

# Geology

**Grade Level or Special Area:** 4<sup>th</sup> grade

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**Length of Unit:** Seven lessons (14 days - approximately 45 minutes each)

## I. ABSTRACT

This unit is designed to provide fourth graders with an overview of geology and to provide teachers with lessons to cover the fourth-grade geology requirements from the *Core Knowledge Sequence*. Through class discussions and hands-on activities, the students will gain an understanding of the geological contents of the Earth, the activities that take place in the Earth, and the theories about the Earth's history.

## II. OVERVIEW

### A. Concept Objectives

1. Students will understand the composition of the Earth, its history and the natural processes that shape it. (Jefferson County Standard 4.1)
2. Students will appreciate the affects the various layers of the earth have on the natural events that occur on the earth's surface such as volcanoes, earthquakes, geysers, and hot springs.
3. Students will develop an awareness of the various theories on how the continents and oceans were formed.

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

1. Fourth Grade Science: Geology: The Earth and Its Changes: The Earth's Layers
  - a. Crust, mantle, core (inner core and outer core)
  - b. Movement of the 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
    - iv. Famous volcanoes: Vesuvius, Krakatoa, Mount St. Helens
  - 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

### C. Skill Objectives

1. Students will be able to identify the Earth's layers.
2. Students will be able to list the characteristics of the Earth's crust, mantle, and core.
3. Students will create a scale model of the Earth's layers and label them.
4. Students will be able to identify the forces that change the Earth's surface.
5. Students will be able to explain the patterns of change in the Earth's crustal plates.
6. Students will discuss clues the continents provide geologists about concerning the earth's history.
7. Students will be able to summarize the events that take place in sea-floor spreading.

8. Students will be able to identify three forms of evidence that supports the theory of sea-floor spreading.
9. Students will be able to explain what happens in subduction at the deep-ocean trenches.
10. Students will be able to explain what the theory of plate tectonics is.
11. Students will be able to list the results of the movement of the Earth's plates.
12. Students will be able to identify the different kinds of seismic waves and name the instrument used to measure them.
13. Students will be able to name the scales used to measure the intensity of an earthquake.
14. Students will be able to label the parts of a volcano and name the three activity stages.
15. Students will be able to name and describe the four types of volcanoes.
16. Students will describe how geysers and hot springs are formed from volcanic activity.
17. Students will identify one famous geyser and one famous hot spring.
18. Students will be able to define what a fault is and explain where faults occur.
19. Students will be able to explain how tsunamis can be a result of an earthquake.
20. Students will be able to identify where the Earth's volcanic regions are and why they are located there.
21. Students will complete the final exam over the unit of the geology of the Earth.
22. Students will review the information covered in this unit on the Earth's geology and prepare for the final test.

### III. BACKGROUND KNOWLEDGE

- A. For Teacher
  1. *Prentice Hall Science Explorer Inside Earth: Teacher's Edition*, "Plate Tectonics," "Earthquakes," "Volcanoes"
  2. Eyewitness Books, *The Visual Dictionary of the Earth*
  3. *Inside Earth*, World Almanac Library
- B. For Students
  1. *Core Knowledge Sequence: 1st Grade Science: The Earth*

### IV. RESOURCES

- A. *Prentice Hall Science Explorer Inside Earth*, by Prentice Hall (Lessons One-Five)
- B. *Prentice Hall Science Explorer Inside Earth Teacher's Edition*, by Prentice Hall (Lesson One)
- C. *Eyewitness Visual Dictionary The Visual Dictionary of the Earth*, DK Publishing Book (Lessons Four and Five)
- D. *Planet Earth*, by Avalyn McGinley (Lesson Five)
- E. *Kids Discover Volcanoes* magazine (Lesson Five)
- F. Video: *Earth Science for Children, All About Volcanoes*, by Schlessinger science library films (Lesson Five)
- G. *Inside the Earth* by World Almanac (Lesson One)
- H. *Teaching Resources with Color Transparencies*, by Prentice Hall (Lesson One)
- I. *Earth Science for Children All About Earthquakes* by Schlessinger Media (Lesson Four)

## V. LESSONS

### Lesson One: The Earth's Layers (two class periods – 45 minutes each day)

#### A. Daily Objectives

1. Concept Objective
  - a. Students will understand the composition of the Earth, its history and the natural processes that shape it. (Jefferson County Standard 4.1)
2. Lesson Content from the *Core Knowledge Sequence*
  - a. Crust, mantle, and core ( outer core and inner core)
  - b. Movement of the crustal plates
3. Skill Objective(s)
  - a. Students will be able to identify the Earth's layers.
  - b. Students will be able to list the characteristics of the Earth's crust, mantle, and core (inner core and outer core).
  - c. Students will create a scale model of the Earth's layers and label them.

#### B. Materials

1. Playdough – red, yellow, orange, and brown (or blue) – enough for each student to make a scale model of the Earth's layers
2. Prentice Hall *Science Explorer Inside Earth* book (one per student) pp. 16 – 24
3. Overhead – “Exploring the Earth's Interior” from *Science Explorer Inside Earth* Teacher's Edition
4. **Advance Planning** – Make an overhead of “Journey to the Center of the Earth” (Appendix B)
5. Toothpicks (used to make labels for the model of the Earth's labels)
6. Sticky labels (used to make labels for the model of the Earth's labels)
7. Appendix A worksheet – one per child
8. Appendix C Quiz 1 – one per child
9. Pencils – one per child
10. Crayons for each child
11. **Advance Planning** – Make an overhead of “Exploring the Earth's Interior” (Appendix A)
12. Books such as *Inside the Earth* or other resources that show diagrams of the Earth's Interior

#### C. Key Vocabulary

1. A *geologist* is a scientist who studies the forces that make and shape planet Earth.
2. *Rock* is material that forms the Earth's hard surface.
3. *Geology* is the study of planet Earth.
4. *Constructive forces* are forces that shape the surface by building up mountains and landmasses.
5. *Destructive forces* are forces that slowly wear away mountains and other landforms or features on the surface.
6. *Continents* are large landmasses surrounded by oceans.
7. *Seismic waves* are vibrations that travel through the Earth carrying the energy released during an earthquake.
8. *Pressure* is the amount of force pushing on a surface or an area.
9. The *crust* is the layer of rock that forms Earth's outer surface.
10. The *mantle* is the layer of hot, solid material between Earth's crust and core.
11. The *lithosphere* is a rigid layer made up of the uppermost part of the mantle and the crust.
12. The *asthenosphere* is the soft layer of the mantle on which the lithosphere floats.
13. The *outer core* is a layer of molten iron and nickel that surrounds the inner core of the Earth.

14. The *inner core* is a dense sphere of solid iron and nickel in the center of the Earth.

D. *Procedures and Activities*

**Day One:**

1. To introduce this lesson, display a globe and ask the students what they know about what makes up the Earth, who studies the Earth, and how it is studied.
2. Have a KWL chart to write down student responses to these questions. Put all accurate responses under the “K” column representing the things they know.
3. Ask the students what they would like to know about the Earth, its formations, and geological events that take place in and on it.
4. Record the student responses on the KWL chart under the “W” column representing what things the students would like to learn.
5. Use the overhead sheet called “Exploring Earth’s Interior” (Appendix A) to show students the various layers of the Earth. Show each layer and discuss the information given on the overhead concerning the temperature and depth of each level. Tell the kids that this information has been given to them with metric measures, but that it will also be given to them in standard measurements as well as other information about the layers they are studying. I use pictures of the layers from *Inside the Earth* at this time.
6. Read and discuss pages 16-23 in Prentice Hall’s *Science Explorer Inside Earth*. As you come upon the bold-typed vocabulary words, stop and discuss them and check for understanding.
7. Possible discussions questions:
  - a. Why is it important for geologists to study the earth? (Geologists learn about the composition of the Earth, its movements, and past geological events that help them to better determine future happenings of the Earth’s movements.)
  - b. How do constructive forces change the appearance of the Earth’s surface? (Constructive forces build up the Earth’s surface.)
  - c. How do destructive forces change the appearance of the Earth’s surface? (Destructive forces wear away the Earth’s surface)
  - d. What kind of indirect evidence do geologists use to study the structure of the Earth? (Sonic waves)
  - e. What materials make up the inner core, outer core, mantle, and crust? (inner core- a dense solid ball of nickel and iron; outer core – molten nickel and iron; mantle – a layer of hot rock; the crust is made up of rocks, soil, and water)
8. After reading, use the overhead sheet “Journey to the Center of the Earth” (Appendix A). Also, pass out the worksheet that goes with the overhead. Color and label each layer of the Earth and note in each of the boxes shown, the depth, temperatures, and materials that make up the layers.

**Day Two:**

9. Review concepts from previous lesson. Use overhead of Appendix A to review the Earth’s layers.
10. Pull up the KWL chart and ask students what they have learned about the Earth, what makes it up and who studies it. Put their responses on the chart.
11. Tell the students that today they will make a layer model of the Earth out of clay and label it appropriately.
  - a. Instructions – Make a layer model of the Earth wrapping the different colors of clay around each other to represent the various layers of the Earth. Use the yellow color clay to represent the inner core, the orange

color to represent the outer core, the red color to represent the mantle and the blue/brown color to represent the crust. When you are finished with your model, use your scissors to cut a section of the model out so the students can see the layers. Label your layers.

12. After students complete models, administer Quiz 1 (Appendix C) and collect to grade.

E. *Assessment/Evaluation*

1. Collect Quiz 1 and grade to check for mastery of the concepts.

**Lesson Two: The Earth's Crustal Plates and Theorized History (one class period – 45 minutes)**

A. *Daily Objectives*

1. Concept Objective(s)
  - a. Students will understand the composition of the Earth, its history and the natural processes that shape it. (Jefferson County Standard 4.1)
  - b. Students will appreciate the affects the various layers of the earth have on the natural events that occur on the earth's surface such as volcanoes, earthquakes, geysers, and hot springs.
  - c. Students will develop an awareness of the various theories on how the continents and oceans were formed.
2. Lesson Content
  - a. Movement of crustal plates
  - b. Theories of how the continents and oceans were formed: Pangaea and continental drift
3. Skill Objective(s)
  - a. Students will be able to identify the forces that change the Earth's surface.
  - b. Students will be able to explain the patterns of change in the Earth's crustal plates.
  - c. Students will discuss clues the continents provide geologists with concerning the Earth's history.

B. *Materials*

1. Worksheets – Appendix D, “ What Happens During Convection” and Appendix F, “The Earth's Jigsaw Puzzle”– one per student
2. Crayons and scissors for every student
4. Blue construction paper – (9” x 12”) for every student
5. Glue sticks (one per student)
6. *Science Explorer Inside Earth* book for every student

C. *Key Vocabulary*

1. *Heat transfer* is the movement of energy from a warmer object to a cooler object.
2. *Radiation* is the transfer of energy through empty space.
3. *Conduction* is heat transferred by direct contact of particles of matter.
4. *Convection* is heat transferred by the movement of fluids.
5. *Density* is the measure of how much mass there is in a volume of a substance.
7. *Continental Drift* is the idea that continents moved slowly over the Earth's surface.
8. *Fossils* are any traces of ancient organisms that have been preserved in rock.

D. *Procedures/Activities*

1. Review the Earth's layers with the class.

2. Begin this lesson by explaining that what goes on in these various layers affects the surface of the Earth and causes it to be ever changing, as they will see in the pages they will be reading.
  3. Read and discuss “Convection Currents and the Mantle” in the *Science Explorer Inside Earth* book, pages 25 – 27. The following are some suggested discussion questions:
    - a. What are three types of heat transfer? (radiation, conduction, and convection)
    - b. How is heat transferred by conduction different from heat transferred by convection? (Heat transferred by conduction is transferred through direct contact with the particles of matter whereas by convection heat is transferred by the movement of fluids.)
    - c. What causes convection currents in the Earth’s mantle? (The Earth’s hot core and mantle itself causes convection currents in the mantle.)
  4. Do the worksheet “What Happens During Convection?” (Appendix D) together and discuss this process together.
  5. Read and discuss “Drifting Continents,” p. 28 – 31 in *Science Explorer Inside Earth*. Be sure to discuss what clues the continental plates give scientists concerning the Earth’s history (including landforms, fossils, and climate evidence).
  6. Give students the “Earth’s Jigsaw” worksheet (Appendix F). Allow them time to color the pieces, cut them out and glue them to the blue construction paper.
- E. *Assessment/Evaluation*
1. Collect the “Earth’s Jigsaw” (Appendix F) and check for understanding as to how scientists believed the Earth once appeared. Use this as an informal evaluation.

**Lesson Three: Sea Floor Spreading and Plate Movement (two class periods – 45 minutes each)**

- A. *Daily Objectives*
1. Concept Objective(s)
    - a. Students will understand the composition of the Earth, its history and the natural processes that shape it. (Jefferson County Standard 4.1)
    - b. Students will appreciate the affects the various layers of the earth have on the natural events that occur on the earth’s surface such as volcanoes, earthquakes, geysers, and hot springs.
    - c. Students will develop an awareness of the various theories on how the continents and oceans were formed.
  2. Lesson Content
    - a. Movement of the crustal plates
  3. Skill Objective(s)
    - a. Students will be able to summarize the events that take place in sea-floor spreading.
    - b. Students will be able to identify three forms of evidence that supports the theory of sea-floor spreading.
    - c. Students will be able to explain what happens in subduction at the deep-ocean trenches.
    - d. Students will be able to explain what the theory of plate tectonics is.
- B. *Materials*
1. *Prentice Hall’s Science Explorer Inside Earth* – one for each student
  2. Quiz 2 (Appendix E) – one for each student
  3. Pencils – enough for each student

- C. *Key Vocabulary*
1. The *mid-ocean ridge* is the longest chain of mountains in the world.
  2. *Sonar* is the device (*instrument*) that bounces sound waves off underwater objects and records the echoes of these sound waves.
  3. *Sea-floor spreading* is the process that continually adds new material to the ocean floor.
  4. A *deep-ocean trench* is a deep underwater canyon.
  5. *Subduction* is the process by which the ocean floor sinks beneath a deep-ocean trench and back into the mantle.
  6. A *scientific theory* is a well-tested concept that explains a wide range of observations.
  7. *Plate tectonics* is a geographical theory that states that pieces of the Earth's lithosphere are in constant, slow motion, driven by convection currents in the mantle.
  8. *Faults* are breaks in the Earth's crust where rocks have slipped past each other.
  9. *Transform boundary* is a place where two plates slip past each other.
  10. A *divergent boundary* is where two plates move apart.
  11. A *convergent boundary* is where two plates come together or converge.

D. *Procedures/Activities*

**Day One:**

1. Read and discuss pages 33-39 in *Prentice Hall's Science Explorer Inside Earth*. Suggested discussion questions:
  - a. Describe what happens in "sea-floor spreading." (At the mid-ocean ridge, molten material rises from the mantle and erupts. The molten material then spreads out, pushing older rock to both sides of the ridge.)
  - b. How could "sea-floor spreading" possibly cause continents to move? (The movement of the ocean floor puts pressure on the continental plates and therefore can cause some movement over time.)
  - c. "Sea-floor spreading" is a theory. What evidence was given to support this theory? (Evidence is found in molten material found along the ocean ridge, in the magnetic stripes found on rocks on the ocean floor, and from drilling samples of rocks found in and on the ocean ridges.)
2. Read and discuss "The Theory of Plate Tectonics," pages 42-47. Suggested discussion questions:
  - a. Have a student explain what the theory of plate tectonics is.
  - b. What is a fault? (See Key Vocabulary.)
  - c. Name and describe the three types of boundaries. (See Key Vocabulary.)

**Day Two:**

3. Review the concepts taught in the last lesson and show the movie *Planet Earth; The Living Machine*. Have students take notes on the movie. Discuss note after the movie.
4. Give Quiz 2 (Appendix E). Administer the quiz and collect to grade.

E. *Assessment/Evaluation*

1. Grade Quiz 2 to check for understanding of the concepts taught.

**Lesson Four: Monitoring Faults and Earthquakes (three class periods – 45 minutes each)**

A. *Daily Objectives*

1. Concept Objective(s)
  - a. Students will appreciate the affects the various layers of the earth have on the natural events that occur on the earth's surface such as volcanoes, earthquakes, geysers, and hot springs.

2. Lesson Content
  - a. Earthquakes
    - i. Faults, San Andreas fault
    - ii. Measuring intensity: seismograph and Richter Scale
    - iii. Tsunamis (also called tidal waves)
3. Skill Objective(s)
  - a. Students will be able to list the results of the movement of the Earth's plates.
  - b. Students will be able to identify the different kinds of seismic waves and name the instrument used to measure them.
  - c. Students will be able to name the scales used to measure the intensity of an earthquake.
  - d. Students will be able to define what a fault is and explain where faults occur.
  - e. Students will be able to explain how tsunamis can be a result of an earthquake.

**B. Materials**

1. **Advance planning** – Bring in pictures of faults, damage from earthquakes, and Earthquake zones to share with the class (I use the *Eyewitness Visual Dictionaries The Dictionary of the Earth* for some of the pictures and I also use pictures from other books, magazines, and the internet)
2. *Prentice Hall's science Explorer Inside Earth* (one for each child)
3. Movie on Earthquakes – *Earth Science for Children All About Earthquakes* by Schlessinger Media
4. Paper and pencils for each child to take notes on from the movie
5. Earthquake quiz (Appendix G) – one for each student

**C. Key Vocabulary**

1. An *earthquake* is the shaking and trembling that results from the movement of rock beneath Earth's surface.
2. *Stress* is a force that acts on rock to change its shape or volume. (Reminder: Volume is the amount of space an object takes up.)
3. *Folds* are bends in rock that form when compression shortens and thickens part of Earth's crust.
4. A *plateau* is a large area of flat land elevated high above sea level.
5. *Seismic waves* are vibrations that travel through Earth carrying the energy released during an earthquake.
6. A *seismograph* is an instrument that records the ground movements caused by seismic waves as they move through the Earth.
7. *Magnitude* is a measurement of earthquake strength based on seismic waves and movement along faults.
8. The *Richter scale* is a rating of the size of seismic waves as measured by a particular type of mechanical seismograph.
9. A *tsunami* is a large wave produced by an earthquake on the ocean floor.

**D. Procedures/Activities**

**Day One:**

1. To introduce this lesson, display or show pictures of the aftermath of earthquakes that have occurred around the world. This will peak the students' interest in learning more about how earthquakes occur, where they are most likely to occur, and what causes them. I use the *Eyewitness Visual Dictionaries The Visual Dictionary of the Earth*. I have also used pictures from magazines such as National Geographic that show the results of recent earthquakes.

2. Introduce the vocabulary words to the students. Discuss their meanings with the students.
3. Show the movie on earthquakes. Have students take notes during the movie especially noting if any of the vocabulary words were used.

**Day Two:**

4. Briefly review the vocabulary words and the things they observed in the movie on earthquakes.
5. Read and discuss pages 54 -61 in Prentice Hall's *Science Explorer Inside Earth*. Some possible discussions questions follow:
  - a. What are the three types of stress that occur in the crust? Describe each. (*Shearing*- stress that pushes a mass of rock in two opposite directions. *Tension* – a stress force that pulls on the crust, stretching rock so that it becomes thinner in the middle. *Compression* - a stress that squeezes rock until it folds or breaks.)
  - b. What are the three types of faults that occur in the crust? Describe each. (Strike-slip faults – the rocks on either side of the fault slip past each other sideways with little up-or-down motion. Normal faults – the fault is at an angle so one block of rock lies above the fault while the other block lies below the fault. Reverse faults – this has the same structure as a normal fault, but the blocks move in the opposite direction.)
  - c. What are the two types of folds? (Anticline is a fold in the rock that bends upward into an arch. Syncline is a fold in rock that bends downward in the middle to form a bowl.)
6. Continue reading in the book pages 64-69 about seismic waves. Ask the following question about the seismic waves:
  - a. What are three kinds of seismic waves? (Primary waves are the first waves to arrive, secondary waves are the waves that vibrate from side to side as well as up and down, and surface waves move slowly but produce the most ground movement.)

**Day Three:**

7. Review with the students the information in the pages they read the previous in the *Science Explorer Inside Earth* book. The following are some ideas:
  - a. Give the Earthquake Quiz 2 (Appendix G).
  - b. (Possible activity – Field Trip: University of Mines – Earthquake Center)

E. *Assessment/Evaluation*

1. Day 1 - Collect the notes after viewing the movie on earthquakes for an informal evaluation.
2. Day 3 - Collect and grade the earthquake quiz (Appendix G).

**Lesson Five: Volcanoes (four class periods – 45 minutes each)**

A. *Daily Objectives*

1. Concept Objective(s)
  - a. Students will appreciate the affects the various layers of the earth have on the natural events that occur on the earth's surface such as volcanoes, earthquakes, geysers, and hot springs.
  - b. Students will develop an awareness of the various theories on how the continents and oceans were formed.
2. Lesson Content
  - a. Volcanoes
    - i. Magma

- ii. Lava and lava flow
  - iii. Active, dormant, or extinct
  - iv. Famous volcanoes: Vesuvius, Krakatoa, Mount St. Helens
3. Skill Objective(s)
- a. Students will be able to label the parts of a volcano and name the three activity stages.
  - b. Students will be able to name and describe the four types of volcanoes.
  - c. Students will describe how geysers and hot springs are formed from volcanic activity.
  - d. Students will identify one famous geyser and one famous hot spring.
  - e. Students will be able to identify where the Earth's volcanic regions are and why they are located there.

B. *Materials*

1. **Advance Planning** – Find pictures of volcanoes (especially ones that show the four types of volcanoes), volcanic diagrams, and volcanic eruptions to display in the classroom (I have used *Eyewitness Visual Dictionaries The Visual Dictionary of the Earth*, *Kids Discover Volcanoes* magazine, and *Planet Earth* teacher workbook by Milliken)
2. **Advance Planning** – Write out the vocabulary words on cards to show the students when explaining their meanings.
3. **Advance Planning** –
  - a. Six cone-shaped plastic drinking cups with flat bottoms
  - b. Six 8-inch disposable aluminum pie plates
  - c. Six - bottom two-thirds of empty eggshells
  - d. A small amount of clay for each group of students (enough to secure the eggshell to the cup)
  - e. Enough sand or soil to cover each plastic cup (probably a one cup would do – I put the dirt in zip-lock bags for the groups)
  - f. Enough vinegar to fill the eggshell (six small containers to hold vinegar for each group)
  - g. One small bottle of red food coloring
  - h. One teaspoon of baking soda per group (one-half measuring spoons for measuring)
4. Video: *Earth Science for Children, All About Volcanoes*, by Schlessinger science library films
5. *Prentice Hall Science Explorer Inside Earth* book – one for each student
6. Paper and pencil for each student to take notes on during the movie
7. Directions for making the volcano (Appendix H)
8. Review sheet (Appendix I)

C. *Key Vocabulary*

1. A *volcano* is a weak spot in the crust where molten material, or magma, comes to the surface.
2. *Lava* is magma that has reached the surface of the Earth.
3. The *Ring of Fire* is a major volcanic belt formed by many volcanoes that rim the Pacific Ocean.
4. A *hot spot* is an area where magma from deep within the mantle melts through the crust like a blowtorch.
5. The *magma chamber* is a pocket beneath the volcano that collects magma.
6. A *pipe* is a long tube in the ground that connects the magma chamber to the Earth's surface.

7. The *vent* is the opening at the top of the volcano that molten rock and gases escape from.
8. *Lava flow* is the area covered by lava as it pours out of a vent.
9. The *crater* is the bowl-shaped area that may form at the top of a volcano.

D. *Procedures/Activities*

**Day One:**

1. Begin this lesson showing pictures different types of volcanoes, especially if you can find them in the different stages of eruption. Also, show pictures of the destruction they can cause. I use the Eyewitness Visual Dictionaries *The Visual Dictionary of the Earth*. I also use the magazine *Volcanoes* by KIDS Discover. Be sure to include the picture (Appendix E) that diagrams the inside of a volcano.
2. Review the vocabulary words with the students, pointing out on the volcano diagram the various parts of the volcano.
3. Show the movie on volcanoes. Have students take notes on the movie.

**Day Two:**

4. Briefly review the vocabulary words about volcanoes and things the students learned from the movie from the last lesson.
5. Read and discuss pages 88 – 102 from the *Prentice Hall Scientific Explorer Inside Earth* book. Some suggested discussion questions are as follows:
  - a. How can scientists determine if a volcanic eruption was a quiet one or an explosive one? (The silica content of the magma reveals this. Magma that is thick and has a high silica content came from an explosive eruption. Magma that was thinner and had a lower silica content came from a quiet eruption.)
  - b. Where do hot springs form? (Hot springs form when groundwater is heated by a nearby body of magma that has risen to the surface. This water may contain dissolved gases and other substances from deep within the Earth.)
  - c. How can we get geothermal energy from volcanic area? (Steam, from deep under the ground, is piped into turbines. Once in the turbine, the steam turns a wheel that turns a generator and changes the energy into electricity.)
  - d. Name and describe the four types of volcanoes. (Shield volcano- a wide, gently-sloping mountain, example- Hawaiian Islands; Cinder Cone volcano- a steep, cone-shaped hill or mountain, example – Paricutin in Mexico; Composite volcanoes- tall, cone-shaped mountain in which layers of lava alternate with layers of ash, example – Mount St. Helens in Washington state. Lava plateaus – some volcanic eruptions form high, level areas called lava plateaus, example – Columbia Plateau in Washington state and Oregon.)

**Day Three:**

8. Review the parts of a volcano and the different types of eruptions.
9. Read and discuss pages 103 – 112 in the *Prentice Hall Science Explorer Inside Earth* book. Some suggestions questions are as follows:
  - a. Name and describe the four types of volcanoes. (Shield volcano- a wide, gently-sloping mountain, example- Hawaiian Islands; Cinder Cone volcano- a steep, cone-shaped hill or mountain, example – Paricutin in Mexico; Composite volcanoes- tall, cone-shaped mountain in which layers of lava alternate with layers of ash, example – Mount St. Helens in Washington state. Lava plateaus – some volcanic eruptions form high,

- level areas called lava plateaus, example – Columbia Plateau in Washington state and Oregon.)
- b. What are some other landforms that magma can produce? (Volcanic necks – When magma hardens in a volcano’s pipe and hardens, the softer rock around it wears away and produces a “neck.” Dike- When magma forces itself across rock layers it forms a dike. Sill – When magma squeezes between layers of rock, it forms a sill.)
8. Inform the students that they will be making volcanoes during the next science period. Give them verbal instructions as to how the experiment will be done. Inform them of the groups they will be in, the cooperation needed to make the experiment a success, and the class rules about experimentation that they must follow. This will help them to come to class prepared for the experiment and for working with others.

**Day Four:**

9. Today the class will be making volcanoes. Explain to the class that they will be doing an experiment today. Be sure that you review your safety rules with the class before beginning the day’s experiment. Divide the class into six groups. Have a parent helper with each group, if possible. (Note: Try to meet with the parent helpers a few minutes ahead of time to inform them of what they are to do to help the children.) Assign a table captain to be in charge of delegating the jobs to be done to complete the experiment. Give the instruction sheet to the table captain to read as the group follows along reading their own sheets. Once the instructions have been read to the group, they may begin their experiment. The teacher will make informal observations to see if the groups are following directions and following your safety guidelines.
  10. When the experiment is finished, discuss the results with the class.
  11. Give the students the review sheet over the geology of the Earth for homework. Inform them that you will be going over this in class the next day.
- E. *Assessment/Evaluation*
1. Collect the notes on the movie seen on day one and make an informal evaluation.

**Lesson Six: Review Sheet on the Geology of the Earth (one day – 45 minutes)**

A. *Daily Objectives*

1. Concept Objective(s)
  - a. Students will understand the composition of the Earth, its history and the natural processes that shape it. (Jefferson County Standard 4.1)
  - b. Students will appreciate the affects the various layers of the Earth have on the natural events that occur on the Earth’s surface such as volcanoes, earthquakes, geysers, and hot springs.
  - c. Students will develop an awareness of the various theories on how the continents and oceans were formed.
2. Lesson Content from *Core Knowledge Sequence*
  - a. Crust, mantle, and core (outer core and inner core)
  - b. Movement of the 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
      - iv. Famous volcanoes: Vesuvius, Krakatoa, Mt. St. Helens
    - 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
  - 3. Skill Objectives
    - a. Students will review the information covered in this unit on the Earth's geology and prepare for the final test.
- B. *Materials*
- 1. Review sheet (Appendix J) that the students did for homework
- C. *Vocabulary*
- No new words, just review the words given throughout each lesson.
- D. *Procedures and Activities*
- 1. Go over the review sheet with the class discussing the questions as you go over them. I spend about one-half of the class going over the review sheet. The other half of the class I play a game using questions from the lessons they have studied.
  - 2. Use questions from lessons, the review sheet, quizzes, and the test to play a game. (Suggestions: Divide the class in groups of X's and O's and play tic, tack, toe. Another game is baseball. Make a baseball diamond and a marker for each group. The group's markers move around the bases as they answer questions; but for each question missed, it is considered an out. This can also be played by making up a football field. Each team starts at the 50-yard line as students come up to answer questions, if they are correct, they move their team's football ten yards closer to the goal post.)
- E. *Assessment/Evaluations*
- 1. Informal Evaluation – You will be able to informally assess whether the class is ready for the final test by how they have completed the review sheet and by how they do as they play a review game.

**Lesson Seven: Final Test (one day – 45 minutes each)**

- A. *Daily Objectives*
- 1. Concept Objective(s)
    - a. Students will understand the composition of the Earth, its history and the natural processes that shape it. (Jefferson County Standard 4.1)
    - b. Students will appreciate the affects the various layers of the earth have on the natural events that occur on the earth's surface such as volcanoes, earthquakes, geysers, and hot springs.
    - c. Students will develop an awareness of the various theories on how the continents and oceans were formed.
  - 2. Lesson Content
    - a. Crust, mantle, and core (outer core and inner core)
    - b. Movement of the 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
      - iv. Famous volcanoes: Vesuvius, Krakatoa, Mt. St. Helens

- 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
- 3. Skill Objective(s)
  - a. Students will complete the final exam over the unit of the geology of the Earth.
- B. *Materials*
  - 1. Final Test (Appendix K) – copies for all students
- C. *Key Vocabulary*  
None
- D. *Procedures/Activities*
  - 1. Administer the final test and collect when students finish.
- E. *Assessment/Evaluation*
  - 1. Grade the test and check for mastery of concepts.

## V. CULMINATING ACTIVITY

- A. Field Trip to the Earthquake Center at the University of Mines

## VI. HANDOUTS/WORKSHEETS

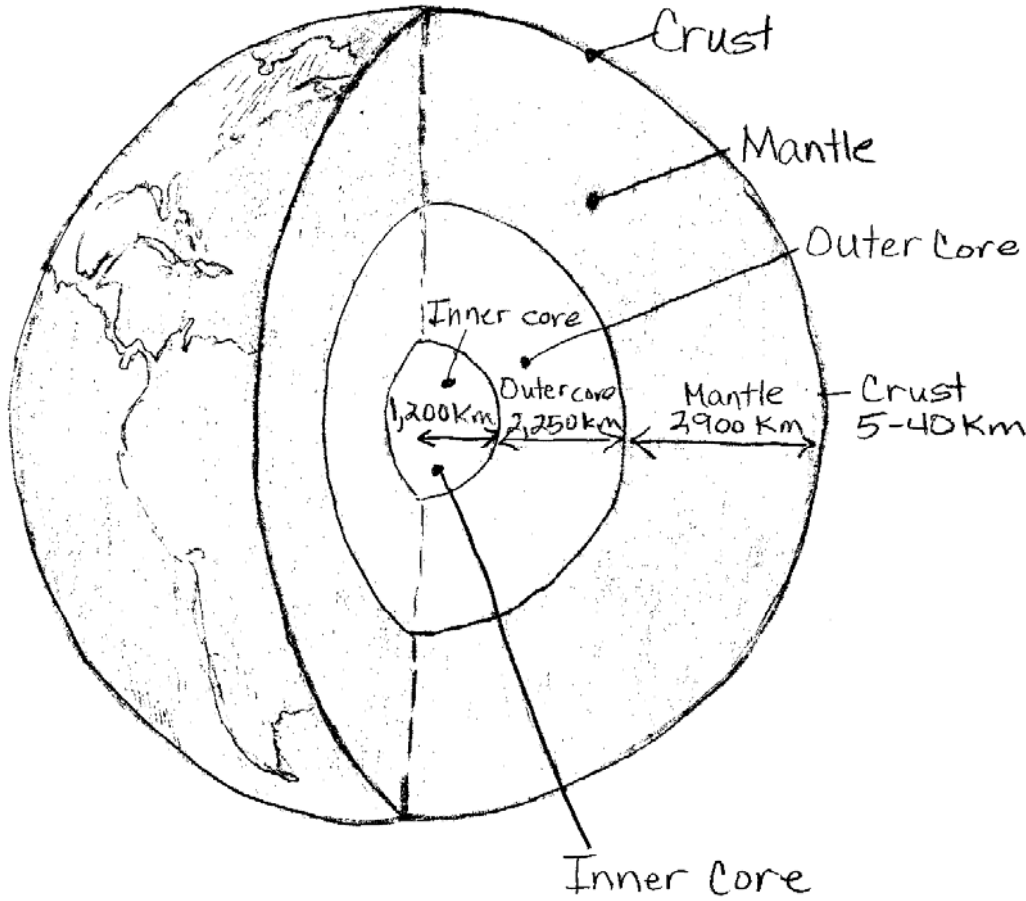
- A. Appendix A: Exploring Earth’s Interior
- B. Appendix B: Journey to the Center of the Earth
- C. Appendix C: Quiz 1
- D. Appendix D: What’s Happening During Convection
- E. Appendix E: Quiz 2
- F. Appendix F: The Earth’s Jigsaw Puzzle
- G. Appendix G: Quiz #2 Earthquakes
- H. Appendix H: Making a Volcano
- I. Appendix I: Review Sheet
- J. Appendix J: Final Test

## VII. BIBLIOGRAPHY

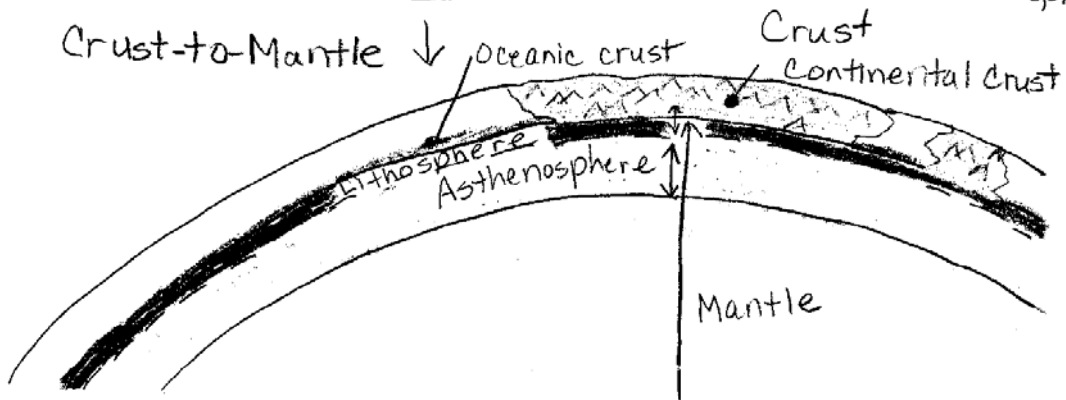
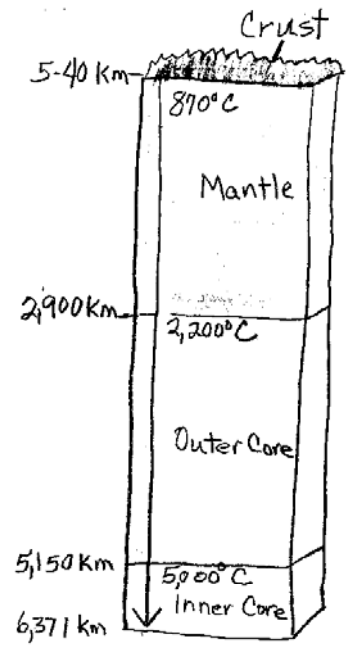
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# Appendix A

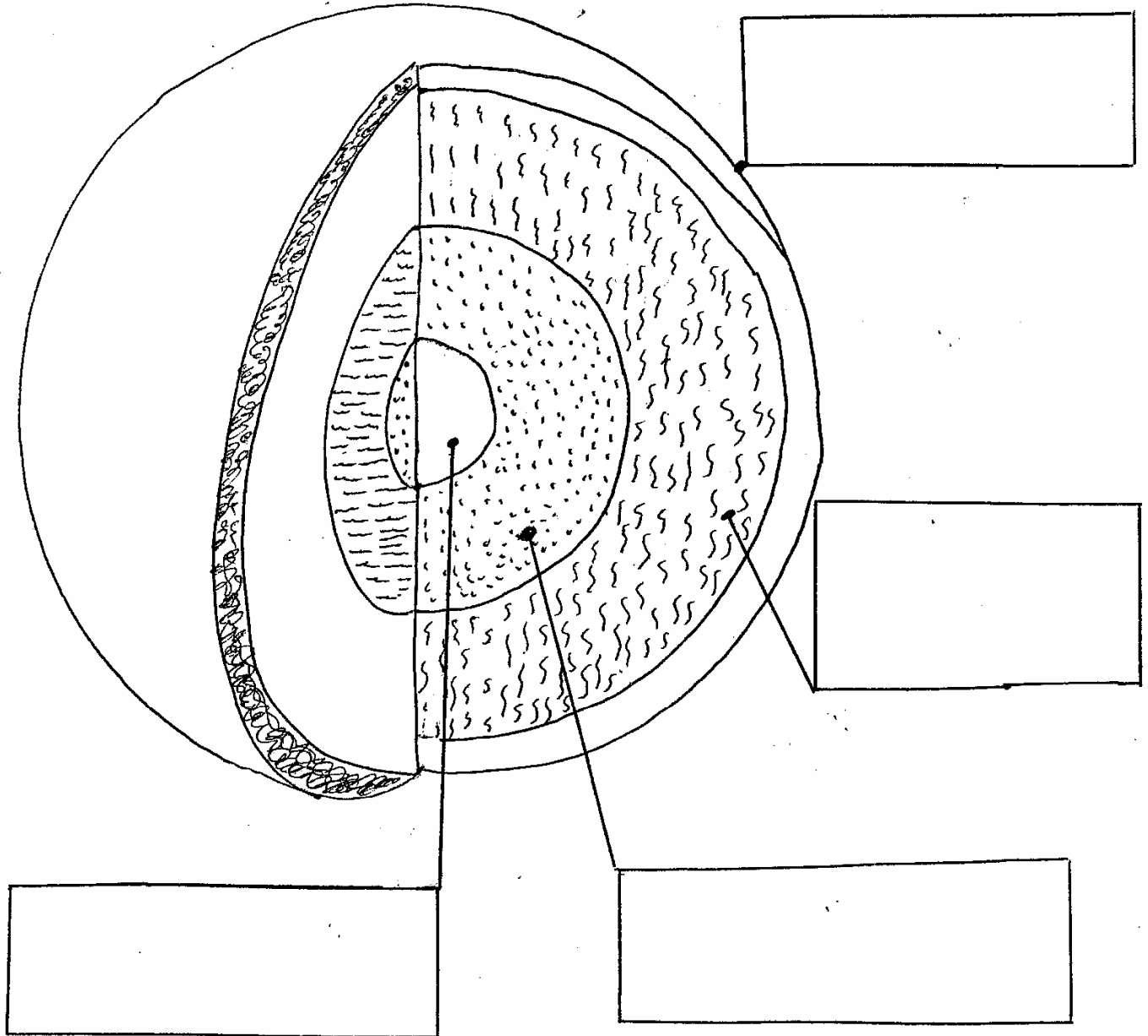
## Exploring Earth's Interior



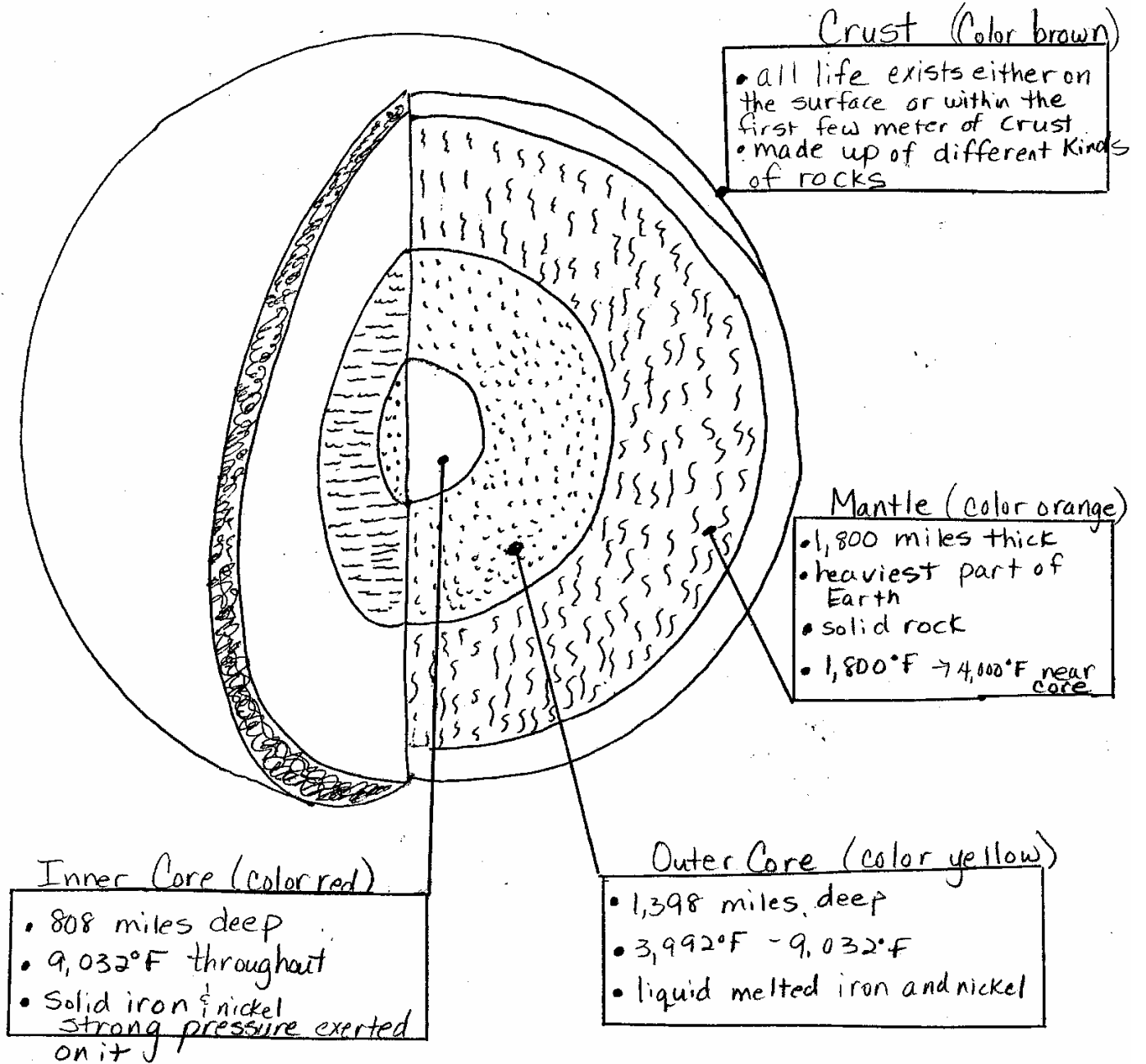
Cross Section From Surface to Center



# Journey to the Center of the Earth



## Journey to the Center of the Earth Key



# QUIZ 1

1. The \_\_\_\_\_ is the layer of rock that forms the Earth's outer skin.
2. The \_\_\_\_\_ is a layer of molten iron and nickel.
3. The upper most part of the mantle and the crust that form a rigid layer form the \_\_\_\_\_.
4. \_\_\_\_\_ is a dense, dark rock with a fine texture which helps to make up the ocean floor.
5. The layer of the mantle near the crust known as the "soft layer" is called \_\_\_\_\_.
6. The \_\_\_\_\_ is a dense solid ball of metal.
7. The large layer of the Earth that makes up about 80% of the Earth's total volume is known as the \_\_\_\_\_.
8. \_\_\_\_\_ is a rock that has larger crystals than Basalt, but is not as dense and is found on the Earth's crust.
9. The study of the Earth is known as \_\_\_\_\_.
10. One of the indirect methods geologists use to study the interior of the earth is with \_\_\_\_\_.

## Word Bank

Geology	Basalt	Asthenosphere	Lithosphere	Granite
Outer Core	Inner Core	Limestone	Oxygen	Mantle
Seismic waves	Geologists	Pressure	Crust	Ore

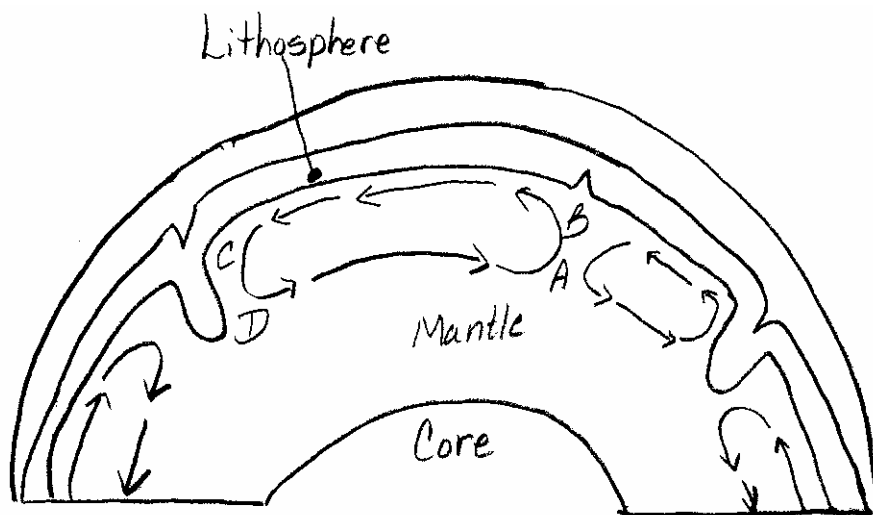
## QUIZ 1 ANSWER KEY

1. crust
2. inner core
3. lithosphere
4. Basalt
5. asthenosphere
6. inner core
7. mantle
8. Granite
9. geology
10. seismic waves

Name \_\_\_\_\_

## What's Happening During Convection?

The figure below shows a convection cell in the Earth's mantle. A convection cell is one complete loop of a convection current. Use the figure to answer the questions below.



1. Where does the heat come from that drives this convection current in the mantle?
2. Where is the temperature of the mantle material greater, at point B or point C? Explain why.
3. Where is the density of the material greater, at point A or point B? Explain why.
4. What causes the convection cell to turn to the left at point B?
5. What happens to the temperature and density of the material between points B and C?
6. What force causes the convection cell to turn down at point C?
7. What happens to the temperature and density of the material between points D and A?
8. What causes the convection cell to turn up at point A?
9. How do you think this convection cell might affect the crust material above it?

Name \_\_\_\_\_

## What's Happening During Convection? Answer Key

1. Where does the heat come from that drives this convection current in the mantle?  
Earth's Core and mantle
2. Where is the temperature of the mantle material greater, at point B or point C? Explain why.  
Point A. It is closer to the heat source and beginning to rise.
3. Where is the density of the material greater, at point A or point B? Explain why.  
Density is greater at C. The convection current slowly cools off and cooler material is denser than hot material.
4. What causes the convection cell to turn to the left at point B?  
The rising material hits the rigid lithosphere and cannot go up any farther.
5. What happens to the temperature and density of the material between points B and C?  
The material continues to cool, and the temperature drops between points b and c. As the temperature drops, its density increases.
6. What force causes the convection cell to turn down at point C?  
The force of Gravity
7. What happens to the temperature and density of the material between points D and A?  
The heat from the core causes the temperature of the material to rise between points a and d.
8. What causes the convection cell to turn up at point A?  
The density of the material is less than the material above it, so the material begins to rise.
9. How do you think this convection cell might affect the crust material above it?  
The movement of the mantle material will cause some movement in the crustal material... (answers may vary)

## QUIZ 2

Matching – Match the letter with the correct answer next to the clue given

- |          |  |    |                       |
|----------|--|----|-----------------------|
| _____1.  | A place where two plates slip past each other.   | A. | Convergent Boundaries |
| _____2.  | A well tested concept that explains a wide range of observations.                          | B. | Plate Tectonics       |
| _____3.  | Breaks in the Earth’s crust where rocks have slipped past each other.                      | C. | Deep-Ocean Trench     |
| _____4.  | A place where two plates come together.  | D. | Theory                |
| _____5.  | A geological theory that states that pieces of Earth’s crust are in constant, slow motion. | E. | Divergent Boundaries  |
| _____6.  | The process by which the ocean floor sinks boundaries into the mantle.                     | F. | Mid-Ocean Ridge       |
| _____7.  | A place where two plates pull apart from each other.                                       | G. | Transform             |
| _____8.  | The longest chain of mountains in the world.   | H. | Molten Material       |
| _____9.  | A deep underwater canyon.  | I. | Faults                |
| _____10. | Evidence of the sea-floor spreading has been found in this substance.                      | J. | Subduction            |

## QUIZ 2 ANSWER KEY

1. g
2. d
3. i
4. a
5. b
6. j
7. e
8. f
9. c
10. h

Appendix F, page 1  
**The Earth's Jigsaw Puzzle**  
**PANGAEA**

Directions: Color each of the seven pieces different colors. Carefully cut them out, fit them together, and glue them onto a blue piece of construction paper (9" x 12") to construct the super continent, Pangaea.



Appendix F, page 2  
**The Earth's Jigsaw Puzzle**  
**PANGAEA ANSWER KEY**



Appendix G, page 1  
**Quiz #2**  
**Earthquakes**

Name\_\_\_\_\_

1. What are the three types of seismic waves? \_\_\_\_\_

\_\_\_\_\_

2. What is the earthquake's focus? \_\_\_\_\_

\_\_\_\_\_

3. What is the earthquake's epicenter? \_\_\_\_\_

\_\_\_\_\_

4. What does the Richter Scale measure? \_\_\_\_\_

\_\_\_\_\_

5. Much of the damage after an earthquake is caused by fire. How might the fires start? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Identify which type of volcano "I" am. (Composite, Shield, or Cinder Cone)

6. I have cinder and rock particles that are blown into the air. I am a small mountain but have steep sides. Paricutin in Mexico is an example of the type of volcano that I am. What type of volcano am I?

\_\_\_\_\_

7. I have violent eruptions that send up volcanic bombs, cinders and ash. A quiet volcanic flow follows the explosion. Alternating layers continue forming the mountain. I am a large mountain and my sides are steep. I am a cone-shaped mountain. An example of the type of volcano that I am is Mt. St Helen's in Washington state. What type of volcano am I?

\_\_\_\_\_

8. I am a dome-shaped mountain that covers a large area. My sides are gently sloped. Lava quietly flows from my vent. An example of the type of volcano that I am is Mauna Loa, Hawaii. What type of volcano am I?

\_\_\_\_\_

**Appendix G, page 2**

**Quiz #2**

**Earthquakes**

**Answer Key**

1. Primary waves, Secondary waves, and Surface waves
2. It is the starting point of the earthquake.
3. The epicenter is the point on the surface directly above the focus.
4. The Richter scale is a rating of the seismic waves measured by a seismograph.
5. The ground shaking can cause buildings to topple and gas lines to break. The gas lines breaking can cause large explosions and fires.
6. Cinder cone volcano
7. Composite volcano
8. Shield volcano

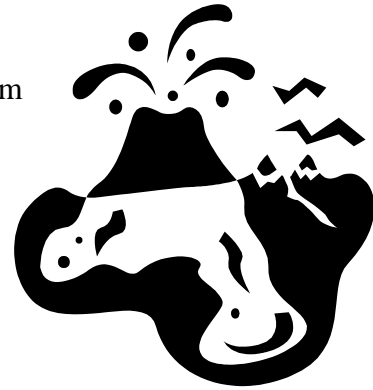
## Appendix H

# Making a Volcano

A volcano is a special type of mountain. It contains hot molten rocks, steam, and gas, which force their way up to the earth's surface from the center of the Earth. When the pressure inside the volcano becomes too great, it explodes and lava pours out of the top. Follow the directions below to make your own imitation volcano.

Start with:

- a cone-shaped plastic drinking cup with a flat bottom
- an 8" disposable aluminum pie plate
- the bottom two-thirds of an empty eggshell
- a bit of clay
- enough soil or sand to cover the plastic cup
- enough vinegar to fill the eggshell
- a drop of red food coloring
- one teaspoon of baking soda



- Step One: Place the drinking cup upside down in the aluminum pie plate.
- Step Two: Attach the eggshell to the bottom of the cup with a small amount of clay
- Step Three: Mound the sand or soil around the drinking cup and the eggshell so that it looks like a volcano. Make sure to leave the cone open at the top.
- Step Four: Fill the eggshell with vinegar and add a drop of red food coloring.
- Step Five: Slowly add the one-half teaspoon of baking soda.

Record below what happened in your experiment. (Group Captains will be recording your group's results.) \_\_\_\_\_

---

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Bonus: what Happens when you add another one-half teaspoon of baking soda?

---

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Appendix I, page 1  
**Review Sheet**  
**Geology of the Earth**

Vocabulary

- |                               |    |  |
|-------------------------------|----|--|
| _____ 1. geologist            | a. | dense sphere of solid iron and nickel in the center of the Earth                           |
| _____ 2. rock                 | b. | a layer of molten iron and nickel that surrounds the inner core of the Earth               |
| _____ 3. geology              | c. | the soft layer of the mantle on which the lithosphere floats                               |
| _____ 4. constructive forces  | d. | a rigid layer made up of the uppermost part of the mantle and the crust                    |
| _____ 5. destructive forces   | e. | the layer of hot, solid material between Earth's crust and core                            |
| _____ 6. continents           | f. | the layer of rock that forms Earth's outer surface   |
| _____ 7. seismic waves        | g. | the amount of force pushing on a surface or an area  |
| _____ 8. pressure             | h. | vibrations that travel through the Earth carrying the energy released during an earthquake |
| _____ 9. crust                | i. | large landmasses surrounded by oceans  |
| _____ 10. mantle              | j. | forces that slowly wear away mountains and other land forms or features on the surface     |
| _____ 11. lithosphere         | k. | forces that shape the surface by building up mountains and landmasses                      |
| _____ 12. asthenosphere       | l. | the study of the planet Earth  |
| _____ 13. outer core          | m. | material that forms the Earth  |
| _____ 14. inner core          | n. | a scientist who studies the forces that make and shape planet Earth.                       |
| _____ 15. radiation           | o. | heat transferred by the movement of fluids   |
| _____ 16. conduction          | p. | the transfer of energy through empty space   |
| _____ 17. convection          | q. | heat transferred by direct contact of particles of Matter                                  |
| _____ 18. sea-floor spreading | r. | the ocean floor sinks beneath a deep-ocean trench  |
| _____ 19. divergent boundary  | s. | process that adds new material to the ocean floor  |
| _____ 20. subduction          | t. | where two plates move apart  |

Appendix I, page 2

Fill in the Blank

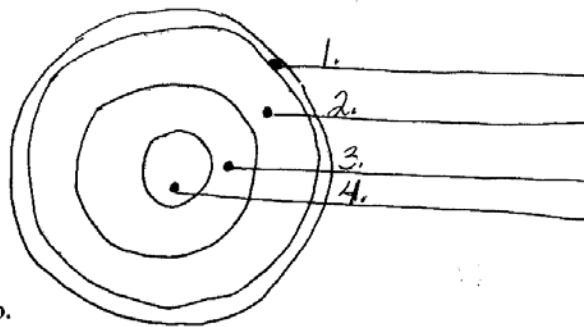
1. The crust is made up mainly of the rock known as \_\_\_\_\_.
2. The process in which oceanic crust sinks beneath trenches is known as \_\_\_\_\_.
3. The earth's \_\_\_\_\_ is broken into separate sections called plates
4. In the \_\_\_\_\_ current of a pan of soup, the cooler, denser fluid sinks to the bottom.
5. The transfer of energy through an empty space is called \_\_\_\_\_.
6. \_\_\_\_\_ are the type of seismic waves that arrive first at a seismograph.
7. Anticlines and synclines are types of \_\_\_\_\_.
8. The \_\_\_\_\_ is the point beneath the Earth's surface where the crust breaks and triggers an earthquake.
9. A \_\_\_\_\_ is an area where magma melts through crust in the middle of a plate.
10. A pocket inside a volcano where magma collects is called a \_\_\_\_\_.
11. \_\_\_\_\_ is the super continent that scientists believe our continents today came from.
12. The lithosphere includes parts of the \_\_\_\_\_ and \_\_\_\_\_.
13. The three types of stress forces are \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.
14. Large landmasses surrounded by oceans are called \_\_\_\_\_.
15. \_\_\_\_\_ is the study of the planet Earth.
16. \_\_\_\_\_ and \_\_\_\_\_ are the types of rock that mainly make up the crust of the Earth.
17. The process by which oceanic crust sinks beneath trenches is known as \_\_\_\_\_.

Appendix I, page 3

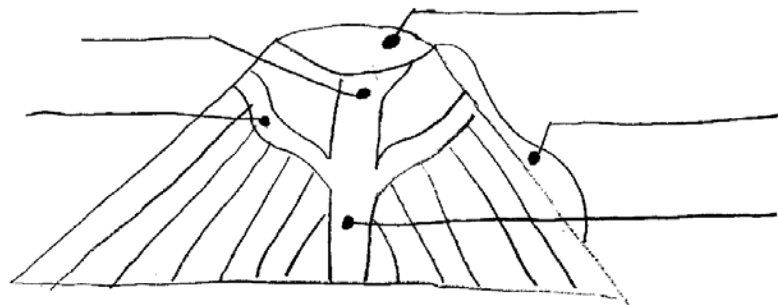
- 18. The Earth's lithosphere is broken into \_\_\_\_\_.
- 19. The ocean floor plunges into deep underwater canyons called \_\_\_\_\_.
- 20. Breaks in the Earth's crust are called \_\_\_\_\_.
- 21. Alfred Wegner is the scientist that did the most to try to prove the theory of \_\_\_\_\_.
- 22. The place where two plates come together or converge is called \_\_\_\_\_.
- 23. Any change in the volume or shape of the Earth's crust is called \_\_\_\_\_.
- 24. A(n) \_\_\_\_\_ occurs when there is shaking and trembling resulting from the movement of rock beneath Earth's surface.
- 25. \_\_\_\_\_ is a measurement of earthquake strength based on seismic waves and movement along faults.

Labeling Diagrams

Label the layers of the Earth.



Label the parts of the volcano.



Appendix I, page 4  
**Review Sheet**  
**Geology of the Earth**

Vocabulary

1. n
2. m
3. l
4. k
5. j
6. i
7. h
8. g
9. f
10. e
11. d
12. c
13. b
14. e
15. p
16. q
17. o
18. s
19. t
20. r

Fill in the Blank

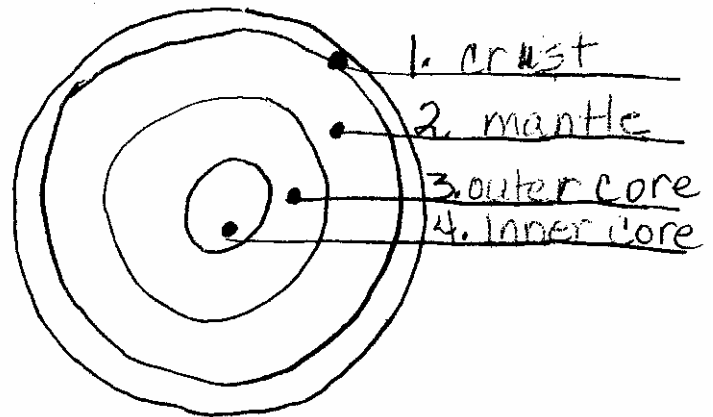
1. granite
2. subduction
3. lithosphere
4. convection
5. radiation
6. Primary waves
7. folds
8. focus
9. hot spot
10. magma chamber
11. Pangaea
12. crust; mantle
13. shearing, tension, and compression
14. continents

Appendix I, page 5

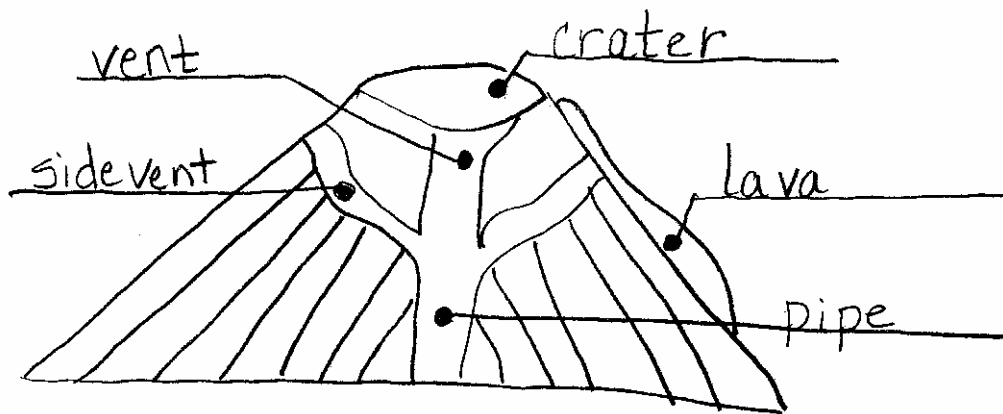
- 15. Geology
- 16. Granite; basalt
- 17. Subduction
- 18. plates
- 19. deep-ocean trench
- 20. faults
- 21. Plate Tectonics
- 22. convergent boundary
- 23. stress
- 24. earthquake
- 25. Magnitude

Labeling Diagrams

Label the layers of the Earth.



Label the parts of the volcano.



**Appendix J, page 1**  
**Final Test**  
**Geology of the Earth**

Fill in the blank – Choose a word from the word bank that best completes each sentence below.

**Word Bank:**

lithosphere	crust	pressure	destructive forces
outer core	seismic waves	rock	geologist
geology	mantle	inner core	continents
asthenosphere	aa	surface waves	epicenter

1. \_\_\_\_\_ is the amount of force pushed on a surface or an area.
2. The \_\_\_\_\_ is a dense sphere of solid iron and nickel in the center of the Earth.
3. A(n) \_\_\_\_\_ is a scientist who studies the forces that make and shape planet Earth.
4. The \_\_\_\_\_ is the layer of rock that forms Earth's outer surface.
5. \_\_\_\_\_ are forces that slowly wear away mountains and other landforms or features on the Earth's surface.
6. \_\_\_\_\_ is material that forms Earth's hard surface.
7. The \_\_\_\_\_ is a layer of molten iron and nickel that surrounds the inner core of the Earth.
8. The \_\_\_\_\_ is a rigid layer made up of the upper most part of the mantle and the crust.
9. The \_\_\_\_\_ is the layer of hot, solid material between Earth's crust and core.
10. \_\_\_\_\_ are vibrations that travel through the Earth carrying the energy released during an earthquake.
11. \_\_\_\_\_ are large landmasses surrounded by oceans.

## Appendix J, page 2

12. \_\_\_\_\_ is the study of planet Earth.
13. \_\_\_\_\_ are forces that shape the surface of the Earth by building up mountains and landmasses.
14. The \_\_\_\_\_ is the soft layer of the mantle on which the lithosphere floats.

**Multiple Choice** – Answer the following questions by putting the letter that has the correct answer next to it in the blank.

- \_\_\_\_\_ 1. The crust consists mainly of the rock  
a. nickel                      b. basalt  
c. mantle                      d. granite
- \_\_\_\_\_ 2. Subduction is  
a. the process by which oceanic crust sinks beneath trenches  
b. the direct transfer of heat through solid materials  
c. the process that continually adds ocean floor  
d. the device that bounces sounds waves off underwater objects
- \_\_\_\_\_ 3. The Earth's lithosphere is broken into separate sections called  
a. plates                      b. faults  
c. trenches                      d. rifts
- \_\_\_\_\_ 4. In the convection current of a pan of soup, the cooler, denser fluid  
a. rises to the top              b. sinks to the bottom  
c. stays where it is              d. stays on top
- \_\_\_\_\_ 5. The transfer of energy through an empty space  
a. subduction                      b. convection  
c. radiation                      d. conduction
- \_\_\_\_\_ 6. Which type of seismic waves arrive first at a seismograph?  
a. surface waves              b. tsunamis  
c. S waves                      d. P waves
- \_\_\_\_\_ 7. Anticlines and synclines are two types of  
a. seismic waves              b. folds  
c. faults                      d. aftershocks

Appendix J, page 3

- \_\_\_\_\_ 8. The point beneath the Earth's surface where the crust breaks and triggers an earthquake is called the
- |              |              |
|--------------|--------------|
| a. epicenter | b. faults    |
| c. focus     | d. magnitude |
- \_\_\_\_\_ 9. An area where magma melts through crust in the middle of a plate is called a(n) \_\_\_\_\_
- |               |             |
|---------------|-------------|
| a. island arc | b. hot spot |
| c. geyser     | d. pipe     |
- \_\_\_\_\_ 10. Inside a volcano, magma collects in a pocket called a
- |         |                  |
|---------|------------------|
| a. pipe | b. caldera       |
| c. vent | d. magma chamber |

**True/False** – If the statement is true, write true. If it is false, change the underlined word or words to make the statement true.

- \_\_\_\_\_ 1. The continents we have today are believed to have once belonged to a super continent named Antarctica.
- \_\_\_\_\_ 2. As oceanic crust moves away from the mid-oceanic ridge, it cools and becomes denser.
- \_\_\_\_\_ 3. The lithosphere includes all of the core and part of the mantle.
- \_\_\_\_\_ 4. The type of stress that pushes masses of rock sideways in opposite directions is tension.
- \_\_\_\_\_ 5. By drawing circles to show distances from three seismic stations, geologists can locate the magnitude of an earthquake.
- \_\_\_\_\_ 6. Water displaced by an undersea earthquake is called a tsunami.
- \_\_\_\_\_ 7. Pahoehoe and aa are produced during explosive eruptions.
- \_\_\_\_\_ 8. When the top of a mountain collapses, a crater is formed.
- \_\_\_\_\_ 9. Compression, tension, and shearing are the three types of faults that cause deformation of the crust.
- \_\_\_\_\_ 10. A rift valley forms along a divergent boundary on land.

**Appendix J, page 4**

**Essay** – Answer each of the following on the spaces provided. Remember to answer in complete sentences.

1. Explain why ash, cinders, and bombs, are produced only in explosive eruptions, not in quiet eruptions. \_\_\_\_\_

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2. Describe the process of sea-floor spreading. \_\_\_\_\_

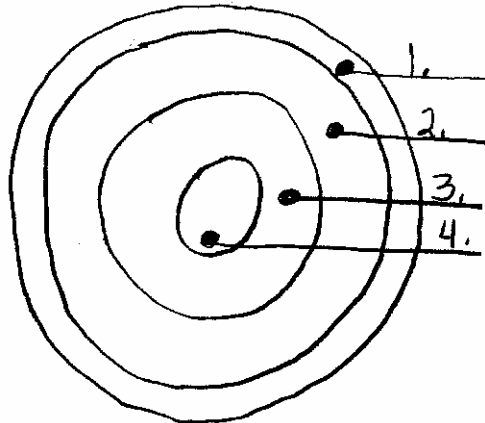
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**Interpreting Diagrams** – Use the diagram below to answer the following questions:

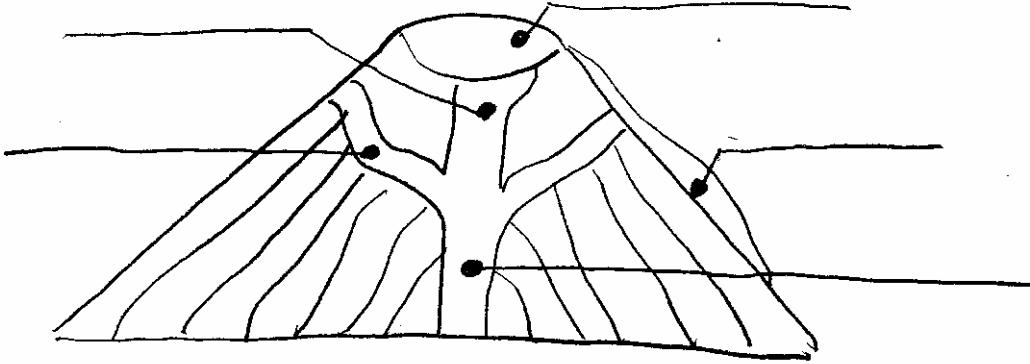


Name each of the layers on the figure in order, from outermost to innermost.

1. \_\_\_\_\_ 2. \_\_\_\_\_  
3. \_\_\_\_\_ 4. \_\_\_\_\_

**Appendix J, page 5**

Label the parts of the volcano below:



Appendix J, page 6  
**Final Test Answer Key**  
**Geology of the Earth**

**Fill in the blank** – Choose a word from the word bank that best completes each sentence below.

1. Pressure
2. inner core
3. geologist
4. crust
5. Destructive
6. Rock
7. outer core
8. lithosphere
9. mantle
10. Seismic waves
11. Continents
12. Geology
13. Constructive forces
14. asthenosphere

**Multiple Choice** – Answer the following questions by putting the letter that has the correct answer next to it in the blank.

1. d
2. a
3. a
4. b
5. c
6. d
7. b
8. c
9. b
10. d

**True/False** – If the statement is true, write true. If it is false, change the underlined word or words to make the statement true.

1. False-Pangaea
2. True

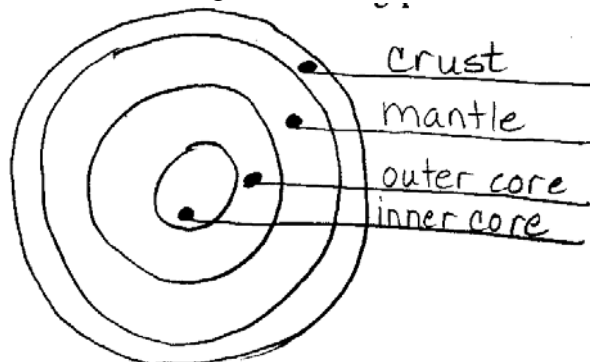
Appendix J, page 7

3. False-crust
4. False-shearing
5. False-epicenter
6. True
7. False-quiet
8. False-caldera
9. False-stress
10. True

**Essay** – Answer each of the following on the spaces provided. Remember to answer in complete sentences.

1. Explain why ash, cinders, and bombs, are produced only in explosive eruptions, not in quiet eruptions. In order of ash, cinders, and bombs to form, lava must be ejected forcefully from a volcano so it is broken into fragments that cool and harden quickly to form pieces of different sizes.
2. Describe the process of sea-floor spreading. In sea-floor spreading, Molten material arises from the mantle and erupts through the mid-ocean ridge. The molten material then spreads out, pushing older rock to both sides of the ridge.  
  
This process continually adds new material to floor.

**Interpreting Diagrams** – Use the diagram below to answer the following questions:



Name each of the layers on the figure in order, from outermost to innermost.

1. crust
2. mantle
3. outer core
4. inner core

Appendix J, page 8

Label the parts of the volcano below.

