Science & Technology Concepts

STC/MS™

for Middle Schools™

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, the U.S. Geological Survey/Smithsonian Institution map *This Dynamic Planet* has gone out of print indefinitely. The National Geographic map titled *Earth's Fractured Surface* has been substituted for use with Lesson 15 inquiries. Additional resource information, including a downloadable copy of *This Dynamic Planet* in PDF format, is available for use at http://pubs.usgs.gov/pdf/planet.html.

This errata set includes the following:

- For the *Catastrophic Events* Teacher's Guide – revised pages 201, 202, 203, 205, and 209.
- For the *Catastrophic Events* Student Guide and Source Book – revised pages 171 and 178.

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*.

CAROLINA

Carolina Biological Supply Company

800.334.5551 www.carolina.com

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Reading Selections

The first reading selection in this lesson of the Student Guide, "Colliding, Sliding, and Separating Plates," describes lithospheric plates and their role in creating new landforms. "Earthquakes and Faults" concerns the relationship between these two natural phenomena. "Earth's Moving Plates: A Look Back" recounts the work of geologists of the past and present who have contributed to the understanding of how continents have changed over time. It concludes with a simple introduction to plate tectonics theory.

MATERIALS FOR GETTING STARTED

For the teacher

Map, National Geographic wall map: *Earth's Fractured Surface*
20 removable adhesive red dots
CD-ROM, Tasa Graphic Arts, Inc.: *The Theory of Plate Tectonics*
Computer and other hardware to project images*
Relief globes (up to 8, if available)
Masking tape*

For each student

1 completed homework copy of Student Sheet 14.1: Plotting Volcanic Activity
1 copy of Student Sheet 15.1: Plotting Earthquakes by Depth*
3 pencils, markers, pens, or crayons (blue, green, and red)*

NOTE For Inquiries 15.1 and 15.2, you will need enough materials for only four groups, since four groups will do Inquiry 15.1, four groups will do Inquiry 15.2, and then they will rotate.

MATERIALS FOR INQUIRY 15.1

For each of 4 groups (of 4 students)

2 thick foam pads (9 x 12 x ½ in)
2 thin foam pads (9 x 12 x ¼ in)
2 desks, thick books, or other thick, flat surfaces*
1 relief globe (if available)

MATERIALS FOR INQUIRY 15.2

For each of 4 groups (of 4 students)

1 Moving Plates Model™
1 continent stencil (North America, South America, and Africa)
Crayola Dough™, green (approximately 112 g)
1 Map, *Catastrophic Events World Map*
1 sharp toothpick
1 relief globe (if available)

MATERIALS FOR INQUIRY 15.3

For the teacher

1 transparency or sheet of newsprint*
Transparency markers*
Miscellaneous brittle materials (tongue depressors, dried dough, frozen caramel candies, taper candles)*
Miscellaneous ductile materials (room-temperature caramel candies, copper wire, soft dough)*
Access to a freezer
Video, Newton's Apple: *Earthquakes*
Video player and TV monitor*
Masking tape*
Graph paper from Appendix C (optional)*
1 pair of safety goggles*

For each student

1 copy of Student Sheet 15.3c: Making a Plate Model*
1 copy of Student Sheet 15.3d: Putting It All Together*

*Needed, but not supplied

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 Probeware and Computer Applications for STC/MS*™ available at www.nsrconline.com.

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 Segments #9 through #12 of the high school 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 Segments #9 through #12 of *The Theory of Plate Tectonics* CD-ROM; these segments are titled "Introduction to Plate Boundaries," "Divergent Boundaries," "Convergent Boundaries," and "Transform Fault Boundaries." 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.

represented by the red belt, rises inside the earth and pushes aside the old rock, represented by the black belt.)

C. Think about what happened to the black belt as it reached the edges of the model's lid. What landform is created when the ocean floor sinks back into the earth? (A trench forms.)

D. What patterns did you observe in the shapes of Africa and South America? (They fit together like puzzle pieces.) *How did the shapes of these continents compare with the shape of the Mid-Atlantic Ridge?* (The Mid-Atlantic Ridge has the same shape as the coastlines of these continents, which border the Atlantic. This is because the continents broke apart as the ridge formed.)

E. What landform is created when plates separate? Give an example. (A ridge forms. The Mid-Atlantic Ridge is an example of a landform created by separating plates.)

F. What landform is created when two continental plates collide? Give an example. (A mountain forms. For example, the Appalachian Mountains formed when the continent that is now Africa collided with the continent that is now North America.)

NOTE Make sure that students understand that these processes (formation of mountains and trenches, for example) took place over millions of years.

4. Have students look at the plate boundaries map, "Earth's Fractured Surface." Ask them why they think there are mountains north of India. (The Himalayas are forming there as the Indian-Australian Plate collides with the Eurasian Plate.)

Inquiry 15.3
Investigating Faults With Models

PREPARATION

1. For each group, make one copy of Student Sheet 15.3a: Investigating Faults: Experimental Design and Observations and Student Sheet 15.3b: Investigating Faults: Recording and Analyzing Data. (If you want students to complete these sheets individually, make a copy for each student.) For each student, make one copy of Student Sheet 15.3c: Making a Plate Model and Student Sheet 15.3d: Putting It All Together, which students will complete for homework.
2. Collect and prepare the miscellaneous brittle and ductile items required for "Getting Started." The kit contains tongue depressors and green dough. Obtain a bag of caramel candies and freeze half of them. Leave the remaining candies at room temperature. Freeze or dry out one piece of dough for each group. Obtain taper candles. When preparing for more than one class, keep in mind that you may need multiple sets of some items, since students may break them when testing to see if they are brittle.
3. Make certain that the Velcro® is adhered to the blocks as shown in Figure 15.3.
4. Using the groups' and other materials specified in the Materials list, set up one Fault Laboratory for each group. Using Figure 15.4 as a guide, do the following:

   A. Make certain the hook is securely attached to the center of one of the narrow sides of the solid block. This is Block A.
   B. Secure the block with the hole to the plastic box using a bolt, two washers, and a wing nut. This is Block B. Place one washer under the plastic box and

10. Encourage students to work freely with the equipment at first. They should observe how the blocks move when someone applies a force. Students can also place masking tape across the fault to model how surfaces on the earth react to stress building up along the fault. They can put centimeter cubes on each block to model how houses might respond when a fault ruptures.

11. Ask students to collect data by completing the experimental designs they outlined on Student Sheet 15.3a. Procedure Steps 11 and 12 in the Student Guide provide tips for conducting the inquiry. Have students complete Student Sheet 15.3b before completing the last box on Student Sheet 15.3a.

12. Have students clean up.

REFLECTIONS

1. Invite students to share their results with the class. Ask these questions:

A. How did the amount of friction along the fault affect the amount of force needed to rupture the fault? Use data to support your answer. (The greater the friction, the more force is needed to rupture the fault. The hooks and loops of the Velcro act like protrusions that connect the rock across the fault.)

B. Under what conditions did the blocks rupture more abruptly? (The greater the force applied to the block, the more abrupt the rupture.)

C. Under what conditions did the block slip (move slowly) but not rupture? (When students used two strips of loop Velcro side by side, the friction along the fault was at its lowest. When resistance along a fault is low, blocks of rock can slip without faulting.)

D. Think about what happened with the masking tape. Is there any sign on the earth's surface that the earth is moving slowly beneath the crust? (Look at SG Figure 15.9 and use the caption to answer this question.)

2. Have students create a working definition for the word "fault." Then help them understand that a fracture in the earth's surface becomes a fault when measurable movement of rock occurs along a fracture.

3. Using the wall map "Earth's Fractured Surface," ask students to find one place on the earth where a transform fault is located. (The Anatolian Fault near Turkey and the San Andreas Fault are two examples of transform faults located on a transform plate boundary.)

4. Show students the video *Earthquakes,* which summarizes concepts investigated in Part 2: Earthquakes. Discuss how this video relates to what students modeled in this lesson.

HOMEWORK

Period 1

Have students complete the first section of Student Sheet 15.1, in which they plot earthquake data on a graph.

Period 2

Have students answer the questions in the "Reflecting" section in the Student Guide for Inquiries 15.1 and 15.2. They should also complete the questions on Student Sheet 15.1.

Getting Started

1. Look at the wall map called "Earth's Fractured Surface" with your class. How is this map different from others you have seen? How is it the same?

2. Review your homework (Student Sheet 14.1) from Lesson 14 with your teacher. You may be asked to plot a volcano data point on the wall map. Describe any patterns you notice in the location of volcanoes and earthquakes.

3. Look at the plates shown on the map. Describe any relationship you see between the locations of earthquakes and volcanoes on the earth and the boundaries, or outer edges, of plates. What ideas do you have to explain this relationship?

4. View the CD-ROM, *The Theory of Plate Tectonics.* How do plates move? How does plate movement cause earthquakes, volcanoes, mountains, and trenches? Discuss your observations with your class.

5. Discuss what you know about models with your class.

6. Look at the models you will use in this lesson. Which kind of plate boundary do you think you will model with each one? Discuss with your class why and how models are used in the science classroom.

MATERIALS FOR GETTING STARTED

For you

- 1 completed homework copy of Student Sheet 14.1: Plotting Volcanic Activity
- 1 copy of Student Sheet 15.1: Plotting Earthquakes by Depth
- 3 pencils, pens, or crayons (red, blue, and green)

10. Look at the relief globe. Do the following with your group, and discuss the answers to the questions as you work:

A. Feel the globe. What do you observe? How is it different from other globes you have used?

B .Where on the earth do you see evidence that plates collided in the past? What evidence do you have that plates may have collided there? (Answer the next question only if you have already completed Inquiry 15.1.) *Do you think those plates were continental, oceanic, or both? Why?*

C. Where on the globe do you think plates are separating? Find evidence of this both within continents and under the ocean.

D. Find Japan and the Japan Trench. Feel these areas on the relief globe. What do you observe about these areas? What do you think is happening to the two plates that meet at this trench?

E. Find the middle of the Atlantic Ocean, called the Mid-Atlantic Ridge. Feel this ridge on the relief globe. What do you observe about this landform? What do you think is happening to the two plates located along the Mid-Atlantic Ridge? Why do you think this ridge is higher than the rest of the ocean floor?

F. Are there other places on the globe similar to the Japan Trench and the Mid-Atlantic Ridge?

11. Clean up. Remove any dough that may be stuck to the belts of the Moving Plates Model. Roll the dough back into a ball.

REFLECTING ON WHAT YOU'VE DONE

1. Apply what you observed in this inquiry to the earth's plate boundaries. Answer these questions in your notebook:

A. How do you think the Moving Plates Model shows what happens on the earth when two plates separate?

B. What causes the ocean floor to separate and "grow"?

C. Think about what happened to the black belt as it reached the edges of the model's lid. What landform is created when the ocean floor sinks back into the earth?

D. What patterns did you observe in the shapes of Africa and South America? How did the shapes of these continents compare with the shape of the Mid-Atlantic Ridge?

E. What landform is created when plates separate? Give an example.

F. What landform is created when two continental plates collide? Give an example.

2. Share your observations with the class.

3. With your class, look at the "Earth's Fractured Surface" plate boundaries map. Why do you think there are mountains north of India?