UNIT 1
Studying the earth
2

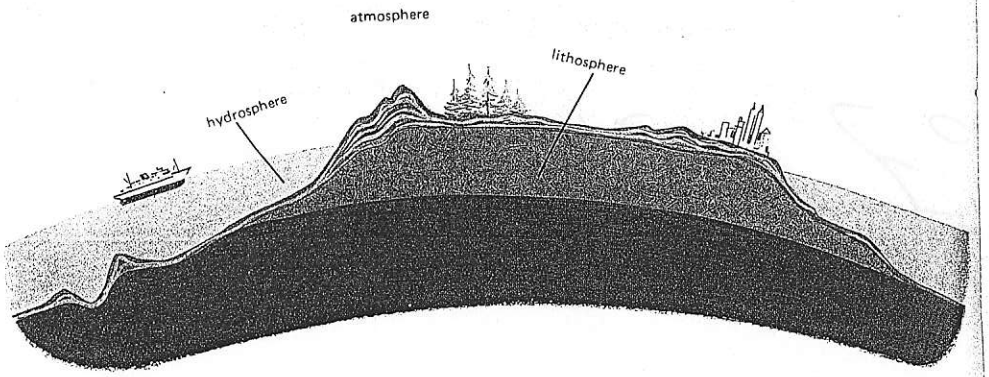
What are the parts of the earth?

What shape is the earth? Look at the photograph of our planet, earth. This picture was taken out in space. What does the earth look like? The earth is shaped like a ball, or sphere (SFEER). The earth is a large sphere.

▶ What is the shape of the earth?

The water. What do you think the blue part of the photograph is? It is the water on the earth. Most of our planet is covered with water. About ¾ of the earth's surface is water. Water is found in the oceans, rivers, and lakes. The part of the earth's surface that is water is the hydrosphere (HY-dro-sfeer).

▶ What is the hydrosphere?



The land. Land is the solid part of the earth. Mountains are raised lands. Valleys are the lower lands between the mountains. The countries of the world are parts of the land. The hard solid part of the earth that makes the land is called the lithosphere (LITH-o-sfeer). There is lithosphere under the oceans, too.

▶ What parts of the earth make up the lithosphere?

The air. There is another part of the earth around the lithosphere and the hydrosphere. This part is called the atmosphere (AT-muh-sfeer). The atmosphere is made of air. The atmosphere is the air that covers all the other parts of the earth.

▶ What is the atmosphere?

WHAT YOU LEARNED

1. Our planet earth is a large sphere or ball.
2. Water covers ¾ of the earth. This is called the hydrosphere.
3. The solid part of the earth is called the lithosphere.
4. The air around the earth makes up the atmosphere.

SCIENCE WORDS

sphere (SFEER)
a ball or globe
hydrosphere (HY-dro-sfeer)
the part of the earth's surface covered by water
lithosphere (LITH-o-sfeer)
the solid part of the earth
atmosphere (AT-muh-sfeer)
the air around the earth

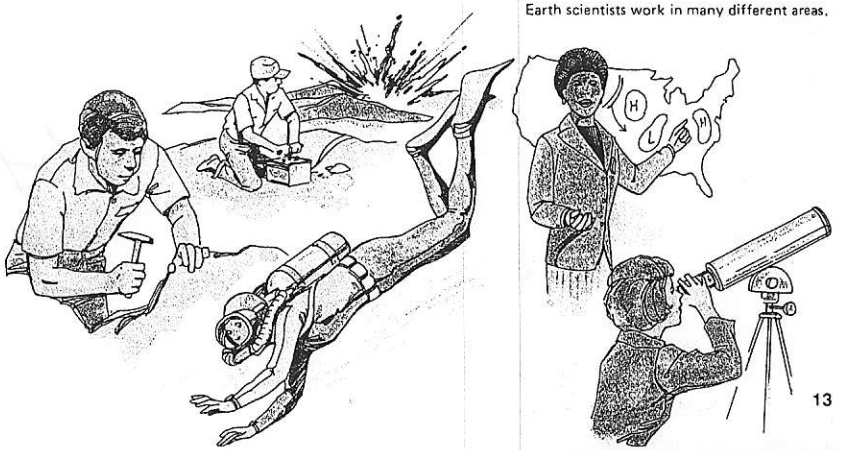
ANSWER THESE

1. Name the three parts of the earth.
2. How much of the earth's surface is the hydrosphere?
3. On which part of the earth do we find your school?

FINDING OUT MORE

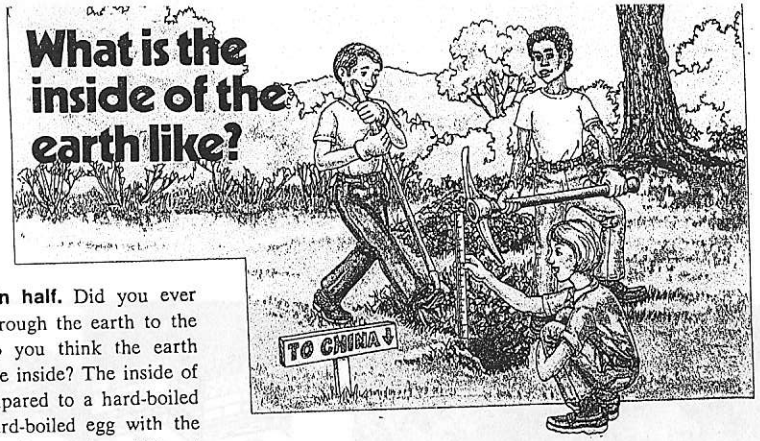
Earth science is a broad subject. It is not only the study of the rocks and minerals found on the land. Some earth scientists study the oceans. Others study the weather. Still others study earthquakes and volcanoes. Even the study of outer space is important to earth scientists.

Earth scientists work in many different areas.



UNIT 1
Studying the earth
3

What is the inside of the earth like?

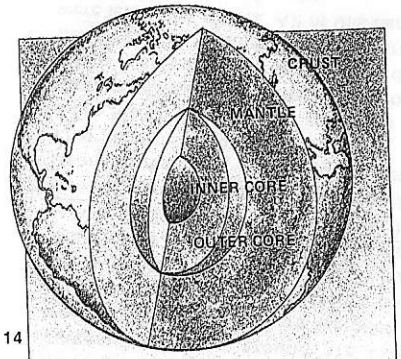


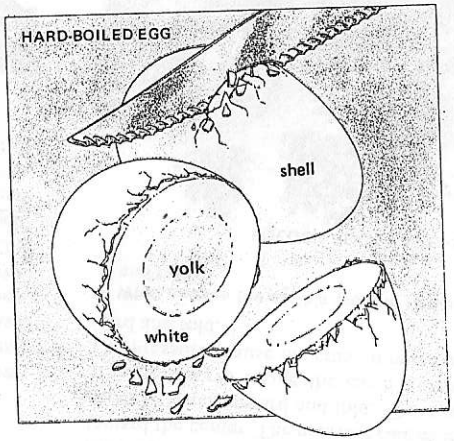
Cutting the earth in half. Did you ever plan to dig a hole through the earth to the other side? What do you think the earth would look like on the inside? The inside of the earth can be compared to a hard-boiled egg. If you cut a hard-boiled egg with the shell on, you see that the egg has different layers. The earth is made of layers, too.

▶ How can the earth be compared to a hard-boiled egg?

The crust of the earth. The shell of the egg is the outside layer. The earth has an outside layer, too. It is called the crust. The shell of the egg is very thin. The earth's crust is about 30 kilometers thick. Could you say the crust is very thin? Yes! To get to the center of the earth, you would have to dig about 6,500 km. Compared to 6,500 km, 30 km is not much. Compared to the whole earth, the crust is very thin.

▶ What is the outer layer of the earth called?





The mantle. The layer under the crust of the earth is called the mantle (MAN-tull). The mantle could be compared to the white of the egg. As you can see in the drawing, it is much thicker than the crust. The mantle is about 3,000 km thick.

▶ What is the layer of the earth found under the crust called?

The core. The center part of the earth is called the core. It can be compared to the yolk of the egg. But the core of the earth is made up of two layers, not just one. They are the outer core and the inner core.

▶ What is the center of the earth called?

WHAT YOU LEARNED

1. The earth has four layers: the crust, the mantle, the outer core, and the inner core.
2. The crust is the thin outside layer of the earth.
3. The mantle is the second layer. It is much thicker than the crust.
4. The core is the center part of the earth. It is made up of the outer core and the inner core.

SCIENCE WORDS

crust
the thin outside layer of the earth

mantle (MAN-tull)
the thick layer of the earth just under the crust

core
the center part of the earth

ANSWER THESE

1. Name the two layers that make up the center of the earth.
2. Which layer of the earth can you touch?
3. What is the name of the layer just below the crust of the earth?

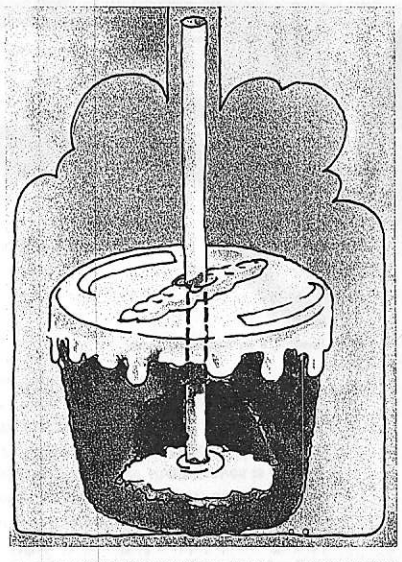
NOW TRY THIS

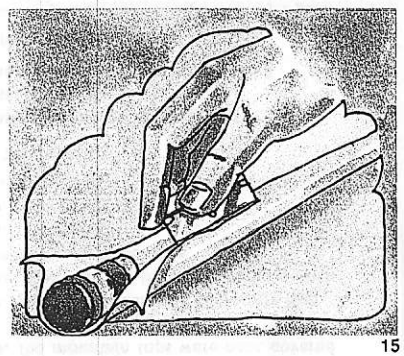
Copy these sentences and complete the rhymes.

1. Run like the wind and kick up the dust;
   It settles right back on the earth's _____.
2. You will need a shovel with a very long handle
   To dig to the earth's second layer, the _____.
3. You could dig and dig and dig still more,
   But you won't even reach the earth's outer _____.

DO THIS AT HOME

Get a cupcake that has icing on top and marshmallow or other filling inside. Push a straw through the top into the center of the cupcake. Now pull the straw out and cut it open. What do you find inside the straw? How could an experiment like this one be used to find out about the inside of the earth?





UNIT 6
Building up the earth
1

How does the earth's crust move?

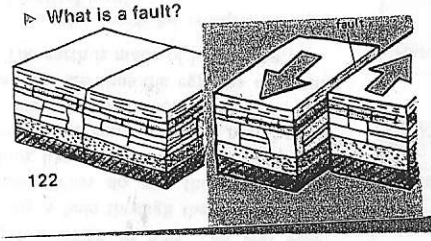
Earthquakes. The earth's crust is always moving, but usually very slowly. Slight movements of the ground are called tremors (TREM-ers). There are over six million tremors a year in the earth's crust. Many of these tremors are too slight to be felt. But an instrument called a seismograph (SIZE-muh-graf) can measure these movements. Earthquakes are sudden, strong movements in the earth's crust. They can cause a lot of damage.

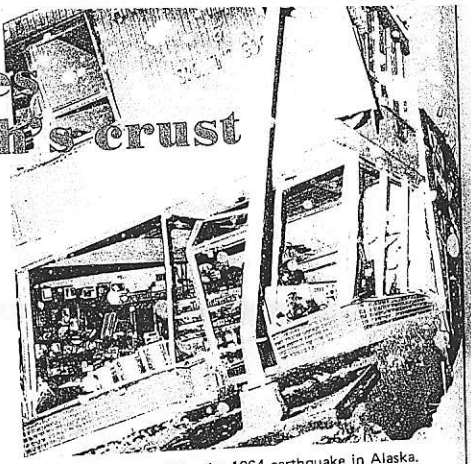
On March 27, 1964, the ground in Anchorage, Alaska, shook with great force. When it stopped, 115 people had died. Buildings had fallen apart. Great cracks were left in the streets. All of this damage was caused by an earthquake.

▷ What is an earthquake?

What causes earthquakes? Scientists believe that pressures in the earth's crust cause earthquakes. These pressures cause the crust to break at a weak point. When the crust breaks, it moves. One part of the crust slips and slides along the other. The break in the earth's crust is called a fault (FAWLT). This movement of the ground along a fault is known as faulting (FAWL-ting). Earthquakes take place as a result of faulting.

▷ What is a fault?





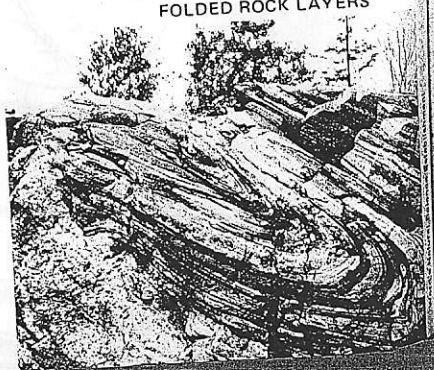
Damage caused by the 1964 earthquake in Alaska.

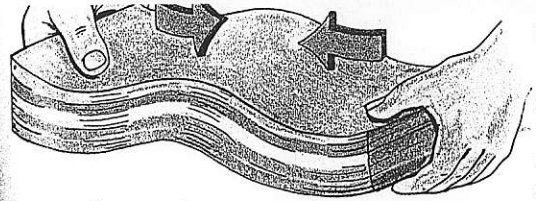
Layers of rock. Sedimentary rocks usually form in flat, or horizontal (hahr-uh-ZON-tul), layers. The picture shows sedimentary rock layers that were folded, or bent and pushed up.

Get a package of colored paper. Each layer of color represents a layer of sedimentary rock. Push both ends of the paper toward the center. The pressure causes the paper to bend upward and fold. There are great pressures inside the earth's crust. The pressures cause the crust to move upward and fold.

▷ What causes the earth's crust to move and fold?

FOLDED ROCK LAYERS





Changes in the crust. Sometimes scientists take special trips, or expeditions (eck-spuh-DISH-uns), to learn more about the earth. In 1835, a young scientist explored the Andes mountains in South America. At a height of over 4000 meters, he found the remains of sea animals and plants that lived long ago. He discovered the remains of trees that usually grow near the sea.

How did these remains get more than 4 kilometers above the sea? The scientist believed that this land was once covered by the sea. Long ago, these mountains may have been part of the ocean floor. Pressure inside the earth caused this land to rise above the ocean.

▷ What did a scientist find high in the Andes mountains?

WHAT YOU LEARNED

1. An earthquake is a sudden, strong movement of the earth's crust.
2. A fault is a break in the earth's crust.
3. Pressure within the earth's crust causes it to fold and move upward.
4. Remains of sea life on mountain tops show that the mountains were once covered by the ocean.

SCIENCE WORDS

tremor (TREM-er)
a slight shaking of the earth's crust

seismograph (SIZE-mo-graf)
an instrument that measures movements in the earth's crust

earthquake
sudden, strong movements in the earth's crust

fault (FAWLT)
a break in the crust of the earth

faulting (FAWL-ting)
movement in the earth's crust so that one part of the ground slides past another part

folded
bent and pushed upward

ANSWER THESE

1. Earth movements caused by pressure result in
   a. folding of rocks
   b. erosion
   c. minerals in the ocean
2. Scientists believe that finding the remains of sea life on mountain tops shows that
   a. sea animals can climb mountains
   b. the mountain tops were once covered by seas
   c. giant waves can be 4 kilometers high
3. The land has not been completely worn away by erosion because
   a. it is too slow
   b. it has stopped
   c. some land is always being built up

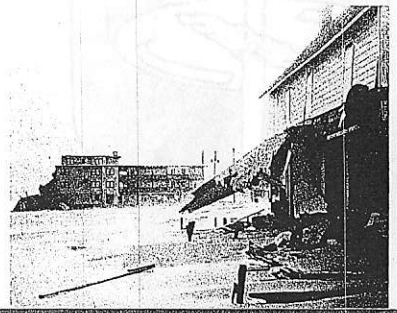
NOW TRY THESE

1. Why are earthquakes dangerous?
2. What is a tremor?
3. Where does the earth's crust break?

FINDING OUT MORE

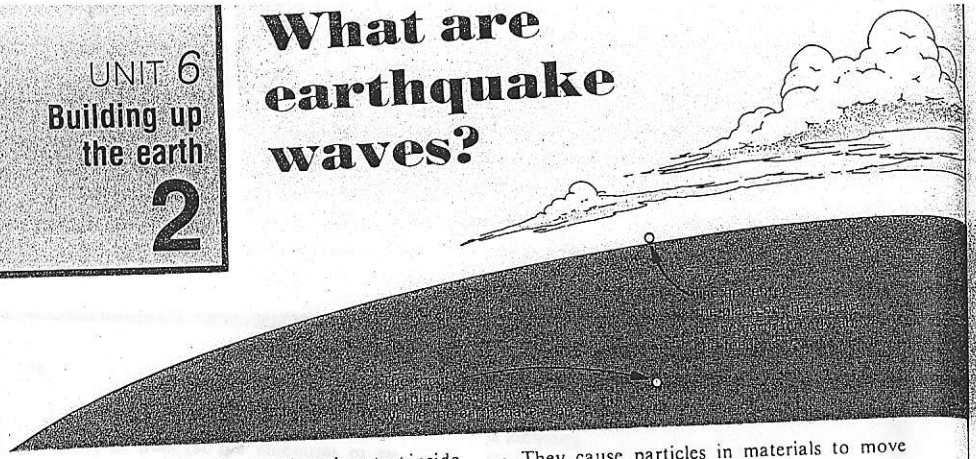
A seashore village can be wiped out by a giant wave. Often it is called a tidal wave. But this kind of wave is not caused by the tides. It may be caused by an earthquake on the ocean floor. The Japanese name for these waves is tsunami (tsew-NAHM-ee). In the middle of the ocean, tsunami are hardly noticeable. But when they hit the shore, they may rise as high as 25 meters and cause death and destruction.

Damage caused by a tsunami



UNIT 6
Building up the earth
2

What are earthquake waves?



Where it all begins. Earthquakes start inside the crust of the earth. They begin at a place along a fault in the earth's crust. The place inside the earth where a quake starts is called the focus (FOH-kus). The place on the surface of the earth directly above the focus is called the epicenter (EP-ih-sen-ter). A quake shakes the surface of the earth hardest at the epicenter.

There are three main kinds of shock waves that travel out from the focus. They are primary (PRY-mer-ee) waves, secondary (SEC-un-der-ee) waves, and surface waves.

▷ What is the focus of an earthquake?

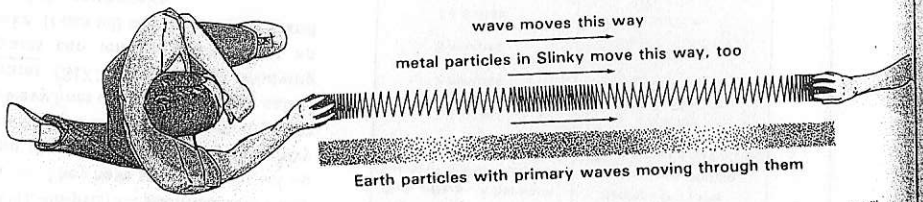
Primary waves. Primary waves or P waves, travel the fastest of the earthquake waves. They cause particles in materials to move back and forth in place. The wave itself moves out from the focus. A Slinky spring can show this. The wave moves along the spring as the coils move back and forth. Waves that move in this manner are called longitudinal (lon-juh-TOO-dih-nul) aves. A primary earthquake wave moves away from the focus in all directions. It can move through solids, liquids, and gases.

▷ How does a P wave affect the particles in a material it travels through?

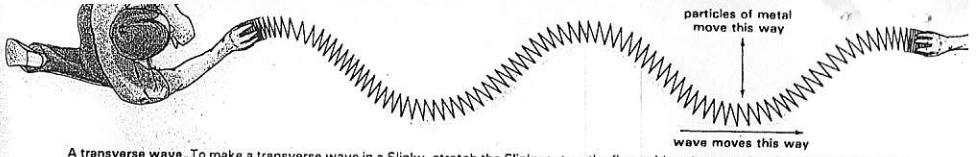
Secondary waves. Tie a rope to a door knob. Shake the other end up and down. A wave called a transverse (trans-VURS) wave forms. When a transverse wave travels through a material, the particles of the material move up and down while the wave moves sideways. Secondary earthquake waves are transverse waves. They travel slower than primary waves but faster than surface waves. They cannot travel through liquids and gases.

Secondary waves are also called shear waves or S waves.

▷ What kind of a wave is a secondary earthquake wave?



A longitudinal wave. To make a longitudinal wave in a Slinky, stretch the Slinky out on the floor with a classmate holding one end still. Give the hand holding the Slinky a quick push toward your classmate. Both the particles of metal in the Slinky and the wave move in the same direction.



A transverse wave. To make a transverse wave in a Slinky, stretch the Slinky out on the floor with a classmate holding one end still. Move your hand back and forth quickly from side to side. While the wave moves from one end of the Slinky to the other, the particles of metal in the Slinky move from side to side.

Surface waves. Surface waves travel the slowest of the three kinds of earthquake waves. They move straight up from the focus to the epicenter. Then they travel along the earth's surface. They cause the most damage to buildings.

▷ How do surface waves travel?

WHAT YOU LEARNED

1. Earthquakes start within the earth's crust at a place called the focus.
2. Earthquakes send out three main types of waves: primary, secondary, and surface waves.
3. Earthquake waves travel at different speeds.

SCIENCE WORDS

focus (FOH-kus)
the place within the crust of the earth where an earthquake starts

epicenter (EP-ih-sen-ter)
place on the surface of the earth directly above the focus

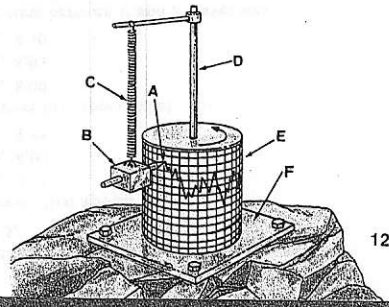
ANSWER THESE

1. Earthquakes start within the earth's crust at the
   a. core b. focus c. epicenter
2. The waves that move the fastest are the
   a. primary waves
   b. secondary waves
   c. surface waves
3. The waves that travel through solids, liquids, and gases are the
   a. primary waves
   b. secondary waves
   c. surface waves
4. The waves that cause the most damage are the
   a. primary waves
   b. shear waves
   c. surface waves

FINDING OUT MORE

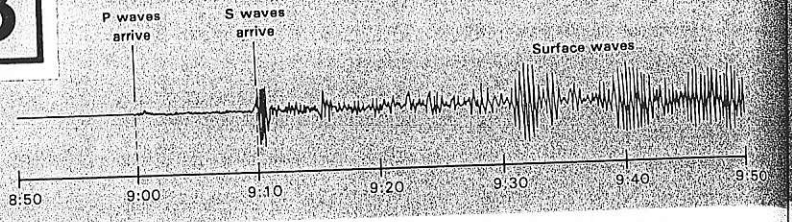
A seismograph (SIZE-muh-graf) is an instrument that measures earthquakes. There are several types. One kind is shown in the picture. A pen (A) is attached to a heavy weight (B). The weight hangs by a spring (C) from the rod (D). The pen touches a moving paper (E) attached to the base (F) of the seismograph.

If the earth moves, so does the base. The pen remains in place. The pen marks a wavy line on the paper if the base moves. This paper makes a record of the movements in the earth's crust.



UNIT 6
Building up the earth
3

What can we learn from earthquake waves?



Studying earthquake waves. Seismologists (size-MAHL-uh-jists) are scientists who study earthquakes. They have seismographs set up all around the world. They study the wavy lines drawn by seismographs. Sheets of paper with the wavy lines drawn on them are called seismograms (SIZE-muh-grams). Studying seismograms can tell us much about an earthquake. It can tell where the focus is and the force of the earthquake.

▷ **What can a seismogram tell us?**

Reading a seismogram. Look at the drawing of a seismogram. The small wavy lines are from the P waves. What time did they first appear? The time scale shows 9:00. Now look at the larger wavy lines. They are from the S waves. What time did they appear? The S waves appeared 10 minutes later at 9:10. There was a 10-minute difference between the times the P and S waves arrived. Scientists can use differences in time to tell the distance of the epicenter from the seismograph. A large time difference means a large distance. A small time difference means a small distance. Charts have been prepared to change time differences into distances.

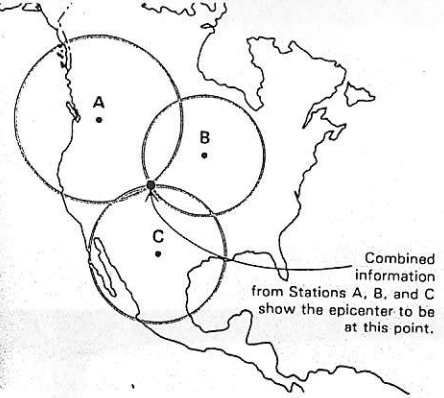
▷ **What tells how far the epicenter of an earthquake is from a seismograph?**

Table A

Time difference between arrival of S and P waves at seismograph station	Distance from the seismograph station to the quake's focus
1 minute	700 km
2 minutes	1200 km
3 minutes	1800 km
4 minutes	2500 km
5 minutes	3400 km
6 minutes	4500 km
7 minutes	5500 km
8 minutes	6500 km

Finding the epicenter. A seismogram tells only how far away the focus is. It does not tell whether the epicenter is north, east, south, or west of the seismograph station. To find the direction, seismograms from three stations are needed. A circle is drawn on a map around each station showing how far the epicenter is from each station. There is only one point where all three circles will cross. This point shows the epicenter of the quake.

▷ **Why doesn't the distance from the epicenter to one station tell where the epicenter is located?**



The strength of an earthquake. In 1935 Charles Richter (RIK-ter) developed a scale for determining the strength of an earthquake. His scale is based on the size of the wavy lines on a seismogram. Large wavy lines mean a strong earthquake. Small ones mean a weak earthquake. The Richter Scale gives each earthquake a score of from 1 to 9 or more. The higher the number, the stronger the earthquake. An earthquake scoring 6 or higher can cause a great deal of damage.

▷ **What does the Richter Scale measure?**

WHAT YOU LEARNED

1. Seismograms can tell how far away an earthquake began.
2. Differences in time between P and S waves are used to find the distance from the seismograph station to the focus.
3. Seismograms from three stations are needed to find the epicenter.
4. The Richter Scale measures how large an earthquake is.

SCIENCE WORDS

seismologists (size-MAHL-uh-jists)
scientists who study earthquakes

seismogram (SIZE-muh-gram)
sheet of paper showing the wavy lines drawn by a seismograph

Richter (RIK-ter) **Scale**
scale that measures how large an earthquake is

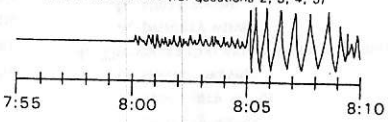
ANSWER THESE

1. Seismograms show
   a. wavy lines caused by earthquake waves
   b. pictures of destruction done by earthquakes
   c. maps of areas where earthquakes took place

Look at the seismogram to answer questions 2, 3, 4, and 5.

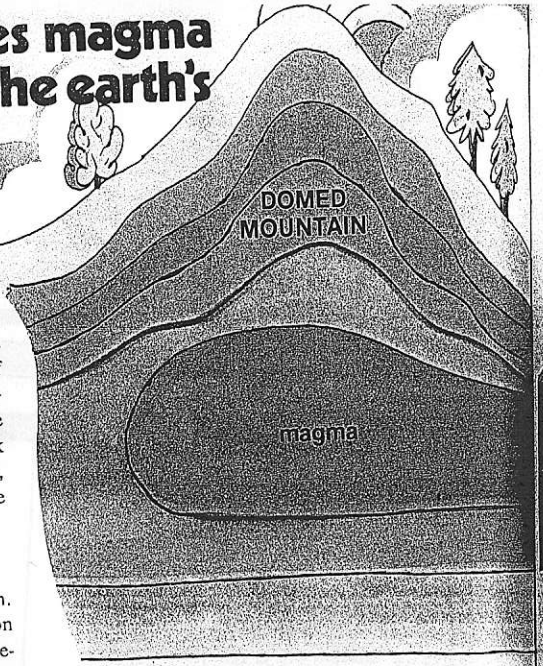
2. P waves first appear at
   a. 7:55
   b. 8:00
   c. 8:55
3. S waves first appeared at
   a. 8:00
   b. 8:05
   c. 8:10
4. The time between P and S waves was
   a. 5 minutes
   b. 10 minutes
   c. 15 minutes
5. According to the seismogram and the information given in Table A, the distance from the station to the focus is
   a. less than 700 kilometers
   b. 1800 kilometers
   c. more than 3000 kilometers
6. Seismograms from the following number of stations are needed to find the epicenter:
   a. 1 station
   b. 2 stations
   c. 3 stations

SEISMOGRAM (for questions 2, 3, 4, 5)



UNIT 6
Building up the earth
4

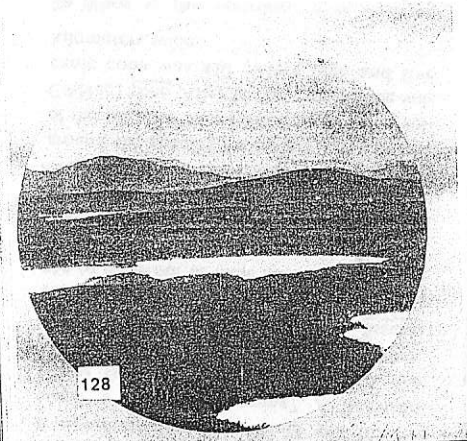
How does magma change the earth's surface?



Movement of the crust. Very high temperatures within the crust of the earth melt rocks to form magma. When magma comes onto the surface, it is called lava. The movement of magma and lava is called volcanism (VOL-ca-nism). Pressure from inside the earth causes the crust to move. The movement of layers of rock in the crust causes folds and faults. Folding, faulting, and volcanism build up the crust of the earth.

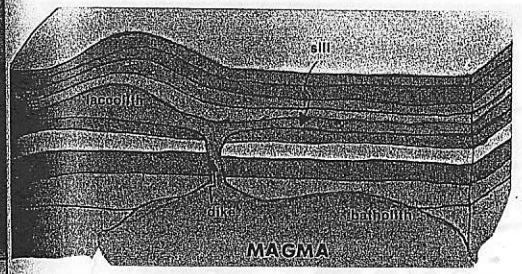
▻ What is volcanism?

Building from inside. Blow up a balloon. The pressure on the inside pushes the balloon outward. Magma deep within the crust sometimes forms giant pools. As more magma flows into these pools, pressure builds up within them. This pressure causes the crust to bend upward. A rounded mountain forms where the crust is pushed up by the magma. The mountain looks like a dome. It is called a domed (DOHMD) mountain. The picture shows part of the Adirondack Mountains in New York State. The Adirondack Mountains are domed mountains.



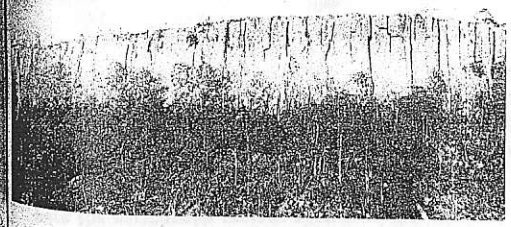
▻ What causes domed mountains to form?

Moving magma. Magma moves into cracks in the earth's crust. It flows between layers of rocks. Magma also moves across layers of rocks. In time, the magma cools and becomes solid. The solid rock formed from magma can be seen in the eroded layers of the crust. Magma that flows between layers of rocks forms a sill. Magma that cuts across the layers forms a dike. The diagram shows the ways magma moves in the crust.



The Palisades along the Hudson River are made of solid magma. These rocks were formed inside the crust. Erosion wore away the surface that once covered them.

▻ What is a sill?



Igneous rocks. As you know, igneous rocks are formed from magma. Volcanism forms igneous rocks. Granite is one kind of igneous rock formed inside the crust of the earth. Large deposits of granite show that there was once volcanism in a region.

▻ What do granite deposits tell you about a region?

WHAT YOU LEARNED

1. Volcanism is the movement of molten rock on or inside the earth's crust.
2. Folding, faulting, and volcanism build up the land on the earth's crust.
3. Domed mountains are formed from upward pressures of magma.

SCIENCE WORDS

volcanism (VOL-ca-nism)
movement of molten rock on or inside the earth's crust.

domed (DOHMD) **mountain**
a mountain formed by magma pushing up the crust to form a dome shape

sill
magma that flows in between the layers of rock in the earth's crust

dike
magma that cuts across layers of rock in the earth's crust

ANSWER THESE

1. Volcanism is the movement of
   a. solid rocks
   b. molten rocks
   c. plastic rocks

2. Domed mountains are produced by
   a. pools of magma
   b. water pressure
   c. earthquakes

3. Igneous rocks tell you that an area once had
   a. animals
   b. oceans
   c. volcanism

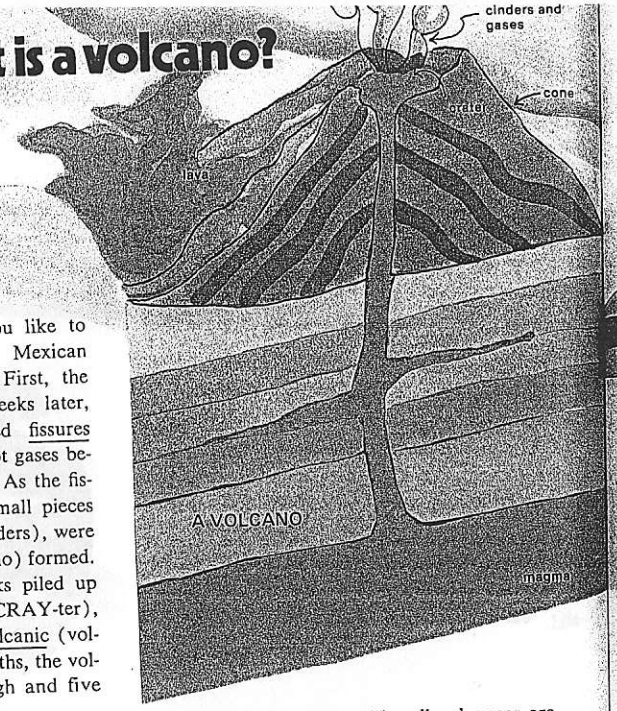
NOW TRY THIS

Unscramble the following words.

GAMAM — hot molten rock
MISVOLANC — movement of molten rock
ONGEIUS — rock formed from molten magma
EMOD — type of mountain formed by the pressure of trapped magma

UNIT 6
Building up the earth
5

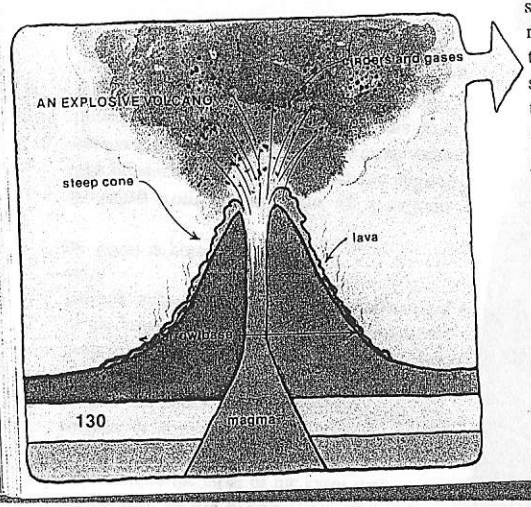
What is a volcano?



A mountain is born. Would you like to watch a mountain forming? A Mexican farmer saw it happen in 1943. First, the ground started shaking. A few weeks later, the farmer found cracks, called fissures (FISH-ers), in the earth. Soon, hot gases began to come out of these fissures. As the fissures widened, lava came out. Small pieces of solid lava, called cinders (SIN-ders), were thrown out. A volcano (vol-CAY-no) formed.

Cinders, lava, ashes, and rocks piled up around the opening, or crater (CRAY-ter), of the volcano. They formed a volcanic (vol-CAN-ic) cone. After several months, the volcanic cone was 450 meters high and five kilometers wide.

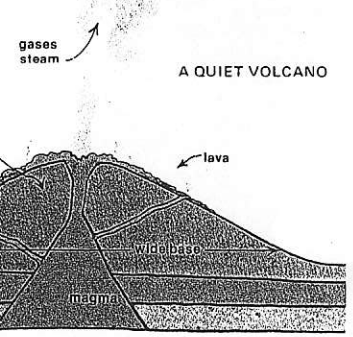
▷ What is the opening of a volcano called?



Types of volcanoes. Not all volcanoes are like the one that formed in Mexico, called Paricutin. But all volcanoes form from pressures inside the earth. The pressure forces magma to the surface. The magma pushes through weak spots in the crust. If the pressure becomes very great, the rock layers on the surface crack. Rocks, lava, gases, and steam shoot up through the cracks. This is an explosive (eck-SPLO-siv) volcano. An explosive volcano has a narrow base. Its cone is steep. The Mexican volcano Paricutin is an example of an explosive volcano.

When lava flows out freely through the fissures, a quiet volcano is formed. A quiet volcano has a wide base. Its cone is not steep. The Hawaiian Islands are examples of quiet volcanoes.

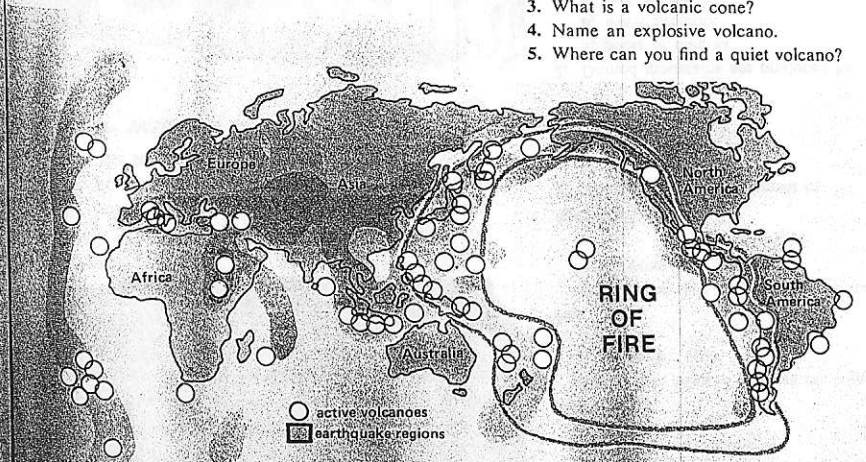
▷ What are two types of volcanoes?



Ring around the Pacific. "The ring of fire" is the name given to the volcanoes that almost form a circle around the Pacific Ocean. The map shows the location of these volcanoes and many others.

Volcanoes are formed in areas where the earth's crust is weak. Earthquakes also take place where the crust is weak. Compare the earthquake regions shown on the map with the volcano regions. Are earthquakes and volcanoes usually found in the same areas?

▷ What is "the ring of fire?"



WHAT YOU LEARNED

1. A volcano forms when pressure within the earth forces magma to the surface.
2. Volcanoes may be explosive or quiet.

SCIENCE WORDS

fissure (FISH-er)
a crack in the earth's crust

cinders (SIN-ders)
solid pieces of lava that are thrown out of a volcano

volcano (vol-CAY-no)
an opening in the earth's crust from which lava comes out

crater (CRAY-ter)
a hole at the top of a volcano

volcanic (vol-CAN-ic) **cone**
a mountain built up around the opening of a volcano

explosive (eck-SPLO-siv) **volcano**
a volcano that shoots up through the surface with great force

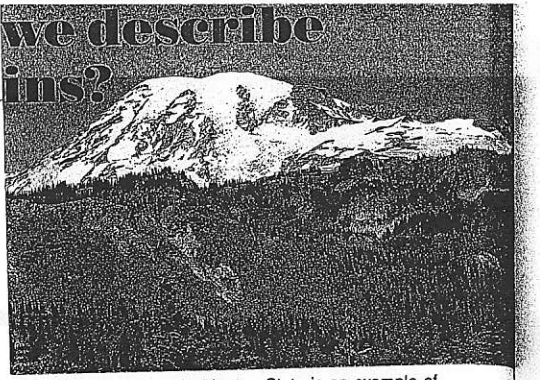
quiet volcano
a volcano formed when lava flows freely through the surface

ANSWER THESE

1. What material forms a volcano?
2. What is a fissure?
3. What is a volcanic cone?
4. Name an explosive volcano.
5. Where can you find a quiet volcano?

UNIT 6
Building up the earth
6

How do we describe mountains?



Mt. Ranier in Washington State is an example of an inactive volcano.

Differences in mountains. The elevation (el-uh-VAY-shun) of a mountain is its distance above sea level. For a hill to be classed as a mountain, its elevation must be at least 600 meters higher than that of the land surrounding it.

Mountains look different. For example, some have gentle slopes. Others have slopes that are steep. Mountains look different because of differences in how they were formed. The appearance of a mountain tells something about how it was formed.

▷ What is the elevation of a mountain?

Folded mountains. The layers of rock in sedimentary rock start out lying flat. Pressures in the crust of the earth can cause these layers to bend. The layers then curve up in one place and down in another. That is, the layers become folded. (See page 110.) An upward fold is called an anticline (AN-tih-kline). A downward fold is called a syncline (SIN-kline). Anticlines can become the peaks of some mountains.

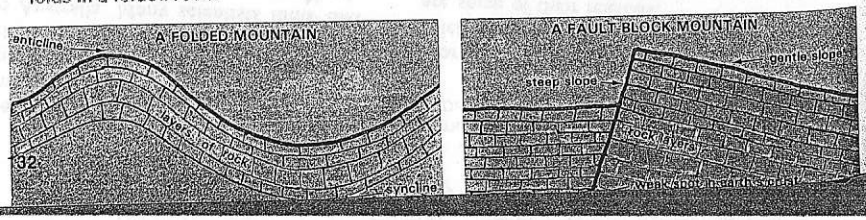
Mountains formed by the folding of rock layers are called folded mountains. The Appalachian (ap-uh-LAY-chee-un) Mountains in Pennsylvania are examples of folded mountains.

▷ What do we call the upward and downward folds in a folded rock?

Fault-block mountains. Recall that a crack can form at a weak spot in the earth's crust. Sometimes pressures cause the crust on one side of the crack to slip up past the crust on the other side. If the crust is pushed up enough, it forms a mountain. The place where the slipping took place will form one side of the mountain. This side will be steep. The other side will be gentle. Mountains formed in this way are called fault-block mountains. The Sierra Nevada Mountains in California are good examples of fault-block mountains.

▷ Which part of a fault-block mountain has a steep slope?

Domed mountains and volcanic cones. As discussed on page 116, the hot magma deep within the crust can push up on the land above. The rounded mountain that forms from this pressure is called a domed (DOHMD) mountain. Magma that pushes all the way to the surface forms volcanic cones. These volcanic cones are often large enough to be mountains.



The Rocky Mountains are complex mountains.

The Black Hills of South Dakota are domed mountains. Mount St. Helens in the state of Washington is a volcanic cone.

▷ What two kinds of mountains are built by the movement of magma within the earth?

Complex mountains. Most mountains are combinations of different types of mountains. For example, folding can form a mountain. Then a crack, or fault, can develop in the folded layers. A section on one side of the fault may slip up past the other section. The result is a mountain that is both a folded mountain and a fault mountain. Mountains that are combinations of two or more types of mountains are called complex (KOM-PLEKS) mountains.

The Rocky Mountains, the Blue Ridge Mountains, and the Laurentian Mountains of Canada are examples of complex mountains.

▷ What are complex mountains?

WHAT YOU LEARNED

1. Mountains look different because of differences in how they were formed.
2. A folded mountain is formed when pressures in the crust of the earth cause sedimentary rock to become curved.
3. A fault-block mountain is formed when the crust on one side of a crack slips up past the crust on the other side.
4. A domed mountain is formed when hot magma deep within the crust pushes up on the land above.

SCIENCE WORDS

mountain
mound of land whose elevation is at least 600 meters higher than the surrounding land

anticline (AN-tih-kline)
upward fold of rock layers

syncline (SIN-kline)
downward fold of rock layers

ANSWER THESE

1. Anticlines and synclines are found in
   a. folded mountains
   b. fault-block mountains
   c. domed mountains
2. In a folded rock layer, a syncline is
   a. an upward fold
   b. a downward fold
   c. a dome
3. If a mass of land is raised up alongside a fault in the earth's crust, the raised land can form a
   a. folded mountain
   b. fault-block mountain
   c. domed mountain

NOW TRY THESE

Match each type of mountain described in Column I with the name of a mountain range given in Column II.

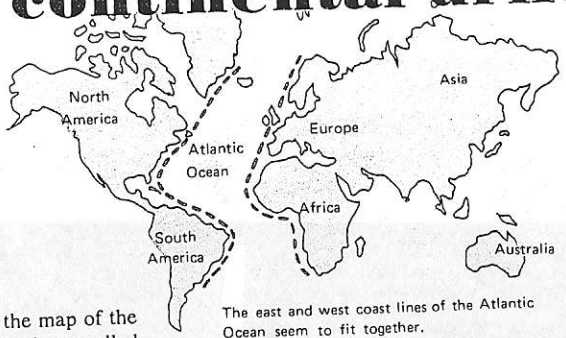
Column I	Column II
1. folded mountains	A. Sierra Nevada Mountains
2. faulted mountains	B. Mt. St. Helens
3. domed mountains	C. Rocky Mountains
4. volcanic cone	D. Appalachian Mountains in Pennsylvania
5. complex mountains	E. Black Hills of South Dakota

FINDING OUT MORE

Distribution of mountains. Mountain ranges are groups of mountains. They are found near the edges of continents. A group of mountain ranges forms a mountain belt. Two important belts, the Mediterranean and Pacific belts, seem to be located in earthquake zones.

UNIT 6
Building up the earth
8

What is the theory of continental drift?



The east and west coast lines of the Atlantic Ocean seem to fit together.

One large island. Look at the map of the world. The large areas of land are called continents (KON-tuh-nents). Find North and South America, Africa, Europe, Asia, and Australia. Many scientists think that long ago there was only one continent. This piece of land had water all around it. Then the land broke into a number of pieces. The pieces slowly drifted apart. They became the continents we know today. Scientists believe the continents are still moving on the earth. The continents move only a few centimeters each year. The idea that continents move is called the theory of continental (con-tuh-NEN-tul) drift.

▷ What do scientists think the continents are doing?

World's largest jigsaw puzzle. On your map, find the Atlantic Ocean. Look at the shape of the coastlines of North and South America. Look across the ocean at the coastline of Europe and Africa. Notice that these two coastlines have the same shape. Both coastlines seem to fit together. Other places can be found that might have once fitted together. One reason for believing in continental drift comes from the shapes of land masses.

▷ How are the coast lines on both sides of the Atlantic Ocean alike?

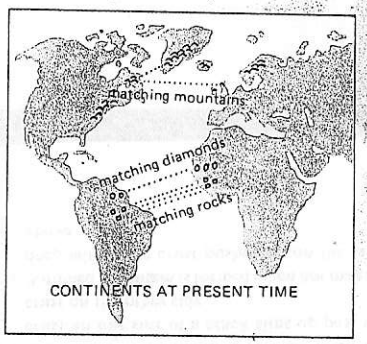
More clues for the puzzle. Today, most scientists believe in continental drift. Here are some of their reasons.

Rocks along matching edges of continents have been studied. In many cases rocks found along one edge match those from the other. Even the sizes of diamonds in Brazil and West Africa are the same. Mountain ranges on different continents also seem to match. There is a mountain range in eastern Canada. It is similar to one in Norway and Sweden. These mountains could have once been part of the same range. The range would have split apart when the continents began moving.

Studies of plants and animals also support the theory. Scientists studied animals and plants in one area. They then studied organisms from a matching area in another continent. Many organisms living in one area also live in the other. Past forms of life have been studied, too. Remains of the same types of life have been found in matching places. Suppose that the continents were once joined. Organisms of the same type would have been carried apart when the land split.

▷ How are diamonds in Brazil like those in West Africa?

Giant jigsaw puzzle. The shapes of the coastlines are only one clue leading to the theory that the continents on either side of the Atlantic Ocean were once joined together in a single continent.



It remains to be seen. The tropics (TROP-iks) are near the equator, where it is hot. The remains of tropical life have been found near the North Pole. How could these forms of life live in such a cold climate? Continental drift may be the answer. Perhaps the land was once in a hotter spot. Then the land might have drifted toward the pole.

▷ Why do we believe that land now near the North Pole once had a warm climate?

WHAT YOU LEARNED

1. Most scientists today believe in the theory of continental drift.
2. The land on one side of the Atlantic Ocean looks as though it may have once been joined to the land on the other side.
3. Studies of rocks, plants, and animals from matching areas on different continents support the idea of continental drift.
4. Land near the North Pole may have drifted there from a warmer spot.

SCIENCE WORDS

continents (KON-tuh-nents)
very large areas of land

theory of continental (kon-tuh-NEN-tul) **drift**
a theory that states that the continents have been moving and still are moving

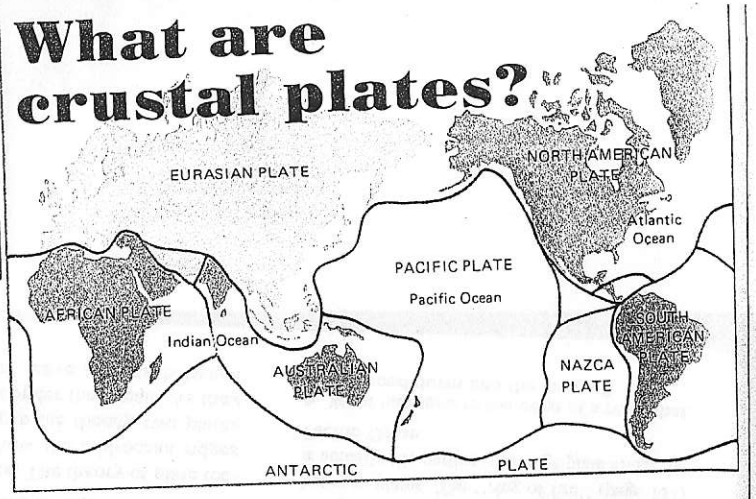
tropics (TROP-iks)
region near the equator where it is hot and damp

ANSWER THESE

1. The eastern part of South America looks as if it could fit into the
   a. eastern part of Africa
   b. western part of Africa
   c. northern part of Africa
2. Evidence to prove the theory of continental drift came from
   a. a comparison of rocks and minerals
   b. caveman drawings
   c. watching the continents move
3. The plants and animals on continents separated by an ocean are
   a. sometimes very much alike
   b. never alike
   c. always alike

UNIT 6
Building up the earth
9

What are crustal plates?



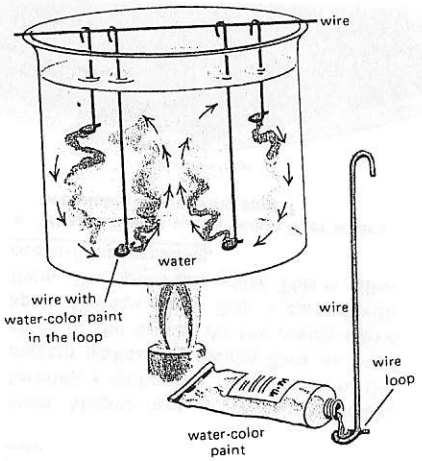
A major crack-up. Scientists have a theory of why the continents move. It is called the theory of plate tectonics (tek-TON-iks). According to the theory, the earth's crust is like the shell of a cracked egg. The crust is cracked in many places. The cracks divide the crust into about 20 pieces. The pieces are called crustal (KRUS-tul) plates. The plates are made of solid rock. The continents and the floors of the oceans rest on the plates. The upper mantle lies below the plates. Scientists believe the earth material in the upper mantle is not completely solid. It is soft like putty or warm wax. It is able to flow like a liquid. The plates float on this soft material and move in it.

Suppose that a continent is resting on a certain plate. When the plate moves, the continent will move, too. The movements of the plates cause the continents to drift.

▷ What kind of material is in the upper mantle?

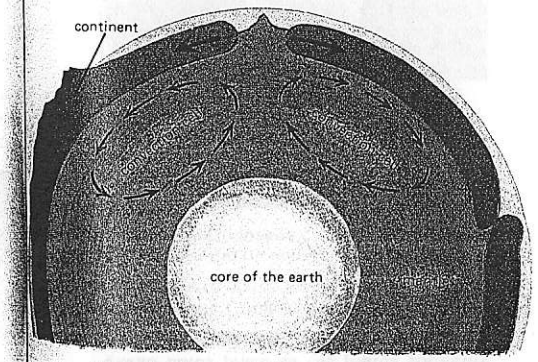
Around she goes. Arrange the equipment as shown in the picture. Fill the beaker with cold water. Place a blob of water-color paint into each loop. Then carefully lower the four wire loops. Put a small flame under the middle of the beaker. See how the water moves the paint in the beaker. The arrows in the diagram show how the water moves. Water moving in this manner is called a convection (kon-VEK-shun) current. A convection current that flows around in a loop is called a convection cell.

▷ What causes a convection current in water?



They move, but why? Scientists are not sure what causes the plates to move. There are a number of theories. According to one theory, there are convection cells within the mantle. Inside the earth there are hot spots. The liquid material in the mantle rises over these hot spots. Then the mantle material spreads out under the crust. As the mantle material moves, it carries the plates of the crust with it. One plate is carried in one direction. The other plate is carried in the other direction. Convection currents in the mantle cause some plates to move apart. They cause other plates to come together. Most scientists think that convection currents best explain how plates move.

▷ What might cause convection currents in the mantle?



One explanation for why the continents drift. Convection cells in the mantle make crustal plates move.

WHAT YOU LEARNED

1. The earth's crust is divided into about 20 pieces called crustal plates.
2. Scientists believe the earth material below the crust can flow like a liquid.
3. Crustal plates float on the liquid-like material in the upper mantle.
4. Some scientists believe that convection currents cause the earth material in the upper mantle to move.

SCIENCE WORDS

theory of plate tectonics (tek-TON-iks)
a theory that states that the earth's crust is cracked to form about 20 large pieces

crustal (KRUS-tul) **plates**
the large pieces of the earth's crust

convection (kon-VEK-shun) **current**
the movement of material within a fluid caused by uneven temperature

convection cell
a convection current that flows around in a loop

ANSWER THESE

1. The continents drift along on
   a. a large body of water
   b. themselves
   c. crustal plates
2. Scientists believe the material in the upper mantle is
   a. solid rock
   b. able to flow like a liquid
   c. mostly gases
3. Above the point where a flame is applied to the bottom of a container of water, the water will
   a. move sideways
   b. move down toward the flame
   c. rise
4. According to one theory, crustal plates move because of
   a. hot water inside the earth
   b. convection cells in the upper mantle
   c. pools of oil that help the plates to slide

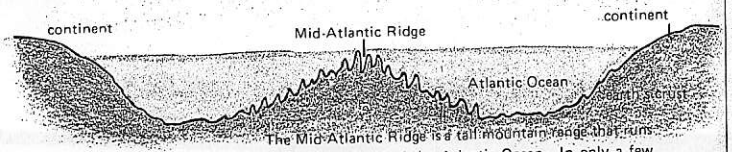
NOW TRY THIS

Unscramble the words in large print.

1. Plates move on material that flows in the earth's LEMTAN.
2. Some scientists believe that CRUNTERS in the mantle make the plates move.

UNIT 6
Building up the earth
10

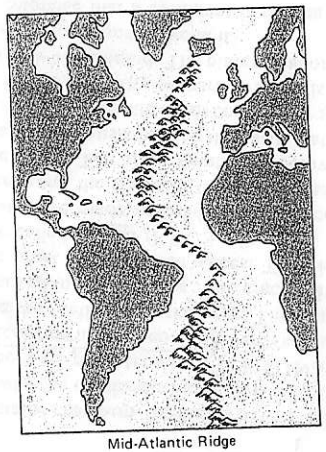
How does plate motion affect the earth's crust?



The Mid-Atlantic Ridge is a tall mountain range that runs down the middle of the Atlantic Ocean. In only a few places does any part of it rise above the surface of the water.

Mountains under the sea. Some of the biggest mountains on the earth are under the oceans. The longest and highest mountain range on the earth runs down the middle of the Atlantic Ocean. It is called the Mid-Atlantic Ridge. Some of its peaks are 6000 meters above the ocean floor. There are mountain ranges like this in most of the oceans. Most of these mountain peaks are under water.

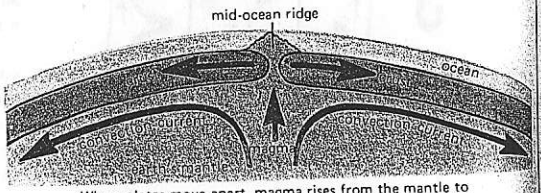
▷ Where is the biggest mountain range on the earth?



Mid-Atlantic Ridge

Filling the cracks. The theory of plate tectonics explains how the mid-ocean ridges form. According to the theory, two plates are moving apart under the ocean. As they move apart, they leave a crack between them. Magma rises up through the crack, forming a mid-ocean ridge. Some of the magma makes new ocean floor on both sides of the crack. As the plates move apart, the new ocean floor is carried with them. The ocean gets wider. This is called ocean-floor spreading.

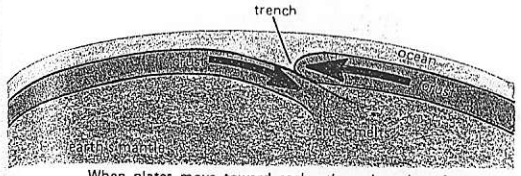
▷ What happens to the ocean floor where two plates are moving apart?



When plates move apart, magma rises from the mantle to fill the crack. The ocean floor spreads apart on either side of the crack.

Make me a trench. Plates can also move toward each other. Then one plate is pushed down under the edge of the other. This forms a deep ditch or trench. As the edge is pushed down into the mantle, it melts. Magma may rise to the surface from the melting plate, and form volcanoes. Many volcanoes are found along the edges between plates. The "ring of fire" (page 131) is actually the outline of a large plate under the Pacific Ocean.

▷ What happens to the edge of a plate that is forced down into the mantle?

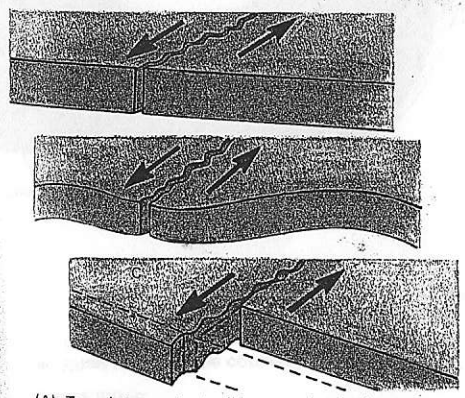


When plates move toward each other, the edge of one plate is pushed down into the mantle. A deep trench is formed in the ocean where the two plates meet.

Give a shake. There is still another way plates can move. They can brush past each other. Faults are found where two plates brush past each other. A well-known fault is the San Andreas Fault in California. This fault is the edge between the Pacific Plate and the North American plate. Most of North America lies on the North American plate.

Sometimes plates lock together as they slide past each other. Pressure begins to build up. When the pressure becomes too great, the plates suddenly slip. An earthquake takes place as the plates suddenly slip. Earthquakes as well as volcanoes are found on the "ring of fire." Both occur at places where plates meet.

▷ How can the movement of crustal plates cause earthquakes?



(A) Two plates may try to slide past each other but may lock together. (B) Strain develops where materials are locked together. (C) When the strain gets too great, the plates spring past each other, causing an earthquake.

WHAT YOU LEARNED

1. Most of the oceans of the world have large underwater mountains.
2. These mid-ocean ridges are formed when two plates move apart and magma rises up through the crack.
3. Deep ditches or trenches are formed where one plate sinks down under the edge of another.
4. Earthquakes take place where plates brush past each other, lock together, and suddenly spring loose.

SCIENCE WORDS

Mid-Atlantic Ridge
a large underwater mountain range running down the middle of the Atlantic Ocean

ocean-floor spreading
the widening of an ocean

ocean trench
a deep ditch in the ocean

ANSWER THESE

1. The longest and highest mountain range on earth is
   a. in Asia
   b. in Alaska
   c. in the Atlantic Ocean
2. Magma rises up where the edges of two neighboring plates
   a. move apart b. move toward each other
   c. brush past each other
3. A trench will form where the edges of two neighboring plates
   a. move apart b. move toward each other
   c. brush past each other
4. Faults are found where the edges of two neighboring plates
   a. move apart b. move toward each other
   c. brush past each other

FINDING OUT MORE

Scientists are trying to find ways of preventing earthquakes. They would like to keep the edges of plates from locking together. They are looking for ways to make the rocks slide quietly past each other. One way being tried is to pump water into the crust along a fault. Water may lubricate (LOO-bruh-kate) the rocks and make it easier for them to slide.