

***Catastrophic Events***  
**Changes to the Teacher's Guide**  
**and**  
***Catastrophic Events***  
**Changes to the Student Guide and Source Book**

Since publication of the *Catastrophic Events* Teacher's Guide and the *Catastrophic Events* Student Guide and Source Book, a component of the unit materials has changed. *The Theory of Plate Tectonics* CD-ROM has been upgraded to Version 2.1. This upgrade affects Lessons 14, 15, and 16 and requires revisions to the unit's printed materials, both for the teacher and the student.

This errata set includes the following:

- For the *Catastrophic Events* Teacher's Guide – revised pages xxxix, 190, 192, 194, 202–203, 221, and 224–225
- For the *Catastrophic Events* Student Guide – revised page 193

Photocopy and distribute these new instruction pages as needed.

If you have questions about these changes or about the module in general, call Carolina's product information staff at 800-227-1150 (8 am–5 pm ET, M–F), or email [stcms@carolina.com](mailto:stcms@carolina.com).

Item Description in Teacher's Guide	Item Description on Packing List	Item Type	Total Quantity Used	Lesson Number (Quantity Used)
Carolina Convection Fluid™	Carolina Convection Fluid™	B	3	16 (3)
CD ROM, Tasa Graphic Arts, Inc.: <i>The Theory of Plate Tectonics</i> Version 2.1	CD ROM: "The Theory of Plate Tectonics"	B	1	14 (1), 15 (1), 16 (1)
Clamp lamp (with reflector)	Lamp, flexible clamp	B	8	3 (8), 7 (1), 8 (1), 25 (8)
Coffee stirrer, wooden	Stir, wooden coffee	B	16	7 (2), 20 (16), 23 (8)
Comparing Catastrophic Events: Activity Board	Comparing Catastrophic Events: Activity Board	B	32	22 (32)
Comparing Catastrophic Events: Activity Card Sheet	Activity Card Sheet, Comparing Catastrophic Events	B	32	22 (32)
Continent stencil set	Continent stencil, set of 4	B	4	15 (4)
Convection Tube™	Convection tubes, pair	B	16	4 (16), 5 (16)
Cornstarch	Cornstarch, 1gal container	R	1	24 (1), 25 (1)
Crayola Dough™, green	Crayola Dough, green	R	1	15 (1)
Dark corn syrup	Syrup, dark, 16-oz container	R	2	20 (2)
Drawing compass	Drawing compass	B	16	12 (16)
Dropper bottle	Plastic dropper bottles	B	8	11 (1), 14 (1), 23 (8)
Dust mask	Dust masks, disposable	R	32	23 (32), 24 (32)
Fault Laboratory™	Fault Laboratory Pack	B	8	15 (8)
Wooden block with approximately 0.4-cm diameter center hole and attached strips of hook Velcro®			1	
Solid wooden block with cup hook and attached strip of loop Velcro®			1	
Bolt, 3.5 cm			1	
Wing nut			1	
Large metal washer			2	
Piece of cord, 40 cm			1	
Spring scale, 50 N			1	
Flashlight	Flashlights	B	8	4 (8), 5 (8), 6 (8), 16 (8), 23 (8)
Flask, 125 mL	Flask, 125mL	B	2	23 (2)
Flask, 125 mL, pre-filled with ash	Volcanic ash, 125-mL flask	B	1	23 (1)
Flexible drinking straw	Straws, flexible	R	40	7 (40)

is, resistant to flow) than the asthenosphere. Because of these divisions in physical properties, scientists divide the earth's interior even further, but these divisions will not be addressed in this module.

### Reading Selections

An extended reading selection on "The Earth's Interior" appears in Lesson 14 in the Student Guide. It describes the layers of the earth. The other reader in this lesson, "Using Waves To Explore the Earth's Interior," describes the use of sonar to map the ocean floor and compares this process with scientists' use of earthquake waves to study the earth's interior.

## MATERIALS FOR LESSON 14

### For the teacher

- 1 knife\*
  - Apple, hard-boiled egg, and hard roll; also avocado, if available\*
- 1 sheet of newsprint or transparency\*
  - Transparency markers or assorted colored markers\*
- 1 plastic box with lid
  - Water\*
- 1 can of soup or other heavy cylinder\*
- 1 dropper bottle
  - Overhead projector\*
  - CD-ROM, Tasa Graphic Arts, Inc.: *The Theory of Plate Tectonics*
  - Computer and other hardware for projecting CD-ROM images\*

### For each student

- Homework items with interior structure and/or a diagram (from Lesson 13)
- 1 copy of Student Sheet 14.1: Plotting Volcanic Activity\*

## PREPARATION

1. For each student, make one copy of Student Sheet 14.1: Plotting Volcanic Activity.
2. Label the newsprint or transparency "What We Know and Want To Know About the Earth's Structure."
3. Get out the knife and the assorted objects you have brought to class as examples of items with a hidden internal structure.
4. Fill the plastic box half way with water. Place the plastic box on the overhead projector, as you did in Lesson 11. Set out the can of soup or cylinder. Fill the dropper bottle with water.
5. Set up *The Theory of Plate Tectonics* CD-ROM and the necessary hardware. Go to the intermediate version of the program. Preview the segment "Earth's Interior," which you will review with students in this lesson. An assessment follows the segment. Decide which portions of the assessment you will use.

\*Needed, but not supplied

4. Direct students' attention to the illustration of the earth's interior on SG page 167. Ask them what they think the motion of an earthquake wave can tell us about the earth's interior. Let students know that earthquake waves travel through some substances but not through others, and that waves travel at different speeds, depending on the properties of the substance through which they are moving. This information helps scientists make hypotheses about the earth's interior.

**NOTE** Using earthquake waves to study the earth's interior is a very complex process and is not addressed fully in this module. It is recommended that you only introduce students to how scientists have made their hypotheses about earth's interior, as described in Step 4.

5. Show students the segment "Earth's Interior" from *The Theory of Plate Tectonics* CD-ROM. Discuss the characteristics of each layer of the earth as described on the CD-ROM. Help students understand the following points:
  - When studying the earth's internal composition, scientists divide the earth into three layers: crust, mantle, and core. The core is divided into an outer core and an inner core.
  - The earth's outer core is liquid. Scientists know this because S-waves do not travel through liquid.
  - When considering the earth's internal physical properties, scientists divide the earth into the lithosphere and asthenosphere (plus other layers that will not be addressed in this module).

## REFLECTIONS

1. Use the review portion of the "Earth's Interior" segment of *The Theory of Plate Tectonics* CD-ROM to assess students' understanding of the earth's interior.
2. Ask students to read "The Earth's Interior" (SG page 167).
3. Have students answer these questions in their notebooks:
  - A. *Why are the images on the CD-ROM and in the reading selection drawings rather than photographs?*
  - B. *Describe each layer of the earth.*
4. Have students read "Using Waves To Explore the Earth's Interior" (SG pages 168–169). Then have them describe how earthquake waves help scientists learn more about the earth's interior.
5. Let students know they will use the information about the earth's structure in Lessons 15 and 16, when they investigate the causes of earthquakes and relate them to the movement of lithospheric plates and the earth's convective mantle. Then assign homework.

■ Mathematics ■ Science

- Have students graph their data from Extension 4 to show the topography of the ocean floor. An example of a setup for a graph is shown below. Ask students to title their graph.

**ASSESSMENT**

Use the review portion of “Earth’s Interior” on the CD-ROM as an embedded assessment. Use Student Sheet 14.1 to assess students’ ability to use longitude and latitude data to plot specific locations. This skill will be formally assessed in Lesson 17.

Ocean Depth (m)	Number of Seconds To Reach Distance									
	1	2	4	8	6	4	2	2	2	1
500										
1500										
2000										
2500										
3000										
	A	B	C	D	E	F	G	H	I	J

Location of Echo

**For each group of 4 students**

- 1 copy of Student Sheet 15.3a: Investigating Faults: Experimental Design and Observations\*
- 1 copy of Student Sheet 15.3b: Investigating Faults: Recording and Analyzing Data\*
- 1 set of miscellaneous brittle materials\*
- 1 set of miscellaneous ductile materials\*
- 1 Fault Laboratory™:
  - 1 plastic box with 2 holes
  - 1 wooden block with approximately 0.4-cm diameter center hole and attached strips of Velcro®
  - 1 solid wooden block with cup hook and attached strip of loop Velcro®
  - 1 bolt, 3.5 cm
  - 1 wing nut
  - 2 large metal washer
  - 1 piece of cord, 50 cm
  - 1 spring scale, 50 N
- 4 pairs of safety goggles\*
- 4 plastic centimeter cubes
- 1–2 tongue depressors (wooden)
- 1 strip of masking tape, 4 × 9 cm\*
- Graph paper from Appendix C (optional)\*
- 1 metric ruler\*

**NOTE** You may wish to have your class perform Inquiry 15.3 as described in *The Guide to Proeware and Computer Applications for STCMS™* available at [www.nsrconline.org](http://www.nsrconline.org).

**SAFETY TIP**

Remind students that everything in science class should be treated as a chemical, even if it is a common food item, such as caramel candies.

\*Needed, but not supplied

## Inquiry 15.1

### Using a Simple Model of Plate Movement

## Inquiry 15.2

### Using the Moving Plates Model

#### PREPARATION FOR INQUIRIES 15.1 AND 15.2

1. For each student, make a copy of Student Sheet 15.1: Plotting Earthquakes by Depth.
2. Hang the National Geographic wall map, “Earth’s Fractured Surface.” Set out the red dots near the map.
3. Set up *The Theory of Plate Tectonics* CD-ROM and necessary hardware for class projection. Preview the segments “Plate Tectonics: A Scientific Revolution Unfolds,” “Divergent Plate Boundaries,” “Convergent Plate Boundaries,” and “Transform Fault Boundaries” of the intermediate version.
4. Locate from the kit one Moving Plates Model™ (see SG Figure 15.4), one set of thin foam pads, and one set of thick foam pads (see SG Figures 15.1 and 15.2). The difference in thickness of the pads is essential to the outcome of this inquiry. Set up one Fault Laboratory™ as described in TG Preparation Steps 3 through 5 of Inquiry 15.3 (pages 205–206). Set up these three items for “Getting Started.”
5. Set up the materials for Inquiries 15.1 and 15.2 in stations around the room. You will need four stations for each inquiry if you have eight groups. Students will use a relief globe during Inquiries 15.1 and 15.2. One relief globe is included in the module kit. Try to find additional relief globes; otherwise, plan to have groups share the globe.
6. After completing this lesson, you may want to provide students with a copy of the plate boundaries map. (See Question 10 on Inquiry Master 17.1b.) If so, duplicate it now. Students can fill in the names of the plates using Transparency 13.3 as a guide.

## Getting Started

1. Show students the wall map, “Earth’s Fractured Surface.” Ask them to list ways in which this map is different from other maps they have used.
2. Review the homework from Lesson 14, Student Sheet 14.1: Plotting Volcanic Activity by inviting volunteers to use removable red dots to plot on the wall map the 20 volcanoes from their data set. Point out the legend on the wall map, which indicates where volcanoes and earthquakes occur worldwide. Ask the class to describe any patterns they notice in the location of volcanoes and earthquakes.
3. Point out the plate boundaries indicated on the map and the names of plates. Ask students to describe any relationships they have observed between the locations of earthquakes and volcanoes and the boundaries—or outer edges—of plates. What ideas do students have to explain these relationships? Show students how the map also indicates plate movement and that plates move in different ways.
4. Show the segments “Plate Tectonics: A Scientific Revolution Unfolds,” “Divergent Plate Boundaries,” “Convergent Plate Boundaries,” and “Transform Fault Boundaries” from *The Theory of Plate Tectonics* CD-ROM. Discuss each segment.
5. To elicit from students what their experiences are with models, ask these questions:

*A. How are the map and computer images used in this lesson like the real earth? How are they different? (The map and computer images are models of the earth.)*

*B. What are some examples of models? (Examples of models include a drawing, a computer image, a globe, a map, or a piece of equipment or material that corresponds to a real object, event [such as the tornado in a bottle], or class of events.)*

*C. Use your own words to describe the word “model.” (After students share their definitions, have them look up the word “model” in the Glossary in the Student Guide.)*

6. Display the three different models groups will use in this lesson to investigate plate movement: (1) a Moving Plates Model, (2) a Fault Laboratory, and (3) a set of foam pads. Ask students to pass the three models around the room and make general observations of each. Then ask which kind of plate boundary can be modeled with each piece of equipment. (The Moving Plates Model can be used to model divergent and convergent plates. The Fault Laboratory can be used to model transform plates. The pads can be used to model all three.) Discuss why and how models are used in the science classroom.
7. Distribute one copy of Student Sheet 15.1 to each student. (See Homework for Period 1.) Review the sheet. Let students know they will complete the the first section, plotting earthquake data on a graph, for homework. They will need a red, blue, and green pencil, pen, or crayon for the assignment.

**NOTE** This is a good stopping point.

### PROCEDURE FOR INQUIRIES 15.1 AND 15.2

1. Let students know that each group will visit two stations and complete two inquiries. Show them how the stations are set up. Half the class will complete Inquiry 15.1, using the foam pads, at one set of stations while the other half completes Inquiry 15.2, using the Moving Plates Model, at another set of stations. They may have to share the relief globe. They will then switch inquiries. Students should work on the “Reflecting” section if they finish before it is time to rotate to the other station.

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### Student Misconceptions

When using the rheoscopic fluid to model convection cells in the mantle, students may develop the misconception that the earth's mantle is a fluid. Although portions of the mantle are able to flow, the mantle is solid. Approximately 1 percent of its volume is magma (molten rock).

### MATERIALS FOR LESSON 16

#### For the teacher

- 1 sheet of newsprint or a transparency\*  
Transparency markers\*
- 1 Moving Plates Model™
- 1 butane lighter
- 3 bottles of Carolina Convection™ Fluid,  
946.4 mL each (32 oz)  
Paper towels\*  
CD-ROM, Tasa Graphic Arts, Inc.: *The Theory of Plate Tectonics*  
Computer and other hardware for projecting  
CD-ROM images\*
- 1 pair of safety goggles\*

#### For each student

- 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 each group of 4 students

- 1 bottle of Carolina Convection™ Fluid (capped)
- 1 tea candle
- 2 wooden blocks
- 1 flashlight
- 1 paper towel\*

**NOTE** A light bulb can be used in place of the candle; however, the heat provided by the candle is more focused and offers better results.

\*Needed, but not supplied

### PREPARATION

**NOTE** The suggested number of class periods for this lesson includes time for students to (a) do Inquiry 16.1, (b) prepare for the Earthquakes final assessment, and (c) present the earthquake-resistant houses assigned in Lesson 11 (if this presentation was not done earlier).

1. Label a sheet of newsprint or transparency “What We Know About Why Plates Move.”
2. For each student, make a copy of Student Sheet 16.1a: Convection in the Mantle and Student Sheet 16.1b: Earthquakes Review.
3. Shake the container of rheoscopic fluid to mix the contents well. Fill each group's jar with rheoscopic fluid. Cap the jars tightly. Test each jar. When the jar is turned on its side, there should be as few air bubbles as possible in the fluid. The filled jars can be stored and reused indefinitely.
4. Set up the computer and necessary hardware to view the CD-ROM, *The Theory of Plate Tectonics*. Set up a large classroom screen or TV monitor. Select the intermediate version of the program and preview the segments “Divergent Plate Boundaries” and “What Drives Plate Motions?,” which you will use in this lesson.

### Getting Started

1. Ask students to brainstorm what they know about why plates move. Record their ideas on the newsprint or transparency.
2. Have students review the process of convection, its relationship to heat, and its effects on air and water (oceans) as investigated in Lessons 4, 5, and 7. Discuss with them these questions:

A. *What do you know about convection in the air?*

7. As students work on Inquiry 16.1, remind them to complete Part A of the student sheet.
8. Have groups clean up. Ask students to use a dry paper towel to wipe off any black carbon marks from the flame that might be on the jar. Save the jars of rheoscopic fluid. They can be stored indefinitely.

## REFLECTIONS

1. Ask students to answer these questions and then discuss them as a class:

*A. What observations did you make of the heated fluid?* (When the jar was on its side, as shown in TG Figure 16.2[B], the fluid rose in response to the heat from the burning candle.)

*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.* (When the heated fluid rose to the surface, it cooled and began to sink again, forming a convection cell. Two opposing convection cells formed, one moving left and the other moving right on either side of the flame, as shown in Figure 16.2. This movement was similar to the movement of the two opposing belts inside the Moving Plates Model.)

*C. What happened to the fluid near the upper surface of the jar (parallel to the table)?* (The convection cells separated and moved in opposite directions at the surface.)

2. Ask each group to relate its observations to the earth. Ask them to answer the following questions:

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

*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?* (Viewed from above, the fluid separated where the two opposing convection cells rose and spread. The same kind of movement occurs along the mid-ocean ridge. The fluid moved down into the jar along the sides where the convection cells descended, just as the belts did in the Moving Plates Model. On the earth, trenches form where plates descend.)

3. Invite groups to share their observations as well as their responses and drawings from Part A of the student sheet.
4. Show the class the segments “Divergent Plate Boundaries” and “What Drives Plate Motions?” of the CD-ROM.

**NOTE** Even if you showed “Divergent Plate Boundaries” in Lesson 15, repeating the sequence of images during this lesson will be beneficial.

5. Have students complete Part B of Student Sheet 16.1a.
6. Let students know that in Part 3 of *Catastrophic Events* they will study how the earth's internal heat is visible in the form of volcanoes.

7. Prepare for the Earthquakes Assessment in Lesson 17 by distributing and reviewing Student Sheet 16.1b. Inform students that you will review their responses to the questions before the assessment in Lesson 17.

**NOTE** If you assigned Student Sheet 11.2: Designing and Building an Earthquake-Resistant House for homework in Lesson 11 to be completed by Lesson 16, proceed with “Reflections” Steps 8 through 10 now or before the completion of Part 2: Earthquakes.

8. Ask students to share their earthquake-resistant houses. As they do, discuss how knowing more about the causes and effects of earthquakes can help reduce the risks associated with building in earthquake-prone regions.
9. Use the wall map “This Dynamic Planet” to show students the locations of Japan and California. Inform students that these two areas are very populated regions of the world. Determine whether each area identified is near a plate boundary. Poll students to determine whether they would choose to live along a plate boundary. If they already do live along a boundary, how do they feel about it?
10. Challenge students with questions regarding risk mitigation, which involves making natural hazards less risky. Questions might include the following:
  - A. *If an earthquake destroyed your house, would you rebuild in that region? Why or why not? What are the advantages of rebuilding there? What are the disadvantages?*
  - B. *Why do you think people rebuild in earthquake-prone areas?*

C. *Do you think there should be laws regulating how homes are built in earthquake-prone areas? Should there be laws regulating whether people can build at all in certain areas? Explain your answers.*

## HOMework

1. Students should complete Student Sheet 16.1a.
2. Have students prepare for the Earthquakes Assessment by completing Student Sheet 16.1b.

## EXTENSIONS

### ■ Instructional Technology ■ Mathematics

1. Set up the CD-ROM *The Theory of Plate Tectonics* in a learning center so students can review the concepts of plate tectonics, plate boundary interaction, and the theory of continental drift. Students can conduct an interactive version of their homework from Lesson 15, in which they describe plate movement at the Tonga Trench and how volcanoes form by plotting data points on a graph. Relevant information is located on the segment “New Evidence: Mapping the Ocean Floor” of the intermediate version of the CD-ROM.

### ■ Art

2. Why does the outside of a dinner roll feel cool even though the inside may be steaming hot? The earth is a continuously cooling sphere. Students can make a list of items that, like the ancient earth, are cooling. That is, they are hot on the inside, cool on the outside. Students can create a three-dimensional model of one of the items.