory – Alfred Wegener’s theory that the Earth’s continents were originally one large supercontinent that broke up into large pieces and drifted to where they are today
  2. Pangaea – the name given to the supercontinent in the continental drift theory.
- D. *Procedures/Activities*
1. Review previous content and skills. What is a theory? (idea based on observation and reasoning) In your own words, what is the difference between theory and fact? (fact is proven, theory is an idea based on observation and reasoning – no conclusive evidence) Explain the plate tectonics theory. (crust is broken into plates that move on convection currents of magma in the mantle)
  2. Hand out Appendix M Jigsaw Puzzle to every student. Have the students cut out the pieces then find a way for the puzzle pieces to fit together. Allow students five-ten minutes to work at the puzzle. Once they have found a way that works, have them glue it into their science journals.
  3. Tell the students about a man named Alfred Wegener who did something very similar to what they just did. Wegener noticed similarities in the shapes of the coastlines of the continents. Wegener used fossil evidence and his observations to theorize that the Earth’s continents were once one large landmass, called Pangaea. Wegener’s theory is known as the continental drift theory. Have students add the terms continental drift and Pangaea (with definitions) into their journals under the activity they just completed.
- E. *Assessment/Evaluation*
1. Students will answer the following question in their science journal.
    - b. How does this theory relate to the plate tectonics theory? (it also suggests that the Earth’s crust is broken into plates that are continually moving)
    - c. How are continental drift and convection currents connected? (just like plate tectonics, convection currents are probably responsible for continental drift)

**Lesson Nine: Tying It All Together! (one 40-minute session)**

- A. *Daily Objectives*
1. Concept Objective(s)
    - a. Students will understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
    - b. Students will know and understand the processes and interactions of Earth’s systems.
    - c. Students will understand that science involves a particular way of knowing and understand common connections among scientific disciplines.
  2. Lesson Content
    - a. Scientific Method
      1. Question
      2. Hypothesis
      3. Procedure
      4. Results

5. Conclusion
3. Skill Objective(s)
    - a. Students will compare results with their prediction and answer the question they set out to answer.
- B. *Materials*
1. Science journal – (one per student)
- C. *Key Vocabulary*
1. Results – information gathered throughout the procedure
  2. Conclusion – states the answer to the question and whether or not the hypothesis was supported
- D. *Procedures/Activities*
1. Review the scientific method. What is the scientific method? (steps for investigating a question) Which steps have we completed? (question, hypothesis, procedure) What was our question? (What causes earthquakes and volcanoes)
  2. Explain to students that we are ready to compile our results. We will look at the information gathered throughout our procedure that will help us answer our question (most of the results will come from the assessment/evaluation portion of each lesson). Ask students to look through their journals and choose the information that helps us answer the question. Write down pertinent information as the students share. For example:
    - a. Earthquake waves revealed that the Earth is made of four layers.
    - b. Volcanoes show that there is magma beneath Earth’s surface
    - c. Volcanoes and earthquakes are mostly located on the edges of plate boundaries.
    - d. The movement of Earth’s plates can cause earthquakes and volcanoes.
    - e. Convection currents under the Earth’s surface cause the plates to move.
    - f. The Earth’s surface may have been very different at one time (Pangaea).
  3. Explain to students we will use our results to formulate our conclusion, which is our answer to the question. Ask for volunteers to share possible conclusions. Write students ideas on the board. From the ideas on the board, draft a formal conclusion. (heat from the Earth’s core heats up magma in the mantle, the magma rises and pushes against the crustal plates, this causes the crustal plates to move and rub against each other, may cause earthquakes or sometimes the magma will push its way to the top, creating a volcano) The students should copy this conclusion into their journal.
  4. Have students add the terms result and conclusion (with definitions) to the science journals.
- E. *Assessment/Evaluation*
1. In their journals, students will compare the conclusion to their hypothesis (whether or not their hypothesis was supported by the conclusion).

## VI. CULMINATING ACTIVITY

- A. Appendix M – Study guide: Hand this out to the students a couple of days before the final assessment so students have time to prepare. The day before the final assessment take time to go over the study guide to make sure students understand the material.
- B. Appendix N – Final assessment

## VII. HANDOUTS/WORKSHEETS

- A. Appendix A: Earth Trivia
- B. Appendix B-1: Earth’s Interior
- C. Appendix B-2: Primary Waves

- D. Appendix B-3: Secondary Waves
- E. Appendix C-1: Earthquake and Volcano Map
- F. Appendix C-2: Plate Boundaries
- G. Appendix D: Cracked Crust
- H. Appendix E: Cracked Crust Key
- I. Appendix F: Convection Currents Demonstration
- J. Appendix G: Convection Diagram
- K. Appendix H: Earth's Layers
- L. Appendix I: Earth's Layers Student Copy
- M. Appendix J: Earth Model Template
- N. Appendix K: Earth Model Checklist
- O. Appendix L : Jigsaw Puzzle
- P. Appendix M: Study Guide
- Q. Appendix N: Unit Test

### VIII. BIBLIOGRAPHY

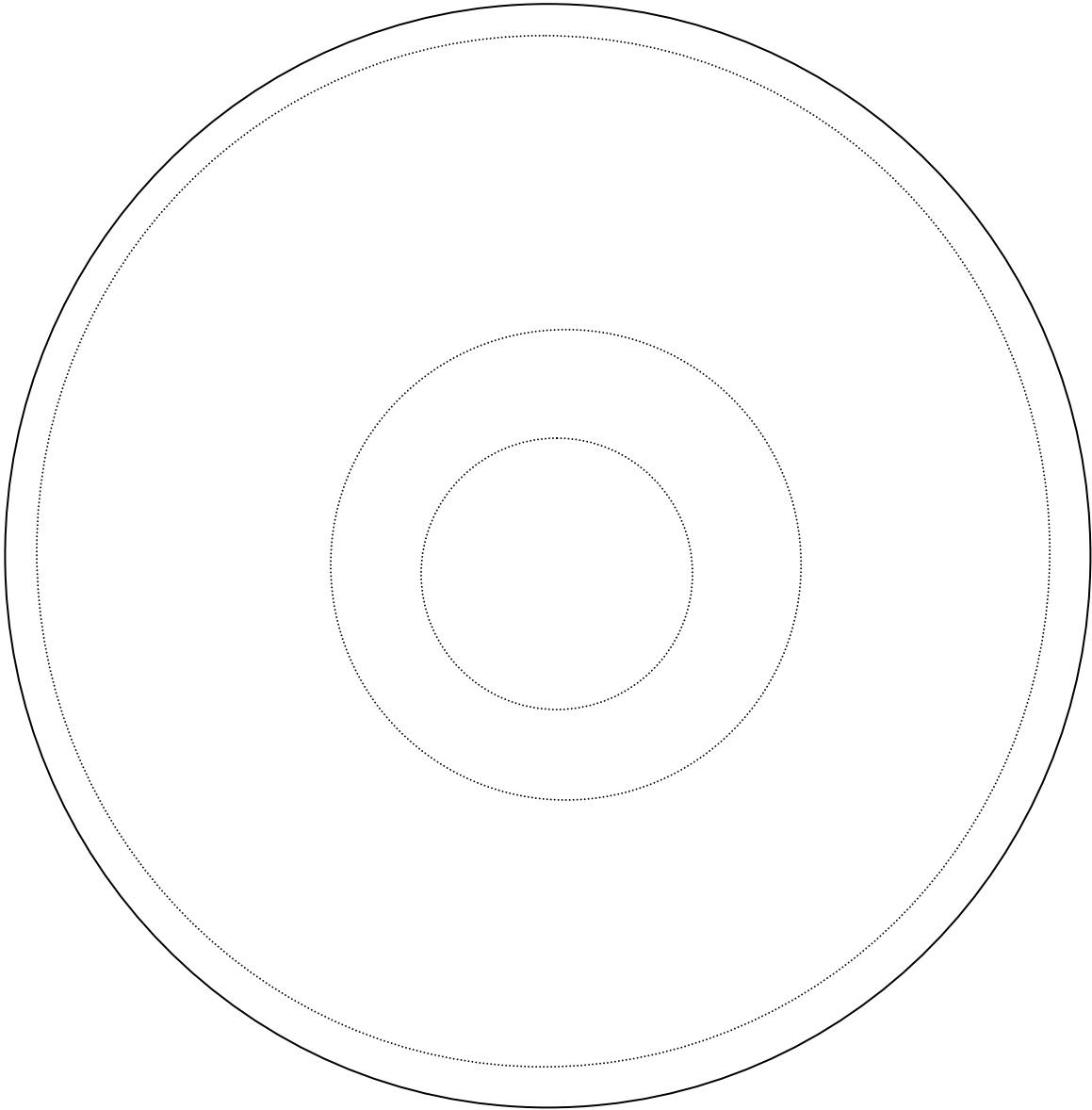
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**Appendix A**  
**Earth Trivia**

1. How many planets are in our solar system? *nine*
2. Earth is the \_\_\_\_\_ planet from the sun. *third*
3. Earth orbits around what star? *sun*
4. How much of Earth's surface is covered with water? *3/4*
5. How much of Earth's surface is covered with land? *1/4*
6. How many continents are there? *7*
7. What are the names of all the continents? *Europe, Asia, Africa, North America, South America, Australia, Antarctica*
8. What is geology? *Study of the Earth*
9. What fraction of Earth's land is covered by mountains? *1/4*
10. At least how tall must a mountain be? *2000 feet*

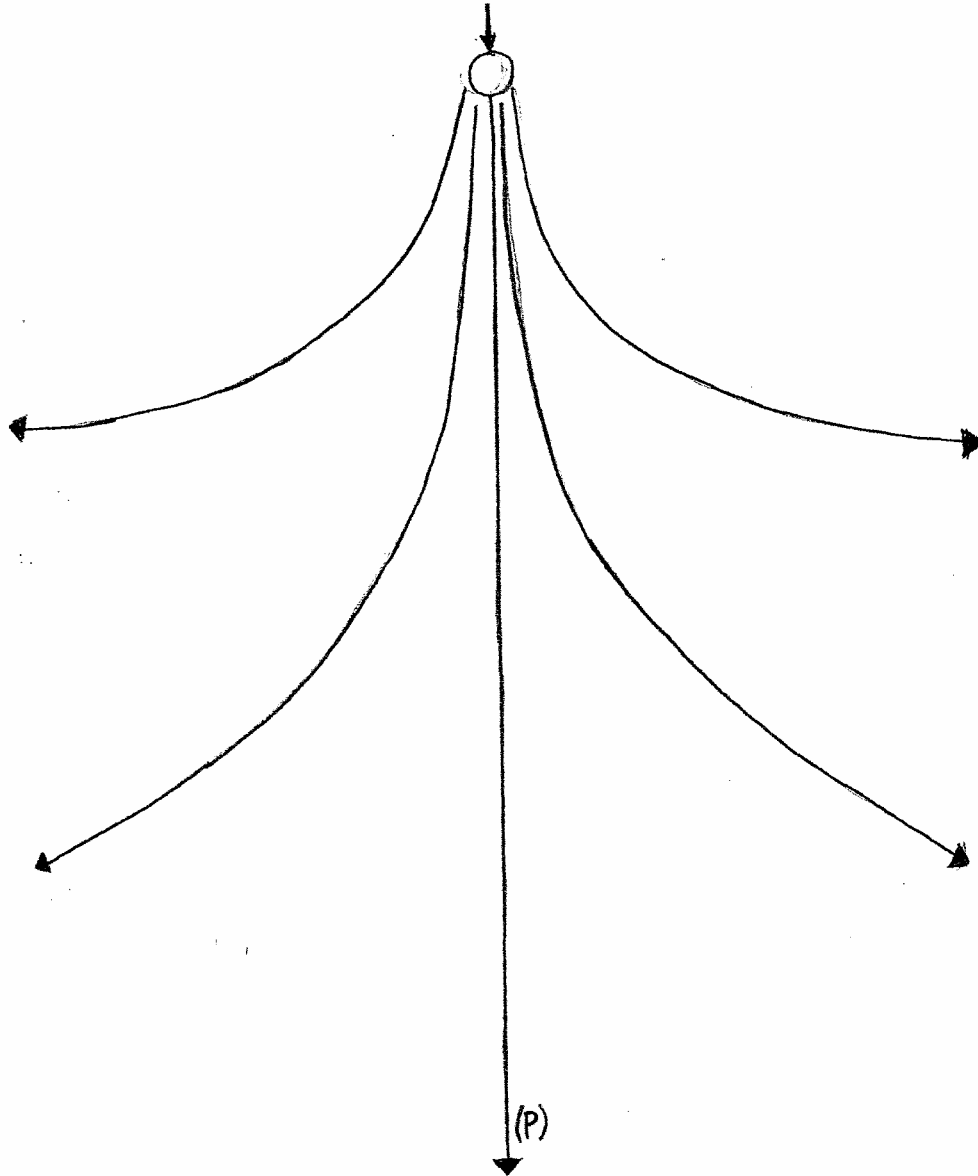
**Appendix B-1**  
**Earth's Interior**

Adapted from *Hands-On Minds-On Science: Geology*, Teacher Created Materials



**Appendix B-2**  
**Primary Waves**

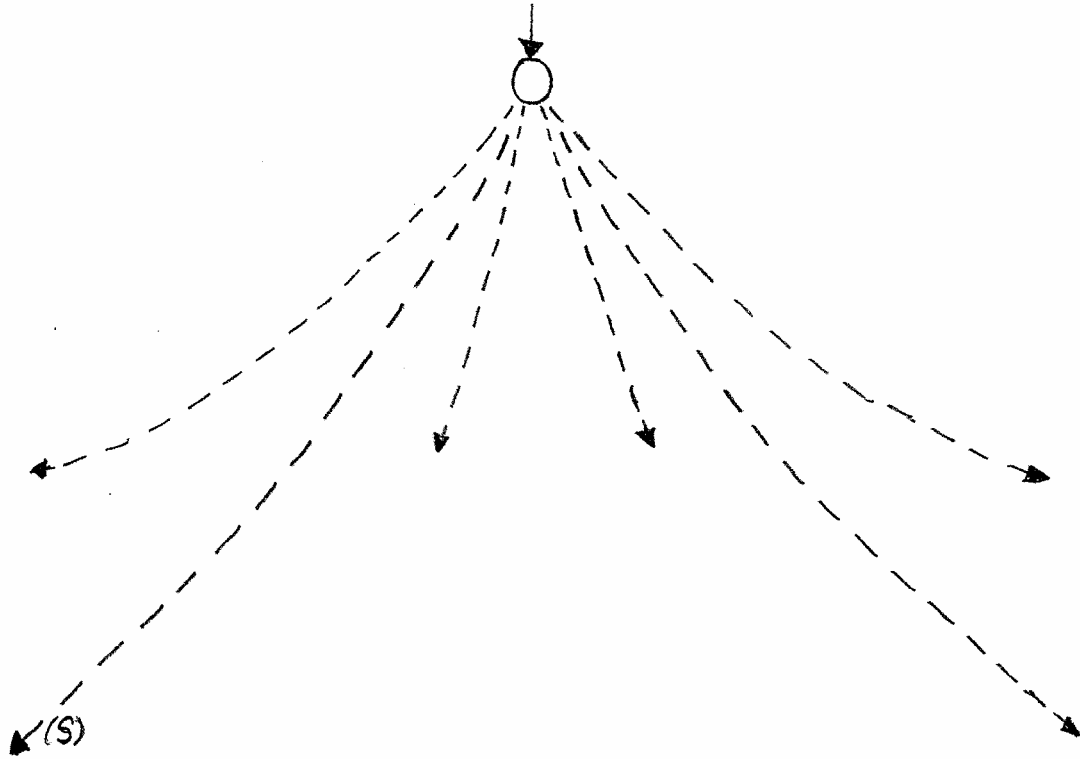
Adapted from *Hands-On Minds-On Science: Geology*, Teacher Created Materials



Primary waves (p-waves) are earthquake waves that pass through the Earth and are the first to be detected. They slow down when they pass through a liquid and speed up when they pass through a solid.

### Appendix B-3 Secondary Waves

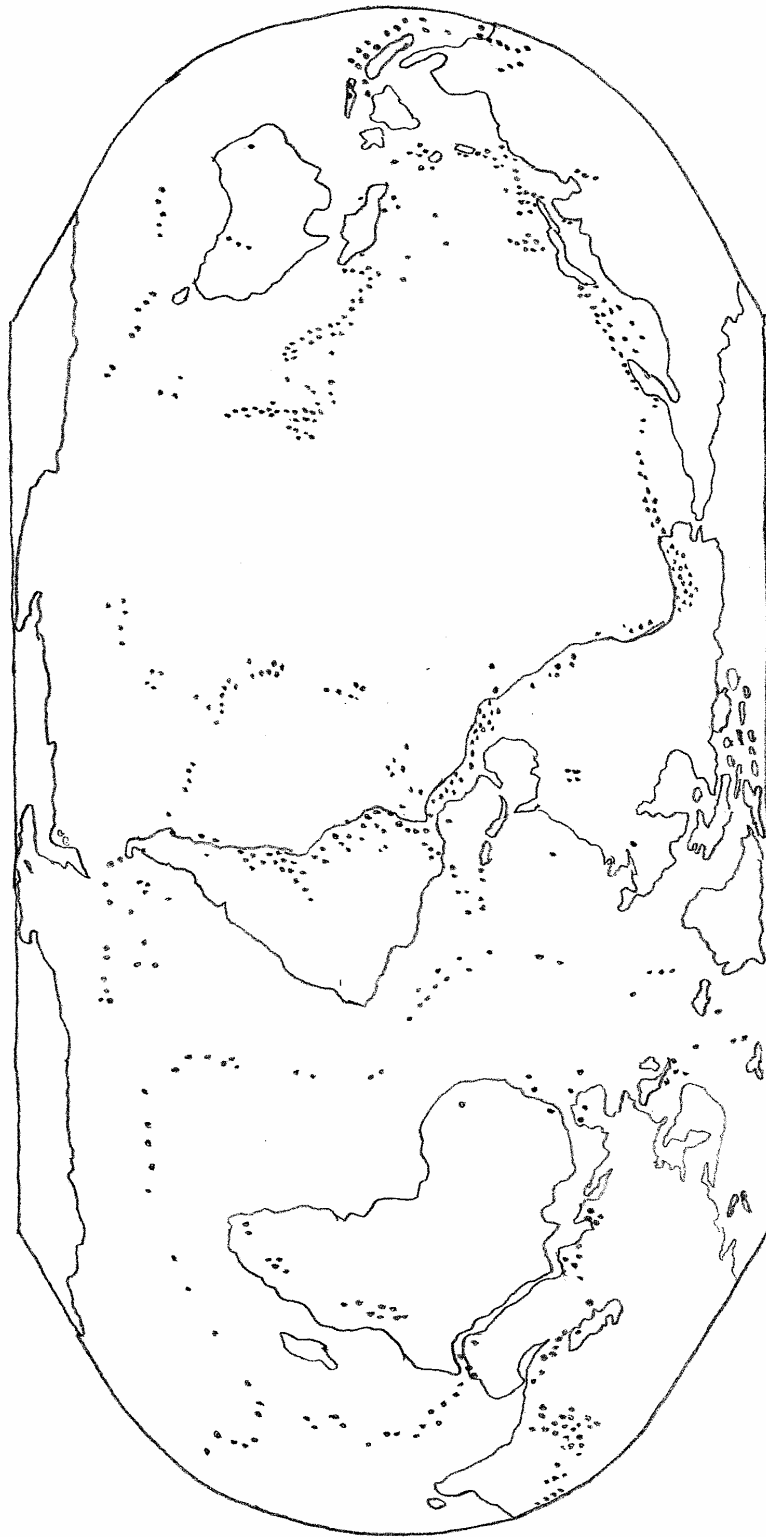
Adapted from *Hands-On Minds-On Science: Geology*, Teacher Created Materials



Secondary waves (s-waves) are earthquake waves that will not pass through liquid and are the second waves to be detected.

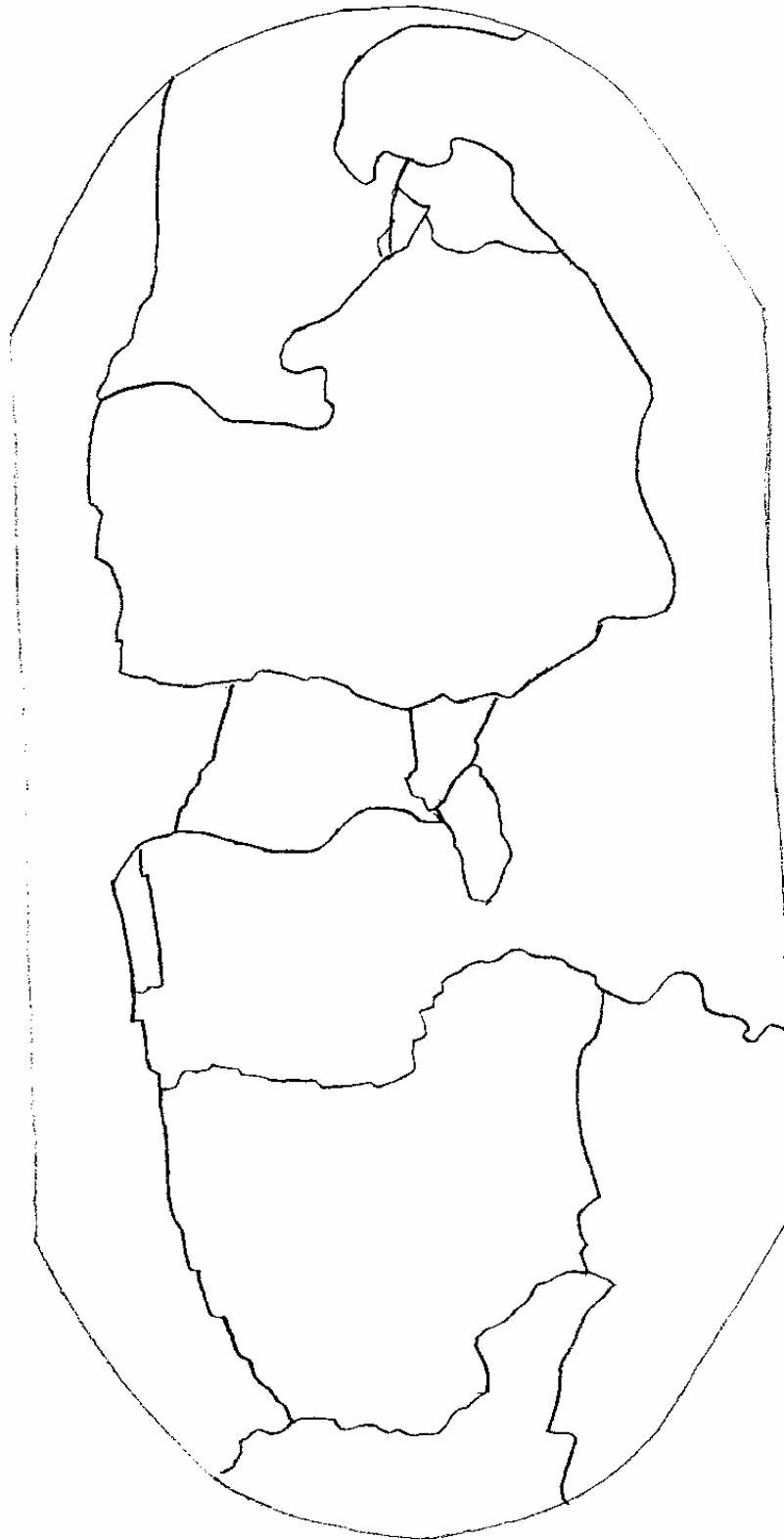
## Appendix C-1 Earthquake and Volcano Map

Adapted from *Hands-On Minds-On Science: Geology*, Teacher Created Materials



## Appendix C-2 Plate Boundaries Overlay

Adapted from *Hands-On Minds-On Science: Geology*, Teacher Created Materials



Appendix D, page 1

Name: \_\_\_\_\_

Date: \_\_\_\_\_

# Cracked Crust Investigation

Adapted from *Geology Rocks* by Cindy Blobaum,

Adapted from *As the Earth Turns* by Marsha Bellinger, Kelley Holdman, and Mary Graham

**Question:** How does the movement of the tectonic plates affect Earth’s crust?

**Hypothesis:** \_\_\_\_\_  
\_\_\_\_\_

**Materials:** two whole graham crackers per student, wax paper squares, cake frosting, water containers

Before you begin break the crackers along the lines so you have eight smaller crackers.

**Investigation #1 Procedure:**

1. Dip one end of each cracker into the water about one centimeter and then lay them end to end on the wax paper with the wet ends nearly touching.
2. Slowly push the two crackers together. ( → ← )

**Results:** What happened at the fault line?

\_\_\_\_\_  
\_\_\_\_\_

**Conclusion:** What kind of landform would this make? \_\_\_\_\_

**Investigation #2 Procedure:**

1. Put two more crackers together, side by side.
2. Put one hand on each cracker piece and apply steady pressure pushing them together, AND at the same time, push one piece away from you and the other toward you. ( ↓ ↑ )

**Results:** What happened at the fault line?

\_\_\_\_\_  
\_\_\_\_\_

**Conclusion:** What would be the result of this type of movement?

\_\_\_\_\_  
\_\_\_\_\_



Appendix E, page 1  
Key

## Cracked Crust Investigation

Adapted from *Geology Rocks* by Cindy Blobaum,

Adapted from *As the Earth Turns* by Marsha Bellinger, Kelley Holdman, and Mary Graham

**Question:** How does the movement of the tectonic plates affect Earth's crust?

**Hypothesis:** answers will vary

**Materials:** two whole graham crackers per student, wax paper squares, cake frosting, water containers

Before you begin break the crackers along the lines so you have eight smaller crackers.

### Investigation #1 Procedure:

1. Dip one end of each cracker into the water about one centimeter and then lay them end to end on the wax paper with the wet ends nearly touching.
2. Slowly push the two crackers together. ( → ← )

**Results:** What happened at the fault line? The crackers pushed up .

**Conclusion:** What kind of landform would this make? Mountains

\*\*\*This is how many mountains ranges were formed, the Himalayas were formed this way when India and Asia collided.

### Investigation #2 Procedure:

1. Put two more crackers together, side by side.
2. Put one hand on each cracker piece and apply steady pressure pushing them together, AND at the same time, push one piece away from you and the other toward you. ( ↓ ↑ )

**Results:** What happened at the fault line? Sometimes the edges of the crackers would catch then give a big lurch, little pieces of the crackers broke off.

**Conclusion:** What would be the result of this type of movement?

This could cause an earthquake

\*\*\*When plates move past each other in this way, it sends vibrations through the earth, which we call and earthquake.



## **Appendix F**

### **Convection Current Demonstration**

Adapted from *Hands-On Minds-On Science: Geology*, Teacher Created Materials

**Purpose:** to show how convection currents in the mantle move the Earth's plates.

**Materials:**

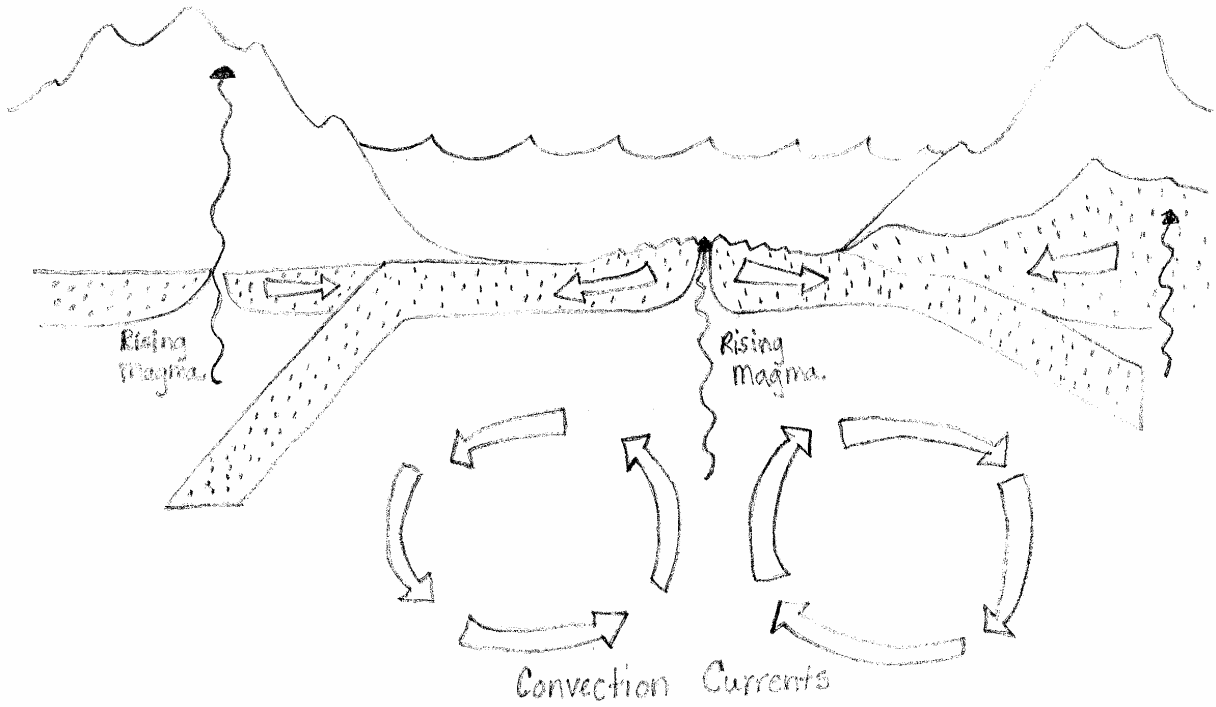
- large glass or Pyrex baking dish
- aquarium heater
- red and blue food coloring
- ice in a seal-able plastic bag (quart size)
- water
- masking tape
- decorative bark chips

**Procedure:**

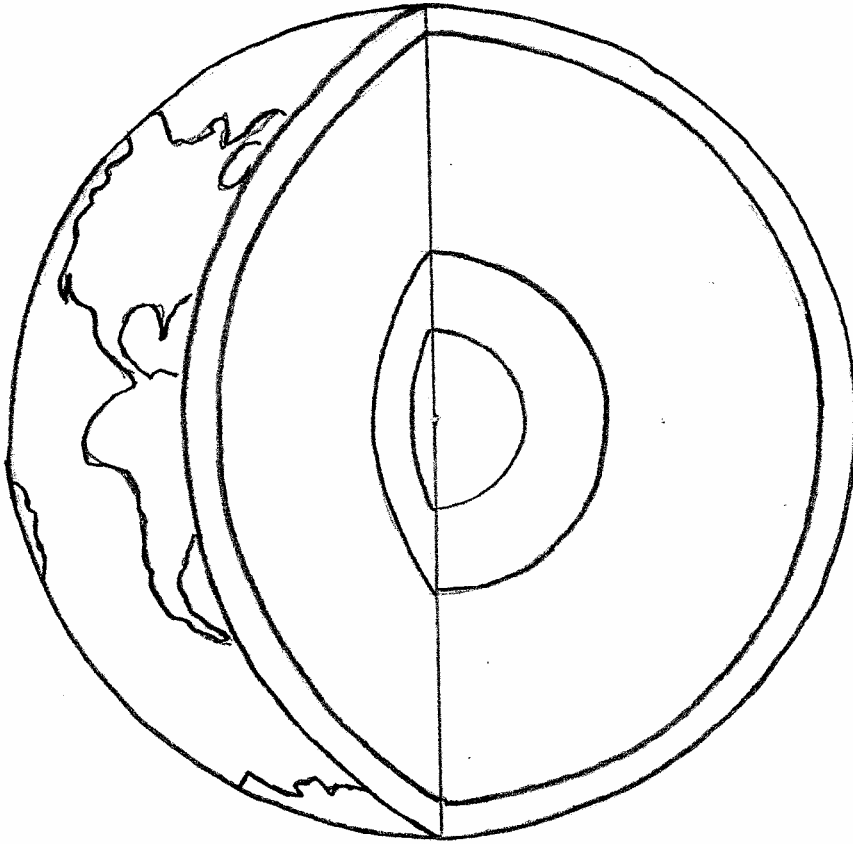
1. Fill the baking dish with water, leaving about 1" at the top.
2. Display the dish at the front of the room so all students can see through the sides.
3. Set up the heater at one end of the baking dish. Give it about five minutes to begin warming the water.
4. Place the bag of ice at the other end of the baking dish, taping it down to keep it in place.
5. Have students watch carefully as you place one drop of red food coloring by the heater to show the hot water and one drop of blue food coloring near the bag of ice to show the cold water.
6. Once students have observed the cycle of the hot water rising and the cold water sinking, place bark chips carefully on the surface of the water. Have the students observe what happens to the bark chips.

**Appendix G**  
**Convection Diagram**

Adapted from *Hands-On Minds-On Science: Geology*, Teacher Created Materials



## Appendix H Earth's Layers



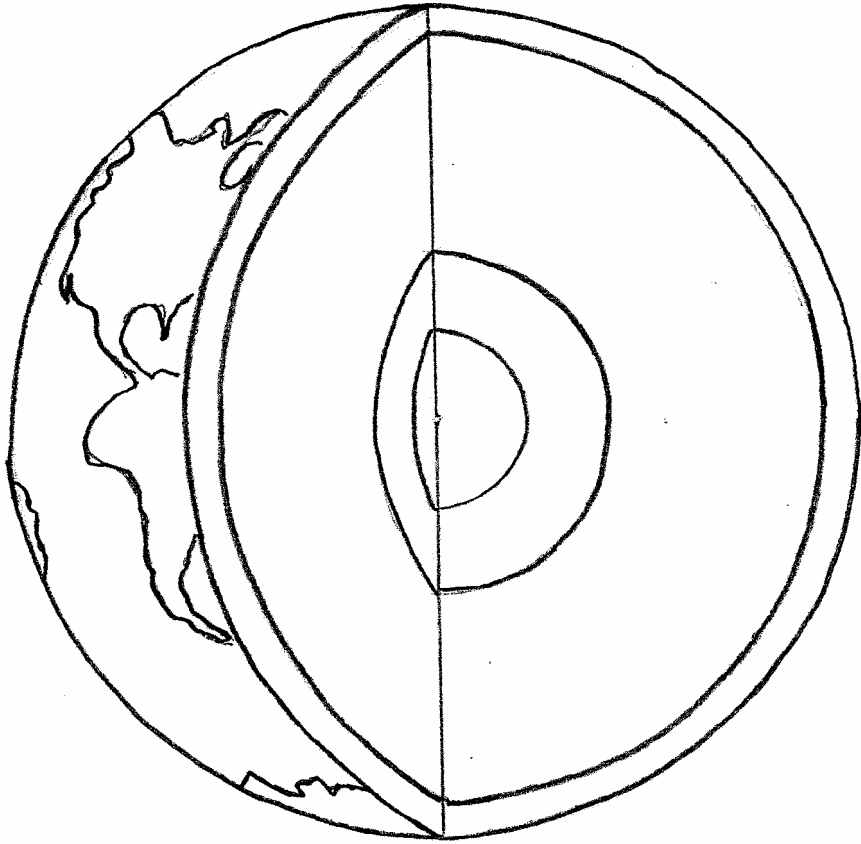
Crust – the outer layer that is mostly rock and varies in thickness from 3 to 34 miles thick

Mantle – the thickest layer, it is 1800 miles thick and is mostly made of rock and magma

Outer core – this layer is completely liquid and is made of iron and nickel

Inner Core – this layer is composed of solid iron and nickel and is about 7,200 ° F

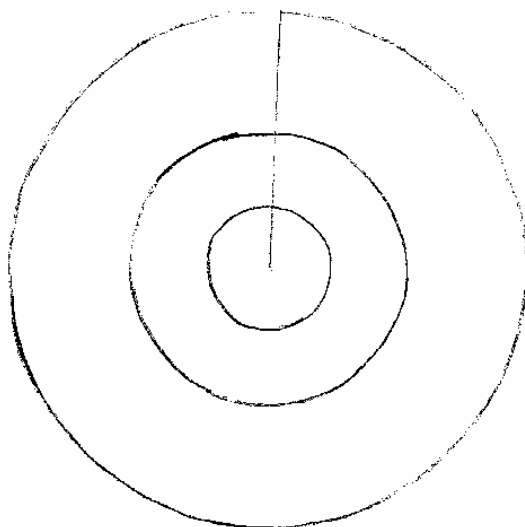
**Appendix I**  
**Earth's Layers Student Copy**



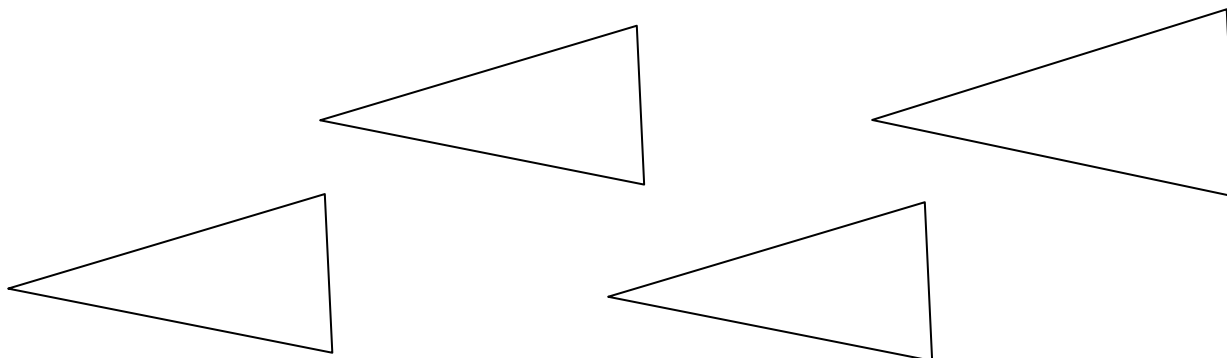
## Appendix J Earth Model Template

Adapted from *Hands-On Minds-On Science: Geology*, Teacher Created Materials

- ✂ First cut around the outside of the circle.
- ✂ Cut on the black line that goes from the outer edge to the very center of the smallest circle.
- ✂ Starting from the cut you just made, cut along the edge of each remaining circle.



- ✂ Cut out the flags. Write the name of the layer and one fact about the layer. Be sure to put your name on each flag!



## Appendix K

### Earth Model Checklist

Student Name: \_\_\_\_\_

Requirements	Yes	No	Comments
Crust labeled correctly	<input type="checkbox"/>	<input type="checkbox"/>	_____
One fact included	<input type="checkbox"/>	<input type="checkbox"/>	_____
Mantle labeled correctly	<input type="checkbox"/>	<input type="checkbox"/>	_____
One fact included	<input type="checkbox"/>	<input type="checkbox"/>	_____
Outer Core labeled correctly	<input type="checkbox"/>	<input type="checkbox"/>	_____
One fact included	<input type="checkbox"/>	<input type="checkbox"/>	_____
Inner Core labeled correctly	<input type="checkbox"/>	<input type="checkbox"/>	_____
One fact included	<input type="checkbox"/>	<input type="checkbox"/>	_____

Student Name: \_\_\_\_\_

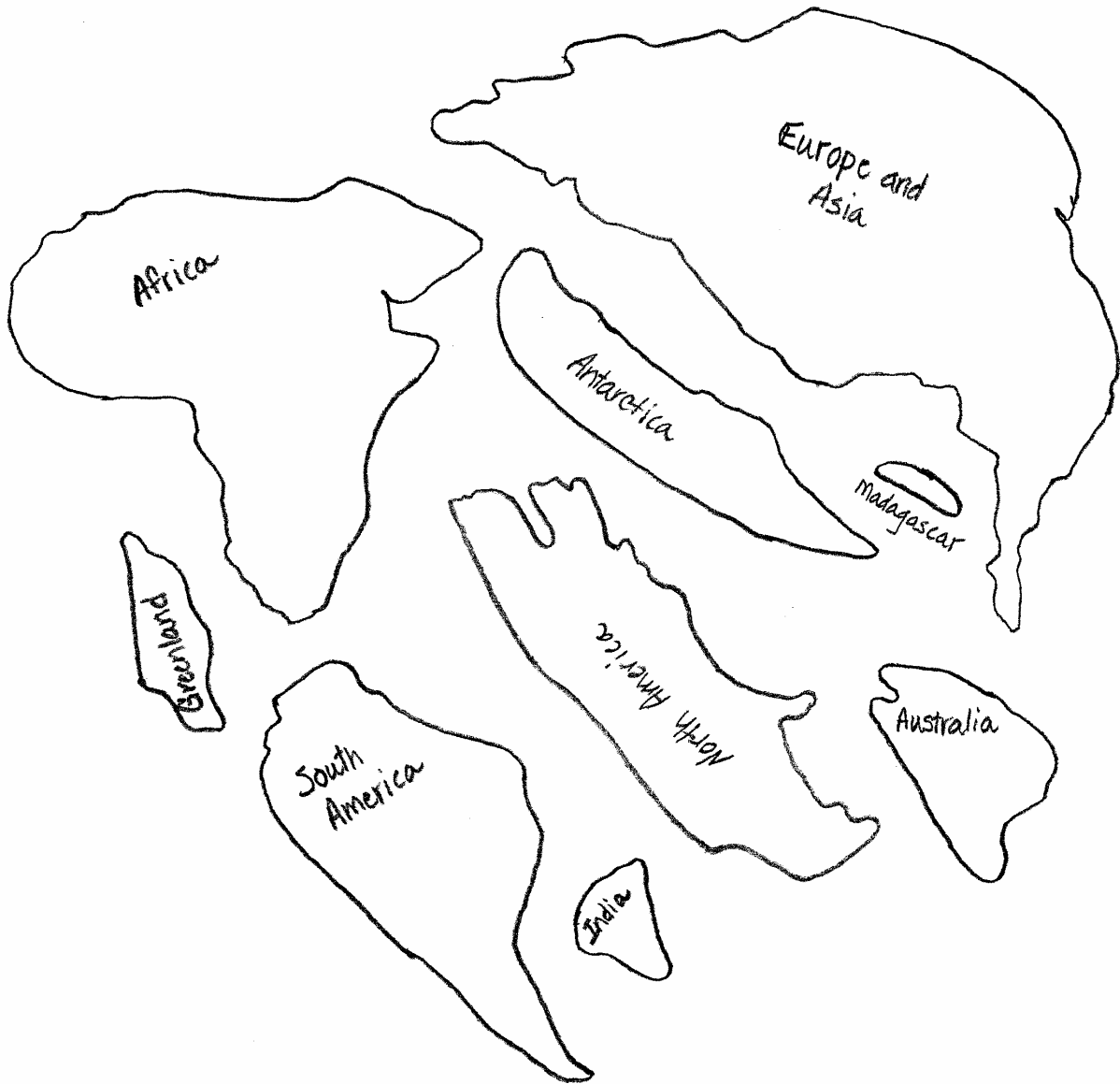
Requirements	Yes	No	Comments
Crust labeled correctly	<input type="checkbox"/>	<input type="checkbox"/>	_____
One fact included	<input type="checkbox"/>	<input type="checkbox"/>	_____
Mantle labeled correctly	<input type="checkbox"/>	<input type="checkbox"/>	_____
One fact included	<input type="checkbox"/>	<input type="checkbox"/>	_____
Outer Core labeled correctly	<input type="checkbox"/>	<input type="checkbox"/>	_____
One fact included	<input type="checkbox"/>	<input type="checkbox"/>	_____
Inner Core labeled correctly	<input type="checkbox"/>	<input type="checkbox"/>	_____
One fact included	<input type="checkbox"/>	<input type="checkbox"/>	_____

Student Name: \_\_\_\_\_

Requirements	Yes	No	Comments
Crust labeled correctly	<input type="checkbox"/>	<input type="checkbox"/>	_____
One fact included	<input type="checkbox"/>	<input type="checkbox"/>	_____
Mantle labeled correctly	<input type="checkbox"/>	<input type="checkbox"/>	_____
One fact included	<input type="checkbox"/>	<input type="checkbox"/>	_____
Outer Core labeled correctly	<input type="checkbox"/>	<input type="checkbox"/>	_____
One fact included	<input type="checkbox"/>	<input type="checkbox"/>	_____
Inner Core labeled correctly	<input type="checkbox"/>	<input type="checkbox"/>	_____
One fact included	<input type="checkbox"/>	<input type="checkbox"/>	_____

## Appendix L Jigsaw Puzzle

Adapted from *The Amazing Earth Model Book: Easy-to-Make, Hands-on Models That Teach*. Scholastic Inc.



**Appendix M, page 1**  
**Study Guide**

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Test Your Notes  
Geology Unit Study Guide

\*The following terms and concepts will be on the unit test. Find them in your notes and write their meaning on the line.

1. Geology  
\_\_\_\_\_
2. Continental Drift Theory  
\_\_\_\_\_
3. Pangaea  
\_\_\_\_\_
4. Plate tectonics  
\_\_\_\_\_
5. Inner core  
\_\_\_\_\_
6. Outer core  
\_\_\_\_\_
7. Mantle  
\_\_\_\_\_
8. Crust  
\_\_\_\_\_
9. Volcano  
\_\_\_\_\_
10. Crater  
\_\_\_\_\_
11. Magma  
\_\_\_\_\_
12. Lava  
\_\_\_\_\_
13. Vent  
\_\_\_\_\_
14. Magma Chamber  
\_\_\_\_\_
15. Fault  
\_\_\_\_\_

16. What clues do earthquakes give us about the interior of the Earth?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Appendix M, page 2**

17. What is the plate tectonics theory, and what facts and information helped scientists come up with it?

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18. What causes earthquakes and volcanoes?

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19. What are the steps of the scientific method and why is it important to use?

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Appendix N, page 1

Name: \_\_\_\_\_ Date: \_\_\_\_\_

☺ Geology Unit Exam ☺

Part I: Use the words from the box to complete the following sentences.

theory	Pangaea	tsunami	lava	continental drift theory
geology	Richter Scale	magma	seismograph	volcano
fault	hypothesis	plate tectonics		crater

- \_\_\_\_\_ is the study of the Earth.
- A \_\_\_\_\_ is an idea or opinion about something that is based on observation and reasoning.
- The theory that Earth's continents were originally one landmass that split up to form the arrangement of continents we see today is called the \_\_\_\_\_.
- Alfred Wegener's name for the super-continent containing all of the world's landmasses is \_\_\_\_\_.
- A large crack in the Earth's surface is called a \_\_\_\_\_.
- \_\_\_\_\_ is the theory that the Earth's crust is divided into a number of constantly moving plates.
- A \_\_\_\_\_ is a place where hot, liquid rock breaks through the Earth's crust.
- The mouth of the volcano is called the \_\_\_\_\_.
- \_\_\_\_\_ is the molten rock inside the Earth, and \_\_\_\_\_ is the molten rock that pours out of a volcano.
- An instrument used to detect and record earthquake waves is called a \_\_\_\_\_.
- A \_\_\_\_\_ is an educated guess to a question you are trying to answer.
- The \_\_\_\_\_ was developed to measure the intensity of earthquake waves.
- A huge wave created by an earthquake is called a \_\_\_\_\_.

Part II: Answer the following questions in complete sentences.

14. What clues do earthquake waves give us about the interior of the Earth?

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15. What is the plate tectonics theory, and what facts and information lead scientists to come up with it?

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**Appendix N, page 2**

16. What causes earthquakes and volcanoes?

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17. What are the steps of the scientific method and why is it important to use?

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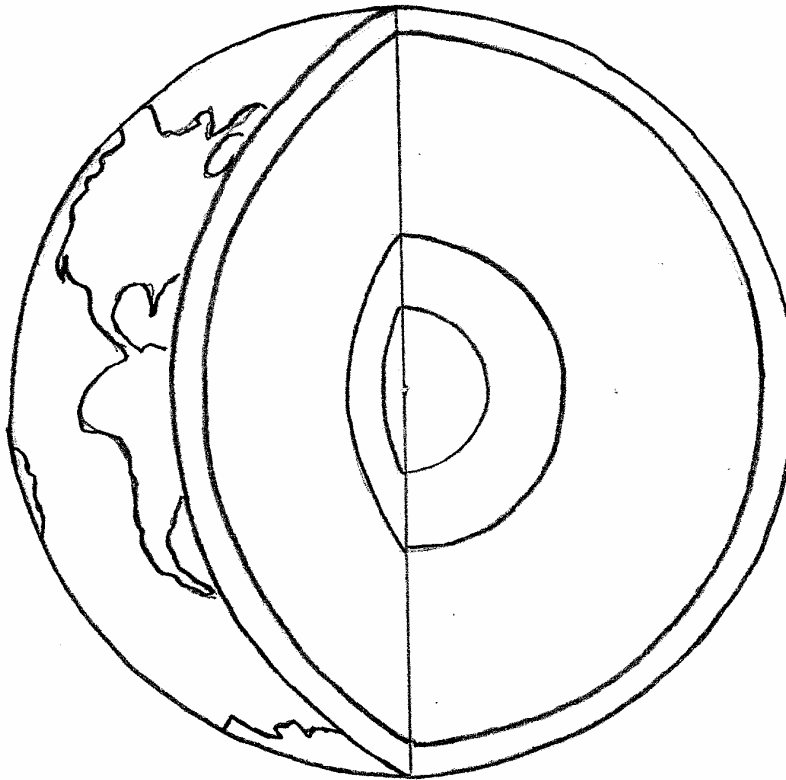
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Part IV: Label the following diagrams using the words provided.

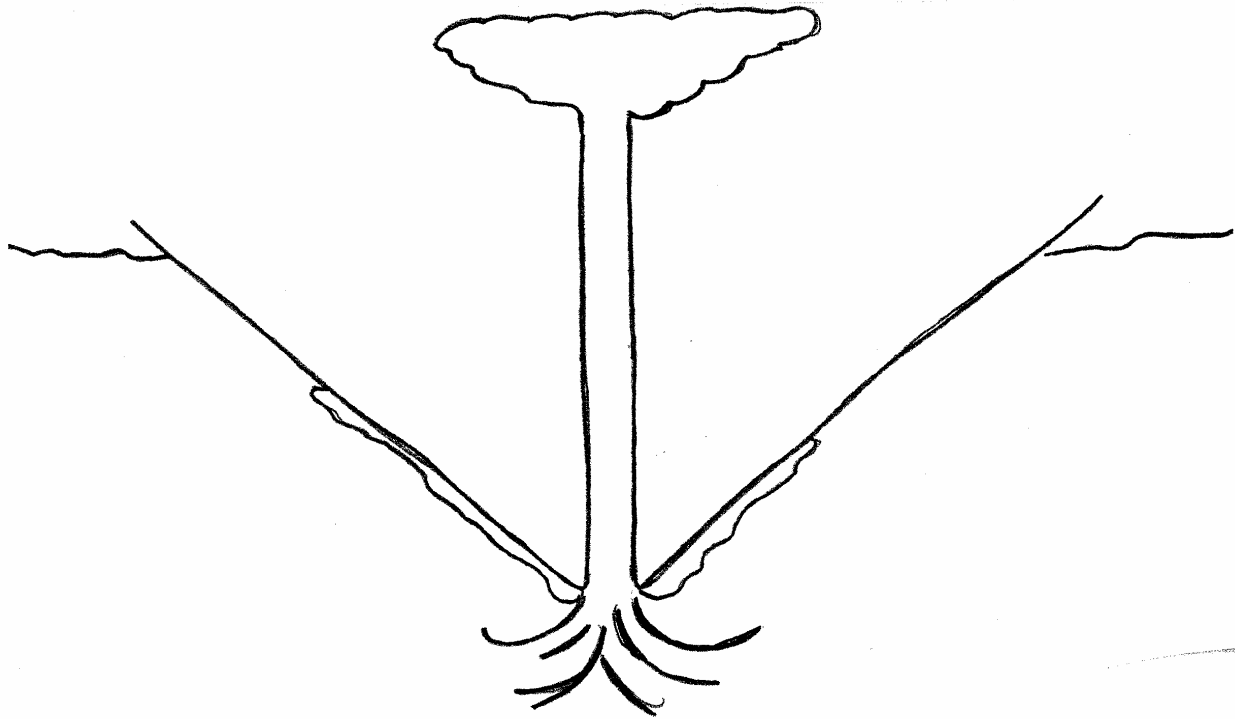
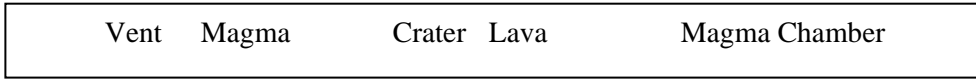
**The Earth's layers**

Inner Core	Mantle	Outer Core	Crust
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Appendix N, page 3

Inside a volcano



**Appendix O, page 1**  
**Test Answer Key**

Name: \_\_\_\_\_ Date: \_\_\_\_\_

☺ Geology Unit Exam ☺  
Answer Key

Part I: Use the words from the box to complete the following sentences.

theory	Pangaea	tsunami	lava	continental drift theory	
geology	Richter Scale	magma	seismograph	volcano	crater
fault	hypothesis	plate tectonics			

18. \_\_\_\_\_ *Geology* \_\_\_\_\_ is the study of the Earth.
19. A \_\_\_\_\_ *theory* \_\_\_\_\_ is an idea or opinion about something that is based on observation and reasoning.
20. The theory that Earth's continents were originally one landmass that split up to form the arrangement of continents we see today is called the \_\_\_\_\_ *continental* \_\_\_\_\_ *drift* \_\_\_\_\_ *theory* \_\_\_\_\_.
21. Alfred Wegener's name for the super-continent containing all of the world's landmasses is \_\_\_\_\_ *Pangaea* \_\_\_\_\_.
22. A large crack in the Earth's surface is called a \_\_\_\_\_ *fault* \_\_\_\_\_.
23. \_\_\_\_\_ *Plate* \_\_\_\_\_ *tectonics* \_\_\_\_\_ is the theory that the Earth's crust is divided into a number of constantly moving plates.
24. A \_\_\_\_\_ *volcano* \_\_\_\_\_ is a place where hot, liquid rock breaks through the Earth's crust.
25. The mouth of the volcano is called the \_\_\_\_\_ *crater* \_\_\_\_\_.
26. \_\_\_\_\_ *Magma* \_\_\_\_\_ is the molten rock inside the Earth, and \_\_\_\_\_ *lava* \_\_\_\_\_ is the molten rock that pours out of a volcano.
27. An instrument used to detect and record earthquake waves is called a \_\_\_\_\_ *seismograph* \_\_\_\_\_.
28. A \_\_\_\_\_ *hypothesis* \_\_\_\_\_ is an educated guess to a question you are trying to answer.
29. The \_\_\_\_\_ *Richter* \_\_\_\_\_ *Scale* \_\_\_\_\_ was developed to measure the intensity of earthquake waves.
30. A huge wave created by an earthquake is called a \_\_\_\_\_ *tsunami* \_\_\_\_\_.

Part II: Answer the following questions in complete sentences. *Answers will vary*

31. What clues do earthquake waves give us about the interior of the Earth?

The Earth is made of layers and one of them is liquid

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32. What is the plate tectonics theory, and what facts and information lead scientists to come up with it?

The plate tectonics theory states that the Earth's surface is broken into large plates. Scientists noticed that earthquakes and volcanoes lined up along the edges of these plates.

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**Appendix O, page 2**

33. What causes earthquakes and volcanoes?

Convection currents beneath Earth's surface cause the crustal plates to move. When plates rub against each other they can cause earthquakes. Sometimes the magma beneath Earth's surface builds up in an area until it finds its way up to the surface, forming a volcano

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34. What are the steps of the scientific method and why is it important to use?

The steps of the scientific method are question, hypothesis, procedure, results, and conclusion. It is important to use the scientific method because other scientists follow the same procedure, you won't leave out an important step, and it makes scientific research consistent.

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Part IV: Label the following diagrams using the words provided.