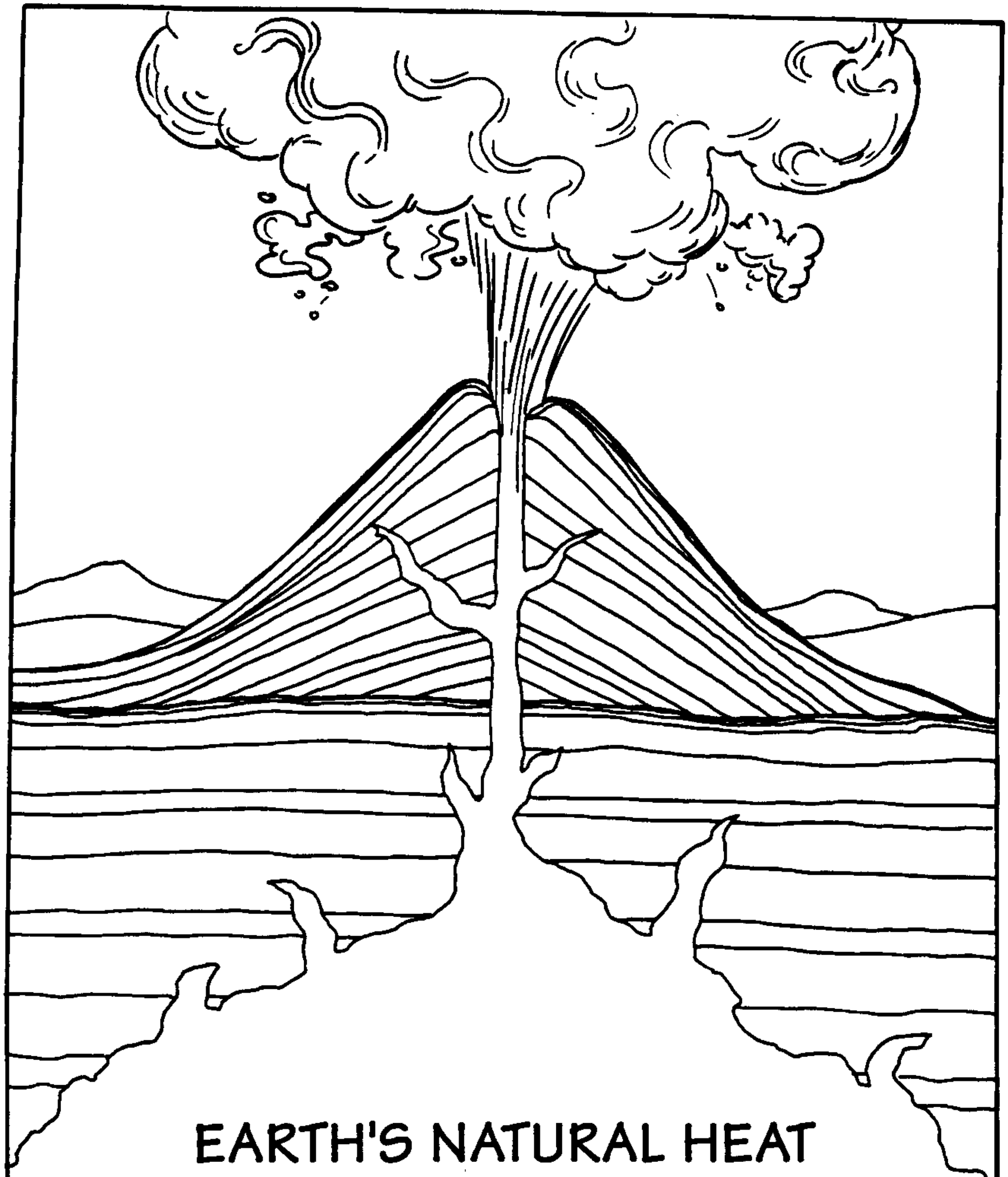


EARTH'S NATURAL HEAT

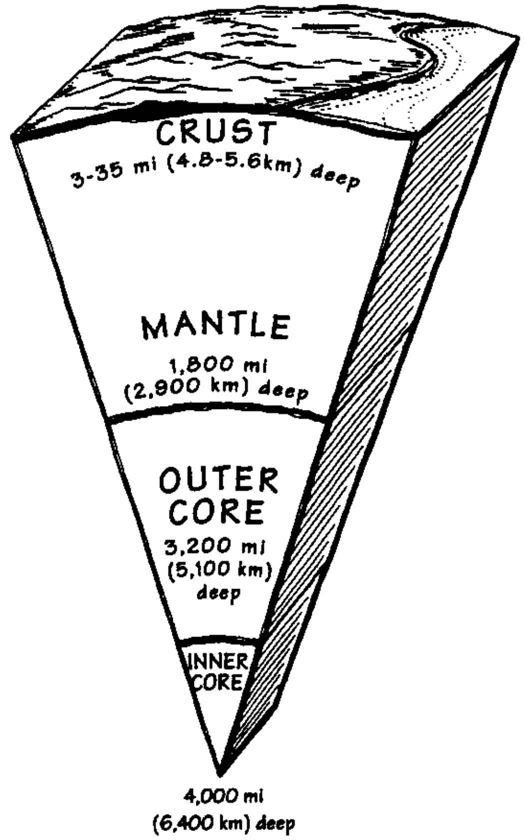
SECTION II

INSIDE THE EARTH

Though the earth seems very solid to us as we walk on it, it is actually always moving and changing. It's been doing so for over 4.5 billion years! The earth is also very hot inside, all the way to the center – about 4000 miles (6,400 kilometers) deep.

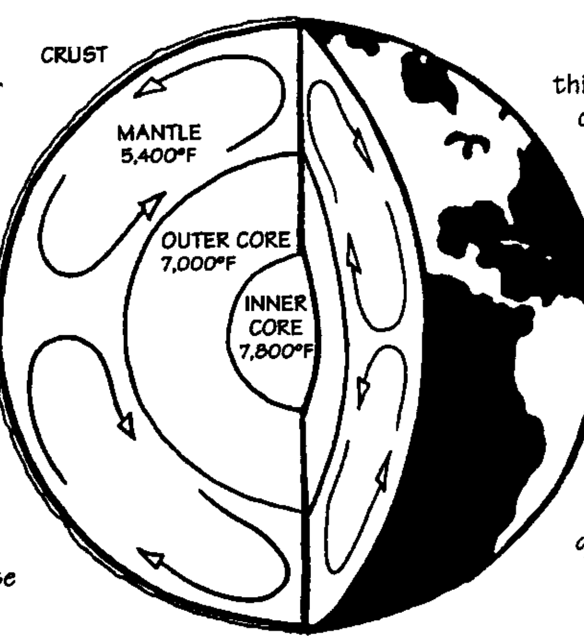
Compare the earth to a hard-boiled egg. The egg shell is like the *crust* of the earth. It is a layer of solid rock which is about 3 miles (4.8 kilometers) thick under the oceans and up to 35 miles (about 56 kilometers) thick under the land. Below the crust is the "white" of the egg, which is the part of the earth that is called the *mantle*. This is about 1,800 miles (2,900 kilometers) below the surface. Rock in the mantle is different from that of the crust and is very hot. Then there is the earth's center, which is a bit different from the yolk because it has two parts. The *outer core* is mostly melted iron and the *inner core* is mainly solid iron. Scientists think that the outer core is about 3,200 miles (5,100 kilometers) down from the earth's surface and that the inner core – which goes all the way to the center of the earth – is about 4,000 miles (6,400 kilometers) deep. The temperatures at the very center of the earth may reach up to 7,800° F (4,300°C)!

HOW DEEP ARE THE LAYERS OF THE EARTH?



MOVING MANTLE

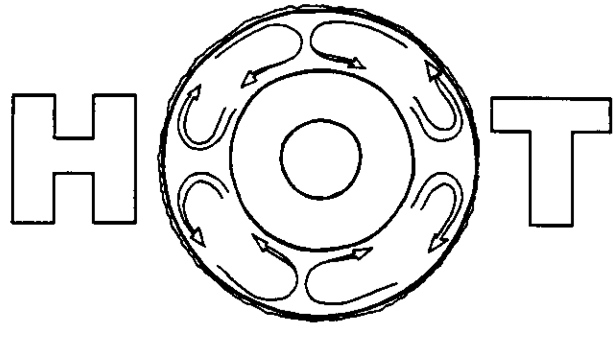
The mantle, the thick layer just beneath the earth's crust, is heated by the earth's hot core. Because it is so hot, mantle rock is flexible enough to flow very, very slowly. As the mantle rock is heated from below, it becomes lighter, or less *dense*. When this happens, it rises up towards the earth's surface. Nearer the surface, it cools and becomes heavier (or more dense), so it sinks. Because this action happens over and over, mantle rock is always moving. The pattern of movement of the mantle is something that happens to many materials when they're heated. These patterns are called *convection currents*. Sometimes, the results of this slow movement end up in some very fast surface changes such as earth-quakes or volcanoes.

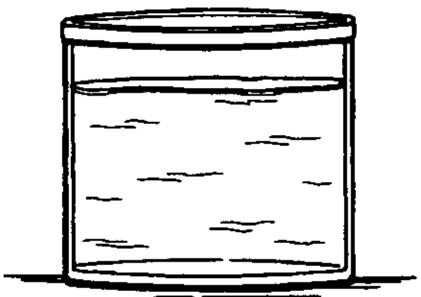


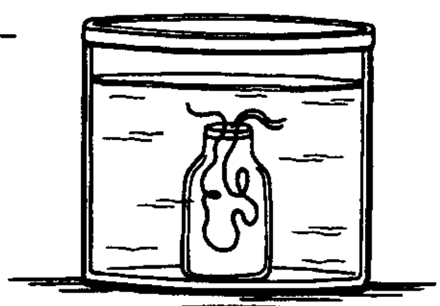
CONVECTION CURRENTS: MANTLE ON THE MOVE

In this experiment you will use swirling colored water to show how hot flexible mantle rock moves in patterns called convection currents.

Remember that the mantle is slowly heated by the earth's core. When heated, mantle rock gets lighter (less dense), so it rises up towards the earth's surface. As it gets nearer the surface, it begins to cool. Thus it gets heavier (more dense) and so it sinks. This happens over and over again, keeping the mantle very slowly on the move.







Materials (Per group of students):
- 1 large, open-mouth straight-sided jar or bowl (clear Pyrex bowl or canning jar, such as a large pickle or spaghetti sauce jar)
- 1 small bottle that will fit in the large jar or bowl
- Food coloring or ink with dropper
- A way to heat water
- Water
- Goggles if possible
- Mitts
- Tongs

Directions:

1.) Fill the large jar or bowl with cold water. Leave a space near the top so the water won't overflow when you put the small jar in.

2.) Fill the small bottle full of boiling water. Add a few drops of the food coloring or ink.

3.) Using tongs and wearing mitt, lower the bottle into the jar or bowl very carefully. Make sure the cold water covers the small bottle. Watch to see what happens to the hot colored water.

4.) Be ready to describe what you observe and to explain why the hot, colored water moves the way it does.

FLOATING PLATES AND THE "RING OF FIRE"

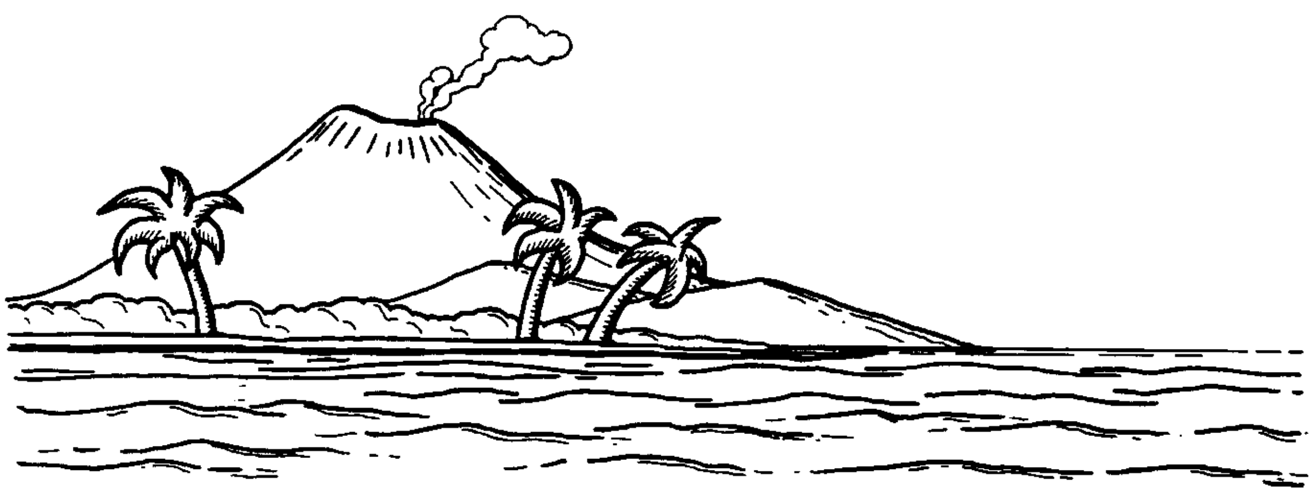
Let's look more closely at the crust of the earth. Picture an egg shell cracked all over. The shell is like our earth's crust, which is actually cracked into huge pieces called *tectonic plates*. The convection currents in the mantle have caused these cracks in the crust. Because the plates float on the mantle, they are constantly being pushed about by the currents. Although we don't feel it, they are always in "slow motion". (They only move a few inches a year.) The movement of the tectonic plates is sometimes called *continental drift*. The general process is referred to as *plate tectonics*.

Tectonic plate movement can result in action at the plate edges: the plates can push against each other, grind past each other, move away from each other, or one plate can slip beneath another. Moving plates often cause earthquakes and visible geothermal occurences such as *volcanoes, geysers, and hot springs*.

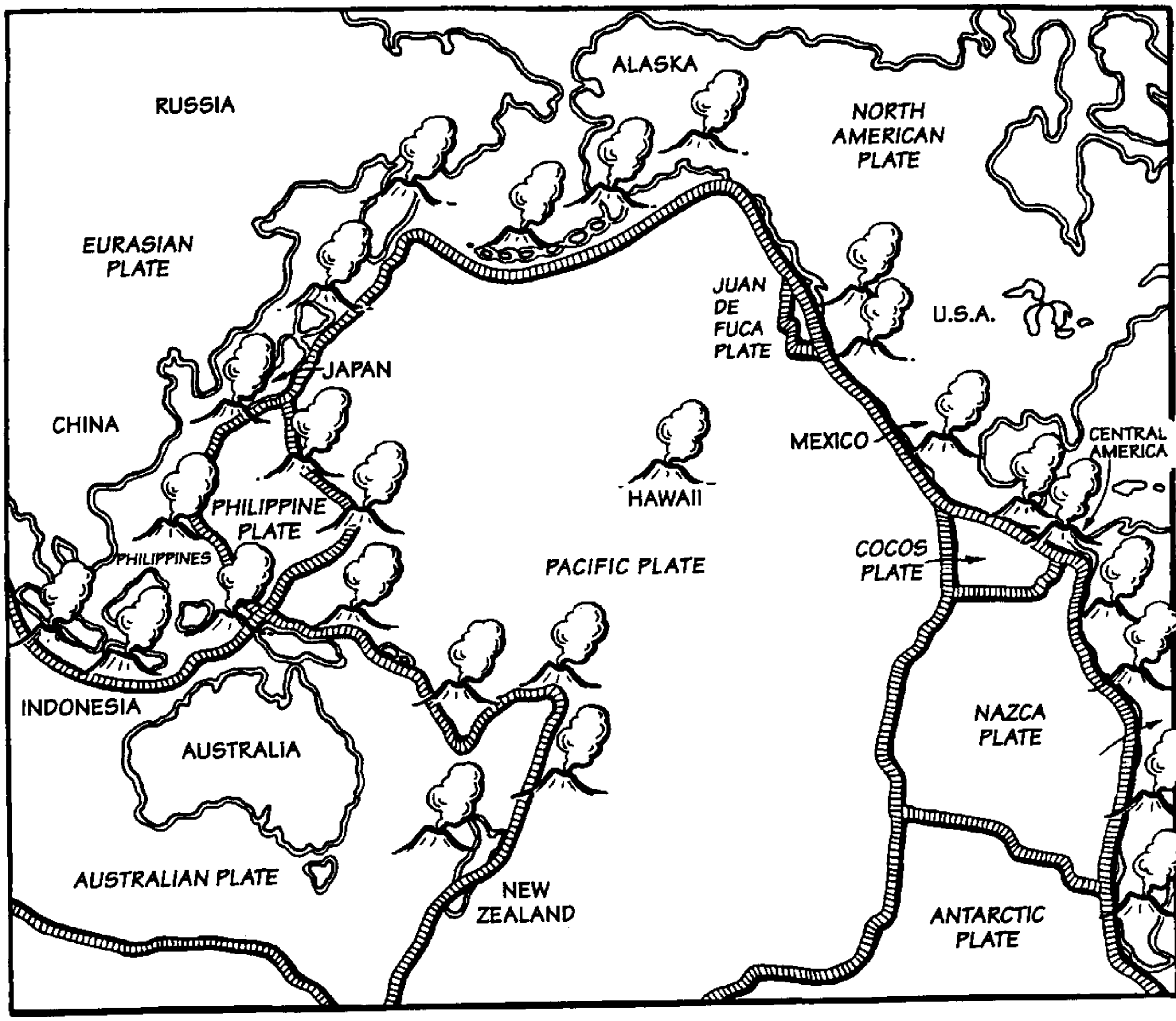
The western edge of the North American continent is an area where the Pacific oceanic plate is grinding along the North American continental plate (at a very slow rate). Those who live in this area know that this area has a number of potentially destructive volcanoes in the north and earthquakes in the south. At the same time, however, they are also fortunate enough to have easier access to Earth's heat.

The edges of a number of the tectonic plates meet in an area surrounding the Pacific Ocean. The result is a belt of intense volcanic and geothermal activity called the Ring of Fire. The Ring of Fire is bordered by New Zealand, the Philippines, Japan, the Aleutian Islands, and the western edges of North, Central, and South America.

The Ring of Fire and other hot spots in the world are evidence of tectonic plate movement. Most of the world's accessible geothermal energy is concentrated in these areas.



THE RING OF FIRE



Note: See related maps, pages 59 and 69.

FITTING IT TOGETHER: CONTINENTAL DRIFT

Remember we learned that geologists believe the continents are slowly moving around the earth's surface in a process called continental drift. Scientists also think that, millions of years ago, most of the continents as we know them today formed one big land mass. They call this huge super-continent *Pangaea*, meaning "all lands." The theory is that Pangaea slowly broke apart into the continental plates which then drifted around the Earth's surface to the positions we know today. If we take the main continents as they are today and move them back towards each other, we can see how they fit together.

Materials:
- Soft pencil
- Tracing paper
- Scissors
- Thick paper or cardboard
- Atlas

Directions:

Simplified Method:

1.) Find the shapes of Africa and South America in an atlas. Put your tracing paper over the shapes and trace around the edge of each continent.

2.) Now turn the tracing paper over and trace the same lines, using a soft pencil. You can then turn it back and draw over these soft pencil lines onto your heavy paper or cardboard. This should leave an outline of the continents on the cardboard.

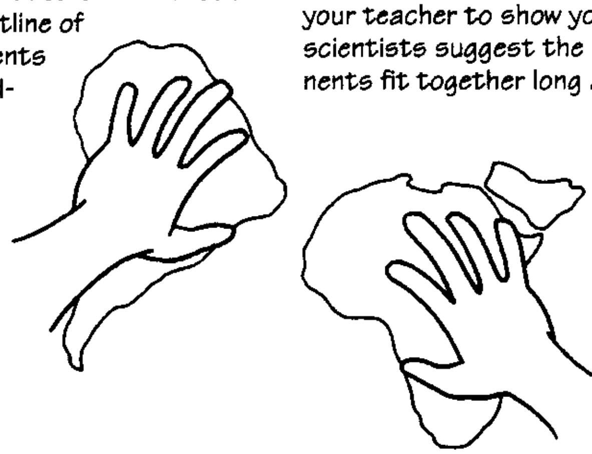
3.) Cut out the shapes carefully. Place them the right way up and move the shape around until you can see how they could be fit together.

More Detailed Method:

1.) Use the above procedure, only do it for all of the main continental shapes. Make Europe and Asia into one big piece (called Eurasia), and include Greenland and Antarctica.

2.) Remember that the pieces won't all fit as neatly as Africa and South America.

3.) When you've fitted them together the best you can, ask your teacher to show you how scientists suggest the continents fit together long ago.

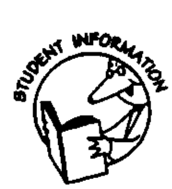


AN EXPERIMENT TO TRY

Crack an egg very gently and place in boiling water. The cooked egg white will push out and move the shell pieces. What does this remind you of?

CLUES FROM THE PAST

Even as recently as 20-30 years ago, people laughed at geologists who suggested that the continents may have all once been one big land mass. Scientists are now convinced that the continents were once joined together. One thing that made them look more closely at this idea was the fact that the ocean floors are spreading out from mid-ocean ridges, pushing apart land masses attached to them. Other evidence has been found to confirm this theory. For example, geologists have found the exact same pattern of layers of rock (called rock strata) in both Brazil and in Africa, just where the continents match when we fit them together in our "jigsaw puzzle". A fossil of a reptile called Lystrosaurus that lived 200 million years ago. has been found in Africa, India, China, and Antarctica. Other fossils of similar plants and animals have been found in South America, Africa, and Antarctica. All of this proves that once, millions of years ago, the continents were joined.



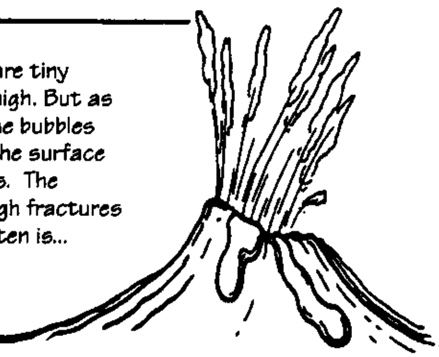
MIGHTY MAGMA

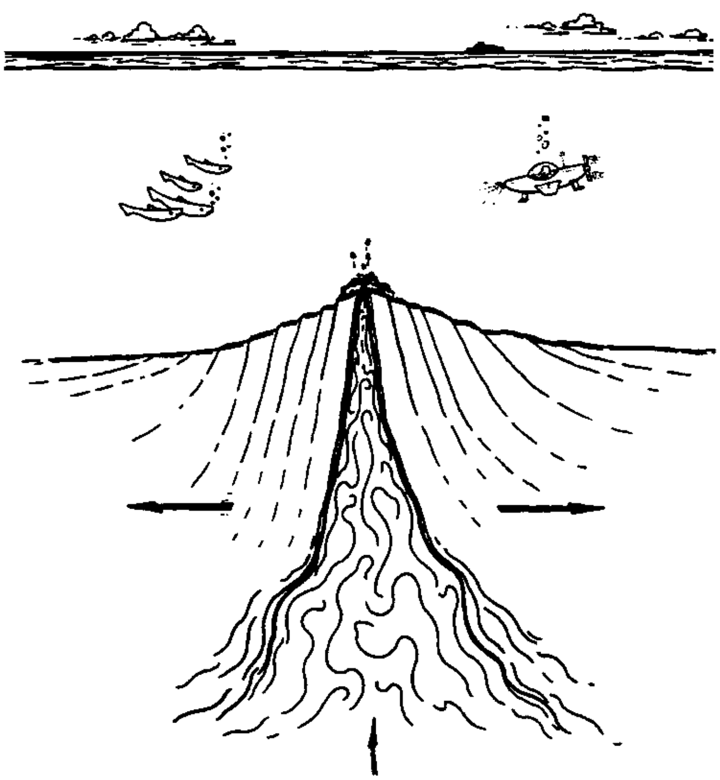
As you'll recall, the mantle is made of incredibly hot rock. There are even some places in the mantle where the rock actually melts.

This *molten* rock, a thick hot liquid, is called *magma*. Magma forms wherever temperatures and pressures are high enough to melt rock. These places include: areas where convection currents in the mantle bring heat close enough to melt rock, at the places where tectonic plates meet and separate, and in areas where one plate shoves underneath another one.

Because it is in melted form, magma spreads out, thus becoming lighter (less dense) than the surrounding rock; so it has a tendency to rise. Like steam rising through the cracks in a hot egg shell, streams of hot melted magma rise through the fractures (cracks) in the crust. Some of the magma reaches the surface, where it's called *lava*, often pouring out of, and sometimes forming, volcanoes. The magma that is still underground heats nearby rocks and water.

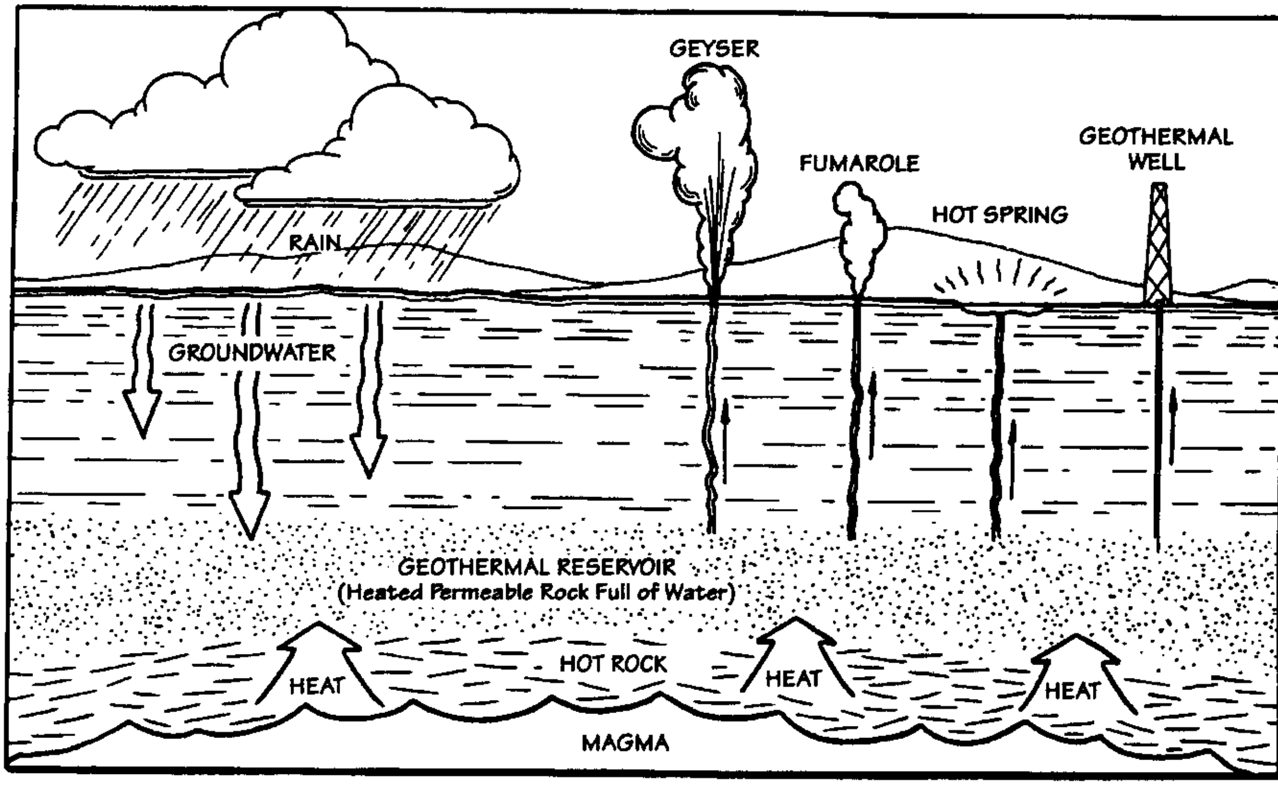
Magma, found in the mantle, is incredibly hot, up to 5,400°F (3,000°C). While still deep under the surface, the magma is under incredible *pressure*. Because of this pressure, gases such as *carbon dioxide* are kept dissolved in the liquid rock. As the magma rises towards the surface, the pressure starts to fall. When the pressure falls, some of the dissolved gas is released in the form of bubbles. First these are tiny because the pressure is still high. But as the pressure becomes less, the bubbles expand. The magma rises to the surface propelled by these gas bubbles. The magma and gas rise up through fractures in the crust and the result often is... a volcanic eruption !





Magma also comes out under the ocean from cracks in the sea floor. As the magma rolls out of these cracks it actually pushes the old sea floor out of the way. This causes the plates on either side of the crack to spread furthur apart. This action is called *sea-floor spreading* (and the areas where this occurs are called spreading centers). As the magma cools and hardens, it forms ridges. One huge example is the Mid-Atlantic Ridge. This is the spreading center that separates the North American plate from the Eurasian Plate and the South American Plate from the African Plate and is approximately 47,000 miles (75,000 kilometers) long!

WATER DOWN BELOW



As magma rises closer to the earth's surface it heats up nearby rock. When this rock is close to water underground, it (and sometimes the magma itself) heats up this water.

Water is able to move underground—far below the surface—because some rock has tiny spaces, called pores. The more spaces certain rock has, the more porous it is. When there are connecting cracks (tiny fractures) between the pores, then rain and water from other sources can flow into and through the rock. This kind of rock is called *permeable*. (The rock that water can't pass through is called *impermeable*.) If a layer of permeable rock is surrounded by lots of impermeable rock, water gets trapped, collecting and forming a reservoir.

If this reservoir is near hot rock or magma, it heats up fast. If the hot water from this reservoir then finds cracks that allow it to flow to the surface, it may show up as a hot spring. If it spurts out like a fountain, it's a *geyser*. If it puffs out as steam, it's a *fumarole*. Sometimes, the hot water collects under the surface, trapped between layers of nonporous rock. Then it's called a *geothermal reservoir*.

TAPPING INTO GEOTHERMAL RESERVOIRS

We can put water and steam from surface hot springs to work right away. But what about all that hot water and steam in the geothermal reservoirs far below the surface? For these "hidden" geothermal resources to be useful, we need to bring them to the surface.

Geothermal engineers reach these resources by drilling wells down to the geothermal reservoirs far underground. Then, through pipes, the hot water and steam comes up to the surface.

Those who live in many areas near the Ring of Fire are fortunate because geothermal resources are more abundant and more accessible there, waiting to be "tapped" and used in many different ways.

WATER DOWN BELOW

Groundwater is a very important part of the geothermal process. But how does rain end up under ground? Water seeps through sand, soil, and even rock through little air holes (pores). Rock that has these little air these holes is said to be porous.

If a material has spaces connecting the pores that allow water or other liquids to flow through, it is called permeable. Rain water collects in permeable rock, thus forming natural underground "reservoirs" of water. These water-rich areas can be found down to hundreds or even thousands of feet underground. If these reservoirs are close enough to hot rock or magma, then the water heats up and we have a geothermal reservoir.

In this experiment you will test the "permeability" of various materials to see how easily water can seep through them.

Materials (Per group of students):

- Stuff to test (your teacher will tell you what you will be using—things like sand, soil, gravel, etc.)
- the top of a large, plastic drink bottle
- cheesecloth or muslin
- pouring pitcher
- measuring cup
- rubber band
- scissors
- watch or timer
- recording sheet or science notebook
- water
- paper cups to scoop up materials
- plastic spoons or other stirring tools
- containers to hold "used," wet stuff

Directions:

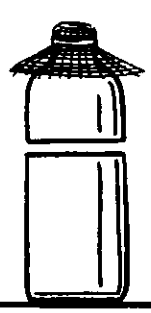
1.) Cut the top off the plastic bottle, as shown below. (Your teacher may have already done this for you.) Cut some cheesecloth or muslin and cover the top of the bottle, fastening the cloth on with the rubber band. Use several layers if you're using cheesecloth with big holes.

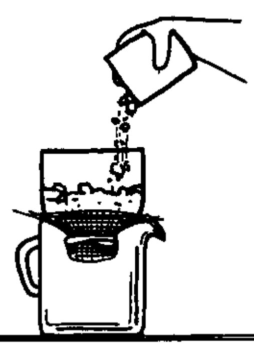
2.) Put the bottle "funnel" in the measuring cup. Fill the funnel with one of the materials to be tested. Mark the level it reaches on the outside of the "funnel."

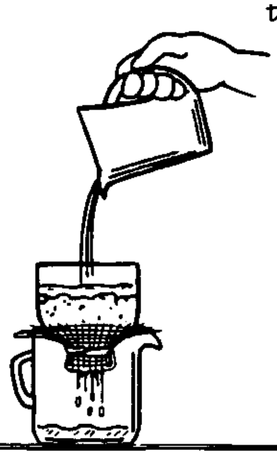
3.) Measure an amount of water to pour through the test material and make a note of this amount. Fill the pitcher with the measured amount of water. Write down the time you start and pour the water into the funnel. Stir around in the narrow part of the funnel if the test material gets "stuck."

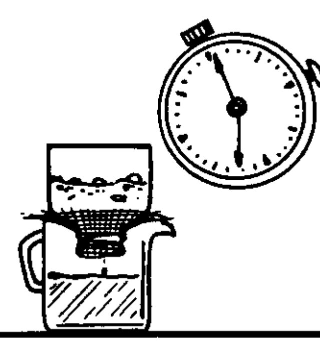
4.) Observe how long it takes the water to seep through the material and record how long it took. Now try another material, using the technique above. Be sure to always fill the material up to the same place you marked in Step 2.

5.) Draw conclusions about which materials seem to be the most permeable and be ready to tell why you think so.









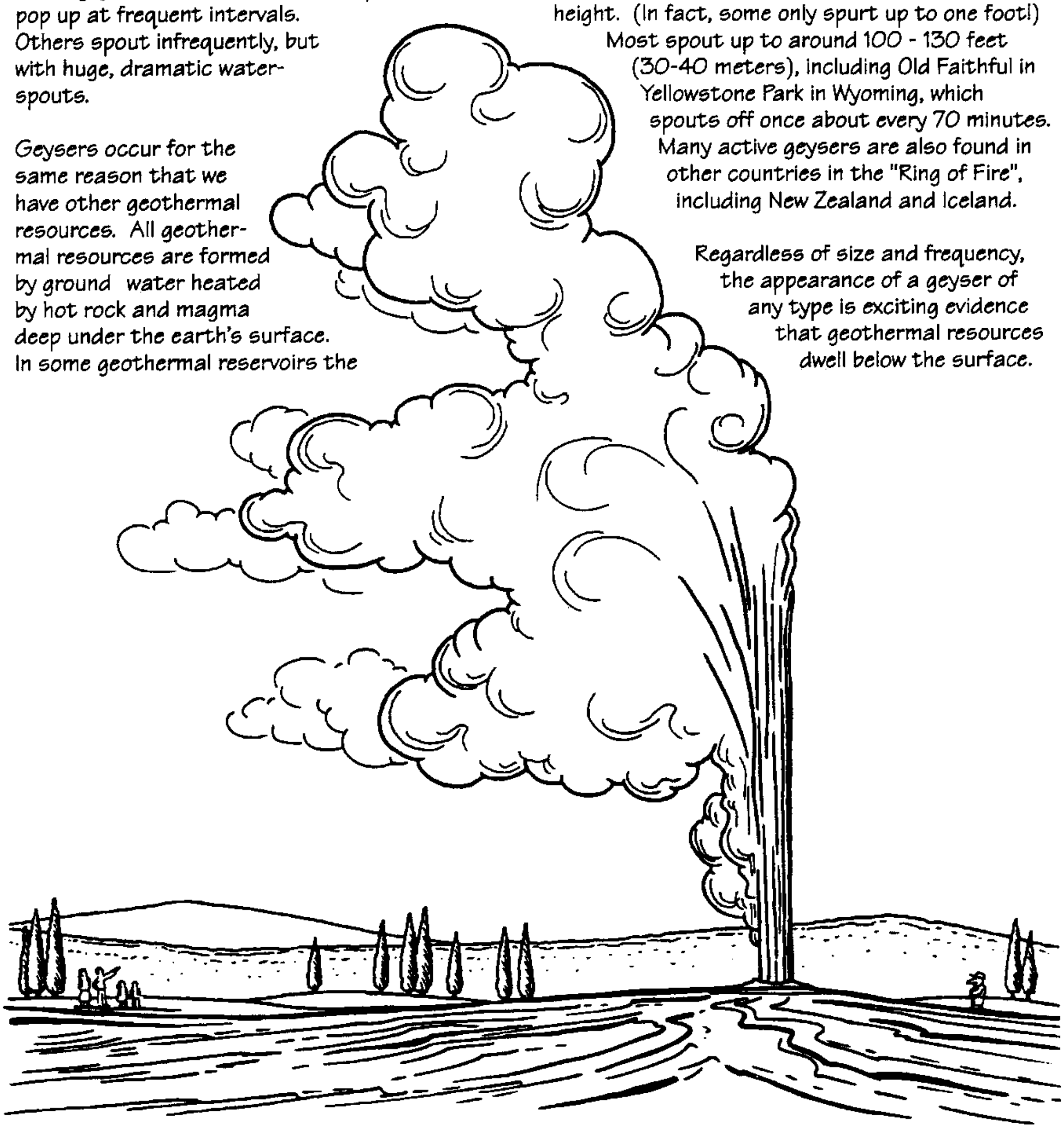
WHAT IS A GEYSER?

Scalding hot water and steam suddenly gush out of the earth. What is this strange apparition? It's a natural geothermal hot water fountain called a geyser. The name comes from the Icelandic word, "Geysir," meaning "gusher". Some geysers send up their spouts regularly, every few minutes, hours or days. Others are very irregular. Some geysers have small, bubbly spouts which pop up at frequent intervals. Others spout infrequently, but with huge, dramatic waterspouts.

Geysers occur for the same reason that we have other geothermal resources. All geothermal resources are formed by ground water heated by hot rock and magma deep under the earth's surface. In some geothermal reservoirs the pressure builds until it has to be released. So hot water and steam whoosh up through weak areas in the rock to the surface, making a hot water and steam fountain.

Some geysers have been known to shoot as high as 1,500 feet (460 meters), such as one found in New Zealand. Most geysers never reach this height. (In fact, some only spurt up to one foot!) Most spout up to around 100 - 130 feet (30-40 meters), including Old Faithful in Yellowstone Park in Wyoming, which spouts off once about every 70 minutes. Many active geysers are also found in other countries in the "Ring of Fire", including New Zealand and Iceland.

Regardless of size and frequency, the appearance of a geyser of any type is exciting evidence that geothermal resources dwell below the surface.

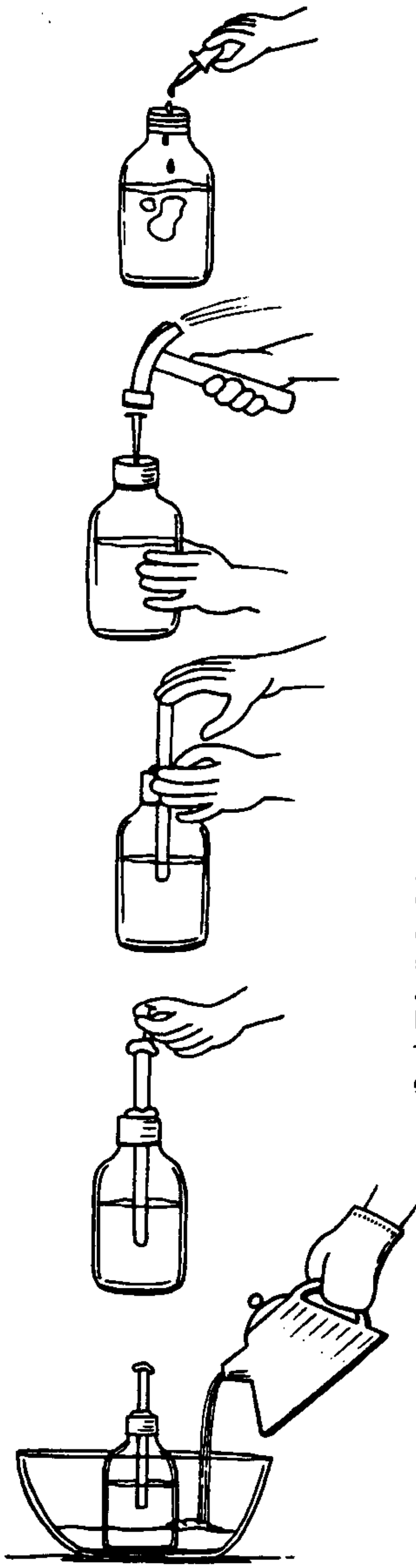


MAKE YOUR OWN GEYSER

In this experiment you will create your own "geyser" using some of the same forces that cause "real" geysers.

Geysers are the result of hot water and steam building up great pressure under the earth's surface. When the heat and pressure are great enough, the water expands (producing steam) and pushes the hot water in a gush up through weak spots and cracks in the earth's surface.

Materials
(Per group of students):
- bowl
- small strong bottle with a screw cap (preferably glass)
- modeling clay
- straw
- pin
- some food coloring or ink
- large nail & hammer
- a method to heat water
- hot mitts
- goggles, if possible
- water



Directions:

1.) Make a hole in the bottle's cap using the nail and hammer. Heat up water so that it will be boiling when you need it.

2.) Half fill the small bottle with cool water. Add a few drops of the ink or food coloring.

3.) Screw on the cap tightly and push the straw through the hole in the cap. Seal the hole well with clay.

4.) Stuff a small piece of clay in the top of the straw. Make a tiny hole all the way through the clay with the pin. Remove the pin.

5.) Pour hot water into the bowl. Stand the bottle in the bowl. Observe what happens. As the air inside the small bottle warms up, it will push the colored water up and out of the straw. This is because the air and water expand when they are heated and spread out, just as the steam expands underground.

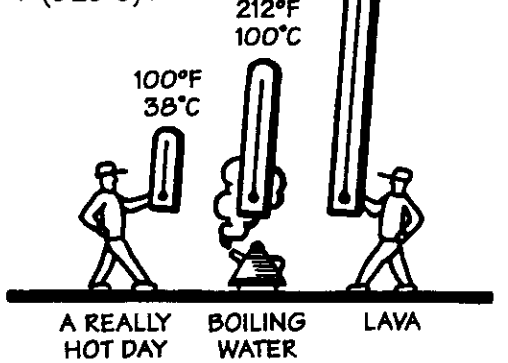
HOT OFF THE PRESS: VOLCANIC NEWS

Crater Lake, the beautiful clear blue natural wonder found in southern Oregon, used to be an active volcano! About 6,850 years ago, this volcano, called Mt. Mazama, exploded in an enormous eruption—a blast many times greater than the recent Mt. St. Helens eruption.

The magma reservoir (from which magma exploded out as lava) was partly emptied, leaving a gaping hole beneath the mountain top. Also, the rock around the top of the mountain was fractured and weakened. As a result, the mountain top collapsed into the emptied reservoir, leaving a bowl-shaped area at the top, called a caldera.

Over time, rain water and melted snow filled the caldera, forming Crater Lake. In the meantime, little eruptions continued in and around the lake. One small volcano continued to produce layers of ash and rock (called a cinder cone) in the lake. The layers emerged above the surface, forming an island, now called Wizard Island. This island stands out in contrast to the calm, startling clear blue waters of Crater Lake, once an enormous, bubbling, hot volcano.

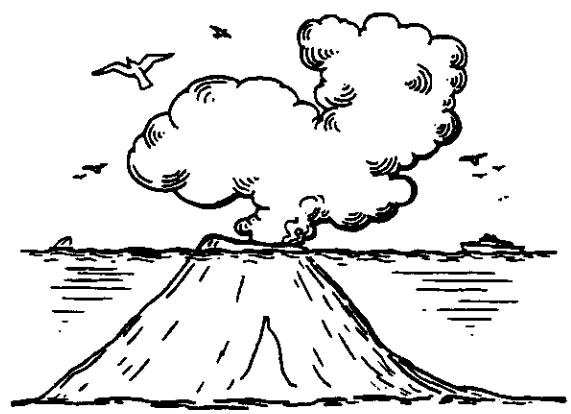
Boiling water, as you know, is very hot. Now imagine something about ten times hotter. That's how hot some lava can be - more than 2,000° F (1,100°C) ! Lava is always at least 1,500 °F (820°C) !



Imagine being the farmer near the village of Paricutín, Mexico, who found ash, smoke and lava pouring out of a crack in his fields on February 20, 1943. In one week, a volcano grew to the height of around 500 feet (150 meters)!

Some volcanoes literally blow their stacks! For example, Mount St. Helens in Washington blew off its top with a huge bang in 1980. In A.D. 79, an enormous explosion blasted the top off Mount Vesuvius, in Italy. The nearby town of Pompeii was buried in about 20 feet (6 meters) of ash, trapping thousands of people.

Speaking of loud bangs...on August 27, 1883, the volcanic island of Krakatoa, near Java, Indonesia, exploded with a noise that was even heard in Australia, 2,500 miles away. The ash and other compounds sent into the air affected the climate all over the world. Incidentally, the ash from the explosion blocked out the sun as much as 50 miles away!



Some islands are the tops of volcanoes. The Hawaiian Islands are one well-known example. Scientists even had the opportunity in 1963 to watch an island in the making when a volcano suddenly exploded out of the sea near Iceland, along the South Coast. It continued to grow, spewing out lava, which cooled and hardened until a new island was formed. It was called Surtsey, after the name of the Icelandic god of fire. Birds which landed on the barren island left seeds and spores from small plants. Eventually these began to grow and break down the lava rock into soil. (Volcanic ash is very fertile for growing plants.) Larger plants took root. This attracted more animal species, and so a new, living island soon developed.

EARTH SEARCH

The following terms relating to the Ring of Fire can be found in this Earth Search. The words are spelled horizontally, vertically and diagonally.

CORE	MAGMA
MANTLE	CRUST
TECTONICS	GEOTHERMAL
CONTINENTAL DRIFT	PLATES
VOLCANO	GEYSER

S Q L M A G M A C B I Z T Y E G M O F R

D G C B A H J K O S R C D G R C E Y Z H

P A J M L I C S N K C P K A S B R U K M

V O L C A N O P M E Y L L Q N O Z U E A

U F X M L Y R X B C A A Q A C D G H S N

F A N I E L E O H R M A F B T L C T O T

G X L M O A C R X R Y L T F G E H N X L

E K H I E N O I E A N E Q R W A S O P E

Y I O S W J R H V X M F G E D B J R Y P

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E I F U N I L H U S X Y F T U W M B R B

F C N T A B P A U T E C T O N I C S V P

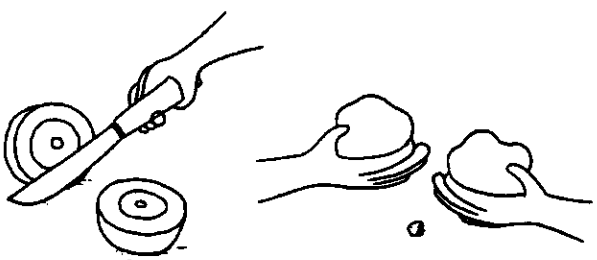
FOR THE TEACHER

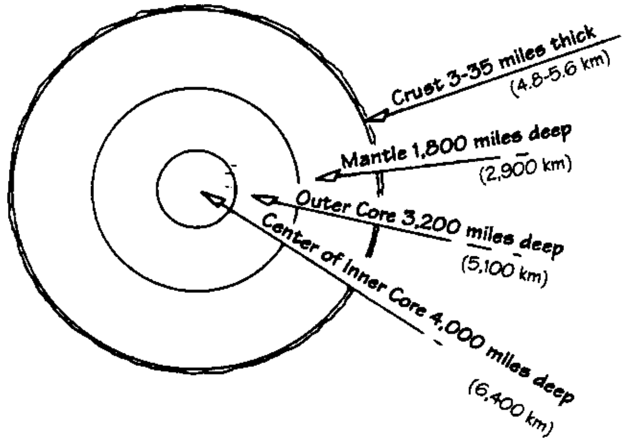
INSIDE THE EARTH

Art/Science Activity: Making a Model to Explain a Theory of the Composition of the Earth's Interior (No student worksheet)

Materials:
- five colors of plasticene clay: red, orange, yellow, and blue and green swirled together
- kitchen knife

Directions:
Have students make a tiny ball the size of a pea out of red clay and put it into the center of a ball of orange plasticene clay about 1 & 1/4 inches (3 cm) in diameter. Have them put this ball inside a ball of yellow clay. Ask them to make the total diameter 2 & 1/2 inches (6 cm). Cover with a very thin shell of swirled blue/green clay. (Alternate crust idea: just roll "earth" in sand to coat.) Cut the spheres in half. Students can then explain the different sections. Management suggestion: Partners could make one ball together and then each get a half when the balls are cut.





AN EXPLOSIVE TOPIC

Demonstration: Why Some Volcanoes Explode
(No student worksheet)

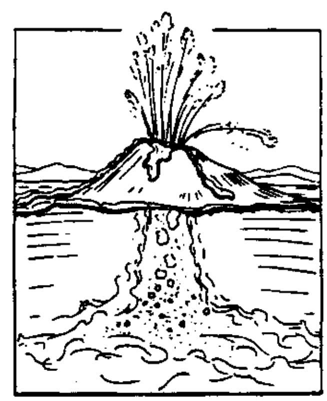
Materials:
- Plastic bottle of seltzer (clear)
- red food coloring (optional)

Directions:
1.) Gently unscrew the cap of the seltzer a little, reducing the pressure. Bubbles will appear. (Bubbles didn't show before because gases dissolve under pressure.) Tighten the cap and they will disappear.

2.) Take off the cap and add a little red food coloring.

3.) Quickly put the cap on tightly and give the bottle a gentle shake.

4.) Unscrew the cap a little, holding the bottle away from you. The liquid will fizz out as the pressure drops, simulating a volcanic eruption.



Explanation: Magma below the earth's crust contains a large amount of gases, primarily carbon dioxide. Because of the tremendous pressures under the surface, the gases are kept dissolved in the molten magma. When the magma finds a way to rise towards the surface, the pressure falls. With less pressure, the magma can hold less gas and so the gas is released. The gas first rises as very small bubbles. But as the pressure lowers as the magma rises, the bubbles get larger, expanding and pushing with explosive power. The seltzer also has carbon dioxide dissolved in it. The bubbles don't show when the bottle is capped because the contents are under pressure. When you release the cap, the pressure is lowered, and the water releases the bubbles. The bubbles expand and "explode", carrying the water with them, just as the gases in a volcano carry lava with them to the surface.

Demonstration: Convection Currents
(No Student Worksheet)

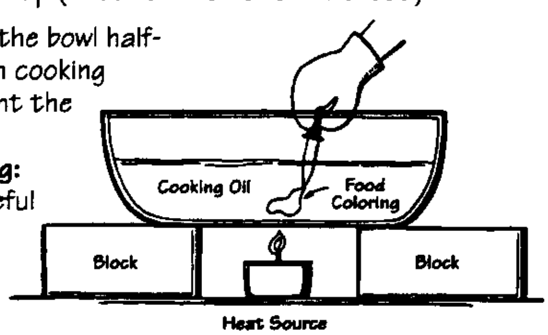
Materials:
- heatproof glass bowl
- votive candle
- food coloring (try different colors, some work better than others)
- cooking oil
- wooden blocks (larger than the height of the candle) (Instead of the candle and the block, a ring stand or other supportive device and a small alcohol burner or sterno burner would also work.)
- dropper
- mitt
- water
- goggles, if possible

Directions:

1.) Place the wooden blocks a few inches apart and place the votive candle between them.

2.) Rest the bowl on the blocks, making sure there is space between the bottom of the bowl and the candle top (about an inch or a little less).

3.) Fill the bowl half-full with cooking oil. Light the candle. **Warning:** Be careful of the hot oil!



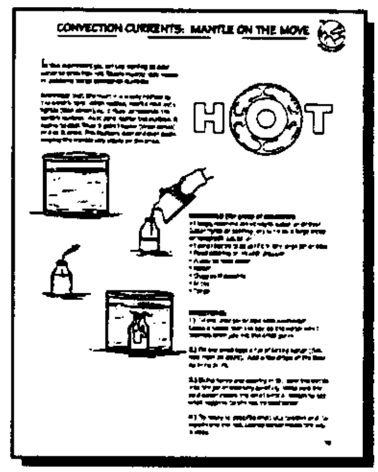
4.) Drop a little food coloring into the middle of the bottom of the bowl. (Actually put the dropper right into the oil.)

5.) **Explanation:** As it heats up, blobs of food coloring escape and are caught up in the convection currents in the oil, which are rising to the surface when the oil heats and gets lighter. Once at the surface, the currents are spreading out because they are being pushed aside by the heated currents flowing up from below. The food coloring blobs move along with these currents. Then, as the currents cool, they get heavier and sink back to the bottom, carrying the food coloring with them. Magma acts in the same manner as the oil, only much, much slower.

MOVING MANTLE

Science Activity: Mantle on the Move: Convection Currents (Student worksheet included)

Materials (Per group of students)
- 1 large, open-mouth straight sided jar (clear pyrex or canning jar such as large pickle or spaghetti sauce jar)
- 1 small bottle that will fit in the large jar or bowl
- food coloring or ink
- dropper
- a way to heat water
- mitt
- goggles, if possible



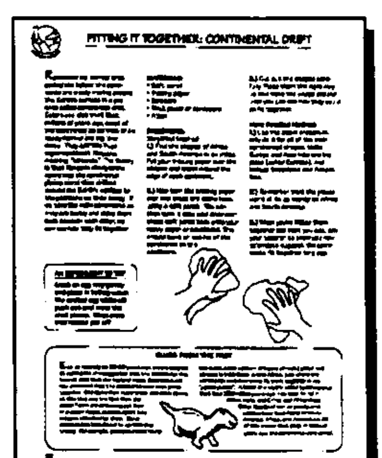
Directions:
Found on student work- sheet.

Management Suggestions:
Make sure that the bottles are small enough to fit well into the bowl or jar. Make sure water is very cold. Older students probably won't need help with lowering the bottle into the hot water.

FLOATING PLATES

Activity: Fitting It Together: Continental Drift (Student worksheet included)

Materials:
- Soft pencil
- Tracing paper
- Scissors
- Thick paper or cardboard
- Atlas



Directions:
Found on student worksheet.

Management Suggestions: You will note that there are two methods of doing this activity. In the simpler version, students trace Africa and South America only. This is very satisfying because they fit together very nicely. The more complicated method is included for those who have more time or

want more challenge for their students. If at all possible, try to use an atlas with Mercator projections (cylindrical projections) which show the whole world on a single map with lines of longitude and latitude at right angles. Even though the continents near the poles are bigger than in reality, the pieces will be easier to trace and work with. You may want to make your own outlines for your students ahead of time. If you wish, simply enlarge the map above and cut it apart before class. Let your students to do the trimming. Or make one set and do this as a group activity on an overhead with the entire class.

WATER DOWN BELOW

Demonstrations: Porosity of Soil and Rocks
(No student worksheet)

Materials:

- glass
- dry soil
- water
- small rocks
- weighing scale
- jar of water

Directions: These demonstrations will give you an opportunity to show and talk about how rocks and soil have air spaces which water can seep into. Because of this we have groundwater, and hence geothermal reservoirs, geysers, hot springs, etc.

1.) Fill a glass three-quarters full of dry soil. Pack it tightly. Now fill the rest of the glass with water. Your students should notice bubbles coming out of the soil. Ask your students to explain where the bubbles come from. (Because soil is porous, it is filled with air pockets. As the water fills the little pockets, the air is pushed out.)

2.) To show how rocks can absorb water, gather several different kinds of small rocks such as granite or marble, cinders or pumice, sandstone or limestone. Weigh the rocks, then place them in a jar of water over night. The next day, weigh each rock and find the difference. Ask your students why some of the rocks weigh more. (Some rocks are more porous, have more air holes, and will absorb more water.)

Science/Math Activity: Water Down Below
(Student worksheet included)

Materials (Per group of students):

- materials to test (use whatever is handy – sand, soil, vermiculite, cleaning powder, gravel, etc.)
- large plastic drink bottle
- cheesecloth or muslin
- pouring pitcher
- measuring cup (big enough to easily hold the top portion of the drink bottle)
- elastic band
- scissors
- watch
- pen & notebook or recording page
- water

Directions: Found on student worksheet.

Management Suggestions: Be sure to use a measuring cup which is bigger than the drink bottles you use. The measuring cup holds the drink bottle "funnel" upright, but the fit shouldn't be tight. Otherwise it's very hard to get the bottle top out when it's full of wet materials. You will most likely want to cut the bottle tops off yourself to save time and prevent accidents. Have students perform three trials for each material. Have them find an average of their three trials. When all the groups are done, have each group share their average times with the class. Record these on the chalkboard, then have students find the average for each material. A chart or graph could also be made of the class averages.

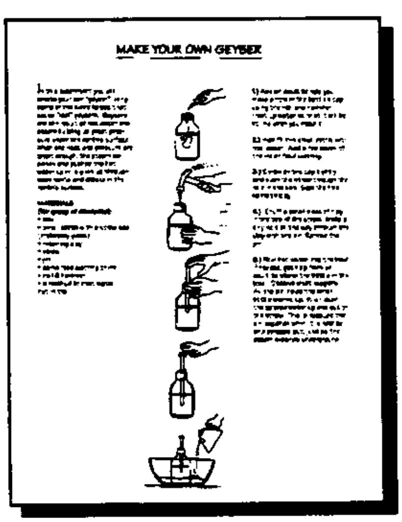
FOR THE TEACHER, cont.

Science Activity:
Make Your Own Geyser
(Student Worksheet Included)

Materials
(Per group of students):
- bowl
- strong small bottle with a screw cap
- modeling clay
- a straw
- pin
- water
- some food coloring or ink
- large nail & a hammer
- a method to heat water
- hot mitts
- goggles, if possible

Directions: Found on student worksheet.

Management Suggestions: This can be done as a demonstration by you, or as a class activity, with the students broken up into cooperative groups of about four each. Each group doesn't need the nail, hammer, and hot water source. They can come to you for these in order to ensure more control over safety.



Cooking/Math Activity:
Baking a Volcano
(No student worksheet)

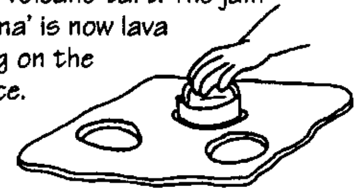
Materials:
- standard pastry (as for pies), made ahead
- strawberry jam
- rolling pins
- cutters
- knives
- spoons
- mini muffin pans or cookie sheet
- oven
- oven mitts

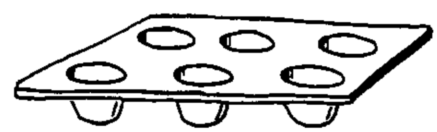
Directions:
1.) Roll out some pastry, and cut out circles for the base and the lid of your small volcanoes (tarts).
2.) Put one circle of pastry in each section of the muffin pan, then add a teaspoon of jam to each one.
3.) Put a pastry lid on each one and press down on the edges to seal them. Make a little hole in the center of each volcano. Make sure the lid presses down completely in the middle. (Alternative: use one piece of dough, put jam on and push in sides to make a "volcano," leaving a little hole.)
4.) Bake, using cookbook directions for tarts. When they are done, the jam "magma" will have erupted.
5.) Enjoy!

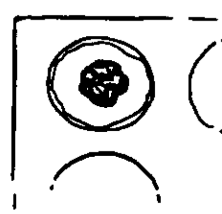
Management Suggestions: Small groups could do this with an aid or volunteer while the rest of the class is doing other activities.

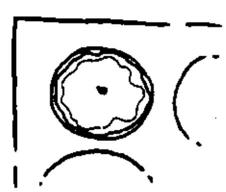
Math ideas: Use measurement and fractions when making the pie dough; try various amounts of jam using measurement (teaspoons, etc.) to see which "explodes" better – keep records of the results; out of each pan or a cookie sheet of tarts, count how many tarts "explode" vs. how many didn't and then make a ratio for each pan or cookie sheet.

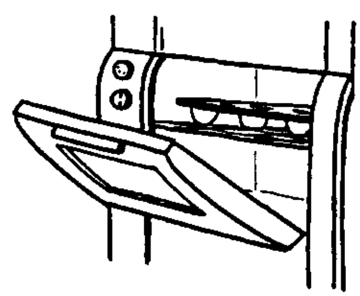
Explanation: The lid of the tart represents the Earth's crust, and the jam is the magma. The small hole is like a weak point in the crust. When the tart heats up, air and jam inside expand, creating pressure that forces the jam up and out of the volcano tart. The jam "magma' is now lava flowing on the surface.











FOR THE TEACHER, cont.

Answers for Earth Search, page 29

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NOTE: Earthquakes are a related topic not covered in this unit, but are often interesting to discuss. Here's an example of an activity and some suggestions.

Demonstration or Activity: Making Models of Fault Lines (No student worksheet)

Materials:
- Several different colors of modeling clay
- knife

Directions:
Review with your students about how the earth's plates push together and pull apart, putting the rocks under tremendous stress. When the pushing gets too hard, the ground slides quickly. This causes an earthquake. The cracks that result are called faults.

1.) Set several strips of alternating colors of clay on top of each other. These represent the different layers of rock called sedimentary layers.

2.) Cut through the layers with the knife. Set the two pieces side by side.
3.) Pushing them together, slide the pieces past each other and move them up and down to demonstrate the different ways faults can break rock layers (see pictures).

Management Suggestions:
This could be done as a student activity so that students have their own clay and make their own models.

The same activity can be done using many-layered peanut butter and jelly sandwiches to demonstrate various types of rock layers. Students cut them and turn them into various faults and then eat them! The activity is found in the AIMS book Overhead and Underfoot.