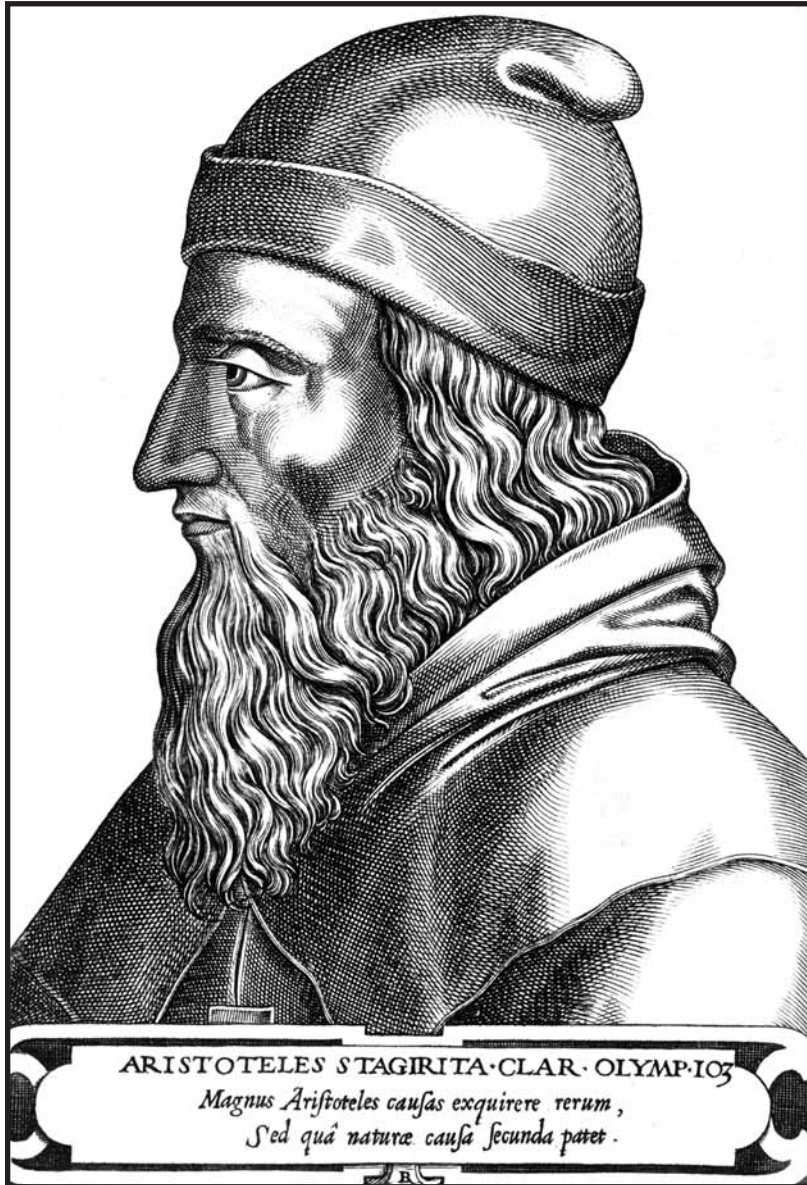


Convection in the Mantle



Aristotle, a Greek philosopher who lived from 384 to 322 B.C.

INTRODUCTION

Like many people in his day, Aristotle, a philosopher in ancient Greece, tried to explain why earthquakes and volcanoes occurred. He believed fire burned deep within the earth. He thought that when winds from the atmosphere were drawn underground, they mixed with the flames inside the earth and then exploded upward toward the surface. The results, according to Aristotle, were earthquakes and volcanic blasts. More than 1000 years later, Benjamin Franklin thought earthquakes came from a spark in the ground.

But why *does* the ground rattle and shake? Both Aristotle's and Franklin's theories had one thing in common—heat. And although theories since their times have changed, the earth's internal heat remains the explanation for why the earth's plates move.

OBJECTIVES FOR THIS LESSON

Use a flow indicator, rheoscopic fluid, to model convection currents in the earth's mantle.

View computer images of the earth's interior to observe convection in the mantle.

Use appropriate vocabulary when communicating ideas about the earth's interior layers.

Identify movement in the earth's mantle as one cause of plate movement, earthquakes, and volcanoes.

Think back to Lessons 4 and 5 when you investigated the conditions under which the air in the atmosphere moves. You discovered that uneven heating caused convection currents. In this lesson, you will apply what you have learned about convection to better understand the earth's mantle. How do convection currents in the mantle cause the earth's plates to separate and sink back into the earth? What causes the continents to move over time? Using a special fluid, called rheoscopic fluid, that is very sensitive to heat, you will model convection currents in the mantle. Then, by viewing computer images, you will be able to “see” what happens inside the earth.

Getting Started

1. With your class, brainstorm what you know about why the earth's plates move.
2. Think back to previous lessons. Discuss these questions with your class:
 - A. *What do you know about convection in the air?*
 - B. *What do you know about convection in the ocean?*
 - C. *How do you think convection in the mantle might be related to plate movement?*
3. Your teacher will demonstrate the Moving Plates Model that you used in Lesson 15. Watch as the belts on the model move. Describe to your class what is happening to the belts at the top of the model. On the basis of the Moving Plates Model, what do you think is causing the plates on the earth to rise and separate at the ridges and sink at the trenches? Discuss this question with the class.
4. In this lesson, you will investigate how convection cells form in the mantle. You will then relate convection cells to the movement of the earth's plates.

MATERIALS FOR LESSON 16

For you

- 1 copy of Student Sheet 16.1a: Convection in the Mantle
- 1 copy of Student Sheet 16.1b: Earthquakes Review
- 1 pair of safety goggles

For your group

- 1 jar of rheoscopic fluid, capped
- 1 candle
- 2 wooden blocks
- 1 flashlight
- 2 paper towels



Figure 16.1 The setup for the rheoscopic fluid

SAFETY TIPS

The fluid in the jar is nontoxic, but do not loosen or remove the cap on the jar.

Wear your safety goggles.

Be careful when working with an open flame.

If you have long sleeves, push them up. *Never* reach across the flame. If your hair is long, tie it back.

Be very careful when working with the heated jar.

Inquiry 16.1 Modeling Convection in the Mantle

PROCEDURE

1. Look at the materials your teacher has set out. Pick up one jar for your group. It contains a special fluid that is a flow indicator. Observe the fluid in the jar.
2. Share your observations with the class. You might have discovered that this fluid is very sensitive to heat. Discuss how you might use it to observe convection cells.
3. Collect one copy of Student Sheet 16.1a: Convection in the Mantle. Discuss it with your teacher.
4. Review Procedure Steps 5 through 10 with your teacher.
5. Before you begin your inquiry, review the Safety Tips with your class.
6. Collect your materials. Shake the rheoscopic fluid so that you can better observe its flow. Set up your equipment as shown in Figure 16.1. Your teacher will light your candle.
7. Place the lit candle under the jar. Shine the flashlight on the fluid to observe its movement, as shown in Figure 16.2. Reposition the candle to observe different patterns of movement in the fluid. Record your observations in both words and pictures on Student Sheet 16.1a. Use arrows to depict the direction in which the fluid moves.
8. Shine the flashlight down on the jar (on the glass surface parallel to your table or desk). What do you observe? Discuss

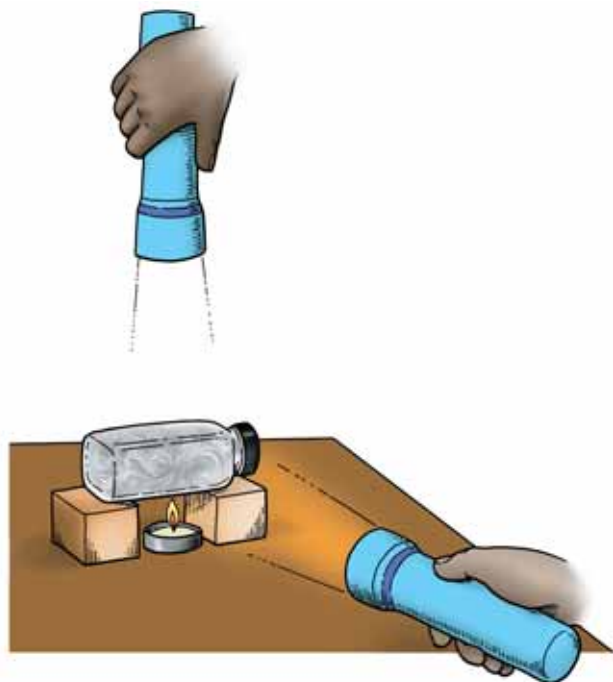


Figure 16.2 Using your flashlight, view the rheoscopic fluid from the front and top of the jar.

your observations with your group. Record them on your student sheet.

9. Complete Part A of the student sheet by summarizing your observations of the fluid.
10. Clean up. Blow out the flame on the candle. Use a dry paper towel to wipe off any black carbon marks from the candle that might be on the jar. Return the jar of rheoscopic fluid to the materials center. It will be used by other classes.

REFLECTING ON WHAT YOU'VE DONE

1. Answer these questions. Then discuss them with the class.

A. What observations did you make of the heated fluid?

B. Under what conditions could you observe convection cells forming inside the jar? How did they move? Compare

this motion with what you observed using the Moving Plates Model.

C. What happened to the fluid near the upper surface of the jar (parallel to the table)?

2. Relate your observations of the jar and candle to the earth. Answer these questions:

A. What causes convection currents in a gas or liquid? (Think back to Lessons 5 and 7.)

B. On the basis of what you have seen in the jar, what effect do you think convection in the hot mantle might have on the earth's plates? What observations of the fluid inside the jar support your explanations?

3. Share with the class your observations, responses, and drawings on Part A of the student sheet.
4. Now watch as your teacher shows you Segments #10 and #16 on the CD-ROM *The Theory of Plate Tectonics*.
5. Complete Part B of Student Sheet 16.1a by comparing your diagram of the jar with the diagram of the earth shown on the sheet. Label your diagram of the jar to show how it is a model of the earth's interior.
6. Look ahead to Part 3 of *Catastrophic Events*, in which you will study how the earth's internal heat forms volcanoes.
7. Prepare for the Earthquakes Assessment in Lesson 17 by completing Student Sheet 16.1b: Earthquake Review, which your teacher will distribute.