

Earth Processes

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About **Earth Processes**

DeltaScienceModules, THIRD EDITION

Students explore the ongoing forces inside Earth and on Earth's surface that have been shaping our planet for hundreds of millions of years. The module begins and ends with two important, related geological theories: continental drift and plate tectonics. In fourteen hands-on activities, students examine the evidence supporting these explanations of Earth's dynamic landforms. As a foundation, students construct a layered Earth replica that demonstrates the planet's structure. Next, students replicate the formation of the three types of rock and trace how heating and cooling, weathering and erosion, and compression create a perpetual rock cycle. They model, map, and measure the forces that result in earthquakes, volcanic eruptions, and mountain building. And finally they investigate the relentless, and sometimes explosive, events that occur at plate boundaries and discover why the Pacific Rim's Ring of Fire is the most volatile area on Earth.

In the Delta Science Reader *Earth Processes*, students read about the layered structure of Earth and the transfer of heat energy through convection currents, which drive earth processes. They explore the theory of continental drift, plate tectonics, and sea-floor spreading, and learn how the interactions at plate boundaries produce such dramatic earth processes as earthquakes and volcanoes. Students trace the rock cycle and find out how weathering, erosion, and deposition slowly, over time, reshape Earth's surface and form soil. A biographical sketch introduces students to geologist Harry Hess, who pioneered the study of mid-ocean ridges and trenches. Finally, students gain an understanding of the geologic time scale and the clues that enabled scientists to create it.

Overview Chart for Hands-on Activities

Hands-on Activity	Student Objectives
1 Pieces of a Puzzle <i>page 13</i>	<ul style="list-style-type: none"> • observe the locations and shapes of the continents on a globe • use paper cutouts of the continents to demonstrate how they fit together somewhat like pieces of a jigsaw puzzle • explore a variety of rocks and see how their distribution around Earth supports the theory of continental drift • explore several other clues that support the theory • raise questions about how continents can move
2 The Structure of Earth <i>page 23</i>	<ul style="list-style-type: none"> • discover that Earth is composed of layers • learn the characteristics of each layer • create a model of Earth and all its layers using a set of concentric spheres
3 Earth's Weathered Crust <i>page 29</i>	<ul style="list-style-type: none"> • examine the composition of Earth's crust • simulate the chemical and mechanical weathering of rocks • examine the composition of different types of soil
4 Sediments Become Rocks <i>page 39</i>	<ul style="list-style-type: none"> • discuss the roles of weathering, erosion, and deposition in the formation of sedimentary rocks • examine fossils and note their presence in sedimentary rocks • observe the deposition rates of different-sized sediments in water • make model sedimentary rocks and compare them to real ones
5 Volcanoes Make Rocks <i>page 47</i>	<ul style="list-style-type: none"> • discover that igneous rocks form when hot liquid rock from the mantle wells up into the crust and cools • model a volcanic eruption to show how magma escapes to form volcanic rocks and mountains • compare the formation of igneous rocks with the formation of sedimentary rocks
6 The Rock Cycle <i>page 55</i>	<ul style="list-style-type: none"> • learn about a third way in which rocks can form • model the formation of a metamorphic rock • explore the interactions of metamorphic, sedimentary, and igneous rocks in the rock cycle
7 Mountain Building <i>page 63</i>	<ul style="list-style-type: none"> • use clay to model layers of Earth's crust • investigate the effects of compression on layers of rock • manipulate the clay to model the various types of faults in Earth's crust • demonstrate the formation of folded, dome, and fault-block mountains
8 Earthquake! <i>page 71</i>	<ul style="list-style-type: none"> • model the energy waves produced by an earthquake • identify the focus and epicenter in their earthquake models • distinguish between compressional and shear waves
9 Building a Seismograph <i>page 81</i>	<ul style="list-style-type: none"> • explore how a seismograph detects and records the movement of the Earth during earthquakes • discuss the Richter scale • build a model seismograph and use it to measure the strength of a simulated earthquake
10 Ring of Fire <i>page 89</i>	<ul style="list-style-type: none"> • learn how to identify locations anywhere on Earth using latitude and longitude • plot the locations of earthquakes and volcanoes on a map and on their Earth models • identify the Ring of Fire
11 A Balancing Act <i>page 97</i>	<ul style="list-style-type: none"> • float blocks of wood in water to simulate how the crust is supported by the mantle • illustrate the effects of mountain building and weathering on the floating continental crust • define <i>isostasy</i> and discuss the earth processes that affect it
12 Convection Currents <i>page 105</i>	<ul style="list-style-type: none"> • create and observe convection currents in water • compare convection currents in water to convection currents in the Earth's mantle • explore the effect of convection currents on Earth's crust
13 The Ocean Floor <i>page 111</i>	<ul style="list-style-type: none"> • model sea-floor spreading • cite the age of rocks close to and farther from mid-ocean ridges as evidence of sea-floor spreading • demonstrate what happens when continental and oceanic crusts collide • relate convection currents to sea-floor spreading and subduction
14 Plate Tectonics <i>page 121</i>	<ul style="list-style-type: none"> • determine the locations of the crustal plates on a globe • discuss the different types of boundaries that exist between plates • relate the earth processes they have learned about to the theory of plate tectonics • create a model to demonstrate the connection between crustal plate movement and continental drift
Assessment <i>page 131</i>	<ul style="list-style-type: none"> • See page 131.

Process Skills	Vocabulary	Delta Science Reader
observe, investigate, analyze data, conclude	fossil, glacier, Pangaea, theory of continental drift	pages 4, 6
observe, compare, make and use models	crust, inner core, mantle, mineral, outer core, rock	pages 2–3
observe, compare, infer, make and use models, use variables	chemical weathering, mechanical weathering, soil, weathering	pages 19–20
infer, predict, investigate, compare, make and use models	deposition, erosion, sediment, sedimentary rocks	pages 11–18
make and use models, investigate, compare, infer	ash, crater, igneous rocks, lava, magma, vent, volcano	pages 10, 16
predict, make and use models, investigate, compare, communicate, conclude	crystal, metamorphic rocks, metamorphism, rock cycle	pages 16–18
make and use models, investigate, define based on observations, compare, classify	compression, dome mountain, fault, fault-block mountain, folded mountain, stress	pages 8–9
make and use models, compare, infer, communicate	compressional wave, earthquake, epicenter, focus, seismic wave, shear wave, surface wave	page 9
interpret data, make and use models, compare, infer, measure	magnitude, Richter scale, seismograph, tracing	page 9
use numbers, record and display data, analyze data, conclude, define based on observations	equator, International Date Line, latitude, longitude, prime meridian, Ring of Fire	page 10
make and use models, investigate, infer, define based on observations, compare	continental crust, isostasy, oceanic crust	pages 2–3
make and use models, predict, investigate, infer	convection current	pages 2–3
make and use models, infer, interpret data, compare, hypothesize, observe	fault zone, mid-ocean ridge, sea-floor spreading, subduction, trench	pages 6, 21
observe, collect and record data, infer, make and use models, communicate, hypothesize	convergent boundary, divergent boundary, lithosphere, plate, theory of plate tectonics, transform boundary	pages 4–5, 7–8

See the following page for the Delta Science Reader Overview Chart.

Overview Chart for Delta Science Reader

Earth Processes

Selections	Vocabulary	Related Activity
Think About...		
What Is Inside Earth? <i>pages 2–3</i>	conduction, continent, convection, convection current, core, crust, geologist, inner core, mantle, outer core	Activities 2, 3, 11, 12
How Has Earth’s Surface Changed Over Time? <i>pages 4–6</i> <ul style="list-style-type: none"> • Theory of Continental Drift • Plate Tectonics • Sea-Floor Spreading 	asthenosphere, continental drift, fossil, lithosphere, magma, mid-ocean ridge, Pangaea, plate, plate tectonics, rift, sea-floor spreading, sonar, subduction, trench	Activities 1, 2, 13, 14
Plate Movements <i>pages 7–10</i> <ul style="list-style-type: none"> • Plate Boundaries • Stresses and Faults • Earthquakes • Volcanoes 	convergent boundary, deformation, divergent boundary, dome mountain, earthquake, epicenter, fault, fault-block mountain, focus, folded mountain, geyser, hot spot, hot spring, lava, magnitude, normal fault, plateau, reverse fault, seismic wave, seismograph, stress, strike-slip fault, transform boundary, tsunami, vent, volcanic neck, volcano	Activities 5, 7, 8, 9, 10, 13, 14
Weathering, Erosion, and Deposition <i>pages 11–15</i> <ul style="list-style-type: none"> • Water • Living Things • Ice and Glaciers • Wind • Gravity 	abrasion, continental glacier, creep, deflation, deposition, drainage basin, dune, erosion, glacier, gravity, groundwater, ice wedging, loess, mass movement, moraine, permeable, runoff, sediments, slump, till, valley glacier, water table, weathering, zone of saturation	Activities 3, 11
How Do Rocks and Soil Form? <i>pages 16–20</i> <ul style="list-style-type: none"> • Rock Formation • The Rock Cycle • Soil Formation • Conserving Soil 	cementation, chemical rock, chemical weathering, clastic rock, compaction, contour plowing, Dust Bowl, extrusive, humus, igneous rock, intrusive, loam, mechanical weathering, metamorphic rock, mineral, organic rock, rock, rock cycle, sedimentary rock, soil, soil conservation, soil horizon, soil profile, strip cropping	Activities 3, 4, 5, 6
People in Science		
<ul style="list-style-type: none"> • Harry Hess <i>page 21</i>		Activities 13, 14
Did You Know?		
<ul style="list-style-type: none"> • About Geologic Time <i>page 22</i>	absolute age, climate, geologic time scale, index fossil, relative age	Activities 1, 2, 4

Teaching suggestions for the Delta Science Reader are in a 32-page booklet included with this guide.

MATERIALS LIST

Earth Processes

Quantity	Description	Quantity	Description
8	bags, plastic, reclosable*	8	spheres, plastic, small
8	balls, foam, black*	8	spheres, wooden
8	beakers, 250-mL	12	spoons, plastic
1	block, wooden, large	1	spring toy
16	blocks, wooden, small	1	stick, wooden*
1	can, metal	1	string, roll*
1	cellophane, yellow, 30 × 50 cm*	1	tape, masking*
8	clay, four colors, 1 lb*†	1	thread, white*
8	containers, plastic, 0.5-gal	1	transparency, Earth Cross-Section
8	Continent Shapes, vinyl*	1	transparency, Ocean Floor
32	cups, paper*	1	transparency, Ring of Fire
9	cups, plastic, 10-oz	1	transparency, The Rock Cycle
1	Delta Science Dictionary	16	tubes, cardboard
1	Delta Science Dictionary Copymaster Booklet	32	tubes, plastic, with cap
16	foam, gray, 22 cm × 28 cm	1	vinegar, 16 oz*
2	foam, red, 45 cm × 60 cm*	60	waxed paper, 30 cm × 30 cm*
1	fossils, p/5†	1	Teacher's Guide
8	gelatin, packets*	8	Delta Science Readers
4	glue, 4 oz*		
3	gravel, 2 lb*†		
1	index cards, p/30		
8	knives, plastic		
1	Land Mass Patterns		
8	magnifiers		
16	metal strips		
1	needle		
8	pans, foil		
1	paper, blue, p/15*		
8	pipettes		
1	plaster of paris, 5 lb*†		
1	plastic wrap*		
3	posters, resource		
1	ribbon, red, 18 m		
2	rocks, gneiss, p/5†		
2	rocks, igneous, 5 types, p/25†		
2	rocks, marble, p/5†		
2	rocks, quartzite, p/5†		
2	rocks, sedimentary, 5 types, p/25†		
2	rocks, slate, p/5†		
8	ropes, 2-m		
3	sand, 2 lb*†		
1	sawdust*†		
1	soil, clay, 1 lb*†		
1	soil, sandy, 1 lb*†		
8	spheres, plastic, large		

TEACHER-PROVIDED ITEMS

- 1 book
- 8 boxes, cereal, empty
- 1 clock, with second hand
- 2 containers, 1-L
- crayons*
- 8 electric hot plates
- 1 globe
- 1 marker, felt-tip
- newspaper*
- 1 overhead projector
- paper towels*
- 32 paper, white*
- 16 pencils
- 8 pencils, colored, blue
- 8 pencils, colored, red
- 48 pennies
- pictures of mountains
- 1 razor blade, single-edged
- 8 rubber bands
- 1 ruler, metric
- 32 safety goggles
- 8 scissors
- tape, transparent*
- water, tap*

* = consumable item † = in Sand and Soil Box

ACTIVITY SUMMARY

This Delta Science Module introduces students to the earth processes that shape the world around them.

ACTIVITY 1 Students are introduced to the theory of continental drift. They demonstrate how the major land masses fit together like pieces of a jigsaw puzzle. They explore several other clues that support the theory and raise questions about how continents can move.

ACTIVITY 2 Students use concentric spheres to construct a model of the Earth that shows its layered structure.

ACTIVITY 3 Students examine the makeup of the outermost layer of Earth—the crust. They are introduced to the concept of weathering and simulate both the mechanical and chemical weathering of rocks.

ACTIVITY 4 Students discuss the process by which sedimentary rocks form. Then they make model sedimentary rocks and compare them with actual sedimentary rock samples.

ACTIVITY 5 Students observe samples of igneous rock and learn that this type of rock forms when molten rock from the mantle wells up into the crust, cools, and then hardens. They simulate a volcanic eruption to show how magma escapes from the mantle.

ACTIVITY 6 Students model the formation of metamorphic rock and survey the interactions among igneous, sedimentary, and metamorphic rock in a process called the rock cycle.

ACTIVITY 7 Students focus on mountain building. They use clay to represent layers of Earth's crust and then manipulate the clay to model the different ways in which mountains form.

ACTIVITY 8 Students model energy waves like those produced by an earthquake and learn to distinguish between the two types of seismic waves: compressional waves and shear waves.

ACTIVITY 9 Students continue to investigate earthquakes. They are introduced to a device that detects and measures earthquakes—a seismograph. Students discuss the Richter scale, then build model seismographs and use them to measure the strength of a simulated earthquake.

ACTIVITY 10 Students discover how to identify any location on a map or globe using lines of latitude and longitude. With this new skill, students plot the locations of earthquakes and volcanoes on a map and identify the resulting pattern as the Ring of Fire.

ACTIVITY 11 Students learn about the balance that exists between the downward force of Earth's crust and the upward force of the mantle—a phenomenon called isostasy.

ACTIVITY 12 Students create convection currents in water and compare them to those of Earth's mantle. They then discuss the potential effect of these currents on the overlying crust.

ACTIVITY 13 Students model sea-floor spreading and subduction.

ACTIVITY 14 Students learn about the theory of plate tectonics. They determine the locations of the crustal plates on their Earth models and create a model to demonstrate the connection between crustal plate movement and continental drift. Finally, they relate what they have learned about earth processes to the theory of plate tectonics.