

# Be an Engineer!

Use the engineering design process to design a structure that will protect a coastal town from possible tsunami damage. Brainstorm design ideas for your structure with a group of classmates. Select and draw your own design. With your group, review one another's designs. Revise your own design as needed on the basis of feedback.

Now build a model of your design using materials your teacher provides. Conduct a test of your model. In a plastic shoebox, make a model coastline that includes sediment, buildings, plants, and people. Pour water in to fill up the "ocean." Then place your model where you think it will do the most good. Use your hand to make waves and test your structure. Observe how well it protects your coastal town. Improve your design as needed based on your observations. Revise and retest your model. Share your results with the class.



## Beyond the Book

Use the Internet to watch a video simulation of how the 2011 tsunami in Japan formed.

FOCUS Book

# *TSUNAMI!*

Science A-Z 

# TSUNAMI!

 **FOCUS Question**

What are the causes and effects of tsunamis?

Cause and Effect

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## What Is a Tsunami?

A giant wall of water swamps a coastal town in mere minutes. This is no regular ocean wave—it's a tsunami!

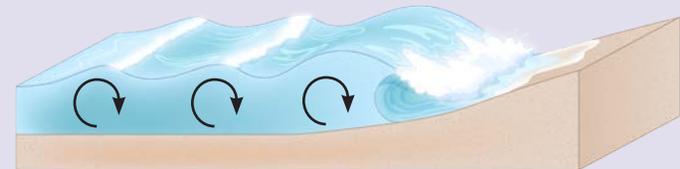
A tsunami (tsoo-NAH-mee) is a group of huge ocean waves that rush onshore. Regular ocean waves are caused by wind, but tsunami waves are caused by sudden movements of the ocean floor.

Tsunami waves are fast and dangerous, traveling far across the ocean at up to 966 kilometers per hour (600 mph) before they reach land. That's faster than a jet airplane!

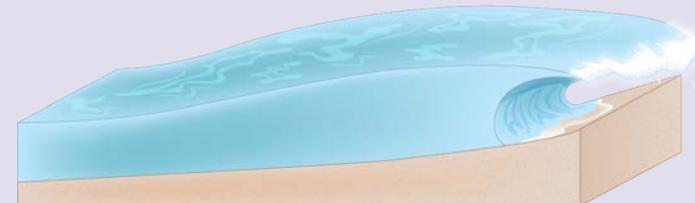
### Word Wise

Tsunamis are not "tidal waves." Tsunamis are caused by geologic movements, not by tides.

### COMPARING REGULAR WAVES TO TSUNAMIS



Waves formed by the wind come and go without flooding higher areas.



A tsunami wave runs quickly over the land as a wall of water.

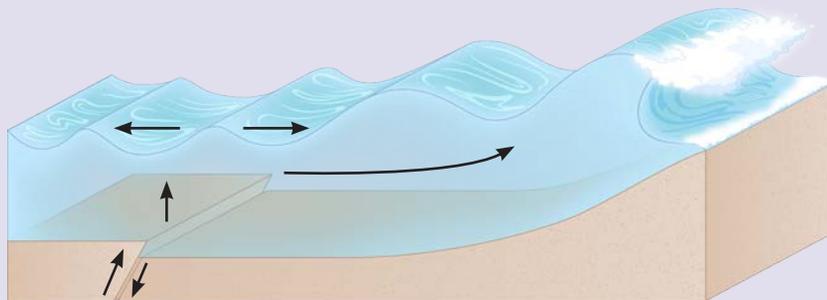
# Making Waves

Underwater earthquakes are the most common cause of tsunamis. Earth's surface is made up of many enormous, rocky plates. Earthquakes happen where two plates rub together and slide past each other.

When an earthquake shakes the land under an ocean, the seafloor gets pushed up. This force pushes on the water and can trigger a tsunami. The waves that form move outward in every direction from the source of the earthquake. Several of Earth's plates meet in the Pacific Ocean. Earthquakes and tsunamis occur more frequently there than in other places.

Of course, earthquakes don't only happen under the ocean. They sometimes cause *landslides* that suddenly force rocks and soil into the ocean. This sudden movement is another cause of tsunamis.

HOW AN EARTHQUAKE CAUSES A TSUNAMI

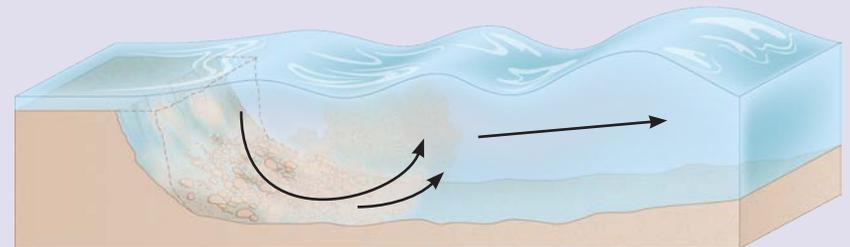


An earthquake causes the ocean floor to push up on the water above it, sending out powerful tsunami-force waves.

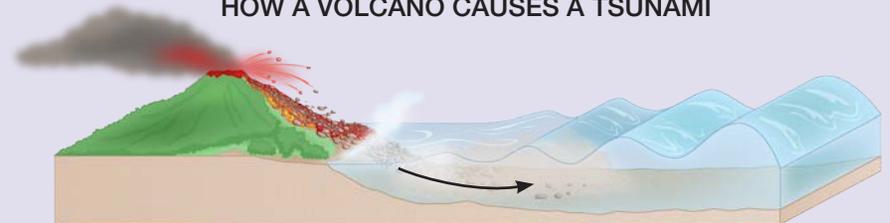
Landslides also happen underwater when large amounts of rock and dirt on the ocean floor move suddenly. If this disturbance is strong enough to affect the water above, a tsunami forms. In 1998, a terrible tsunami hit the coast of Papua New Guinea. This tsunami was caused by an underwater landslide.

Volcanic eruptions above and below the ocean's surface can also result in powerful waves. When volcanoes erupt, rock and debris fall into the ocean and push the water, causing a tsunami. In 1883, a volcano known as Krakatau erupted in Indonesia, causing a tsunami that harmed people hundreds of kilometers away.

HOW A LANDSLIDE CAUSES A TSUNAMI



HOW A VOLCANO CAUSES A TSUNAMI



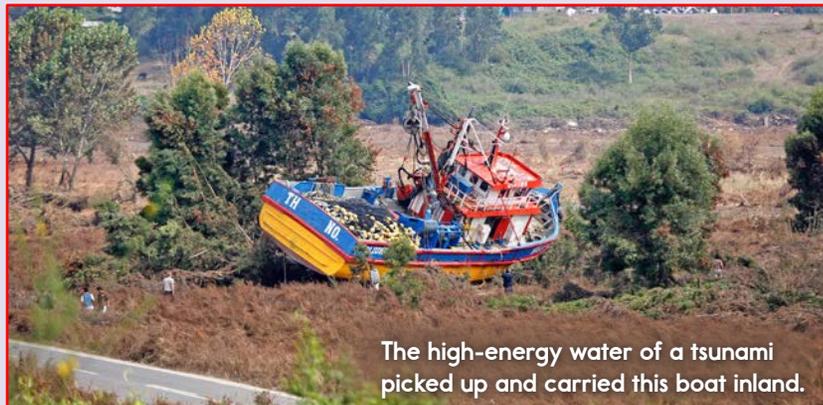
During an underwater landslide, the ocean floor shifts, disturbing the water above. A volcano sends rocky material into the ocean, causing a tsunami to travel out from the shore.

## Hazards and Warnings

Whatever the cause, a tsunami is a *natural hazard*—a natural event that causes damage and endangers people.

Any low area near a coast is at risk. At first, a tsunami may cause the water near the shore to retreat, making a beach seem bigger and exposing the ocean floor. Then the first wave hits. The danger can last for hours afterward as more waves keep hitting.

The waves can flood the land hundreds of meters inland with a wall of fast-moving water, taking many lives in the process. On beaches, they can cause *erosion*—the destruction of an area as sand, sediment, rocks, and plants are cleared away by the force of the water. Waves can easily sweep up heavy boulders, boats, and cars, carrying them inland. The waves can also destroy buildings, bridges, and roads.



The high-energy water of a tsunami picked up and carried this boat inland.

Because they can happen very suddenly, earthquakes, landslides, and volcanic eruptions are hard to predict. As a result, scientists do not know where or when the next tsunami will strike. But once a tsunami starts, they can detect it with special machines.

Tsunami warning centers are run by scientists working all around the world. These experts use tsunami detectors placed in the deep ocean to record movements of the water. Then they use computer models to predict where and when the dangerous waves may hit. The centers warn officials of the threat with the hope of reducing the loss of life and property.



### Fact or Fiction?

Objects from space can cause tsunamis. That's a fact! About two million years ago, a huge asteroid struck the ocean near Chile. It caused a tsunami that swamped parts of South America and Antarctica.

This buoy (BOO-ee) floating in the deep ocean is attached to a tsunami detector on the ocean floor. It relays data to tsunami warning centers by satellite.

## Learning from the Past

Tsunamis are part of Earth's history. By studying these mighty waves, we can learn more about them and hopefully reduce their danger to us.

On December 26, 2004, the largest magnitude earthquake in forty years shook the Indian Ocean and triggered a tsunami. Waves spread out and caused terrible damage. Five million people in eighteen countries around the Indian Ocean were affected. Almost three hundred thousand people died, and many others were hurt and lost their homes.

Many people were caught by surprise because there was no tsunami warning system for the Indian Ocean. Since then, people have learned from this disaster, and a warning system has been set up for the area. It will be put to the test the next time a tsunami hits.



Before



After

These aerial views show that the city of Banda Aceh in Indonesia was destroyed by the 2004 tsunami in the Indian Ocean.

Japan is still recovering from a tsunami that struck on March 11, 2011. It was caused by a large earthquake in the Pacific Ocean just off the coast of Japan. Waves up to 38 meters (125 ft.) high pounded the coast and destroyed more than 330,000 buildings as well as railways, roads, and bridges. Entire coastal towns were destroyed, and more than 15,000 people lost their lives. Damage, including to a nuclear power plant, exceeded 300 billion dollars.

Some towns had structures such as seawalls, floodgates, breakwaters, and dikes that were designed to block high waves. Many of these structures worked, but others were too low to stop the massive waves.



This 15.5-meter (51 ft.) high floodgate and seawall protected Fudai, Japan, from the 2011 tsunami. Since then, many similar structures have been built along the coast of Japan to reduce a tsunami's impact.

## Tsunami Safety

If you live near or visit the ocean, what can you do to stay safe from a tsunami? Be prepared by learning all you can about tsunamis, and then share what you know with family and friends.

That's how Tilly Smith, a ten-year-old British girl, saved more than one hundred people in 2004. Tilly had learned about tsunamis in school. She and her family were on vacation in Thailand when she noticed the ocean quickly retreat from the shore. Tilly remembered that this could occur when a tsunami is approaching. She told her family and other people at the beach. Because of her warnings, those people were able to move away from the water before the tsunami struck.



Tilly Smith's knowledge of tsunamis helped save many lives during the 2004 tsunami in Thailand.

**Be Safe!**

The best way to be safe from a tsunami is to go to higher ground before the powerful waves strike.



## Read-Think-Write

Write your answers on separate paper. Use details from the text as evidence.

- 1 What is a *tsunami*?
- 2 Look at the diagrams on page 2. How are regular ocean waves similar to tsunamis? How are they different?
- 3 What is the cause of most tsunamis?
- 4 Suppose a friend claimed that the erosion on a beach in Indonesia (a group of islands in the Pacific Ocean) was caused by a tsunami. Explain why you would agree or disagree.
- 5 What are two things you can do to stay safe from a tsunami?

### FOCUS Question

What are the causes and effects of tsunamis? Think about what caused the 2011 tsunami in Japan and its effects. Imagine you are a writer for a news blog. Write a blog post summarizing the cause and effects of the tsunami.

