Using the Epicenter Table b, read and record the distance to the epicenter from each station.

4. Convert each distance to cm, so the data can be used on your map. Use the scale 1 cm = 100 km. This data will be the radius of each circle in step 5.

5. On your map draw a circle around Station A, as in c. The radius of the circle is the distance in cm that you recorded in step 4.

6. Repeat step 5 for the other two stations.

7. The location of the epicenter of earthquake X is the point where the three circles intersect. Mark this point with an X.

Analysis

1 . When do scientists need to use this method to find the epicenter?

2. Where is the focus of earthquake X?

3. Why is it necessary to draw a circle around each station with the distance to the epicenter as the radius?

4. How could someone predict the approximate location of an epicenter without a seismograph?

3.2 MAGMA AND LAVA

Like an earthquake, the eruption of a volcano means that something is happening inside the earth. Study these questions as you read:

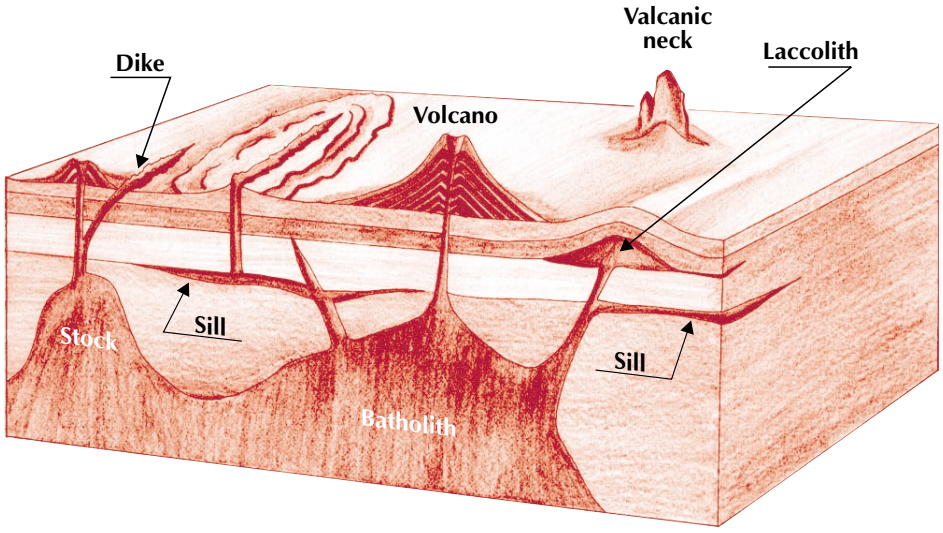
a. What forms when magma is trapped underground?
b. Where does lava reach the surface of the earth?
c. Why is lava important at plate boundaries?
d. How can you classify volcanoes by their activity?
e. How do the shapes of volcanic cones differ?

• Magma Inside the Earth

Rock formed from magma that cools and hardens underground is intrusive rock. You cannot see intrusive rock unless some geologic process exposes the hidden rock. For example, water may wear away the rocks on the surface. Five intrusive structures are illustrated together below, so you can see the shape and relative size of each.

A batholith, shown in the diagram, is so large that its bottom is often unknown.

In fact, the cores of many mountain chains are batholiths. The stock is similar to, but smaller than, a batholith. When magma works its way between rock layers, a sill forms. The mushroom- shaped laccolith forms when magma pushes up on the rock above it. When magma cuts across existing rock layers at an angle, a dike is the result.



Distribution of intrusive and extrusive rocks.

- **Lava on the Earth's Surface**

When magma comes out on the surface of the earth, it is called lava. Lava reaches the surface through volcanoes or through cracks in the ground. These cracks are called fissures. Extrusive rocks are hardened lava on the earth's surface.

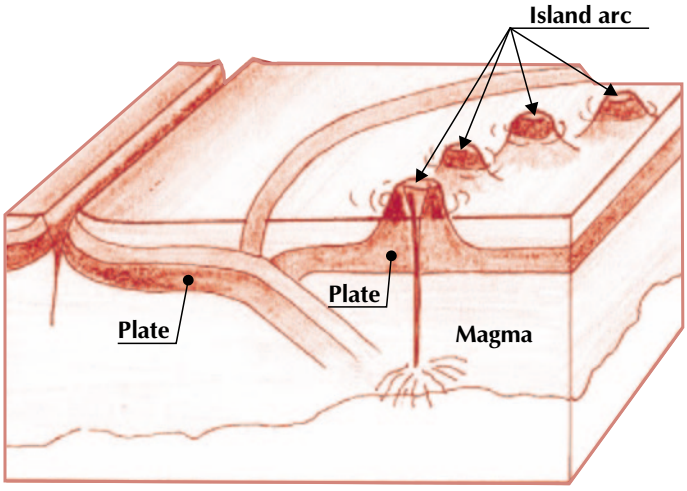
Lava from large fissures may flood wide areas of land, since they may have been several kilometers long.

- **Lava at Plate Boundaries**

Most extrusive rocks form where you cannot see them - on the ocean floor. These rocks are the new crust born at mid-ocean ridges. Vast amounts of lava rise through fissures or volcanoes at spreading boundaries. Occasionally volcanoes on the ocean floor grow large enough to become islands.

Many volcanoes are near colliding boundaries. The diagram below shows one ocean plate sinking under another ocean plate. The sinking crust melts in the asthenosphere. Then the magma that forms from the melted crust rises. This magma gives rise to volcanoes on islands called island arcs. The Japanese Islands are an example of an island arc.

Volcanoes may also form on land where an ocean plate sinks under a land plate. This type of boundary produced the Cascade Mountains of Washington and Oregon in the United States of America, as well as the Andes Mountains of South America.



Colliding boundary.

DO YOU KNOW?

Pillow lava is a type of lava that cooled and hardened under water. It is common at spreading boundaries. The strange, rounded lumps of hot lava pop, hiss, and crackle when they meet with cold ocean water.

- **Volcanic Activity**

Volcanoes differ in appearance and behavior. Some volcanoes explode, shooting out dust, ash and rocks, as well as water vapor and other gases. The 1980 eruption of Mount St. Helens in the United States of America, followed this pattern. Other volcanoes quietly ooze lava.

Why do some volcanoes blow up? Visualize the effects of shaking a warm soda pop. The bottle may explode, releasing the soda and the carbon dioxide, the dissolved gas in the soda. Cases and water vapor, which are under pressure inside a volcano, may also explode.

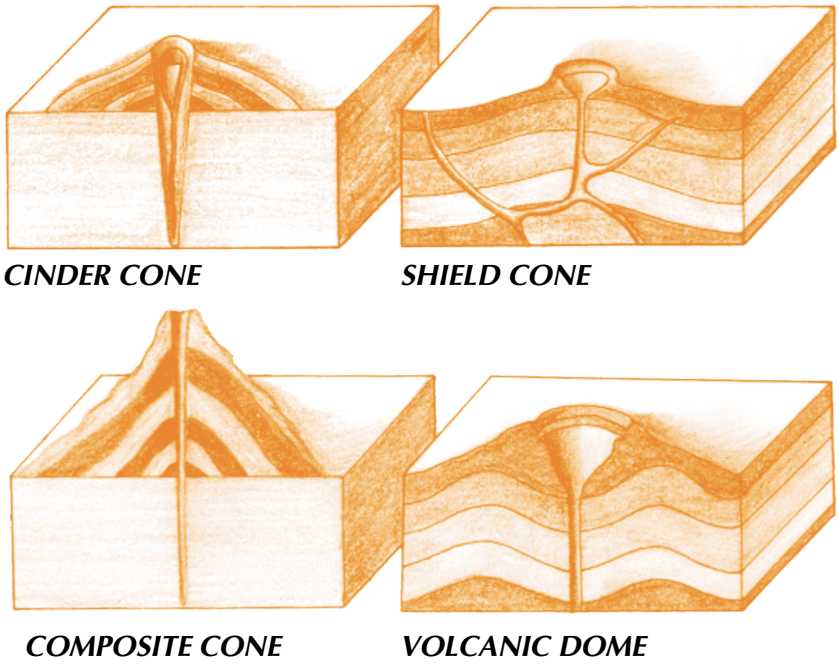
One of the biggest volcanic explosions that ever took place was the eruption of the volcano Krakatau, a volcanic island in the strait between Java and Sumatra. In 1883 it exploded so violently that people heard the explosion 3,200 kilometers away. Most of the island disappeared. Volcanic dust remained in the air around the world for two years. A giant sea wave created by the explosion killed more than 36,000 people on nearby islands.

Volcanoes often give warnings before they erupt. These warnings include gas and smoke from the volcano. Earthquakes may signal the rise of magma inside the volcano. The ground around or on the volcano may bulge or tilt slightly.

If a volcano has erupted in the recent past, it is called an active volcano. A dormant volcano is one that erupted in the past but has been quiet for many years. An extinct volcano is one that is not expected to erupt again. Most of the volcanoes in the Hawaiian Islands are extinct.

DO YOU KNOW?

Many countries of the world use hot water or steam from the ground to heat their homes or make electricity. Water in the ground is heated by igneous activity. Energy from the heat of the earth is called geothermal energy.



Types of volcanic cones.

- **The volcanic Cone**

The mountain built by a number of volcanic eruptions is the volcano's cone. It is made of lava, volcanic ash, and rocks. A cone usually has a central vent. The volcanic materials come up through the vent. The top of the cone ordinarily has a crater, which is a bowl-like depression. The shape of a volcano depends on the way it erupts and the type of volcanic material that leaves the cone.

A cinder cone, pictured above, forms when the eruptions throw out mostly rocks and ash but very little lava. Paricutin is a famous cinder cone volcano in Mexico. In 1943, this volcano appeared in a cornfield. in six days the cone was 150 meters high! The volcano reached 400 meters in height before it became dormant.

Non-explosive eruptions with easy flowing lava create shield cones, shown in the diagram. The volcanic islands of Hawaii with their gently sloping surfaces are typical shield volcanoes.

Alternating eruptions of dust, ash, and rocks followed by quiet lava flows build composite cones, shown above.

Volcanic domes result from violent eruptions of lava so thick that it barely flows. As you can see in the diagram, these volcanoes have sloping sides and dome-shaped tops. Mount Pelée is a dome volcano on the Caribbean Sea island of Martinique. It erupted violently and with little warning in 1902. A fiery cloud of gas and ash rolled down the side of the volcano, killing most of the people in the town below.

The effects of volcanic eruptions are far-reaching. Huge amounts of volcanic dust in the air contribute to beautiful sunsets and sunrises. If dense enough, volcanic dust can change the weather. The increased cloud cover from the dust can cause rain, and even cool weather. The fertile soils of the Hawaiian Islands developed from volcanic ash and rocks. Scientists think the gases in the air and the water in the oceans came from ancient volcanic eruptions.

ACTIVITY

EARTHQUAKES AND VOLCANOES

Purpose

To compare the locations of earthquakes and volcanoes around the Pacific.

Materials

- pencil
- outline map of Pacific and countries surrounding it
- globe or map of the world

Procedure

1. Using a globe or world map, locate on your outline map the earthquake areas named in a. Notice that the area names include cities, states, islands, and countries.

2. On your outline map mark with a Q the locations that you found in the step above.

3. Draw a line from one Q to the next nearest Q until all Qs are joined.

4. Using a globe or world map, locate the volcano sites listed on the next page. You will probably not be able to find the volcanoes themselves, but you can find the islands, states, countries, or areas where the volcanoes are located.

5. Mark these locations with a V on your outline map.

6. Repeat step 3 above for all of the Vs.