Earthquakes, Volcanoes, and Tsunamis

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Earthquakes, Volcanoes, and Tsunamis

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Written by Elizabeth Austin

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Level W Leveled Book

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Table of Contents

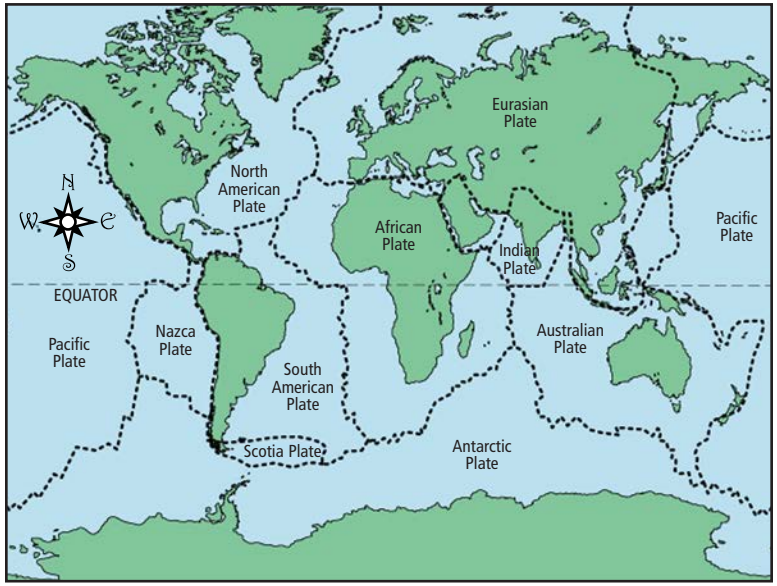
Smoke rises from what seems to be a peaceful volcano.

Introduction

We usually think of the ground and the ocean as stable and peaceful things. The ground lies quietly beneath our feet, and the ocean laps gently against the shore. But forces deep within the Earth can suddenly be unleashed, destroying that peacefulness. These forces cause the violent shakings of **earthquakes;** the explosions of ash, gases, and hot rocks of **volcanoes;** and the huge waves of **tsunamis** (tsoo-NOM-ees). In this book, you will read about these amazing events and the underlying forces that cause them.

Deep Within the Earth

Beneath the soil, rock, and water on the surface of our planet, the Earth is constantly changing. The top layer of Earth is made of giant pieces of rock, like the pieces of a puzzle. These giant pieces of rock, called **tectonic plates,** make up the continents and ocean floors. There are fourteen major tectonic plates and many smaller plates that make up the outermost layer of the Earth's crust. These plates are around 100 km (60 mi) thick. Where the edges of the plates come together, there are often cracks and gaps, called **faults**. Most of the world's earthquakes and volcanic activity occur near the faults along the edges of the tectonic plates.



The dotted lines show the edges of the tectonic plates.

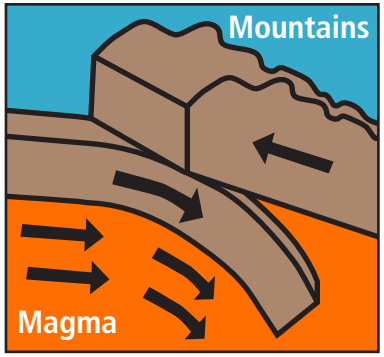


Fig. 1

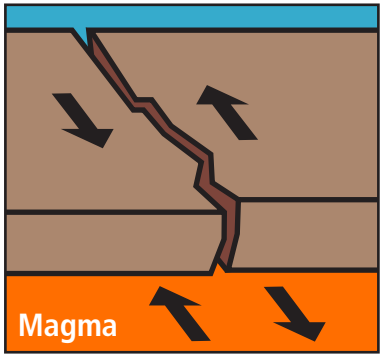


Fig. 2

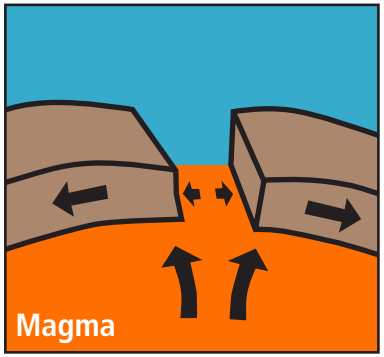


Fig. 3

Underneath the plates, the Earth is very hot, with normal temperatures of 700°C to 1300°C (1,292°F to 2,372°F). It is so hot that rock melts into liquid **magma.** The plates float on top of the underlying magma. The magma is always moving, and as it moves it carries the plates around with it. Tectonic plates normally move at speeds of 0.65 to 8.50 centimeters (0.25 to 3.35 in) per year.

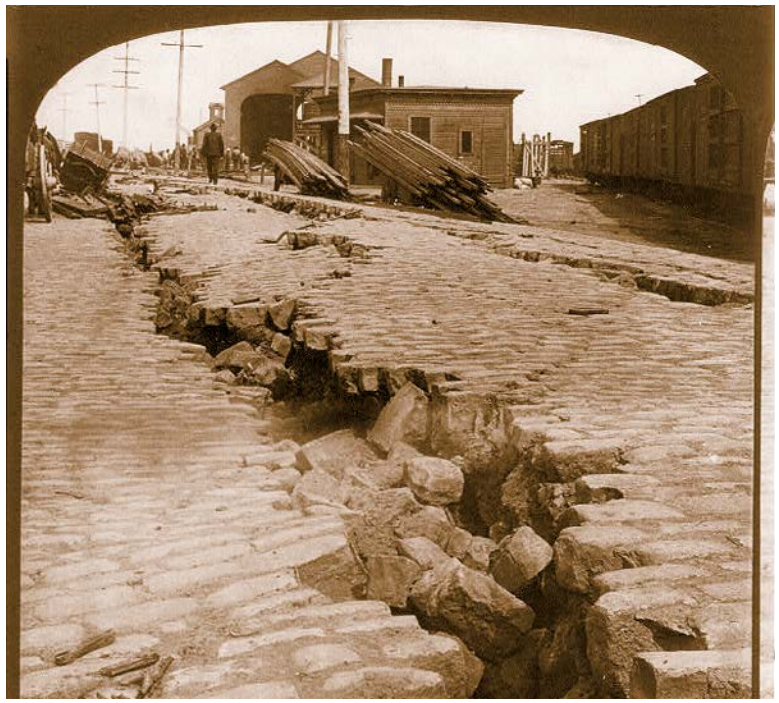
At the edges of the moving plates, three different things can happen. If the plates are moving against each other, one plate slides over or under the other plate (Fig. 1). If the plates are moving past each other, the edges of the plates grind together (Fig. 2). And if the plates are moving apart, they make a gap where magma seeps out (Fig. 3).

Earthquakes can damage or even destroy buildings.

Earthquakes: Terrible Trembling

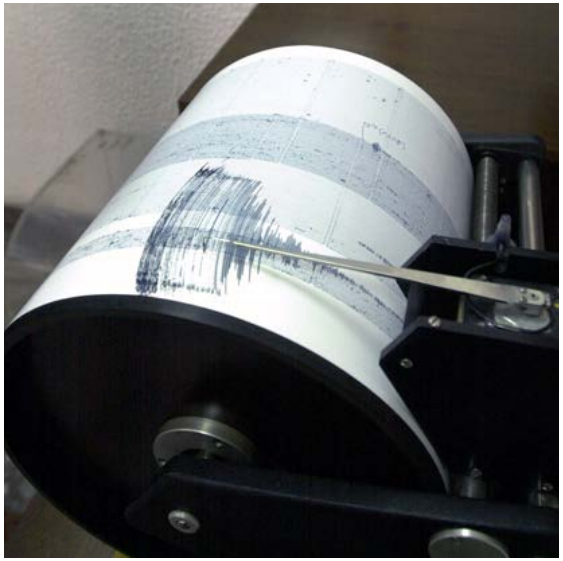
The edges of the tectonic plates usually move very slowly. But sometimes large pieces of the plates get caught on each other. The plates keep trying to move, but these large blocks of rock hold them back. The pressure and energy build up. Then, suddenly, the rocks give way, releasing all that pressure and energy. The plates jerk forward, and the ground shakes. Far above, people feel an earthquake.

Some earthquakes are small and harmless. In a small earthquake, the ground shakes a little, causing some hanging objects to swing. Tree branches sway, as if there were a gentle breeze. Some earthquakes are so small that we do not even notice them. Small earthquakes happen very often in certain parts of the world like California and Alaska in the United States, as well as in other countries like Chile, Greece, and Japan. But sometimes the shaking is so strong that buildings crumble, bridges collapse, and large cracks open in the ground.



The ground here was ripped open by an earthquake.

We measure the strength of earthquakes on an instrument called a seismograph (SIZE-moh-graf). Each earthquake is given a number from the **Richter** (RICK-ter) **scale**, depending on its strength. You can look at the chart on the next page to learn what the different strengths of earthquakes feel like.



A seismograph

For each number on the Richter scale, an earthquake is ten times as strong as the previous number. A 6.0 earthquake is ten times as strong as a 5.0 earthquake. It is one hundred times as strong as a 4.0 earthquake! The largest earthquake ever recorded measured 9.5 on the Richter scale. It occurred on the coast of Chile in South America. Scientists are still learning about these dangerous events. One day, they may be able to warn people before earthquakes occur.

The Richter Scale

1. People cannot feel the earthquake—only sensitive instruments can detect it.
2. People usually do not feel it; some people in tall buildings may sense a slight swaying.
3. Many people near the origin of the earthquake notice the shaking. No damage occurs.
4. People at the origin of the quake definitely feel it. Hanging objects sway. Water sloshes in swimming pools. Some weak buildings may be damaged.
5. Felt over a wider area. Usually lots of damage to weak buildings at and around center. Some damage to strong buildings.
6. Lots of damage to weak buildings; some damage to strong buildings. Damage can spread over 160 kilometers (100 mi).
7. A very major earthquake. Most buildings at the center are destroyed. Cracks form in the earth. Underground pipes break. Large landslides can occur.
8. Buildings and bridges destroyed. Large cracks appear in the ground. Large landslides.
9. The ground appears to move in "waves." Entire rivers may move. Objects can be thrown into the air. Total destruction of buildings and other structures.

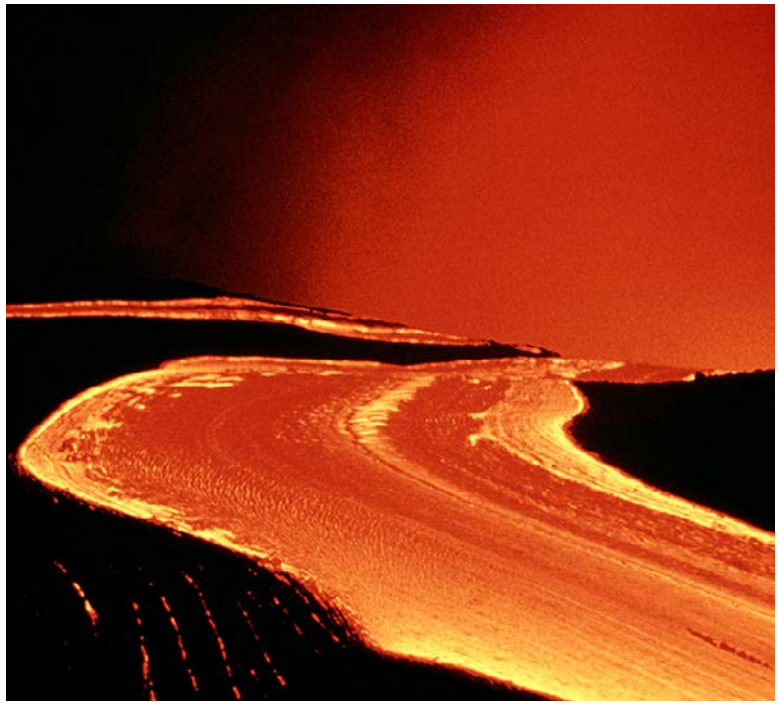
There is no top to the Richter scale, but the strongest earthquake ever recorded was a 9.5.

An earthquake destroyed this building.

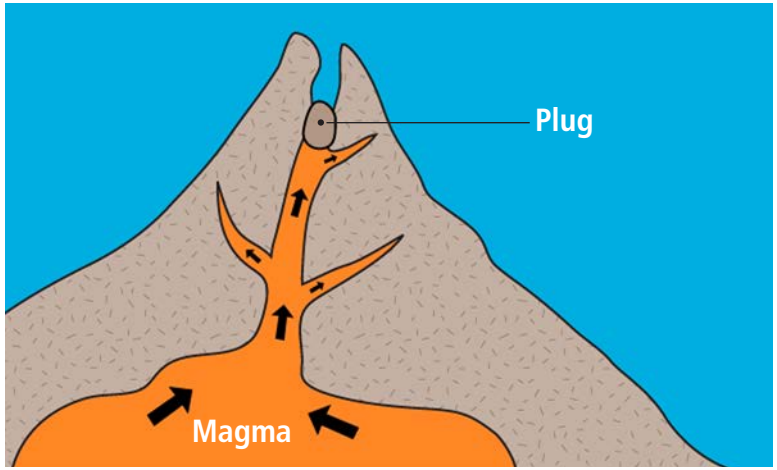
A major earthquake struck the San Francisco Bay Area of California on October 17, 1989. Known as the Loma Prieta Earthquake, it measured 6.9 to 7.1 magnitude on the Richter scale. Although the earthquake lasted only fifteen seconds, it killed more than sixty people and injured several thousand more. The earthquake also caused an estimated $6 billion in damage to buildings, roads, bridges, and other property. This was the largest earthquake to occur on the San Andreas Fault in California since 1906, when an even more powerful earthquake and the fires that followed it destroyed much of the city of San Francisco.

Volcanoes: Enormous Explosions

A volcano occurs wherever magma from deep inside the Earth comes out through a crack in the surface. Volcanoes usually happen near the edges of the tectonic plates, where there are many cracks and thin spots where the magma can leak out. When the magma pours onto the surface, it hardens, often piling up into a mountain. Sometimes, the liquid rock flows peacefully out across the land. Many volcanoes on the Hawaiian Islands act like this.

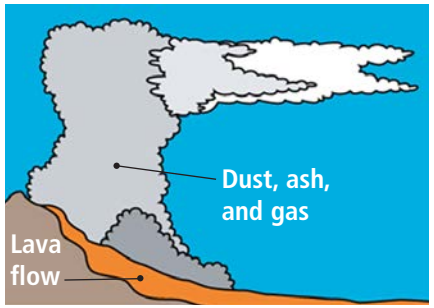


Runny liquid rock on this Hawaiian volcano flows smoothly, like a peaceful river.



Some volcanoes become plugged (above), and then they explode violently (below).

But sometimes, in very powerful volcanoes, the hot magma cools before it gets to the surface. It hardens into a solid piece of rock, plugging up the crack or hole where it had been seeping out. It acts like a plug in a bottle. The magma continues to push upward. Hot gases in the magma press against the plug. The pressure gets greater and greater. Suddenly, the volcano explodes. Huge chunks of rock burst from the volcano. Entire mountainsides can be ripped away. Hot, poisonous gas, ash, and melted rock shoot into the sky. The volcano erupts with unbelievable power.



A volcano creates a gigantic ash cloud.

Many dangerous and destructive things happen during volcanic eruptions. When mountains explode, they send tons of rock rolling down their sides. These falling rocks are called **landslides.** Landslides can bury whole cities. They can block rivers, causing floods. Clouds of ash and dust rise into the air during volcanic eruptions. The ash falls to the ground like snow. The ash is so heavy that the roofs of houses can collapse under its weight. An ash cloud can spread all around the world. Large ash clouds can even block out sunlight. The temperature of the entire Earth can cool down after a large volcanic eruption.

These trees were blown over by the explosion of a volcano.

A volcano can cause an explosion of extremely hot, poisonous gases. The explosion can be so powerful that it knocks over entire forests, and so hot that it starts destructive fires. Some large volcanoes have snow and ice on top. The hot gases melt all the snow and ice at once, and the water rushes down the mountain. This large, dirt-filled flood is called a **mudslide.** A mudslide is like a liquid landslide.

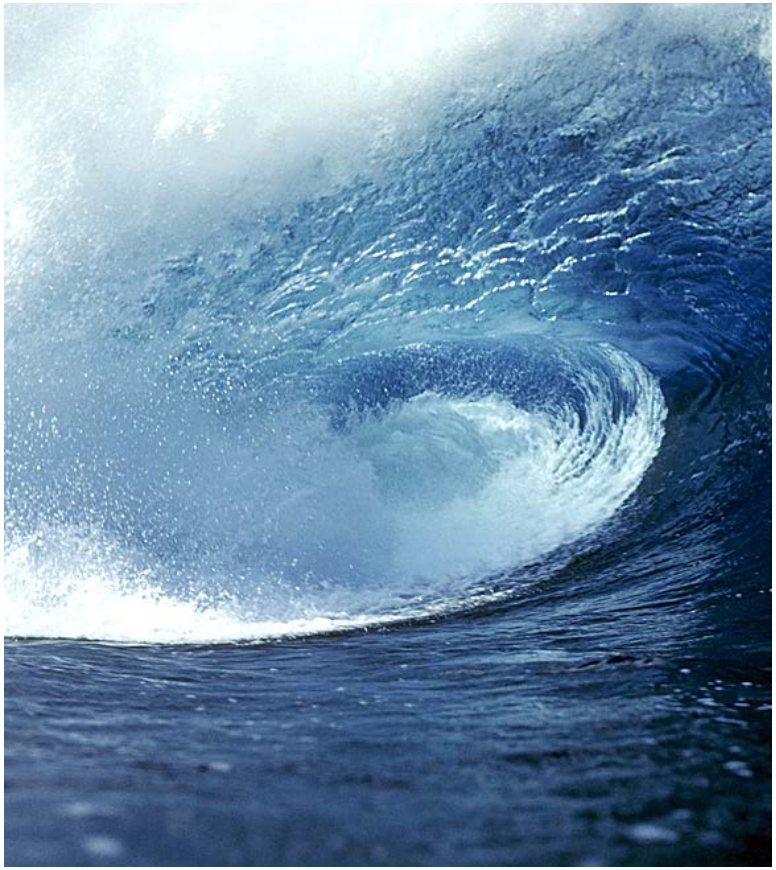
Scientists gather information from a volcanic fissure.

Scientists are not yet able to predict when earthquakes will happen. But fortunately they have gotten very good at predicting when a large volcano is about to erupt. In 1991, scientists warned the people living around a volcano in the country of the Philippines that the volcano was about to erupt. Many people left the area and found safety before the huge volcano erupted.

A very large volcano called Mount St. Helens erupted in Washington State on May 18, 1980. Mount St. Helens is part of a chain of volcanic mountains in the Cascade Mountain Range that runs throughout the Pacific Northwest where the Juan de Fuca tectonic plate meets the North American plate. The explosive power of the volcanic eruption completely destroyed the upper portions of the mountain and flattened all the trees in the forests for miles around. The resulting cloud of ash released into the atmosphere darkened the sky over a large part of the United States. The volcanic ash fell like snow for several hours in ten states following the eruption. The Mount St. Helens eruption was the deadliest in U.S. history, resulting in the deaths of fifty-seven people. It also destroyed homes, bridges, railroads, and highways.

Mount St. Helens, in Washington State, before it erupted in 1980

Mount St. Helens after it erupted



Tsunamis are the largest waves in the world.

Tsunamis: Wild Waves

Tsunamis are huge waves caused by earthquakes or volcanoes. They used to be called "tidal waves." But the word "tidal" means something to do with the ocean's normal tides, and tsunamis have nothing to do with the tides. Tsunamis can be as high as a football field is long. They are the largest waves in the world.

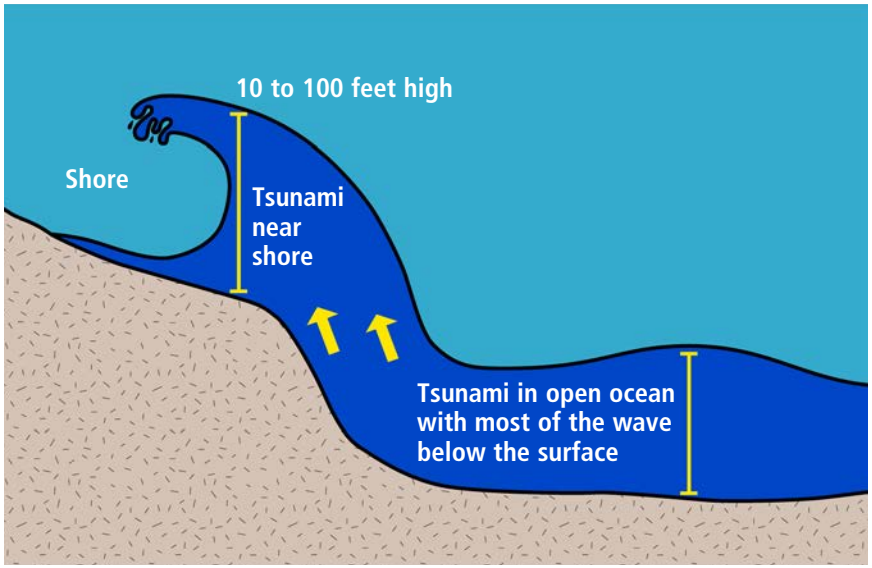
The edges of the plates, where earthquakes and volcanoes often occur, usually lie near the edges of the oceans. The shaking of an earthquake or the explosion of a volcano can cause large landslides. Entire hills can collapse, and sometimes they fall into the sea and make huge waves. Earthquakes and volcanoes can also be found under the sea. Underwater earthquakes cause the sea floor to move violently. Undersea volcanoes cause explosions under the water. Both of these events create huge waves that spread across the surface of the ocean.

Steam rises from a volcano near the sea.

Tsunamis speed outward away from their source in all directions. A tsunami can cross an entire ocean. Tsunamis travel extremely fast—up to 320 kilometers per hour (200 mph).

In the open ocean, tsunamis may not be very high above the surface of the water, but they are very deep. As tsunamis approach land and move into shallow water, the elevated ocean floor pushes the wave upward. The wave slows to about 70 kilometers per hour (45 mph), but the ocean floor lifts it higher and higher. By the time a tsunami reaches land, it is tall enough to destroy almost anything in its path.

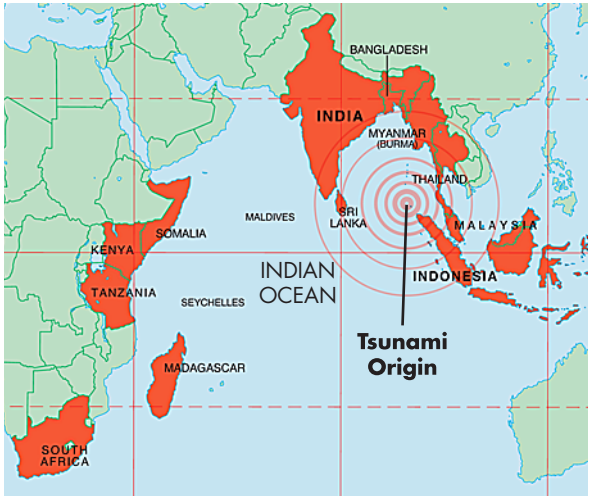
When a Tsunami Wave Reaches Shore



When tsunamis approach the shore, they break as giant waves.

Damage from a tsunami

The largest tsunami ever recorded happened when an earthquake triggered a landslide in a small Alaskan bay in 1958. The landslide splashed water 524 meters (1,720 ft) into the air and sent a giant tsunami racing down the bay. Most tsunamis are not that big—they are usually between one and ten stories high when they reach the shore. That might not sound very high, but it is hard to imagine the power of this much moving water. Most coastal towns and villages are much less than 30 meters (100 ft) above the sea. Even a small tsunami can destroy houses, streets, and entire towns. A tsunami caused by a volcano in Indonesia killed 36,000 people in 1883.



More recently, a large tsunami struck the countries bordering the Indian Ocean in 2004. The Indian Ocean Tsunami began when an earthquake occurred on the ocean floor near the western coast of Indonesia. The earthquake caused a ring of tsunami waves to speed outward from the point of origin, crossing hundreds and even thousands of kilometers of open ocean to strike countries far away. More than 225,000 people in eleven countries bordering the Indian Ocean were killed by the resulting waves. Satellite data analyzed after the tragedy showed that the height of the tsunami wave in the deep ocean was only 60 centimeters (2 ft). When the waves reached the shallow waters near the beaches, however, they often grew to reach over 24 meters (78 ft) tall. As a result of the 2004 Indian Ocean Tsunami, many countries are now working together to create a tsunami warning system for that part of the world.

Like volcanoes, tsunamis are becoming easier to predict. They usually do not hit the shore until a few minutes to a few hours after the earthquake or volcano that causes them. Scientists have instruments that detect volcanoes and earthquakes. When a large eruption or earthquake happens, scientists have time to warn people that a tsunami may be coming. Unfortunately, the system cannot warn people in time to save their homes or belongings. But they do have time to save their lives, which is the most important thing.

Conclusion

Our quiet planet occasionally turns violent. During a large earthquake, the ground shakes, destroying homes and property. In an explosive volcanic eruption, liquid rock, poisonous gases, ash, and landslides can bury cities. And tsunamis can cost billions of dollars in damage along coastlines. Scientists are trying to learn as much as they can about these violent events. As they learn more, scientists can predict volcanoes, earthquakes, and tsunamis in order to save thousands of lives.

Glossary

earthquake *(n.)* the shaking of Earth's crust caused by underground vibrations (p. 4)

faults *(n.)* cracks in Earth's crust along which movement occurs (p. 5)

landslides *(n.)* moving masses of soil and rock that flow down slopes (p. 14)

magma *(n.)* melted, liquid rock beneath Earth's surface (p. 6)

mudslide *(n.)* a dirt- and debris-filled flood of water (p. 15)

Richter scale *(n.)* the scale that measures the strength of earthquakes (p. 9)

tectonic plates *(n.)* large sheets of rock and soil that make up Earth's crust (p. 5)

tsunamis *(n.)* enormous ocean waves caused by underwater earthquakes, landslides, or volcanoes (p. 4)

volcanoes *(n.)* places on the Earth's surface where gases, ash, and lava spew onto the surface (p. 4)