Nancy Larson®

Science 3

Booklet E

Exploring the Earth's Structure

Geology

Geologist Caroline

The Earth's Surface

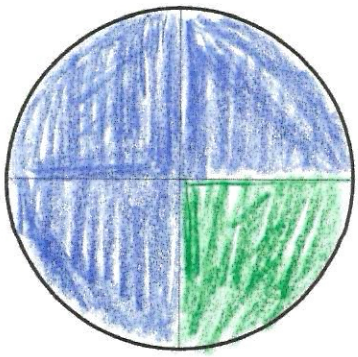
1 About three-fourths of the Earth's surface is covered by water. Most of the water is in the Earth's five oceans.

2 The Earth's five oceans, in order from largest to smallest, are the Pacific, Atlantic, Indian, Southern, and Arctic. All the oceans are connected and water is continually flowing from one to another.

3 About one-fourth of the Earth's surface is not covered by water. The area of the Earth's surface not covered by water is called land. The land is divided into large landmasses called continents.

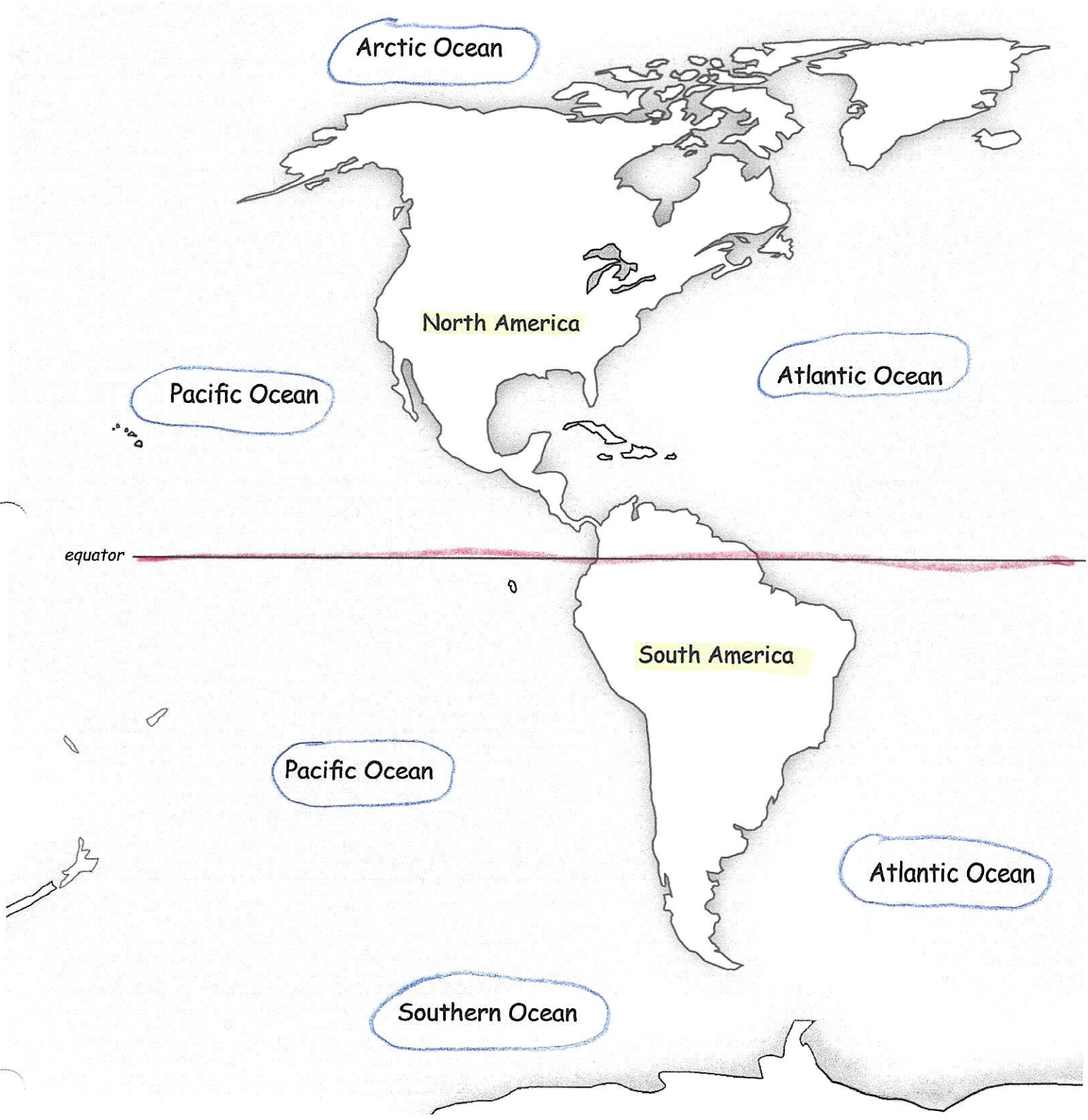
4 The Earth's seven continents, in order from largest to smallest, are Asia, Africa, North America, South America, Antarctica, Europe, and Australia. We live on the continent of North America.

Comparison of the Amount of the Earth's Surface Covered by Water or Land

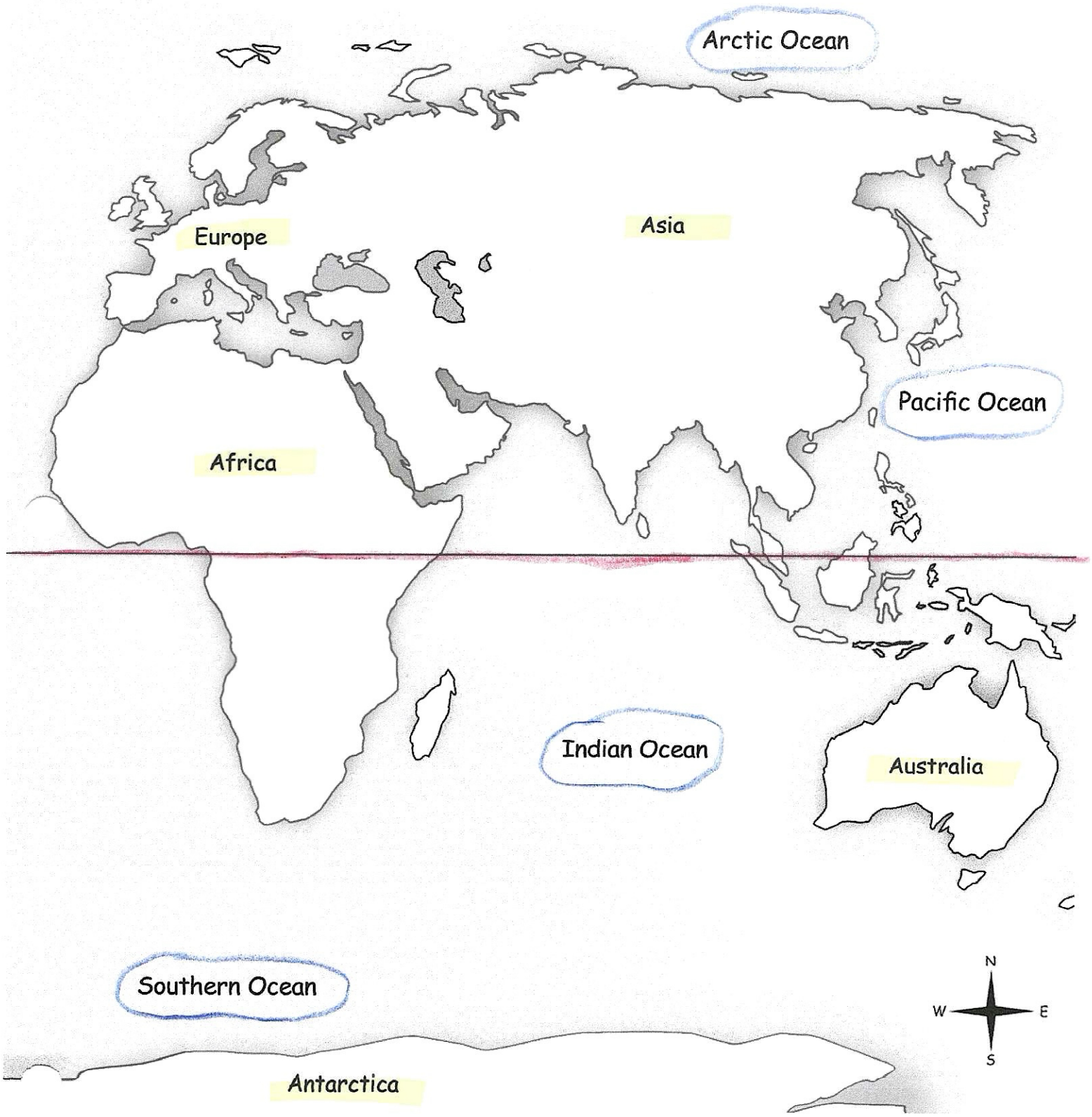


water $\frac{3}{4}$ land $\frac{1}{4}$

Continents



and Oceans



The Layers of Earth

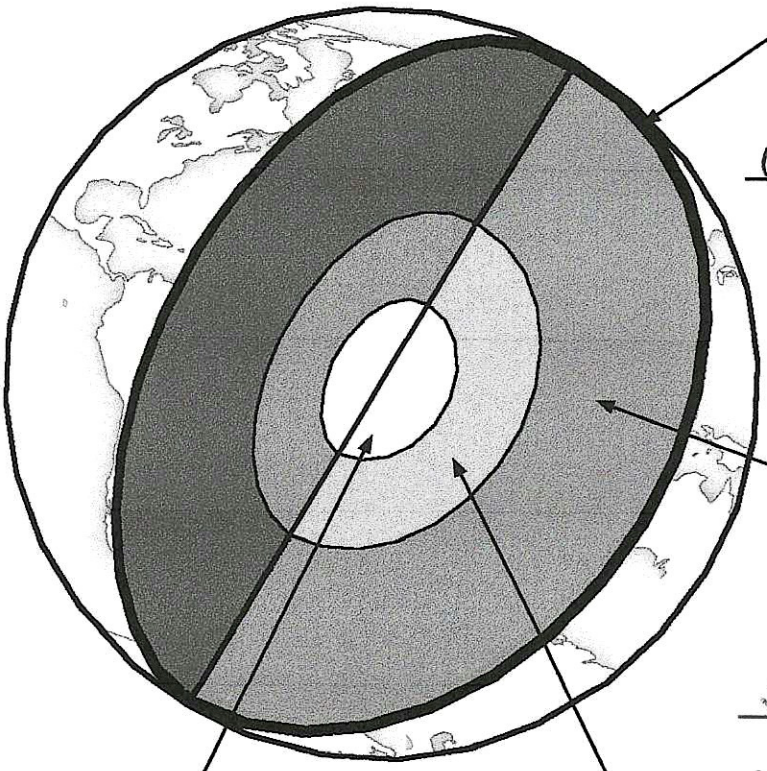
1 There are four layers of Earth. The outermost layer is called the crust. Most of the Earth's crust is solid rock with a thin layer of soil and loose rock at the top. The rocks in the crust contain the elements oxygen (45%), silicon (27%), aluminum, iron, calcium, sodium, potassium, magnesium, and smaller amounts of other elements.

2 The layer below the crust is called the mantle. The mantle is the thickest layer of Earth. The upper mantle is hot enough to melt some of the rock. The thick, hot liquid rock in the mantle is called magma. The mantle contains the elements oxygen, silicon, magnesium, iron, aluminum, and smaller amounts of other elements.

3 Below the mantle is the layer called the outer core. The outer core is hotter than the mantle. The material in this layer is a liquid metal made up of the elements iron and nickel.

4 At the center of Earth is the layer called the inner core. The inner core is the hottest layer of Earth. The inner core is a solid sphere made up of the elements iron and nickel. This innermost layer of Earth is solid because of the pressure from the layers above.

The Layers of Earth



crust

solid rock with a thin layer of soil and loose rock

oxygen silicon

mantle

contains magma

oxygen

silicon magnesium

iron aluminum

inner core

solid sphere

iron nickel

outer core

liquid metal

iron nickel

Tectonic Plates

1 The Earth's crust and upper mantle is broken into large pieces called tectonic plates. Geologists have identified seven large plates and at least nine smaller plates. These tectonic plates cover the entire surface of Earth.

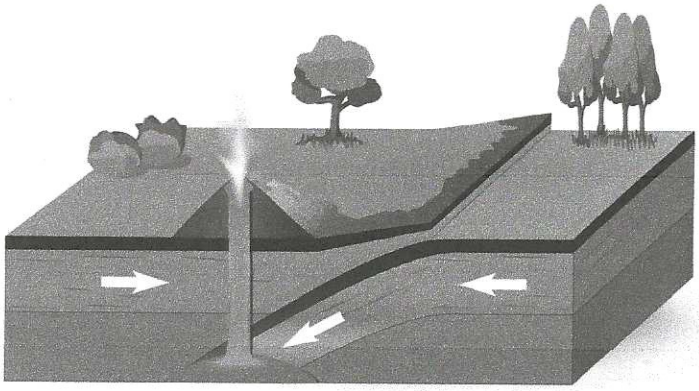
2 Geologists discovered that tectonic plates move a small distance each year. Some plates move toward one another and collide. Some plates move away from one another and separate. Other plates move in opposite directions and rub against one another as they slide past.

3 When tectonic plates collide, the plates move toward one another and one plate often pushes under the other plate. Mountains can form when one plate is pushed up. Plates colliding can cause volcanoes to erupt and earthquakes to occur. The area where tectonic plates collide is called a convergent boundary.

4 When tectonic plates separate, the plates move away from one another. This happens most often in the oceans. When plates separate, volcanoes can erupt and earthquakes can occur. Over time, these volcanoes often become mountains. The area where tectonic plates separate is called a divergent boundary.

5 When tectonic plates slide, the plates move in opposite directions, rubbing against each other as they move. When plates slide suddenly, earthquakes occur. Mountains do not form and volcanoes do not erupt when plates slide. The area where tectonic plates slide is called a transform boundary.

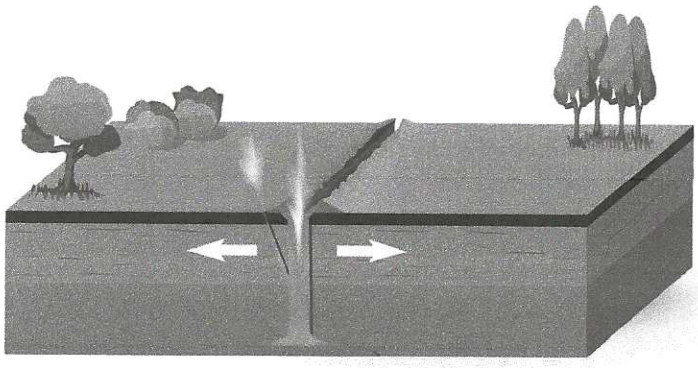
How Tectonic Plates Move



Convergent Boundary

collide

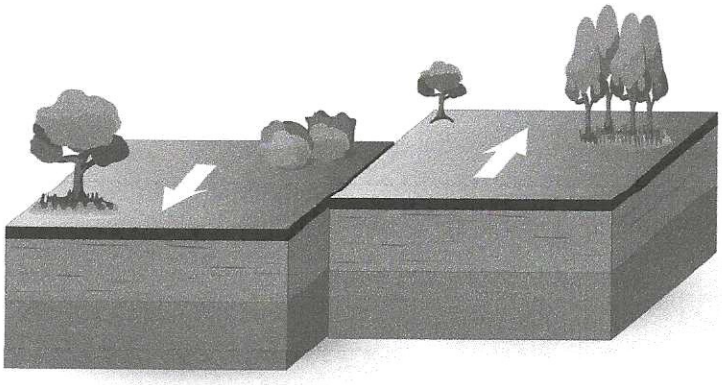
- mountains
- volcanoes
- earthquakes



Divergent Boundary

separate

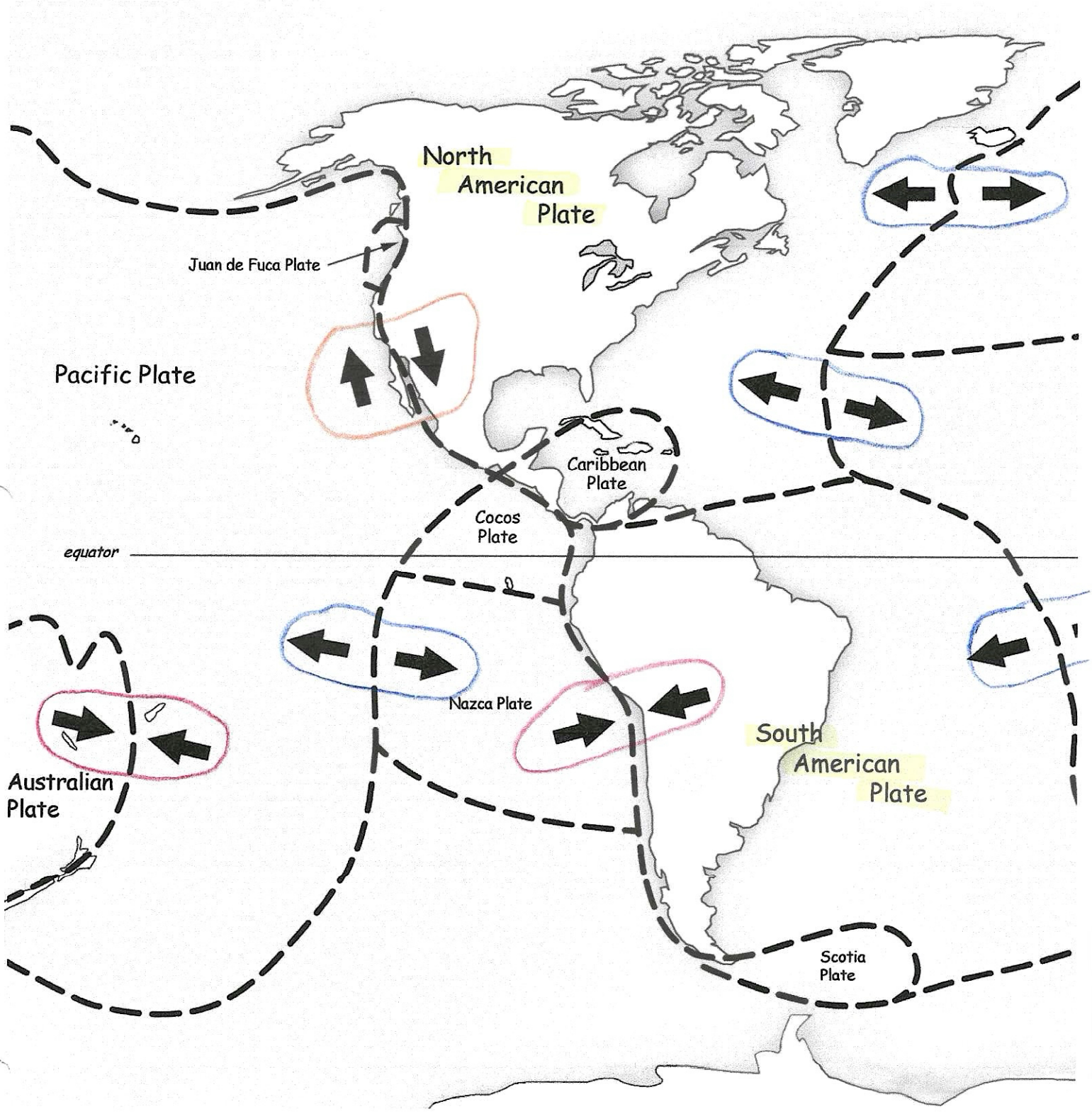
- volcanoes
- earthquakes
- mountains



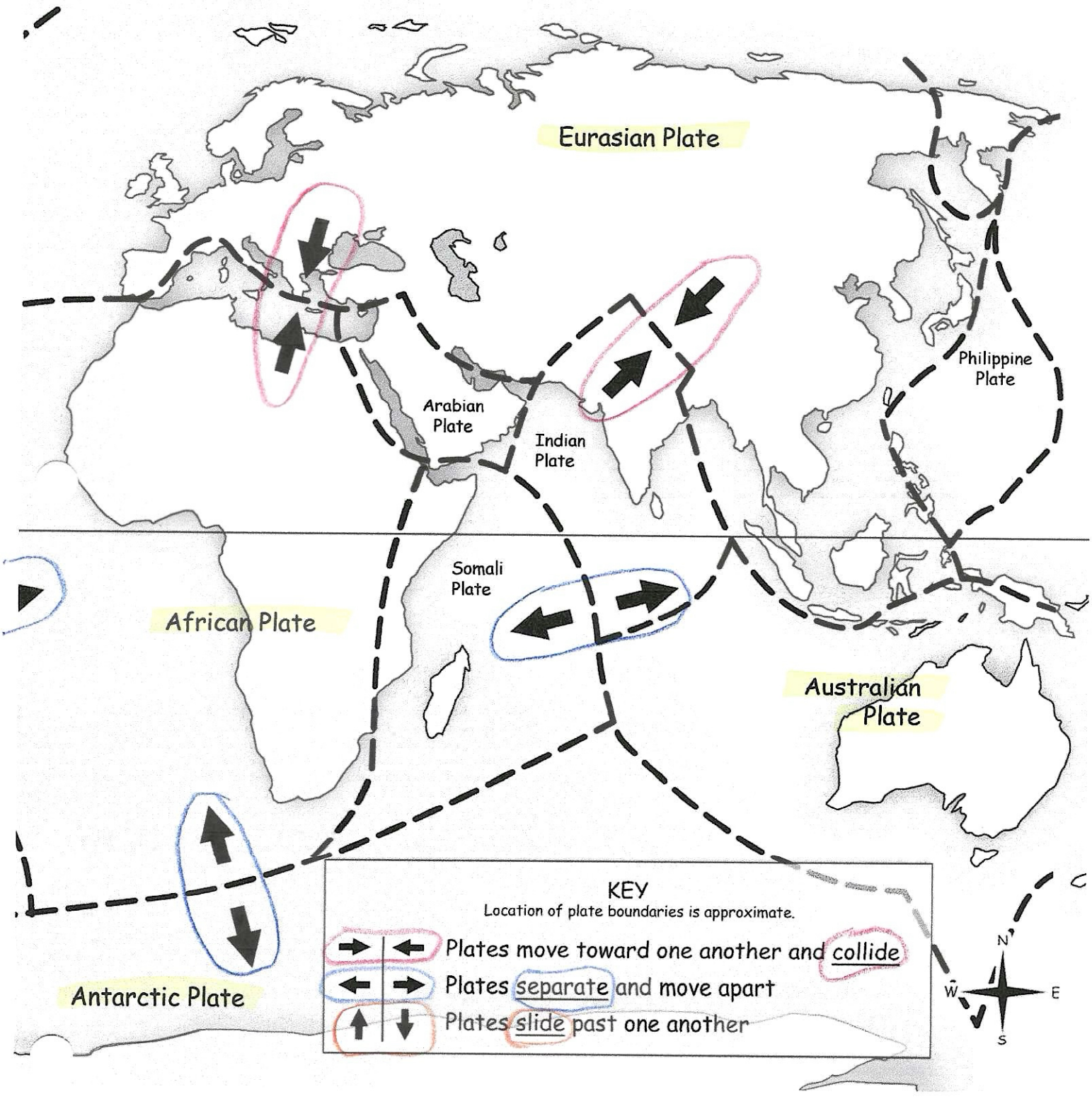
Transform Boundary

slide

- earthquakes



Plates



Earthquakes

1 An earthquake is the sudden and violent shaking of the ground. Most earthquakes are caused by a large section of rock suddenly sliding past another section of rock. Earthquakes often occur where there are large cracks in the Earth's crust called faults.

2 The exact location where an earthquake occurs is called the hypocenter of the earthquake. The hypocenter of an earthquake is usually far below the Earth's surface.

3 After an earthquake occurs, waves of energy, called seismic waves, move outward in all directions from the hypocenter. Seismic waves cause the ground to shake.

4 The place on the surface of Earth directly above the hypocenter is called the epicenter of the earthquake. The greatest damage from seismic waves occurs near the epicenter. Near the epicenter, buildings can collapse, and the land can shift or crack.

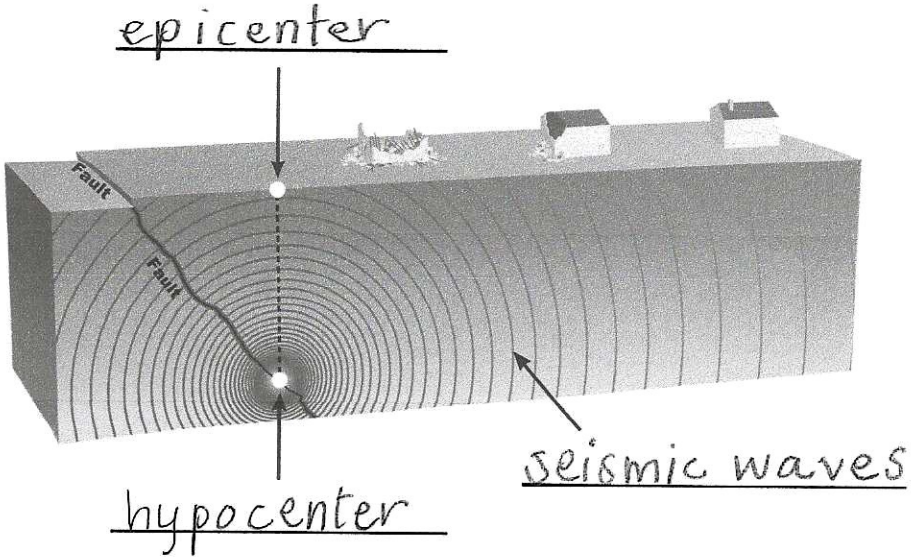
5 A strong earthquake below the ocean floor can cause a series of giant waves called a tsunami. The giant waves move outward in all directions from the epicenter of the earthquake. A tsunami can cause flooding and destruction along coastal areas.

6 The Richter Scale is used to describe the magnitude, or strength, of an earthquake. The Modified Mercalli Intensity Scale is used to describe the possible effects and damage from an earthquake.

Earthquake Scales

U.S. Geological Survey Description	Richter Scale of Earthquake Magnitude	Modified Mercalli Intensity Scale Possible Effects
Micro	0–1.9	• No damage • Not felt by people
Minor	2.0–2.9	• No damage • Not felt by most people
	3.0–3.9	• Hanging objects may swing • Not felt by most people
Light	4.0–4.9	• Windows and dishes rattle • Some windows crack
Moderate	5.0–5.9	• Furniture moves • Walls crack
Strong	6.0–6.9	• Some houses collapse • Roads crack
Major	7.0–7.9	• Large cracks in the ground • Most buildings collapse • Bridges fall down
Great	8.0+	• Total destruction

Earthquake



Volcanoes

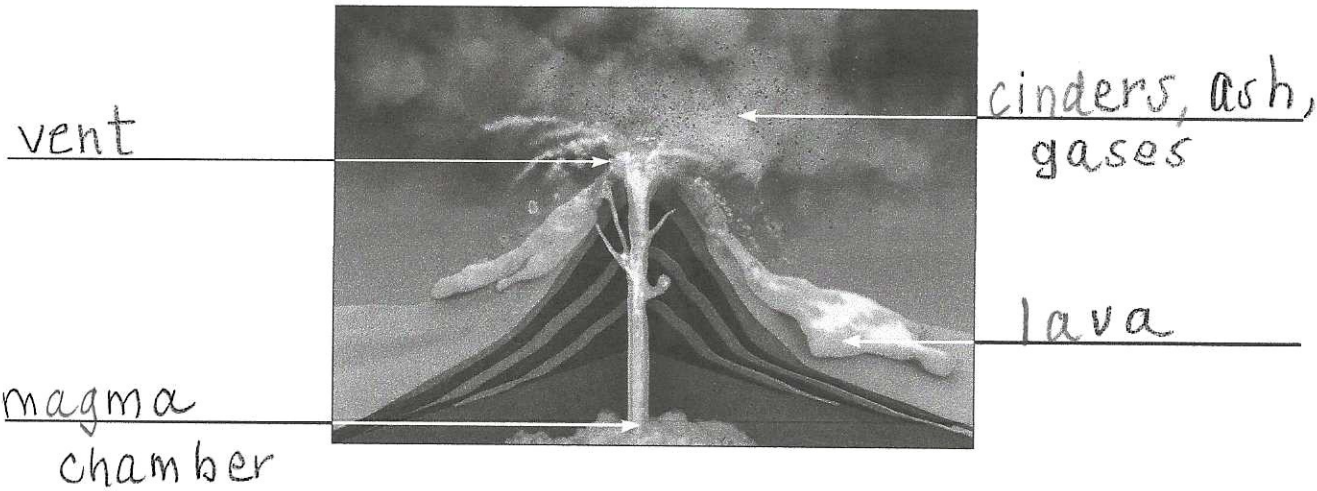
1 A volcano occurs where magma from the mantle pushes upward through openings in the Earth's crust. Most volcanoes are found along the edges of tectonic plates that are separating or colliding. In the United States, the greatest number of active volcanoes are in the states of Alaska, California, Oregon, Washington, and Hawaii.

2 Magma beneath a volcano is located in an area called the magma chamber. Magma and gases move upward from the magma chamber and leave through openings at the Earth's surface called vents. Magma that leaves a volcano is called lava.

3 When volcanoes erupt, they release lava, cinders, ash, and gases. Lava is a thick liquid that will cool and become rock. Cinders are a mixture of lava and gas bubbles. Volcanic ash is tiny pieces of rock dust that can be carried in the air over a large area.

4 Some volcanoes erupt suddenly with great force and for a short amount of time. Other volcanoes erupt slowly and may keep erupting for a long time. Volcanoes that are not expected to erupt in the future are called extinct.

Parts of a Volcano



Weathering of Rock

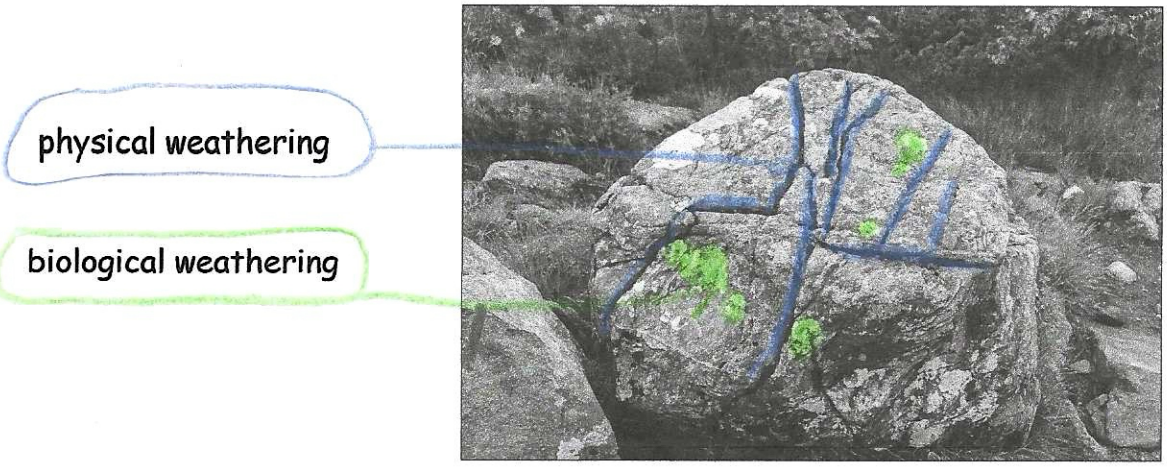
1 Weathering is the breaking apart of rock. Three types of weathering are physical weathering, chemical weathering, and biological weathering.

2 Physical weathering is the breaking apart of rock by natural forces. Natural forces that break apart rock include moving water, ice, wind, and hot and cold temperatures. For example, rock can be broken apart when water freezes in cracks in the rock and pushes the pieces of rock apart.

3 Chemical weathering is the breaking apart of rock by chemicals in air, water, or living organisms. The surfaces of statues, headstones, or buildings made from rock can be broken down by chemical weathering.

4 Biological weathering is the breaking apart of rock by living organisms. Trees and lichens are two examples of living organisms that can break apart rock. When tree roots grow into cracks in a rock, they push apart the rock as they grow larger. Lichens are organisms that live on rock and break down the surface of rock.

Physical and Biological Weathering



Classifying Rocks by Size

1 The breaking apart of rock by weathering produces rocks of different sizes. Geologists classify rocks by size. The words that describe the size of rocks from smallest to largest are clay, silt, sand, pebble, cobble, and boulder.

2 Clay particles are the smallest pieces of rock. They are too small to be seen by the naked eye. When dry, clay particles feel very smooth. When wet, clay particles feel sticky. Water moves slowly between clay particles because the particles are packed together so closely. Depending on the type of rock it comes from, clay may be white, gray, black, red, green, or yellow.

3 Silt particles are a little larger than clay particles, but they are still too small to be seen by the naked eye. Silt particles feel smooth, soft, and silky when dry or wet. Silt is often found in riverbeds and along the sides of rivers. It is also found on the ocean floor.

4 Particles of sand are larger than clay and silt particles. Particles of sand can be seen by the naked eye. Sand particles feel gritty when dry or wet. Water moves quickly between sand particles because there is space between the particles for water molecules to move. Sand may be tan, pink, white, or black.

5 Pebbles are larger than particles of sand. A pebble can fit in the palm of your hand. Cobbles are larger than pebbles and smaller than the size of your booklet. Boulders are the largest size rocks. Boulders are larger than basketballs and can even be larger than cars.

Erosion

1 Erosion is the moving of rock and soil by water, wind, or gravity. Rock and soil that are moved and deposited in a new location are called sediment.

2 Moving water in streams and rivers causes erosion. As water flows, it picks up rock and soil. When the water slows or stops, the rock and soil are deposited in a new location. Erosion caused by moving water can change the path and shape of streams and rivers.

3 Heavy rains and melting snow cause erosion on sloping surfaces. As water moves downhill, it picks up rock and soil. Gullies form on sloping surfaces where rock and soil are removed. Rock and soil carried by the water are deposited when the water slows or stops.

4 Waves on the shoreline of lakes and oceans cause erosion. As the water moves in and out, it picks up and moves rock and soil from the shoreline. During storms, large waves cause erosion and change the shoreline of lakes and oceans when they pull rock, sand, and soil into the water.

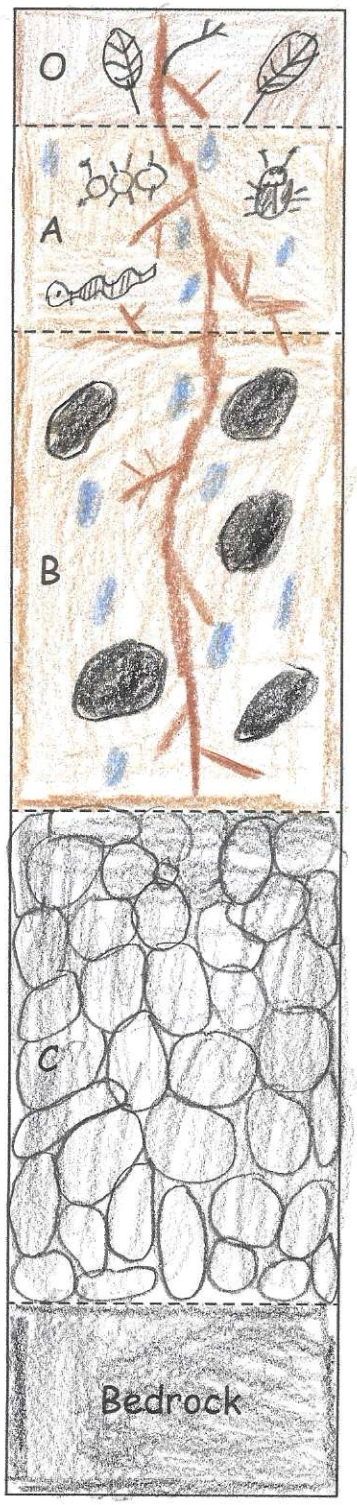
5 Wind causes erosion when it moves soil and deposits it in new locations. Strong winds can cause a dust storm when they pick up and move dry soil. Sandstorms occur when strong winds pick up and move sand to new locations.

6 Gravity causes erosion when it pulls loose rock and soil downhill. Loose rock and soil pulled down a hillside by gravity is called a landslide.

Soil

[1] Soil is a mixture of rocks and decomposed plant and animal matter. Decomposed plant and animal matter in soil is called humus. Soil scientists divide soil into layers called horizons. Each soil horizon has different amounts of rocks and humus.

Soil Horizons



[2] The O horizon is also called the organic surface layer. The organic surface layer contains organic material such as leaves, twigs, and humus.

[3] The A horizon is also called topsoil. Topsoil contains a mixture of sand, silt, clay, and humus. Topsoil is the type of soil in which plants grow best. Topsoil provides water and mineral nutrients plants need to live and grow. Animals, such as worms and insects, live in topsoil. Animals help loosen the topsoil so air and water can reach the roots of plants.

[4] The B horizon is also called subsoil. Subsoil contains mostly clay particles and larger rocks with a small amount of humus. Subsoil stores water and provides nutrients for plants. There are fewer living things in subsoil than in topsoil.

[5] The C horizon is also called parent material. Parent material contains broken-apart rocks that will eventually become part of the B horizon. Plant roots usually do not reach this layer. Below the C horizon, there is solid rock called bedrock.

How Rocks Are Formed

1 Rocks are grouped into three categories based on how they were formed. These three categories are igneous, sedimentary, and metamorphic.

2 Igneous rock is formed when magma or lava cools and hardens. Five types of igneous rock are obsidian, basalt, granite, scoria, and pumice.

3 Most sedimentary rock is formed from layers of sediment that contain clay, silt, sand, and pebbles. Some sedimentary rock includes the remains of past life, such as plants and the shells of animals. When layers of sediment and remains of past life build up and press on lower layers, the pressure forms sedimentary rock. It is often possible to see layers of sedimentary rock along highways cut through hills and mountains. Four types of sedimentary rock are sandstone, shale, conglomerate, and limestone.

4 Metamorphic rock is formed by both heat and pressure. The heat and pressure deep in Earth change igneous or sedimentary rock into metamorphic rock. Many metamorphic rocks seem to have bands or layers of color. These rocks are often gray or black. Four types of metamorphic rock are gneiss, slate, quartzite, and marble.

5 It is common to find fossils in sedimentary rock. Fossils are evidence of organisms that lived in the past. Some fossils were formed when animals or plants died and were covered by sediment. Other fossils were formed when animal footprints became covered by sediment. Common fossils found by geologists include bones, shells, animal tracks, and imprints of plants.

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