

A large volcano is shown erupting, with a massive, billowing plume of white ash and smoke rising high into a clear blue sky. The volcano's conical shape is visible, and the ash plume has a distinct cauliflower-like texture. In the foreground, there are some green plants and a utility pole with a light fixture on the right side.

# Unit 19: Natural Disasters

- What is a natural disaster?
- How do tropical storms, volcanic eruptions, earthquakes and tsunamis occur?
- How are they dangerous?
- What are the signs when natural disasters are approaching?

# 19.1 Natural Disasters



What is a natural disaster?

A natural disaster is a result of a natural occurrence that affects the Earth's surface and the surrounding environment. It is natural because it occurs without human involvement. It causes great destruction to property and leads to loss of human lives.



A natural disaster is different from a man-made disaster. A man-made disaster is a result of human error and accidents. It is similar to a natural disaster because it causes great destruction to property and loss of human lives.



A natural disaster causes great destruction. Thus, we need to know the warning signs before it approaches. Only then can we be better prepared and take precautionary measures to avoid getting hurt.

Some examples of natural disasters are:

- tropical storms
- volcanic eruptions
- earthquakes
- tsunamis



# 19.2 Tropical Storms

How are tropical storms dangerous?

A tropical storm is a strong spiral of wind that forms over warm waters.

## Dangers of Tropical Storms

Tropical storms can destroy the environment with its strong winds, violent thunderstorms and heavy rain. Property as well as human lives can be lost when this natural disaster strikes.





Here are some ways in which tropical storms can be destructive.

The powerful winds can pick up objects from the ground and lift them high up into the air, before moving and flinging them somewhere else, which can be hundreds of kilometers away.



When a tropical storm strikes the land, nearby coastal areas are affected by the huge waves created by hurricanes out at sea.



## Signs of Approaching Tropical Storms

Although scientists have not found a way to prevent tropical storms, they are able to detect them.

Satellites take pictures of the Earth from space. The pictures are taken over a period of time and they are able to show the direction and speed of the wind, clouds and storms.

When a hurricane is detected, the pictures help scientists to estimate the temperature and rainfall in different parts of the hurricane, which can be used to determine its strength and course.



Aircrafts also fly to an approaching hurricane to collect more accurate weather information. At the same time, ships measure the temperature of the sea around the hurricane. Hurricanes often get stronger when moving towards warmer water. As the hurricanes get nearer to land, weather **radars** on land are able to track and monitor them too.



What are the different names for tropical storms?

Tropical storms are known by different names based on their locations.

## Hurricane

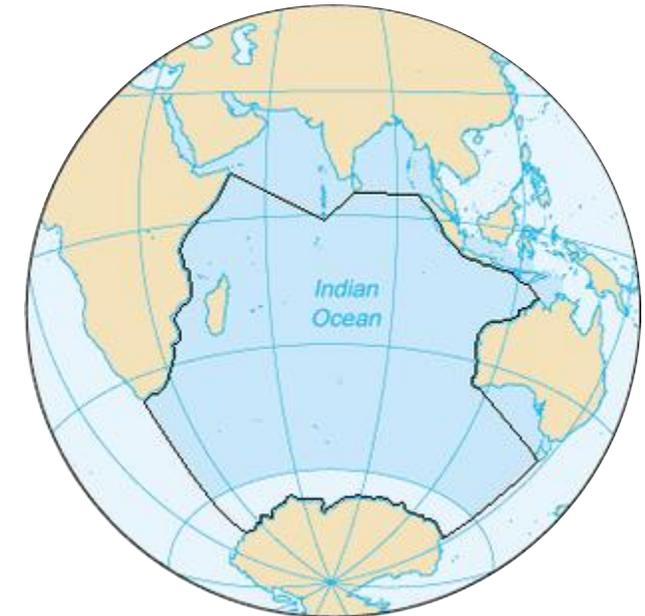
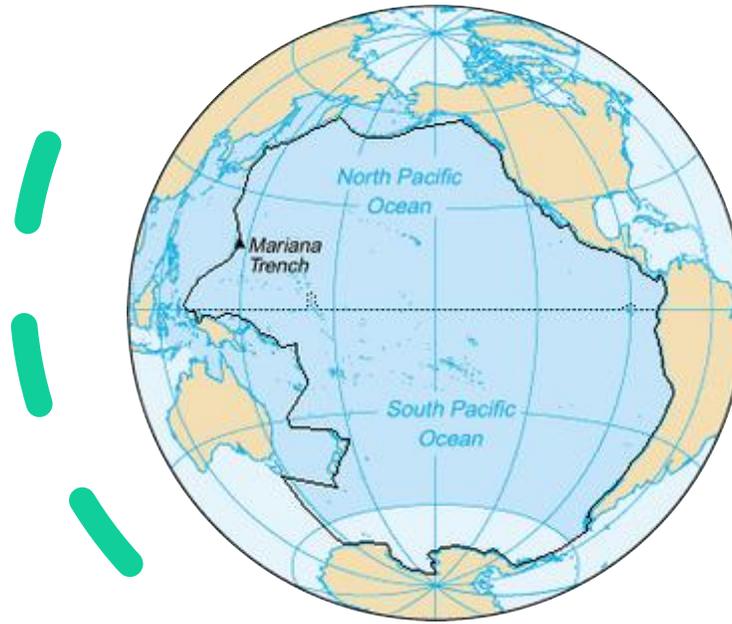
- North Atlantic Ocean and the Northeast Pacific

## Typhoon

- Northwest Pacific

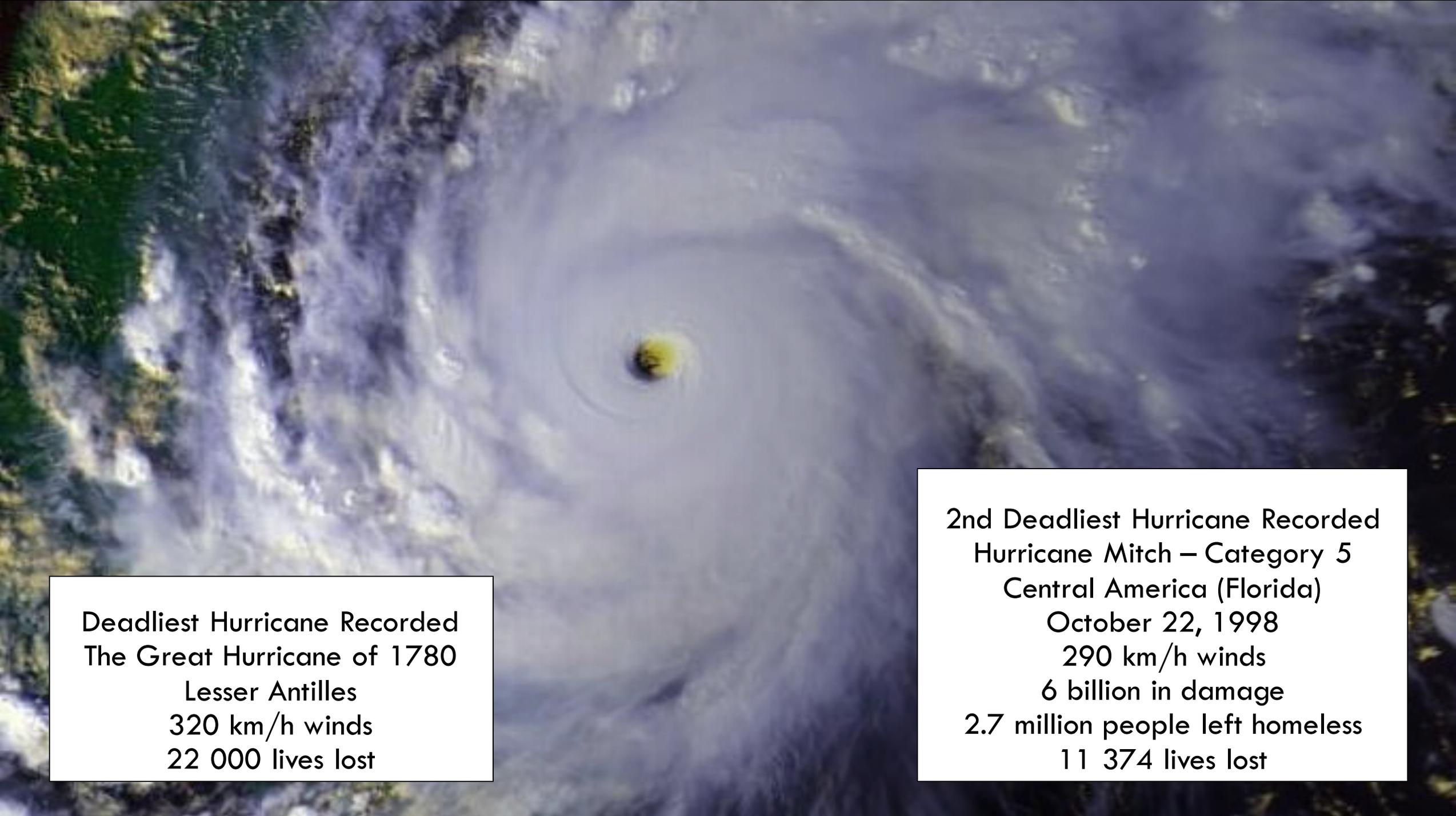
## Cyclone

- South Pacific and Indian Ocean



# Following a Hurricane





Deadliest Hurricane Recorded  
The Great Hurricane of 1780

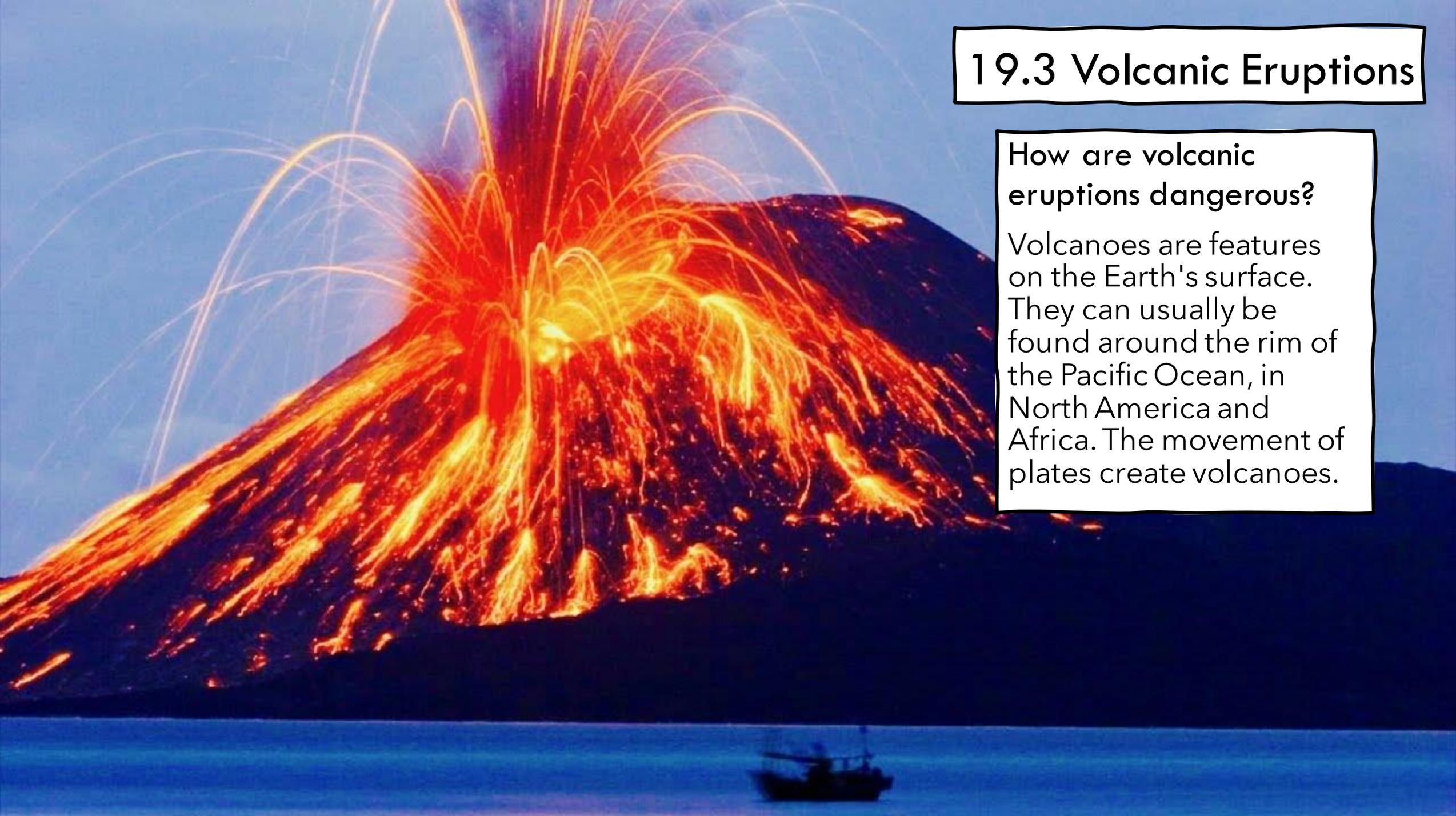
Lesser Antilles  
320 km/h winds  
22 000 lives lost

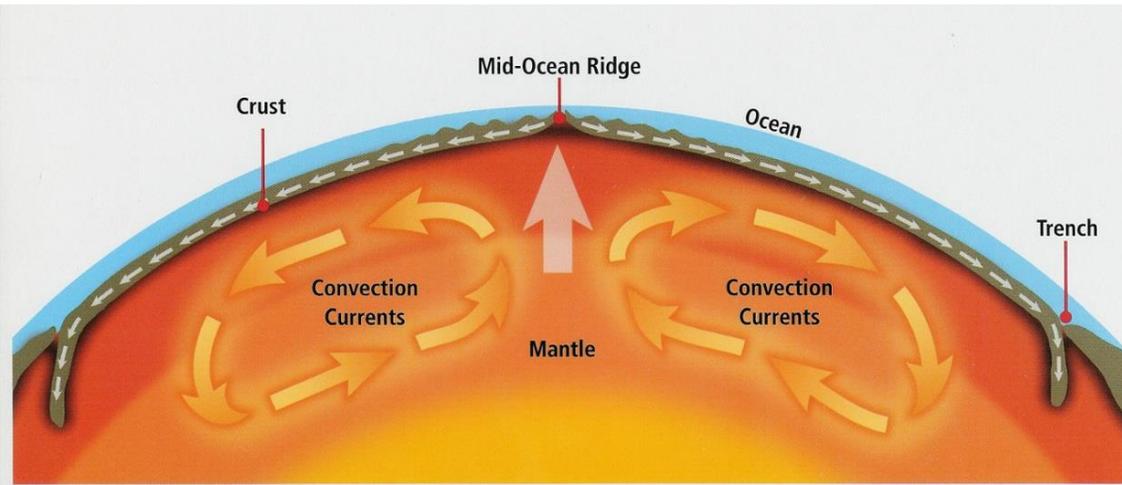
2nd Deadliest Hurricane Recorded  
Hurricane Mitch – Category 5  
Central America (Florida)  
October 22, 1998  
290 km/h winds  
6 billion in damage  
2.7 million people left homeless  
11 374 lives lost

## 19.3 Volcanic Eruptions

How are volcanic eruptions dangerous?

Volcanoes are features on the Earth's surface. They can usually be found around the rim of the Pacific Ocean, in North America and Africa. The movement of plates create volcanoes.

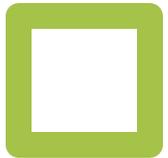




According to one theory, convection currents in Earth's mantle drag along tectonic plates. Here the currents move two plates apart.

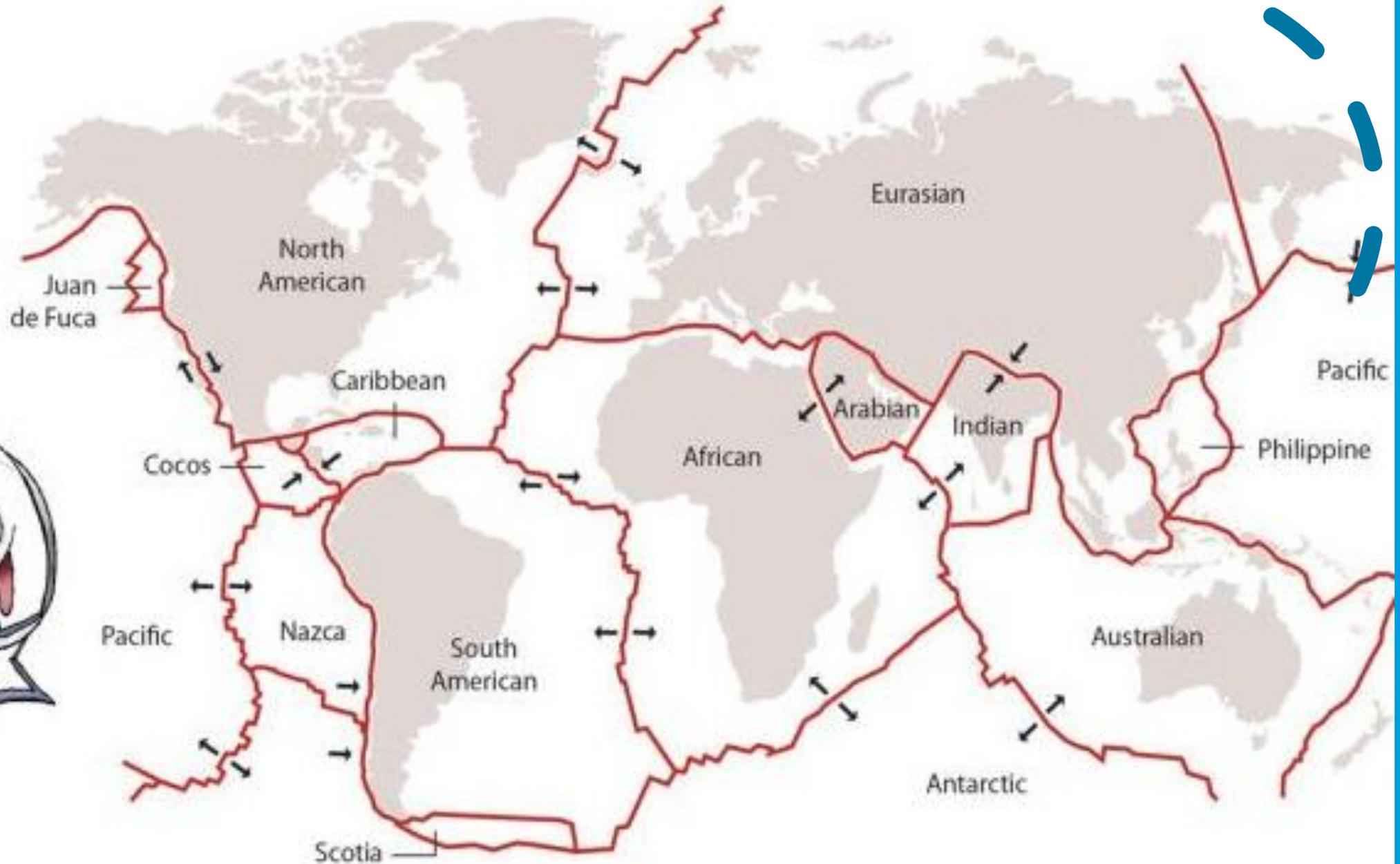
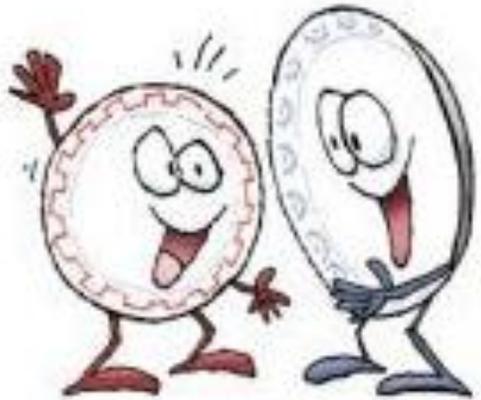
## Let us see what causes plates to move:

1. The magma in the mantle beneath the Earth's crust is heated up by the hot inner core.
2. The magma rises towards the surface as it gets heated. The cooler magma sinks towards the core to be heated up again.
3. This sets up convection currents in the mantle and causes the plates to move in different directions. This is known as the **plate tectonics theory**.

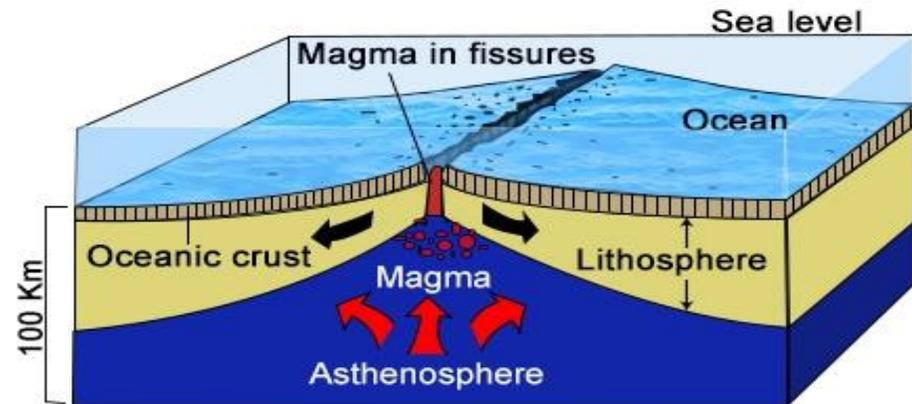
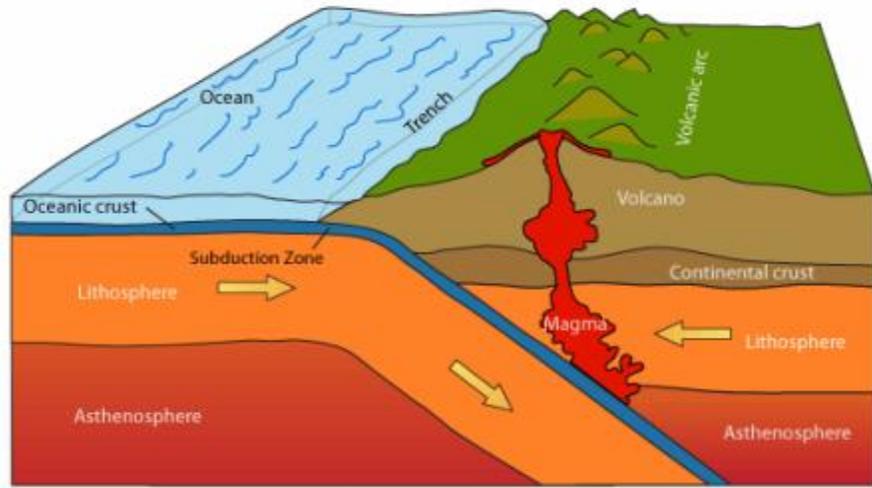


## ■ The plates

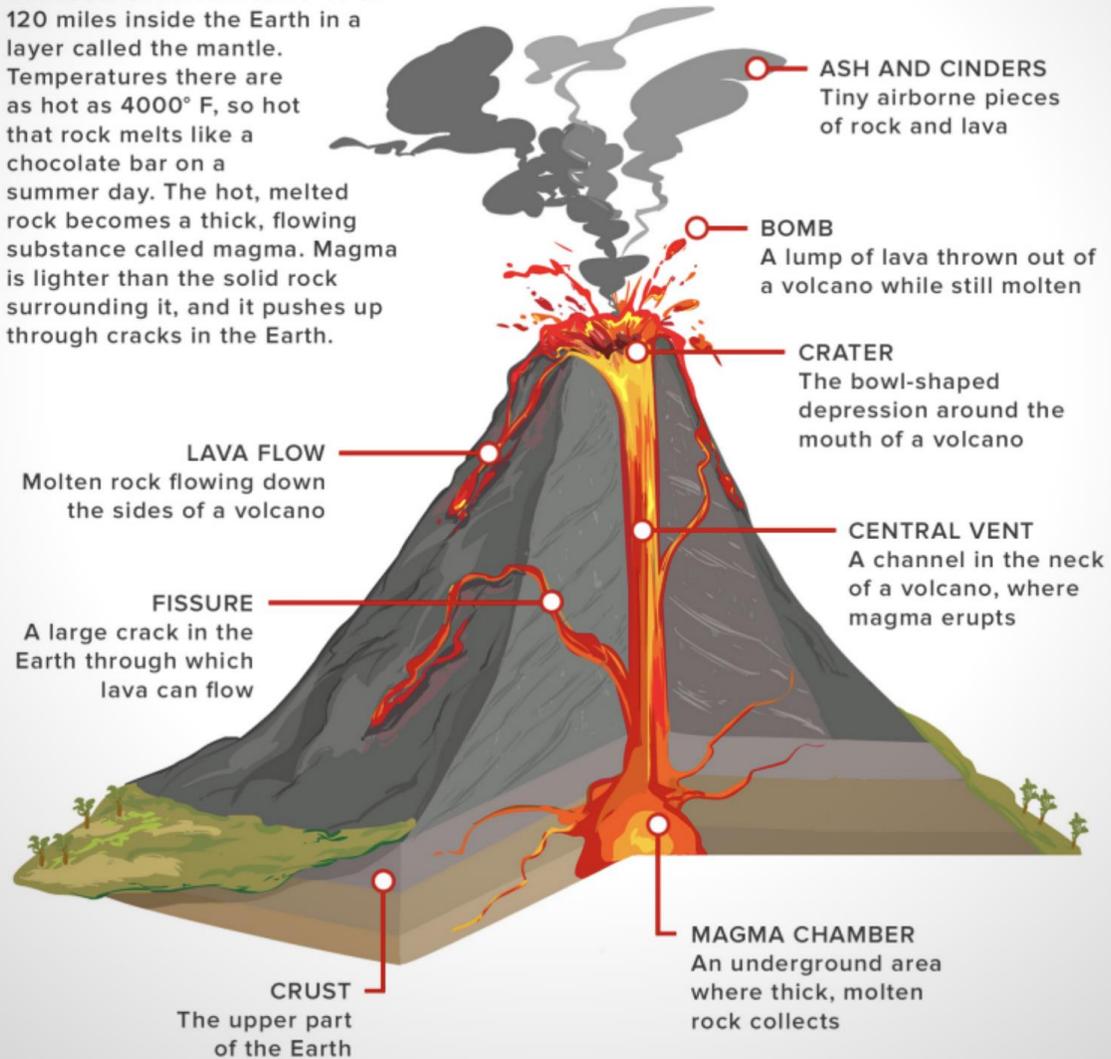
Earth's outermost layer is fragmented into plates that are moving relative to one another as they sit on top of the hot, semifluid material beneath them.



Volcanoes can form on land and in the ocean.



The roots of volcanoes lie 40 to 120 miles inside the Earth in a layer called the mantle. Temperatures there are as hot as 4000° F, so hot that rock melts like a chocolate bar on a summer day. The hot, melted rock becomes a thick, flowing substance called magma. Magma is lighter than the solid rock surrounding it, and it pushes up through cracks in the Earth.

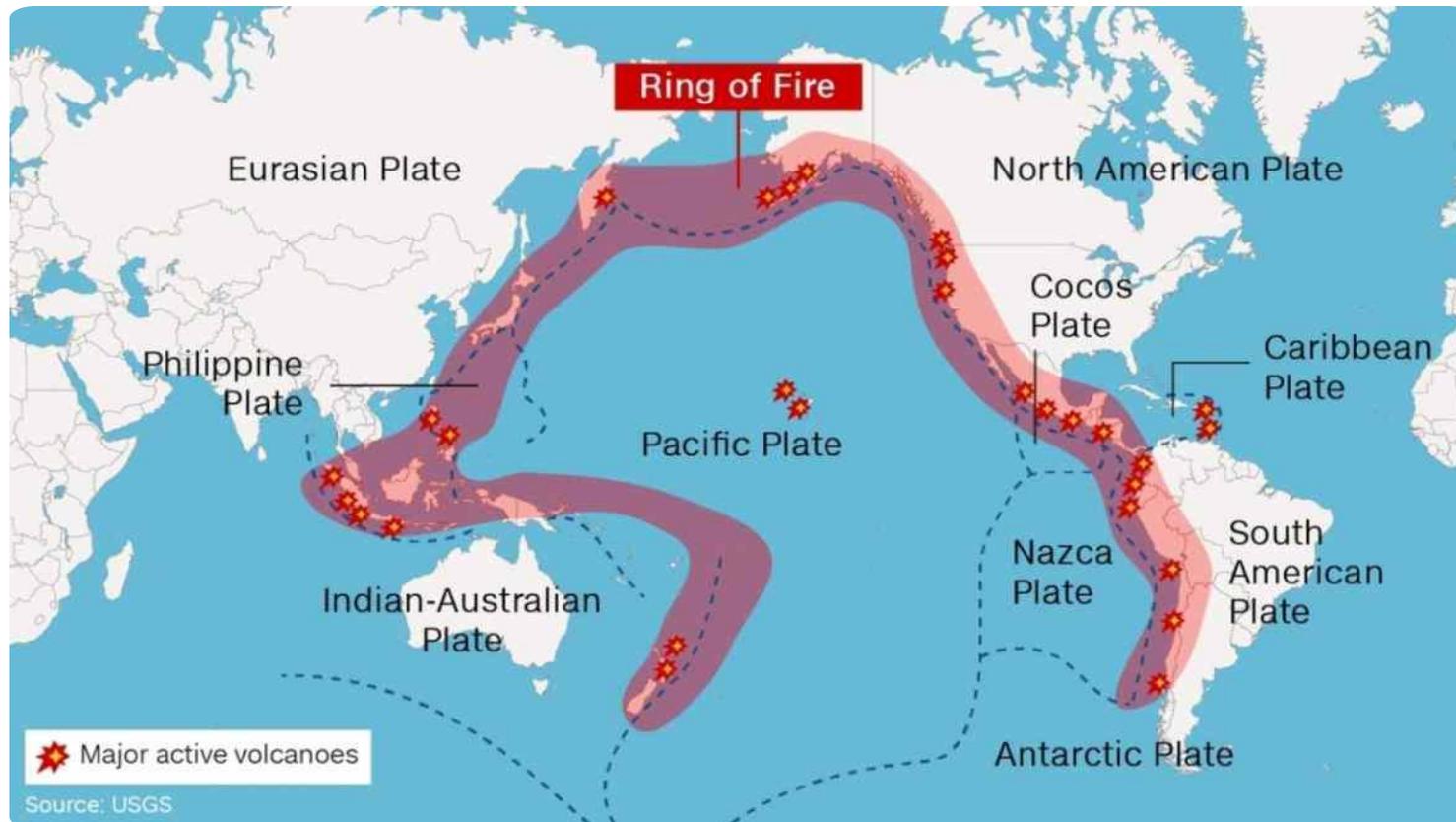


## Let us see how a volcanic eruption occurs.

- The high pressure and temperature in the Earth's mantle forces the hot magma up the Earth's crust or surface.
- The central **vent** of the volcano may become blocked with solidified magma. Pressure then builds up in the **magma chamber**. When the pressure is high enough, the magma may have enough force to shoot itself through the vent and out of the top of the volcano, or the **crater**. A volcanic eruption will then occur.

# Active Volcanoes

An **active volcano** is one that erupted regularly in the past and will do so again in the future. Some countries like the Philippines and Indonesia have many active volcanoes. This is because they are located along a belt around the Pacific Ocean called the **Pacific Ring of Fire**.

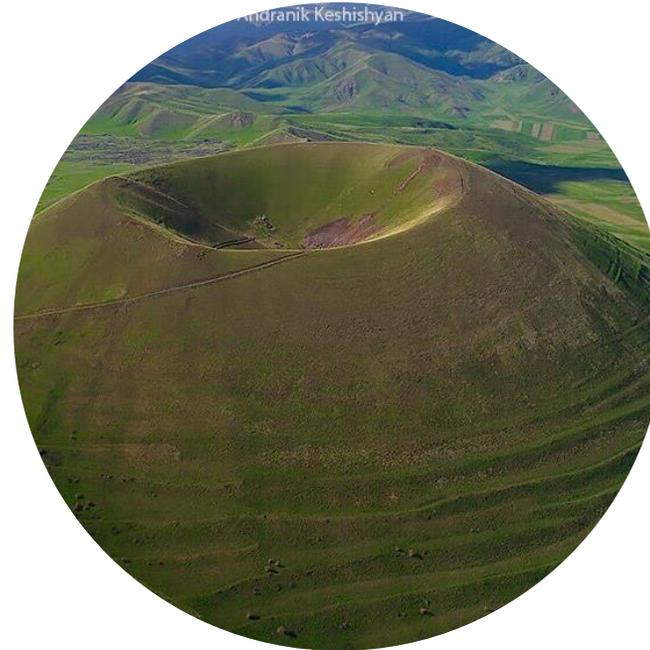


The Pacific Ring of Fire consists of many volcanoes because this is where there is a lot of plate movements. Many islands that are formed in this area are formed due to volcanic activity and plate movements. For example, Java, an island of Indonesia, consists of a chain of mountains and many old volcanoes.

# Java, Indonesia



Volcanic activity also occurs in places such as Hawaii, Iceland and at the bottom of the Pacific Ocean. There are also other types of volcanoes. A **dormant** volcano is one that is currently inactive but may erupt again. An **extinct volcano** is one that scientists consider unlikely to erupt anymore.



# Dangers of Volcanic Eruptions

Some volcanic eruptions are **explosive**. During a volcanic eruption, ash and very big rocks are thrown out of the volcano which can cause great damage to the surrounding physical environment, plants and animals in the area. The hot lava can destroy property. The smoke and ash can fill the air and cause breathing difficulties to humans.



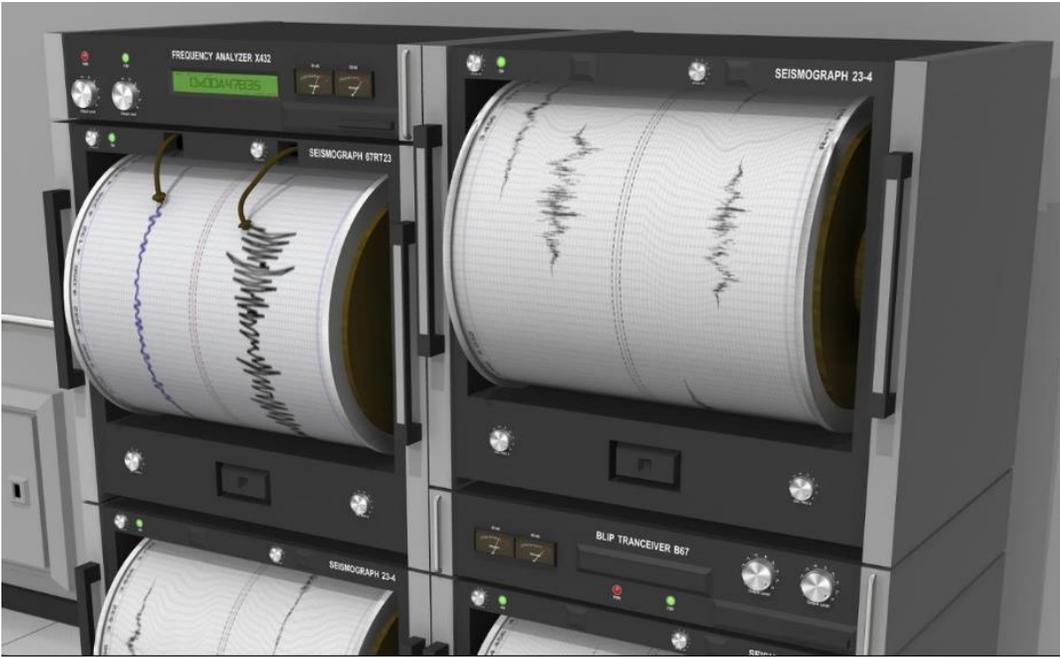
## **Misconception:**

Volcanic eruptions only have negative effects.



## **Actual Fact:**

Volcanic eruptions have some benefits. Volcanic ash makes the soil near the volcano very fertile for the growing of crops. The heat energy released from a volcano can be used to generate electricity.

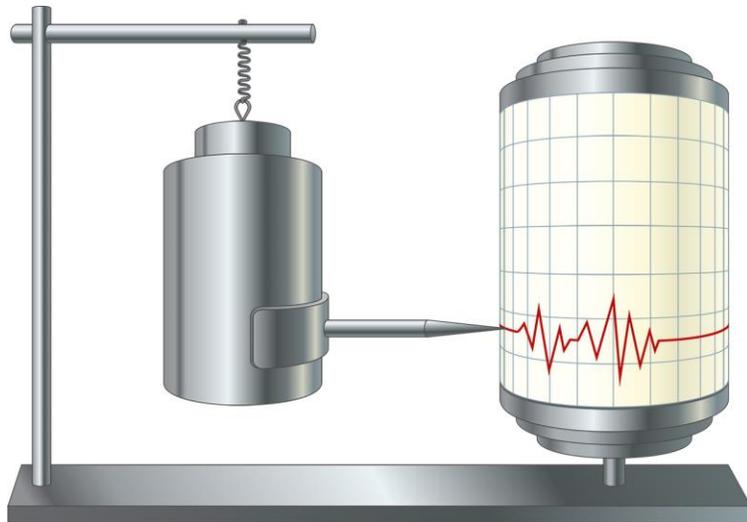
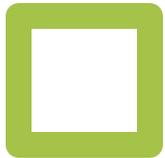


## Signs of Approaching Volcanic Eruption

Being able to predict a volcanic eruption is very important since volcanic eruptions can be very destructive. The instruments used to predict an eruption are a **seismograph** and a **seismometer**.

Satellites also monitor any changes in the land around a volcano. Gas and steam emissions are also measured from volcanoes as they usually increase just before a volcanic eruption.

Sometimes, the magma rising out of the chamber causes the surrounding land to tremble. These **tremors** can be detected and scientists working in a nearby **observatory** can interpret the readings to determine if an eruption is approaching.





Most Devastating Volcanic Eruption  
Mt Tambora, Indonesia  
April 10, 1815  
Volcanic ash 40 km into the sky  
120 000 lives lost

## 19.4 Earthquakes

How are earthquakes dangerous?

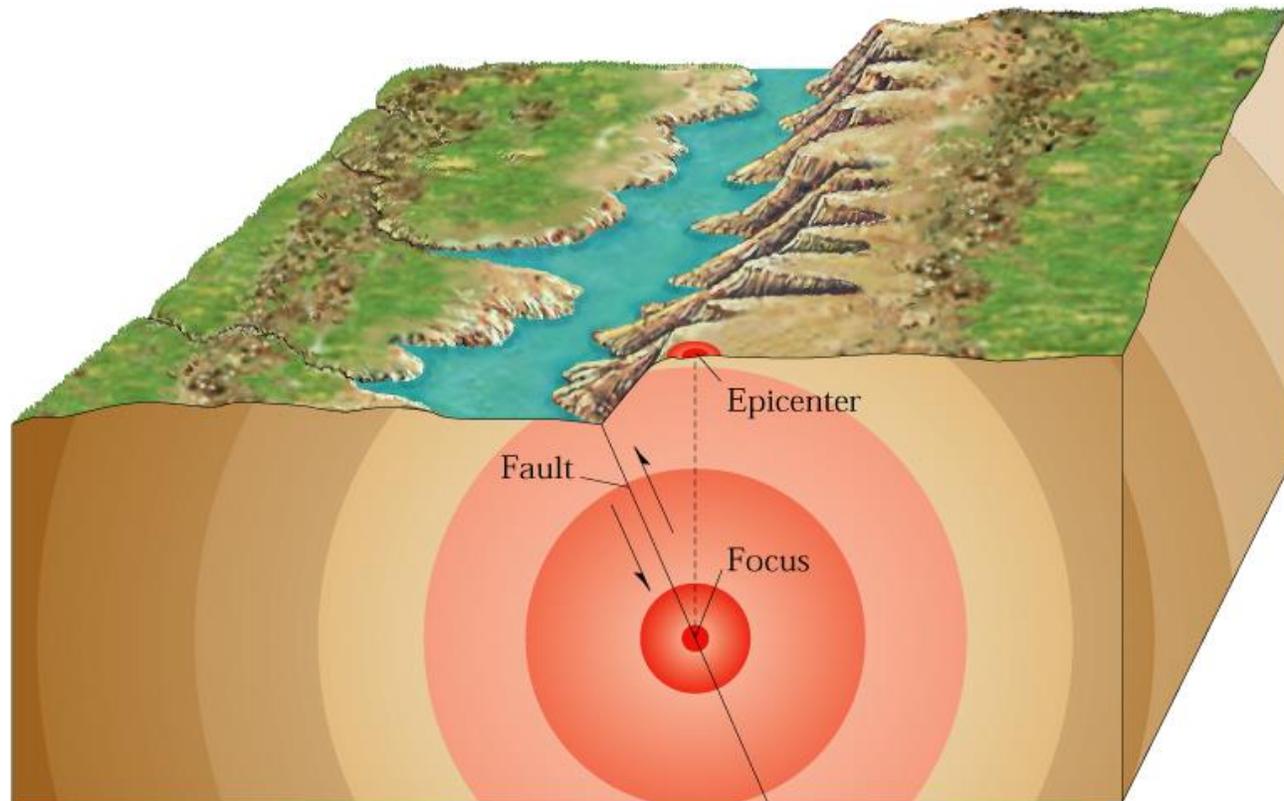
Earthquakes usually occur along **fault lines**. Volcanic activity can also cause earthquakes.

A **fault** is an area of stress in the earth where the different parts of the land are not moving in the same direction. This causes cracks in the Earth's surface known as **fault lines**.



# Measuring Earthquakes

The **epicentre** of the earthquake is the place on the Earth's surface directly above where the earthquake originated from. As we go further away from the epicentre, the energy of the earthquake weakens, and the shaking is less intense.

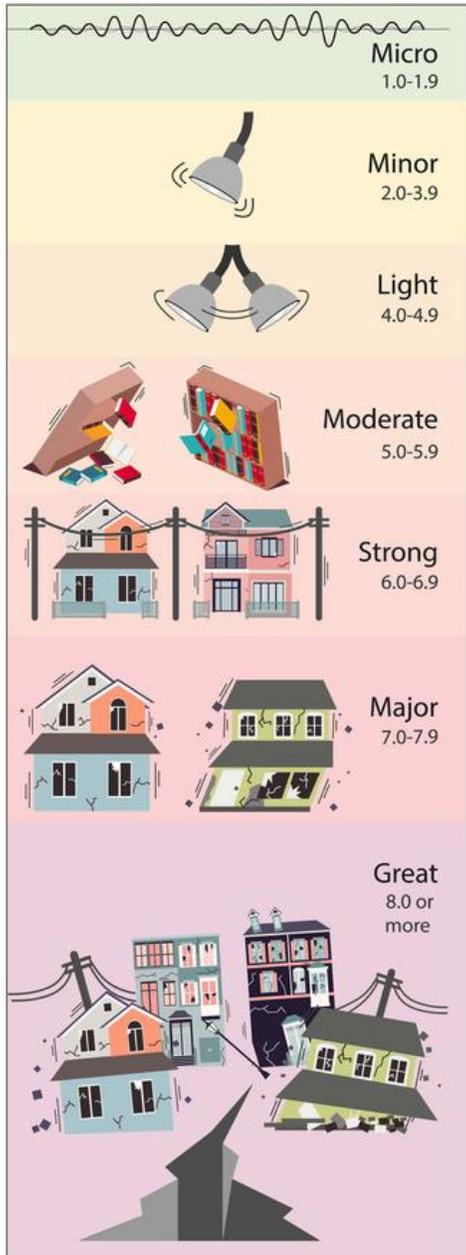


The sudden movement of the Earth's crust or surface creates **seismic waves**. This results in earthquakes.

A seismograph measures the seismic waves and records them in a seismometer. These instruments detect and record the movement of the Earth's crust.



## EARTHQUAKE MAGNITUDE SCALE



The seismograph will show large deflections when the earth is shaking vigorously. Scientists calculate how much energy was released in an earthquake from the seismograph, in order to decide its **magnitude**. The **Richter scale**, which is a standard scale used to compare earthquakes, gives the magnitude of an earthquake. The scale starts from 0 and ends at 10.

# The Richter Scale

The Richter magnitude scale was developed in 1935 by **Charles Richter** as a mathematical device to measure the magnitude of an earthquake - that is the amount of energy it released.

1. Most people cannot feel it. Normally only recorded by seismographs. Frequency: Millions per year
2. Few people will feel the quake. Frequency: Over 1 million per year
3. Some people may feel the quake. Objects inside can be seen shaking. Frequency: 100,000+ per year
4. Most people feel it. The quake will cause damage around the epicentre. Objects may shake or fall to the floor. Frequency: 10,000 to 15,000 per year
5. Can damage or destroy weak buildings. Everyone will feel it. Frequency: 1,000 to 1,500 per year
6. Wide spread shaking far from the epicentre. Buildings likely to be damaged. Frequency: 100 to 150 per year
7. Causes widespread damage in most areas. Frequency: 10 to 15 per year
8. The ground actually rises & falls, causing severe damage, death & destruction covering a widespread area. Frequency: Around 1 per year
9. Total destruction, devastating areas over hundreds of miles. Frequency: Rare

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# Dangers of Earthquakes

Earthquakes can be extremely dangerous because scientists cannot predict exactly when and where they may occur. We can only prepare for an earthquake but cannot avoid one. Also, **aftershocks**, which are earthquakes that happen soon after the first one, may cause more harm as people may think that it is safe after the first earthquake is over.





## Signs of Approaching Earthquakes

Currently, scientists do not have any reliable way to predict when an earthquake will occur or specify an exact location.

Sometimes, however, the physical environment and the animals give us signs. For example, there was an earthquake that occurred in China in 1975. In the months before this earthquake, there were changes in land and its height above sea level as well as ground water levels. There were also many reports of strange animal behaviours or mass animal migration. There were many small shakes which increased in frequency and intensity.

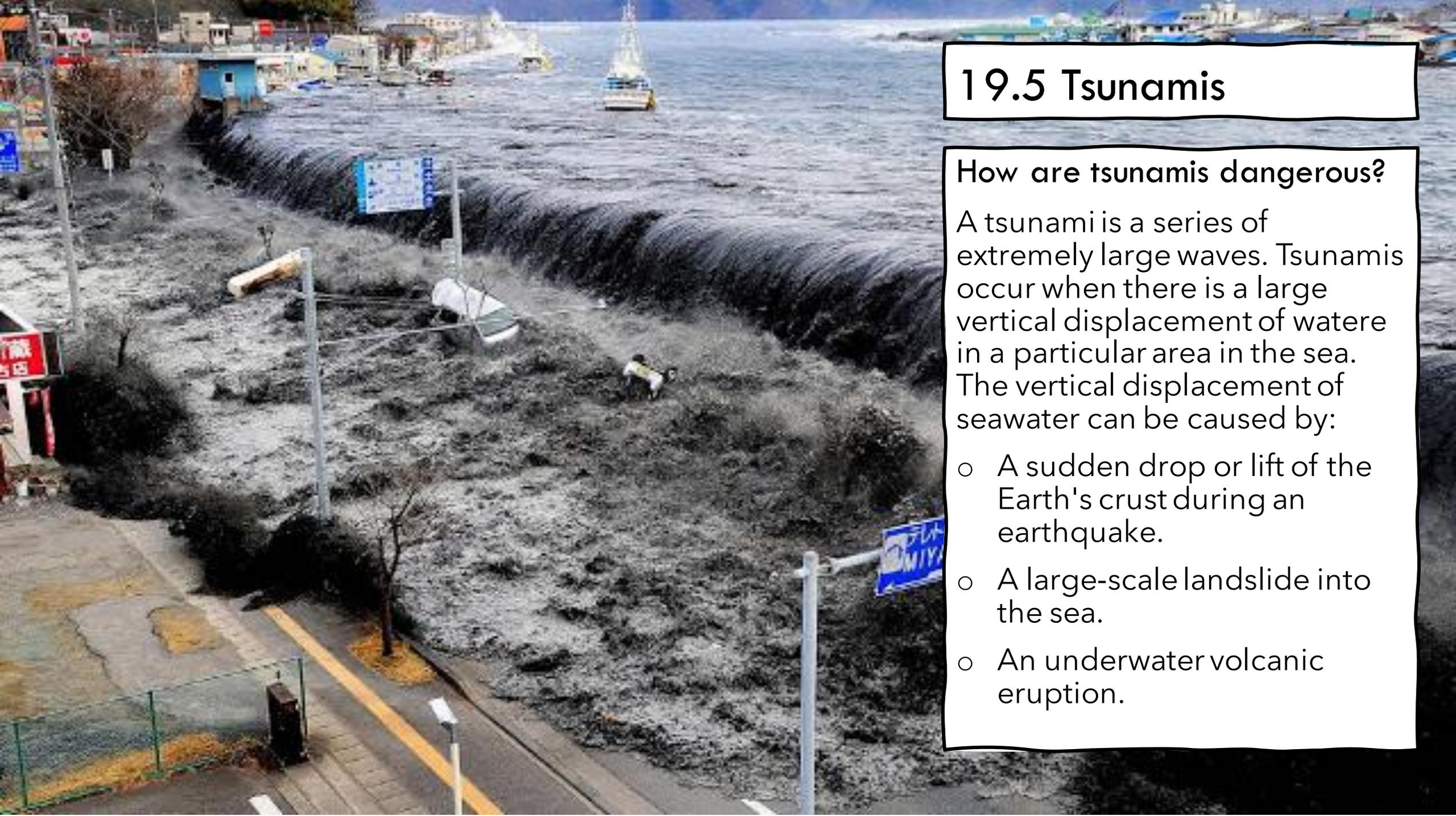
Unfortunately, most earthquakes do not have such obvious signs.





Biggest Recorded Earthquake  
Valdivia, Chile  
May 22, 1960  
9.5 on the Richter scale  
2 000 000 people displaced  
1 655 lives lost





## 19.5 Tsunamis

**How are tsunamis dangerous?**

A tsunami is a series of extremely large waves. Tsunamis occur when there is a large vertical displacement of water in a particular area in the sea. The vertical displacement of seawater can be caused by:

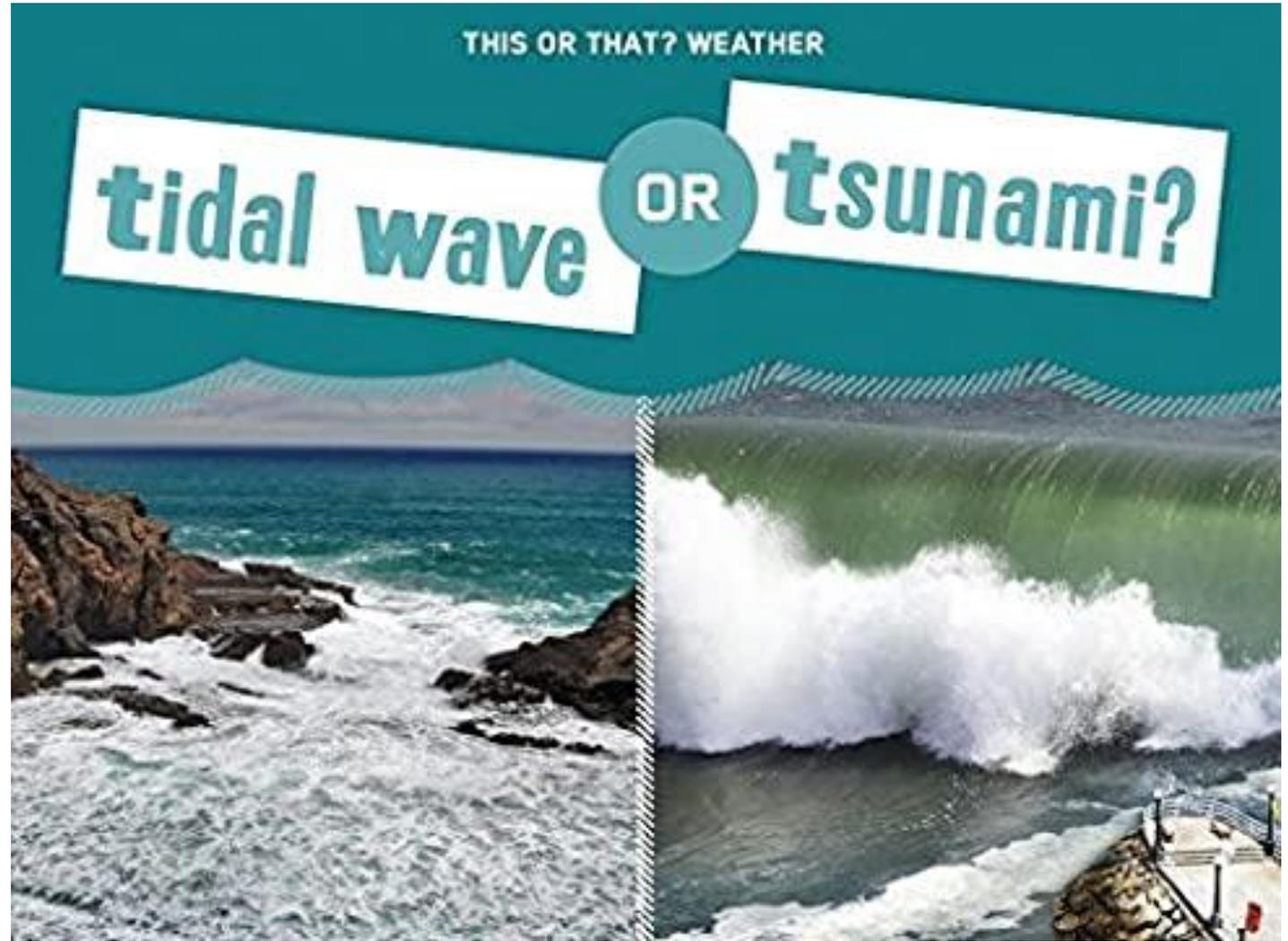
- A sudden drop or lift of the Earth's crust during an earthquake.
- A large-scale landslide into the sea.
- An underwater volcanic eruption.

## Misconception:

Tsunamis are tidal waves.

## Actual Fact:

Tsunamis are not tidal waves as they occur from a large vertical displacement of seawater caused by movements of the Earth's surface. On the other hand, tidal waves are caused by the pull of the gravitational force of the Moon on the Earth. Tsunamis are also different from the waves and currents generated by wind.



The vast majority of tsunamis result from earthquakes. Let us see how this happens.

Sudden rising or sinking of a particular area in the seabed during an earthquake causes a rapid displacement of seawater, triggering a series of large waves. crash onto the shore.

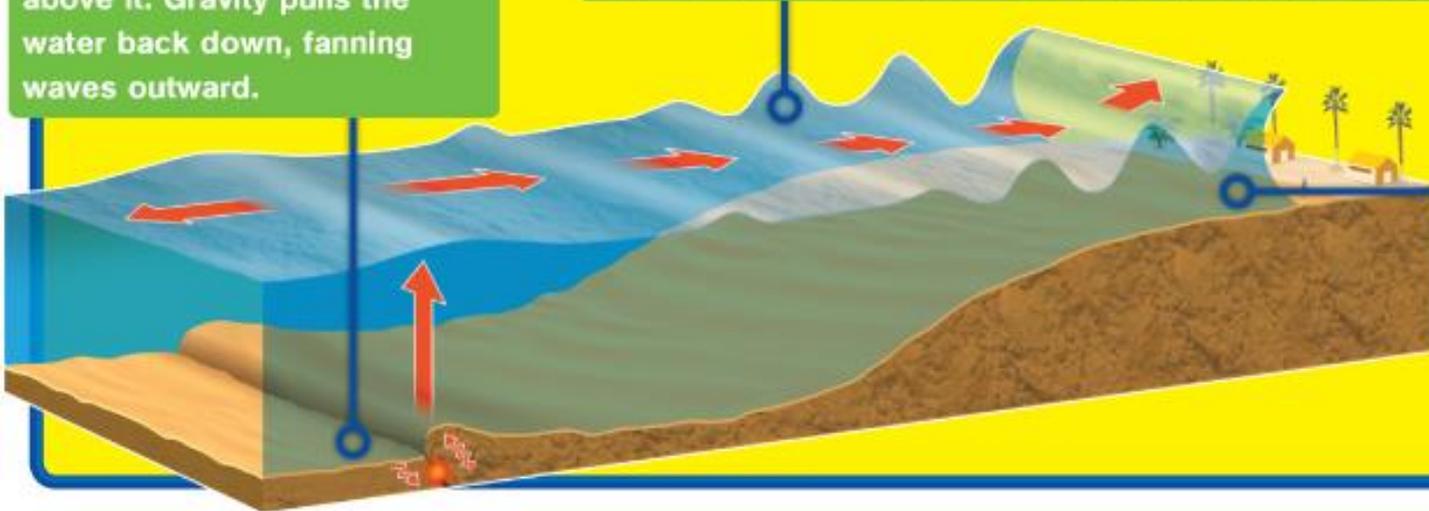
## HOW A TSUNAMI FORMS

**1** An underwater earthquake occurs; the seafloor snaps up, lifting a column of water above it. Gravity pulls the water back down, fanning waves outward.

**2** Individual waves in a tsunami are spread out: The distance between two wave peaks, called the *wavelength*, can be hundreds of kilometers long. Each wave's *amplitude*, or height, is rarely more than 0.9 meters (3 feet) at first.

**3** As waves meet the continental slope and shallower water, wavelength decreases and wave amplitude rises.

This generates waves out in the sea. As the waves approach the shore and shallower water, they increase in height. These large waves then crash onto the shore.





## Explore

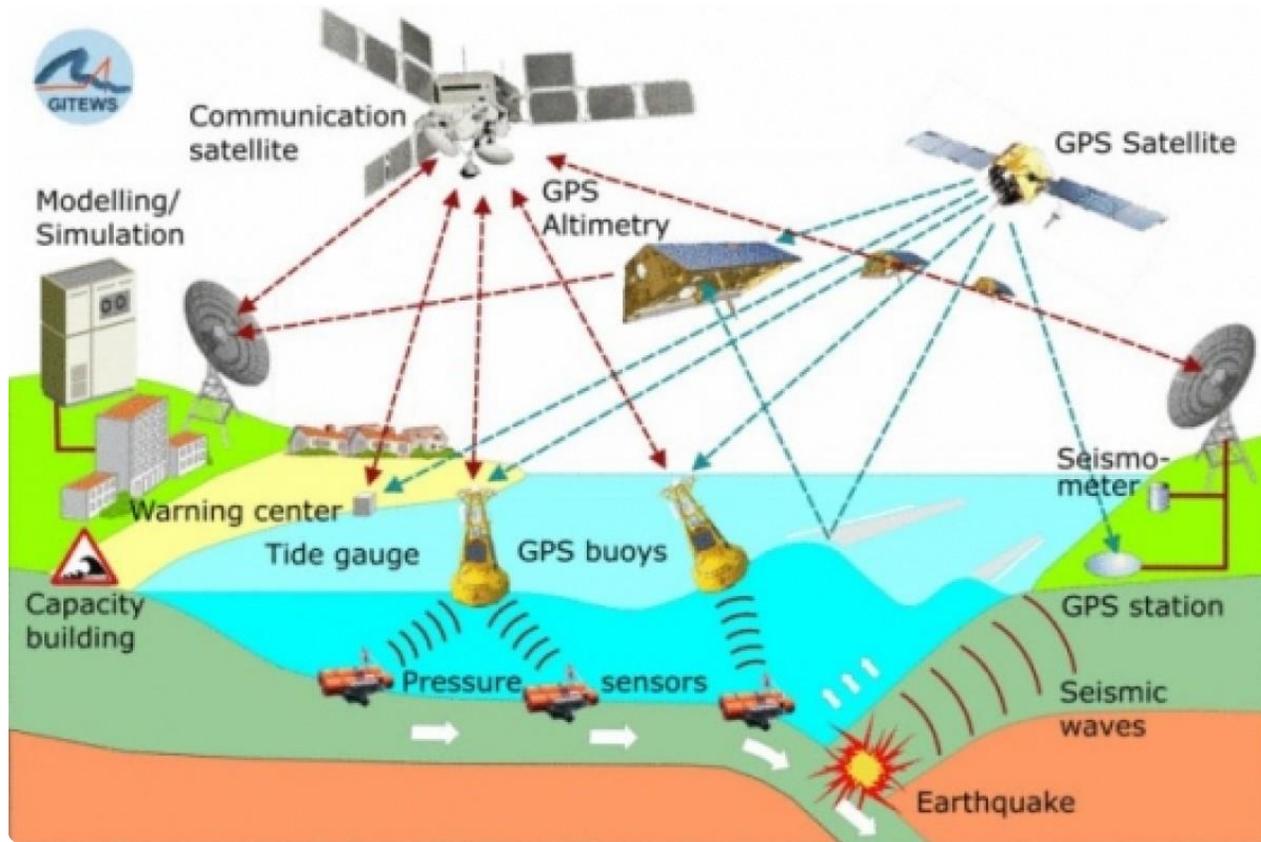
**How are tsunami waves similar to the actions of jumping into or out of a swimming pool that creates water waves?**

The movements of the person cause water in the swimming pool to be displaced quickly and waves to be generated. Likewise, tsunami waves are generated when there is a large vertical displacement of water due to movements of the Earth's surface.



# Dangers of Tsunamis

As tsunamis carry a lot of energy with them, they are very powerful. When they hit the shore, they can destroy coastal properties and human lives. The receding waves can also carry objects far out into the ocean.



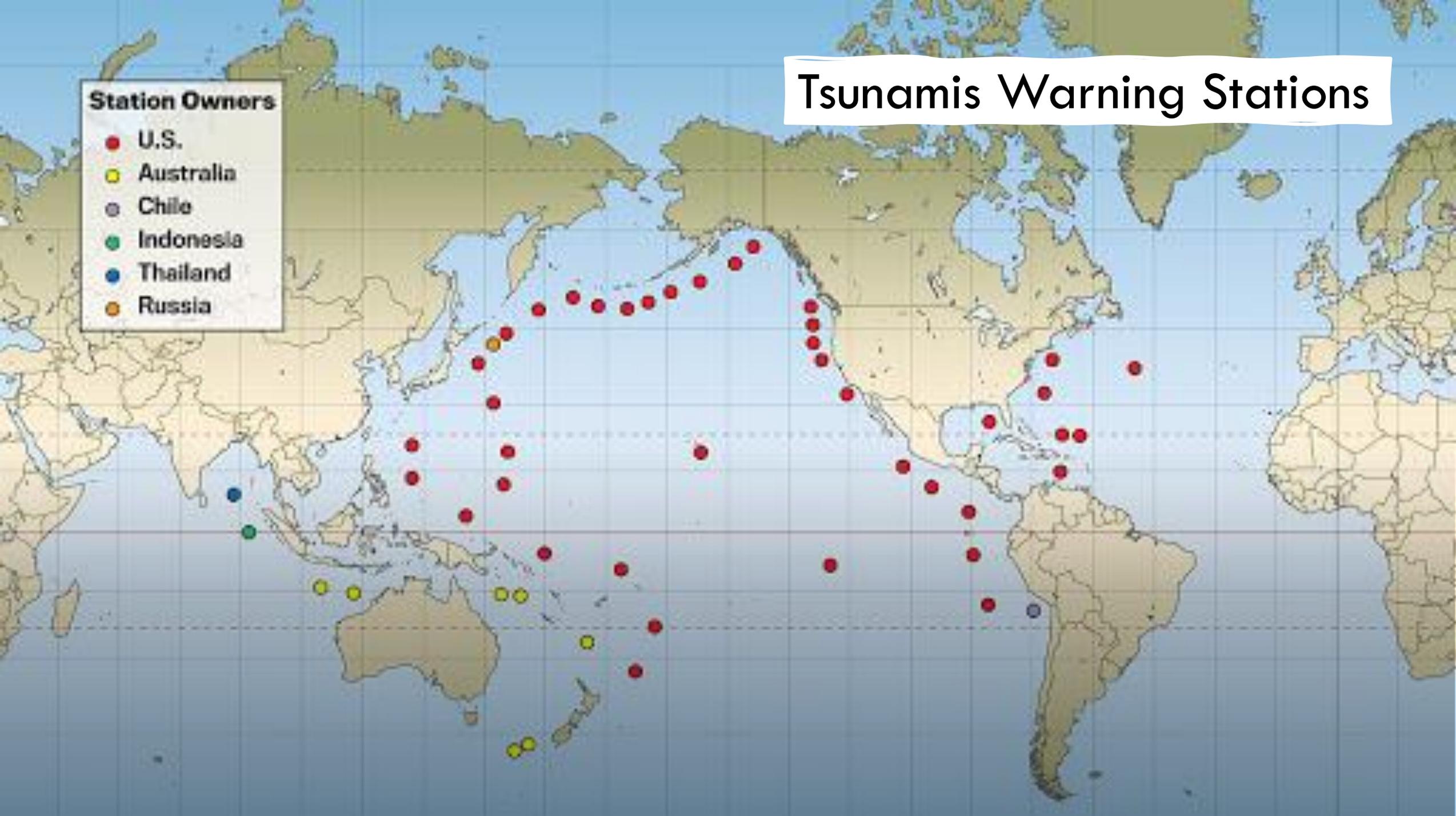
## Signs of Approaching Tsunamis

There is an international system to detect tsunamis and issue warnings to prevent the loss of lives. This is known as the tsunami warning system. It consists of a network of sensors to detect tsunamis and earthquakes, and a communications system to issue warning alarms to coastal areas. Although not all earthquakes will result in tsunamis, a possible tsunami forecast can be determined by scientists. They will decide if a tsunami warning should also be issued.

Currently, tsunami warnings can be delivered through text messaging through mobile phones.

# Tsunamis Warning Stations

- Station Owners**
- U.S.
  - Australia
  - Chile
  - Indonesia
  - Thailand
  - Russia

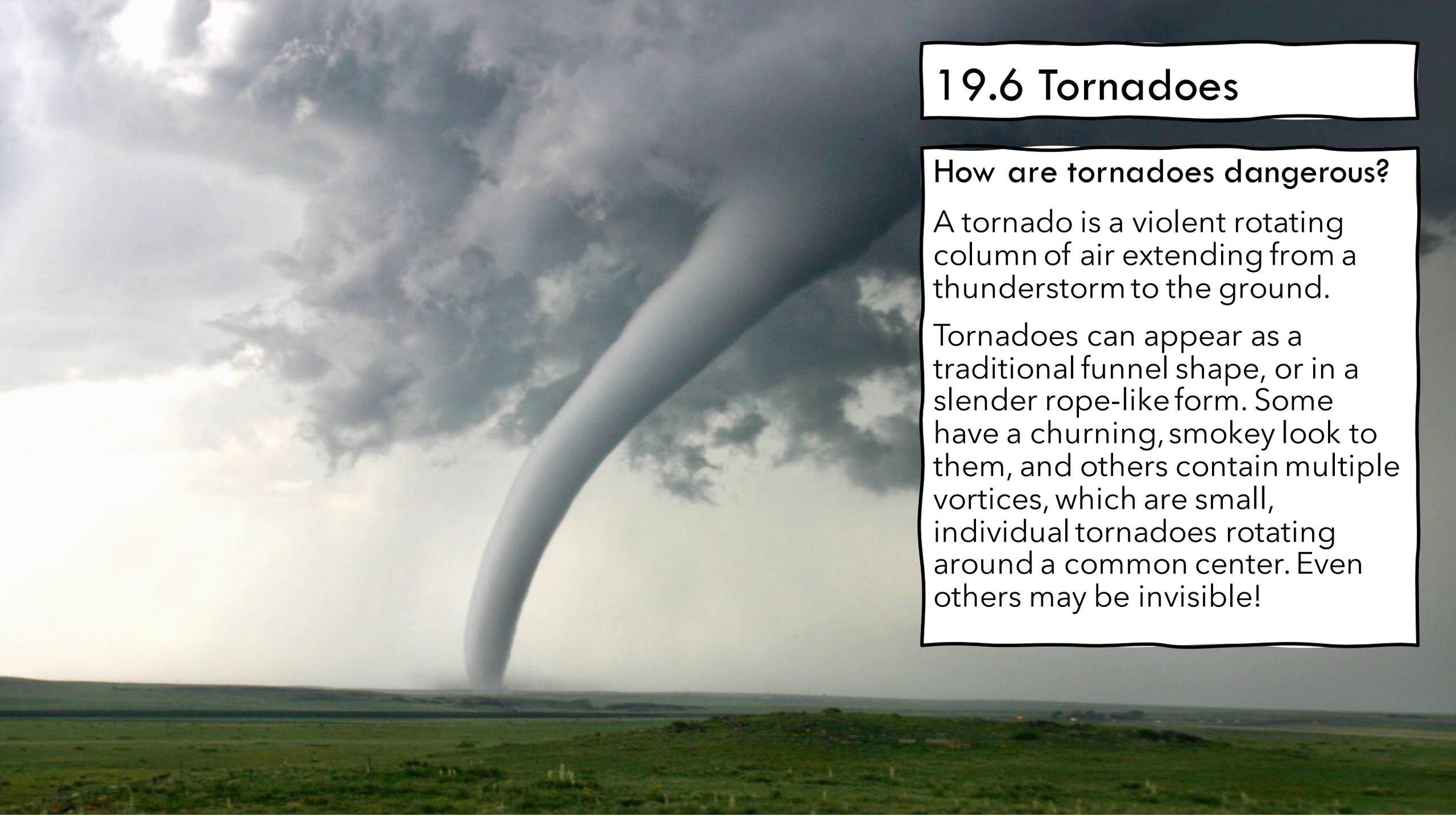




Large meteorites hitting the Earth can also cause tsunamis. If the meteorites land in the seas and oceans, they may trigger large tsunamis.



Most Destructive Tsunami  
Sumatra, Indonesia  
December 26, 2004  
50 m tall and reaching 5 km inland  
10 billion in damages  
230 000 lives lost

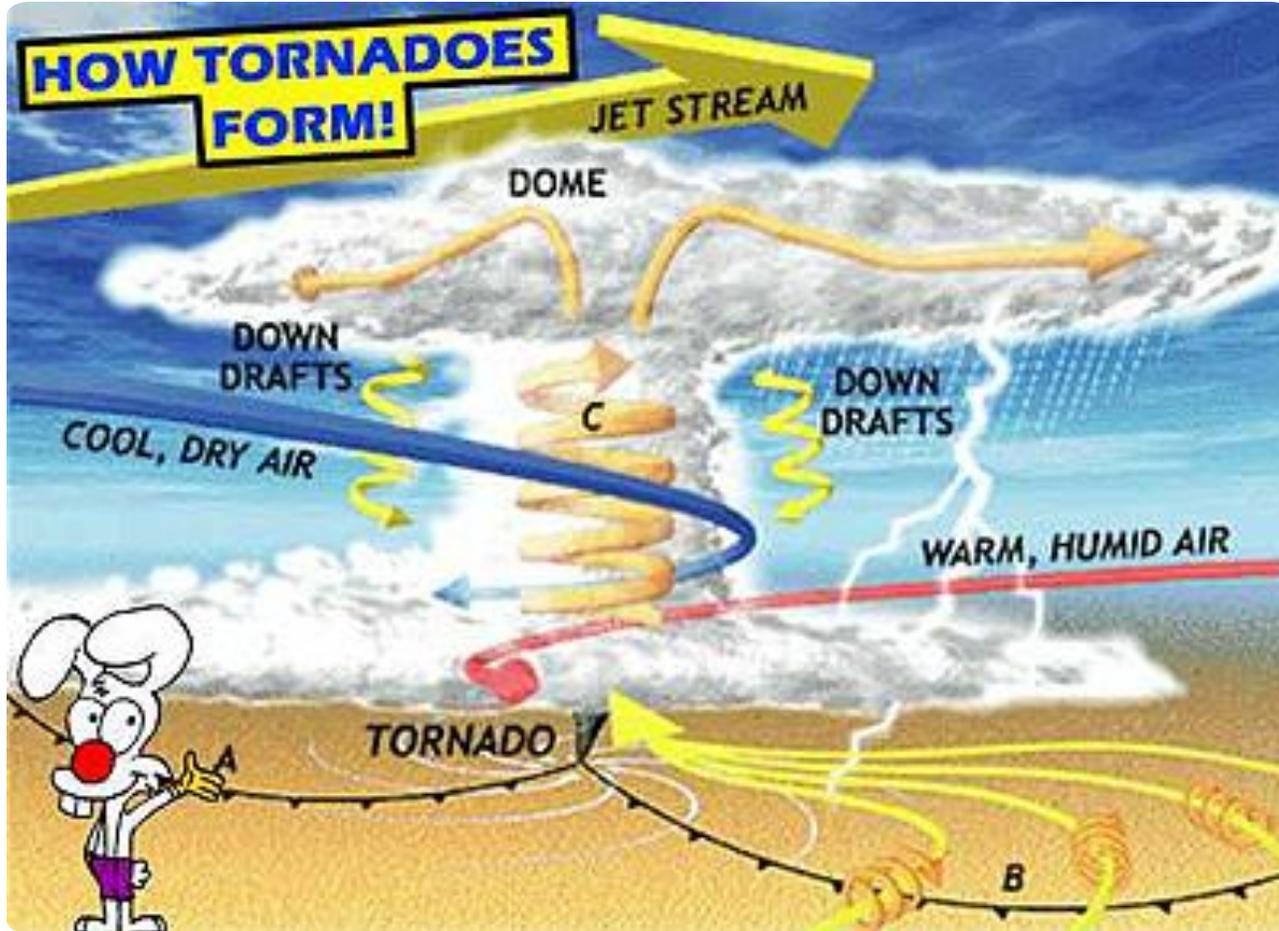
A large, white, rope-like tornado extends from a dark, stormy sky to a green field. The tornado is thick and cylindrical, curving slightly as it descends. The sky is filled with dark, heavy clouds, and the ground is a flat, green landscape.

## 19.6 Tornadoes

How are tornadoes dangerous?

A tornado is a violent rotating column of air extending from a thunderstorm to the ground.

Tornadoes can appear as a traditional funnel shape, or in a slender rope-like form. Some have a churning, smokey look to them, and others contain multiple vortices, which are small, individual tornadoes rotating around a common center. Even others may be invisible!



## Let us see how a tornado forms.

Tornadoes are usually born from thunderstorms. Humid air, which rises, collides with cold air in the atmosphere above it. When these two air masses meet, they create instability in the atmosphere.

A change in wind direction and an increase in wind speed with increasing height creates an invisible, horizontal spinning effect in the lower atmosphere. Rising air within the updraft tilts the rotating air from horizontal to vertical. From here, the tornado is able to expand due to the warm air being sucked into the spinning column.

# Dangers of Tornadoes

Tornadoes are capable of tremendous destruction with wind speeds of up to 450 kph. They can destroy large buildings, uproot trees and hurl vehicles hundreds of meters. Damage paths can be in excess of 1 km to 100 km long. In an average year, about 1000 tornadoes are reported in North America.





Deadliest Tornado  
Tri-State (Missouri, Illinois and Indiana)  
March 18, 1925  
695 lives lost



# Recap – At A Glance

- **Natural disasters** include **tropical storms, volcanic eruptions, earthquakes, tsunamis and tornadoes.**
- Natural disasters are very **dangerous** because they destroy **property** and **human lives.**