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# ENVIRONMENTAL DISASTERS

By

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# Introduction

Environmental disasters are disasters that affect the natural world. They can make the water unsafe to drink. They can damage the land so that people must move away. Some environmental disasters cause damage that lasts for years. Others cause only short-term damage.

Environmental disasters can be very destructive. They may kill or injure hundreds of people. They can damage things that people own. Environmental disasters may also harm wild animals, plants, and other things in the world around us.

# Environmental Hazards & Disasters

- A Hazard is a situation that poses a level of threat of life, Health, Property or Environment.
- A Environmental Hazard is an event which has the potential to threaten the surrounding natural environment or adversely affect people's health, including pollution and natural disasters such as storms and earthquakes.

# Types of Hazards

Hazards can be categorized in four types:

- Chemical Hazards
- Physical Hazards
- Biological Hazards
- Psychosocial Hazards

- **Chemical Hazards**

Chemicals can affect the skin by contact or the body either through the digestive system or through the lungs if air is contaminated with chemicals, vapors, mist or dust. There can be an acute (immediate) effect, or a chronic (medium to long-term) effect from the accumulation of chemicals or substances in or on the body.

- **Physical Hazards**

1. Physical work hazards are workplace hazards that can affect the body.
2. They may include radiation and excessive noise levels, falls or poorly communicated excavation routes.
3. Examples include:- Unguarded machinery, exposed moving parts, constant loud noise hazards, vibrations, working from ladders, scaffolding or heights

- **Biological Hazards**

Biological hazards, also known as biohazards, refer to biological substances that pose a threat to the health of living organisms, primarily that of humans. This can include samples of a microorganism, virus or toxin that can affect human health.

- **Psychosocial Hazards**

1. A psychosocial hazard is a hazard that affects the mental well-being or mental health of the worker by overwhelming individual coping mechanisms and impacting the worker's ability to work in a healthy and safe manner.
2. Psychosocial" factors such as stress, hostility, depression, hopelessness, and job control seem associated with physical health—particularly heart disease. Adverse risk profiles in terms of psychosocial factors seem to cluster with general social disadvantage.



# Killer Spills and Leaks

There are several kinds of environmental disasters. Some of the worst involve spills or leaks of hazardous (dangerous) materials. These disasters usually happen suddenly.

- In 2002 a ship carrying oil sank off the coast of Spain. About 2 million gallons (7.6 million liters) of oil spilled into the water. The sticky black oil washed onto beaches. It killed birds and other animals.



- Poison gas leaked out of a factory in India in 1984. People living nearby breathed in the poison. Thousands of them became ill or died.
- In 1986 radioactive material leaked from a nuclear power plant in Ukraine. About 335,000 people living nearby had to move. The radiation killed some people and made others very sick.

# Slow Disasters

Other environmental disasters happen slowly. **Farmland**, for instance, **may slowly change into desert. Lakes that provide fish may dry up. Factories may release pollution for years.** The pollution may seem harmless. After years of building up, however, the pollution may reach harmful levels. Slow environmental changes can be disastrous. They can make people starve to death. **People also can be forced to leave home and move to a better place.**

# More Disasters Ahead

Scientists worry about pollution from carbon dioxide. Carbon dioxide is a gas. It goes into the air when we burn fossil fuels. Fossil fuels power cars and trucks. They also bring heat and electricity to homes, schools, and businesses.

Carbon dioxide builds up over time. When it builds up, it traps heat near Earth's surface. The sun's rays shine on Earth. Some of the rays soak into the ground. Others bounce off the ground and go back into space. But carbon dioxide stops the rays from leaving Earth's atmosphere. It seals in the rays' heat so it cannot escape.

Hazardous material also may move from one place to another. Oil tankers, for instance, carry crude oil for long distances over the ocean. Trains move tanker cars filled with chemicals. When an oil tanker or train is carrying hazardous materials, a spill or leak could happen anywhere along the vehicle's path. People and animals living nearby are in the danger zone for an environmental disaster.

# Disaster Zones

Environmental disasters often happen near nuclear power plants or factories where large amounts of chemicals are present—but they can happen anywhere around the world.



# Measuring Environmental Disasters

Measuring environmental disasters is important. Measurements help officials learn how severe a disaster is. When officials have this information, they may be able to stop a disaster before it's too late.

Measuring environmental disasters also helps officials know what steps to take to correct a problem. Imagine what might have happened if someone had measured how many passenger pigeons were being hunted. Governments might have realized that the passenger pigeon was becoming extinct. They could have made laws to stop hunters from killing so many birds.

# Quiz

1. What is the type of hazards?
2. Give one example of environmental disasters?



# Earthquakes Hazard Effects:

## **Direct effects:**

1. Ground shaking
2. Ground rupture

## **Indirect effects:**

1. landslides
2. Liquefaction and ground subsidence
3. Tsunamis
4. Fire

## Definitions

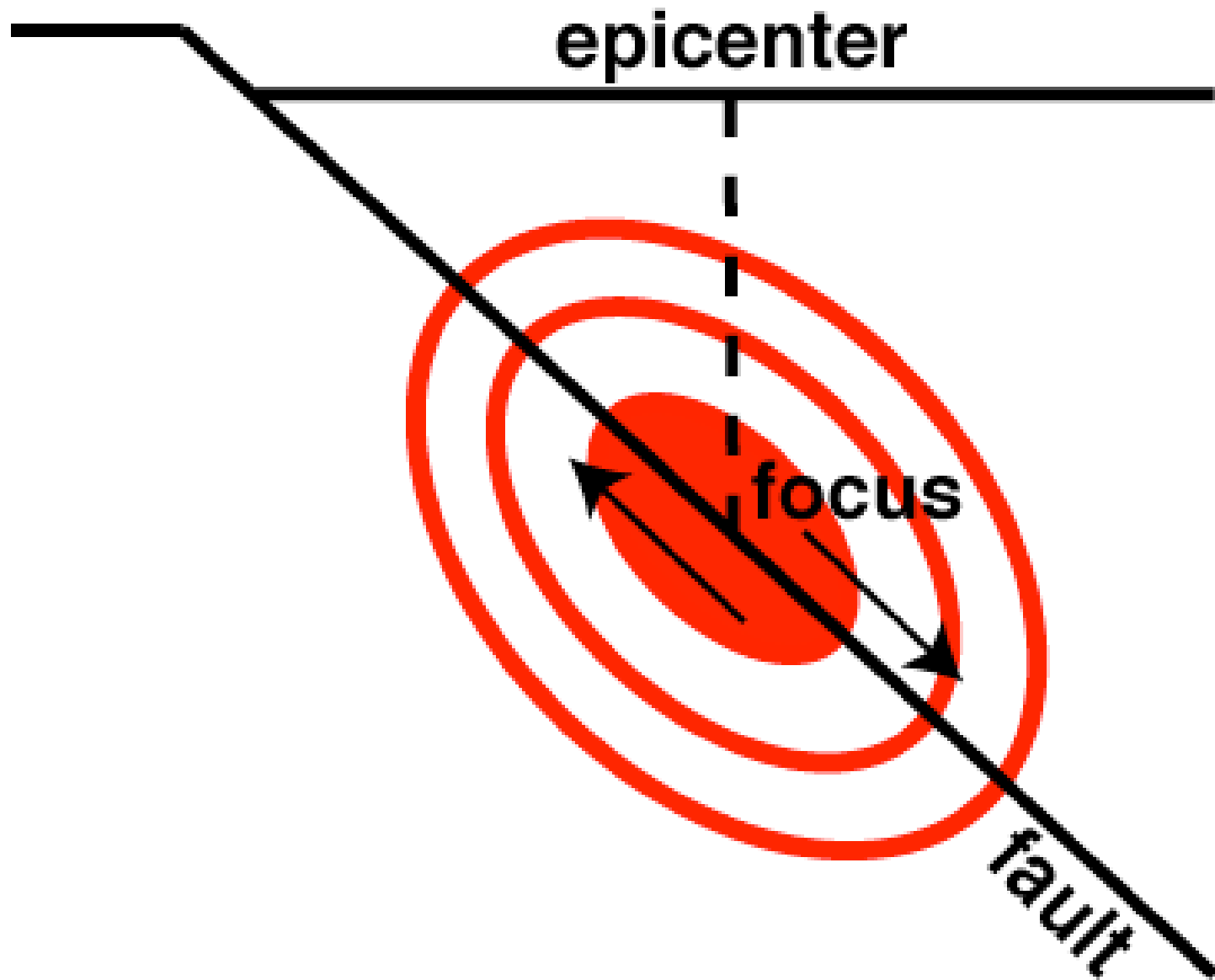
An **earthquake** is the vibration of the Earth produced by a sharp release of energy.

Most commonly, an earthquake is the result of slippage along a fault in the Earth's crust.

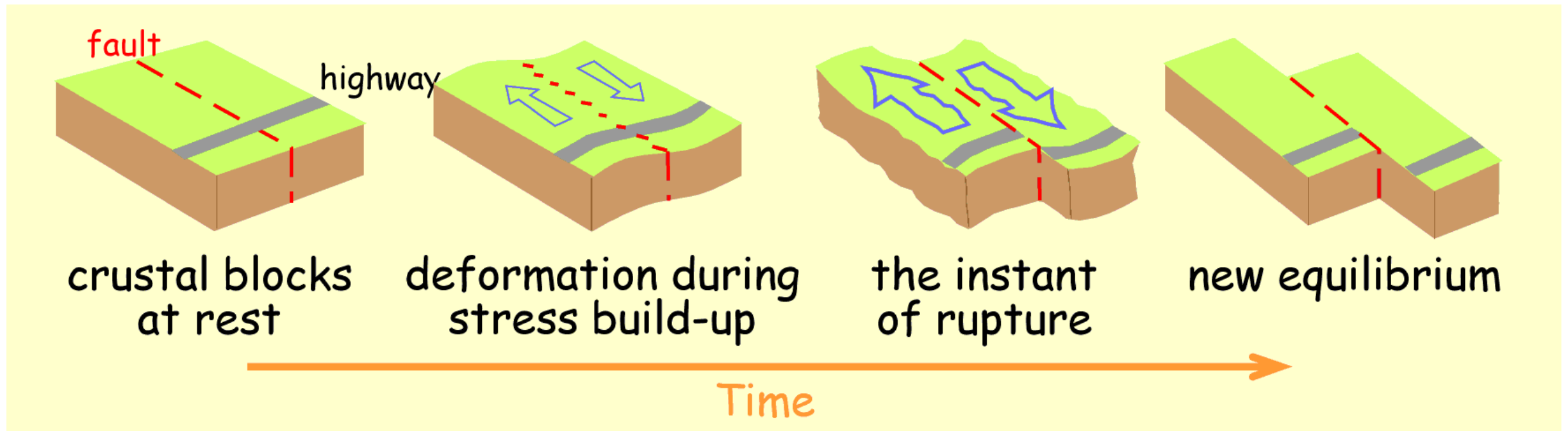
A **fault** is a fracture in the crust on which there has been appreciable displacement.

The energy is released in all directions from its source known as the **focus**.

The **epicenter** of an earthquake is the point on the Earth's surface directly above the focus.



- Accumulated strain leads to fault rupture
- The elastic rebound model



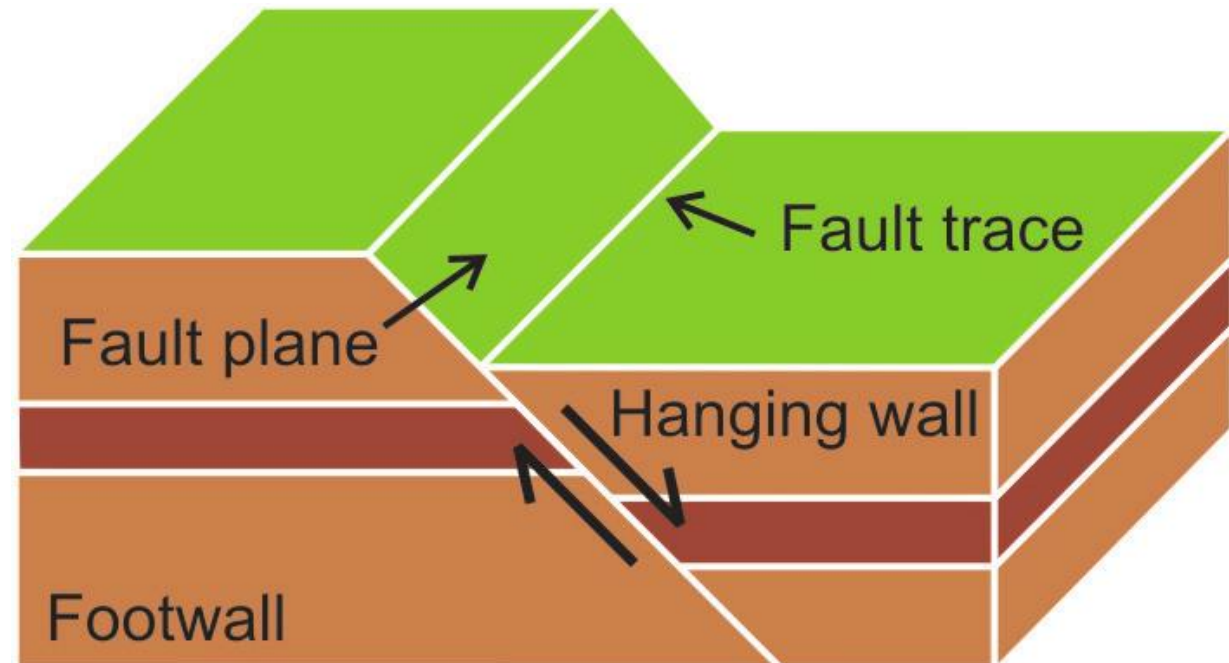
# Faults

**Hanging wall:** rock surface immediately above the fault surface.

**Footwall:** rock surface immediately below the fault surface.

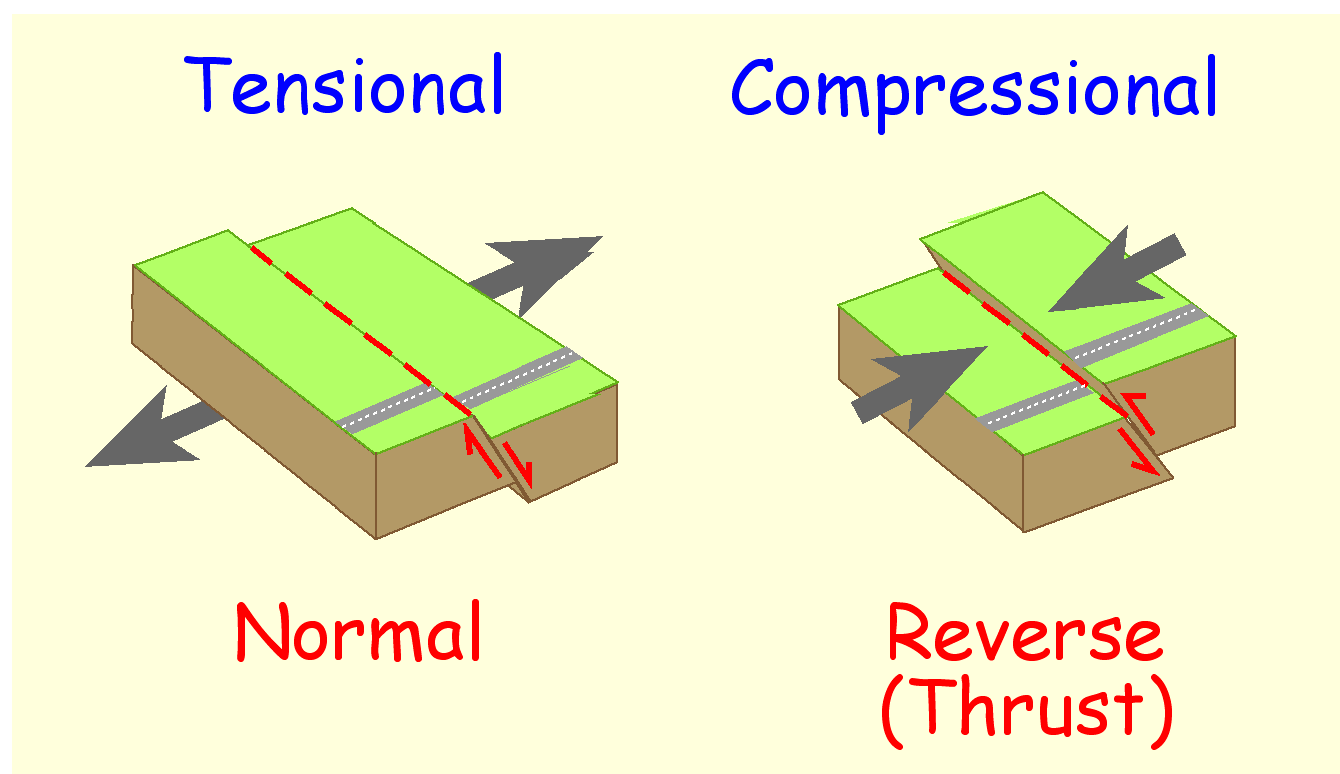
There are several types of faults depending upon the geometry of the fault:

1. Dip-slip faults
  - Normal
  - Reverse (thrust)
2. Strike-slip faults
3. Oblique slip faults



Dip slip faults are faults where the movement is parallel to the dip of the fault surface or plane. There are two main types of dip slip faults:

- **Normal faults:** the hanging wall block moves down relative to the footwall block.
- **Reverse faults:** the hanging wall block moves up relative to the footwall block.



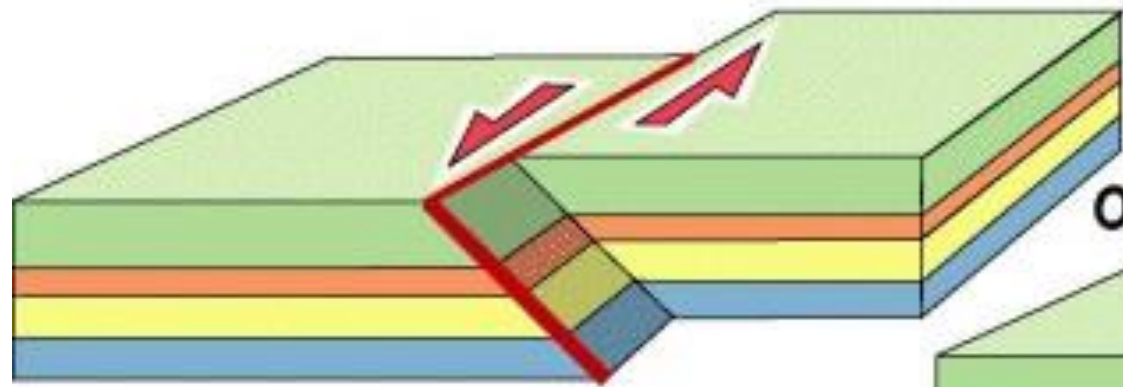
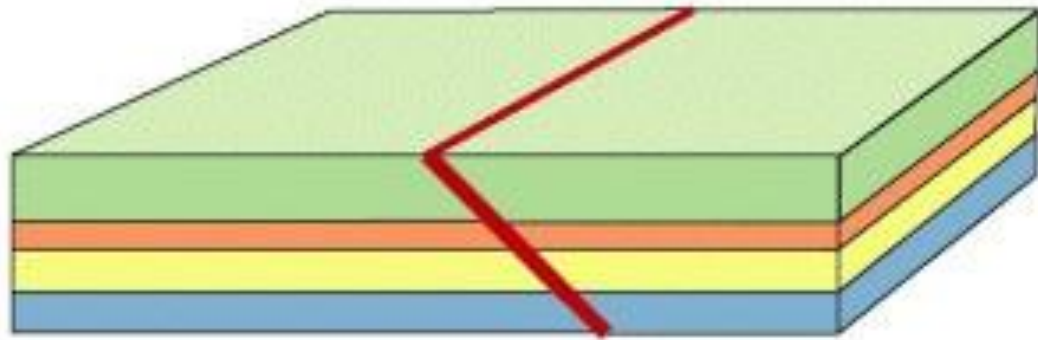
## **Strike-Slip Faults**

In **strike slip faults**, the displacement (movement) is horizontal and parallel to the strike of the fault trace.

**Right-lateral** strike-slip faults have a sense of movement that the crustal block on the opposite of the fault has moved to the right as you face the fault.

In **left-lateral** strike-slip faults, the movement is such that the block on the opposite side of the fault appears to have moved to the left as you face the fault.

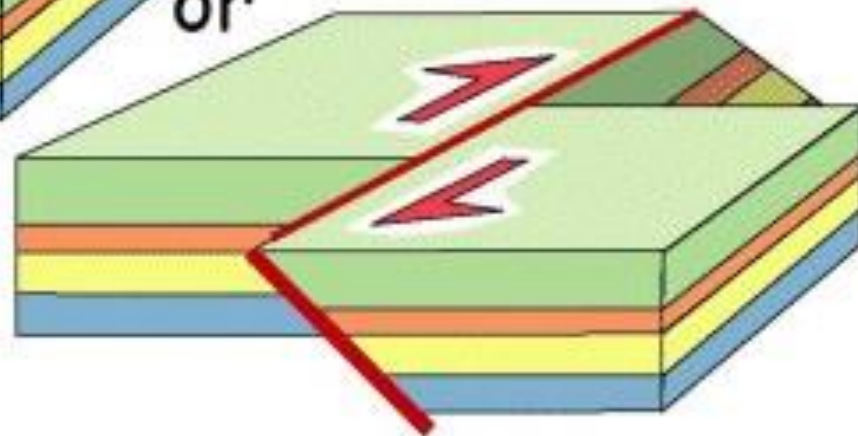
# Strike-slip faults



left-lateral  
(sinistral)

or

right-lateral  
(dextral)





## Oblique-Slip Faults

Strike-slip and dip-slip faults represent end-member models of movement along faults. Some faults may exhibit both strike-slip and dip-slip motion and are classified as **oblique-slip** faults.



## Ground Shaking (Vibration)

- It refers to what we feel when energy built up by the application of stress to the lithosphere is released by faulting during earthquake.
- Technically, it refers to the disruptive up and down and sideways motion experienced during an earthquake.



# How Earthquake Vibrations are Generated?

- Most natural earthquakes are caused by sudden slippage along fault zone. A fault is a fracture on which one body of rock slides past another.
- Slippage along a fault is hindered because there are irregularities on the fault plane. If it were smooth, blocks on opposite sides of fault will just slide past each other continuously.

# How Ground Shaking is Measured?

The strength of ground shaking is measured in terms of:

1. Velocity
2. Acceleration
3. Frequency content of shaking
4. Duration (How long the shaking continues)

# Ground Rapture

The creation of new or the renewed movement of old fractures, oftentimes with two blocks on both side moving in opposite direction.



# How Ground Raptures Form

- An earthquake is generated when fault moves, as its frictional resistance could not match the large amount of accumulated stress related to plate motion.
- The lithosphere breaks when its strength is overcome by the large amount of stress applied. Rock failure that involves the slipping of lithosphere blocks past each other is called faulting.
- When an earthquake is strong enough, faulting initiated at depths may breach the earth's surface to form ground raptures.

| <b>Ground shaking</b>   | <b>Ground rapture</b>   |
|---|---|
| <ol style="list-style-type: none"><li data-bbox="216 401 1268 468">1. Hazard created by earthquakes.</li><li data-bbox="216 534 1268 733">2. Application of stress to the fault in ground.</li><li data-bbox="216 933 1268 1133">3. Vibration of the ground in different direction.</li></ol> | <ol style="list-style-type: none"><li data-bbox="1289 401 2341 468">1. Hazard created by earthquakes.</li><li data-bbox="1289 534 2349 868">2. The creation of a new movement of old fractures in ground.</li><li data-bbox="1289 933 2341 1133">3. Two blocks on both sides moving in opposite directions.</li></ol> |

# Landslides





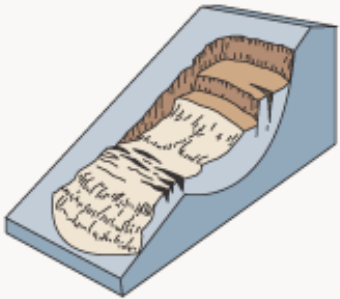
# Landslides

- A landslide, also known as a landslip, is a geological phenomenon that includes a wide range of ground movements, such as rock falls, deep failure of slopes and shallow debris flows.
- Landslides can occur in offshore, coastal and onshore environments. Although the action of gravity is the primary driving force for a landslide to occur, there are other contributing factors affecting the original slope stability

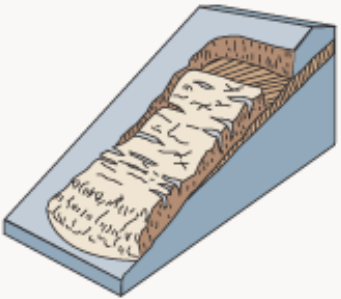
# Causes

- Heavy rains
- Earthquakes
- Volcano eruptions
- Floods
- Ground water changes
- Rapid snow melt
- Quarrying

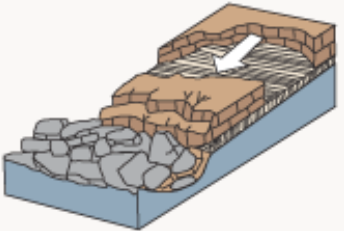
# Types of landslide



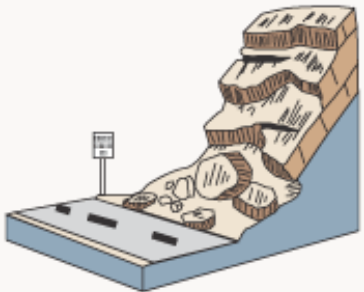
Rotational landslide



Translational landslide



Block slide



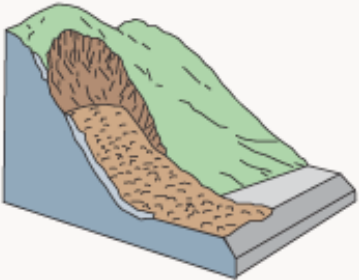
Rockfall



Topple



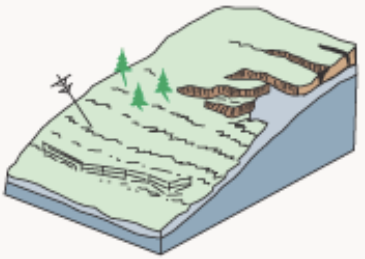
Lateral slide



Debris avalanche or flow



Earth flow



Creep

# 2008 Bukit Antarabangsa landslide

The 2008 Bukit Antarabangsa landslide was a landslide that occurred on the early morning of 6 December 2008, at the town of Bukit Antarabangsa of Selangor, Malaysia. 4 people were killed while 15 others were injured from the incident. 14 houses were destroyed during the process. The landslide was colloquially referred with the Highland Towers collapse of 1993, due to its close proximity and similar circumstances.



# 2011 Hulu Langat landslide

The 2011 Hulu Langat landslide was a landslide attributed to heavy rain that occurred on the afternoon of 21 May 2011, at Kampung Gahal in the district of Hulu Langat at Selangor, Malaysia. The landslide struck an orphanage nearby, killing 16 people, including 13 children.



# 2022 Batang Kali landslide

A landslide occurred in the early hours of 16 December 2022 near the Malaysian town of Batang Kali, Selangor, displacing 450,000 m<sup>3</sup> (16 million cu ft) of soil and burying campsites at an organic farm. The accident trapped 92 people under the collapsed slope; most were campers from the farm. 31 people were killed and 61 were rescued, with 8 people requiring hospitalization.





# How to Minimize Landslide Hazards

1. Choose a safe location to build your home, away from steep slopes and places where landslides have occurred in the past.
2. Prevent deforestation and vegetation removal.
3. Avoid weakening the slope.
4. Plant ground cover on slopes and build retaining walls.

5. In mudflow areas, build channels or deflection walls to direct the flow around buildings.
6. Awareness generation: Educate the public about signs that a landslide is imminent so that personal safety measures may be taken.
7. Financial Mechanisms: Support the establishment of landslide insurance.
8. Legal and Policy: legislation to direct a governmental or private program to reduce landslide losses should be strengthened.

# Soil Liquefaction and Ground Subsidence



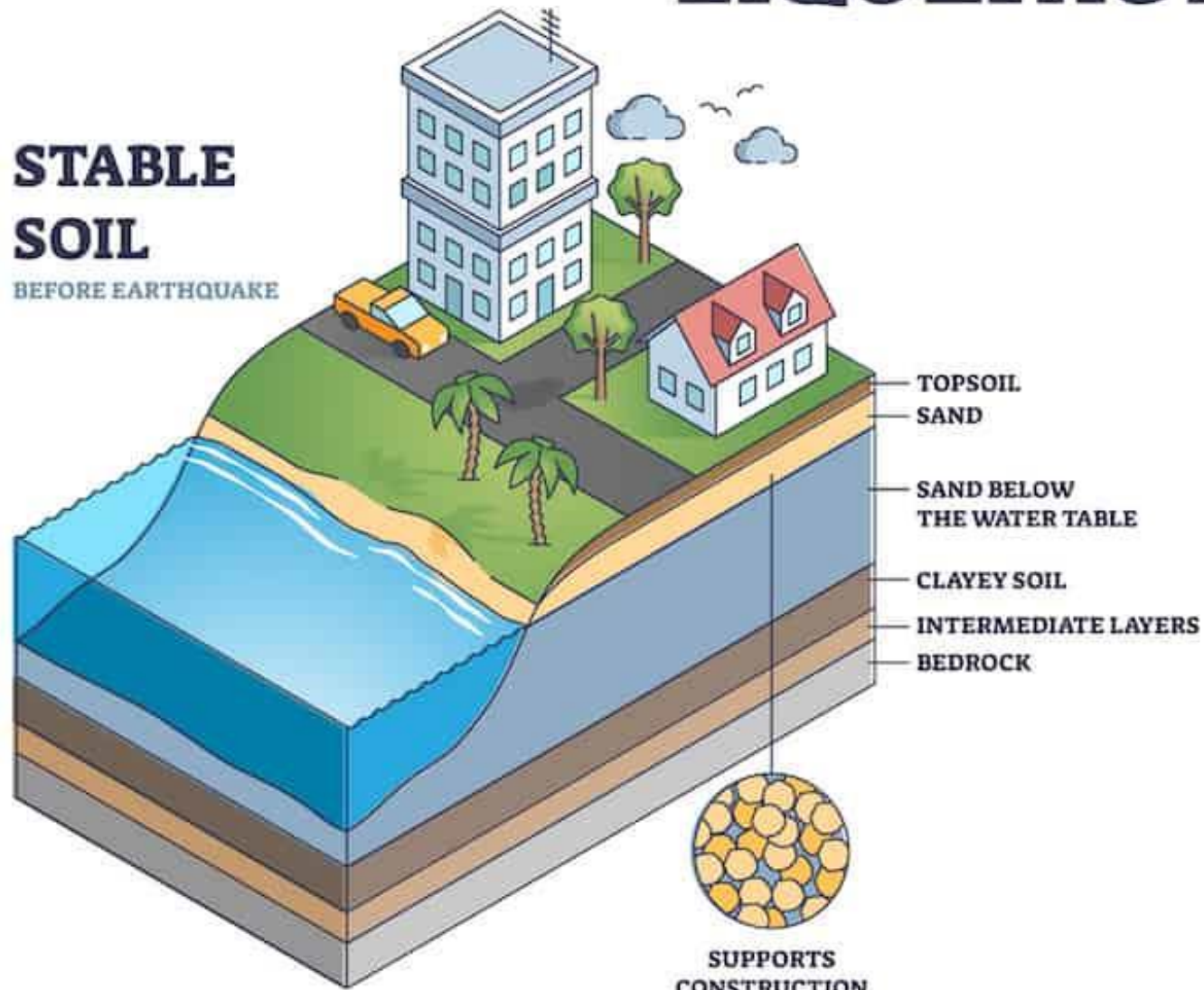
# What is soil liquefaction?

- Liquefaction is the phenomena when there is loss of strength in saturated and cohesion-less soil because of increased pore water pressures and hence effective stress is reduce due to dynamic loading.
- During liquefaction the water pressure become high enough to counteract the gravitational pull on the soil particles and effectively float or suspend the particles.
- Then soil particle move freely with respect to each other. due to this the strength of soil decreases and the ability of a soil deposit to support foundations for buildings and bridge is reduce.

# LIQUEFACTION

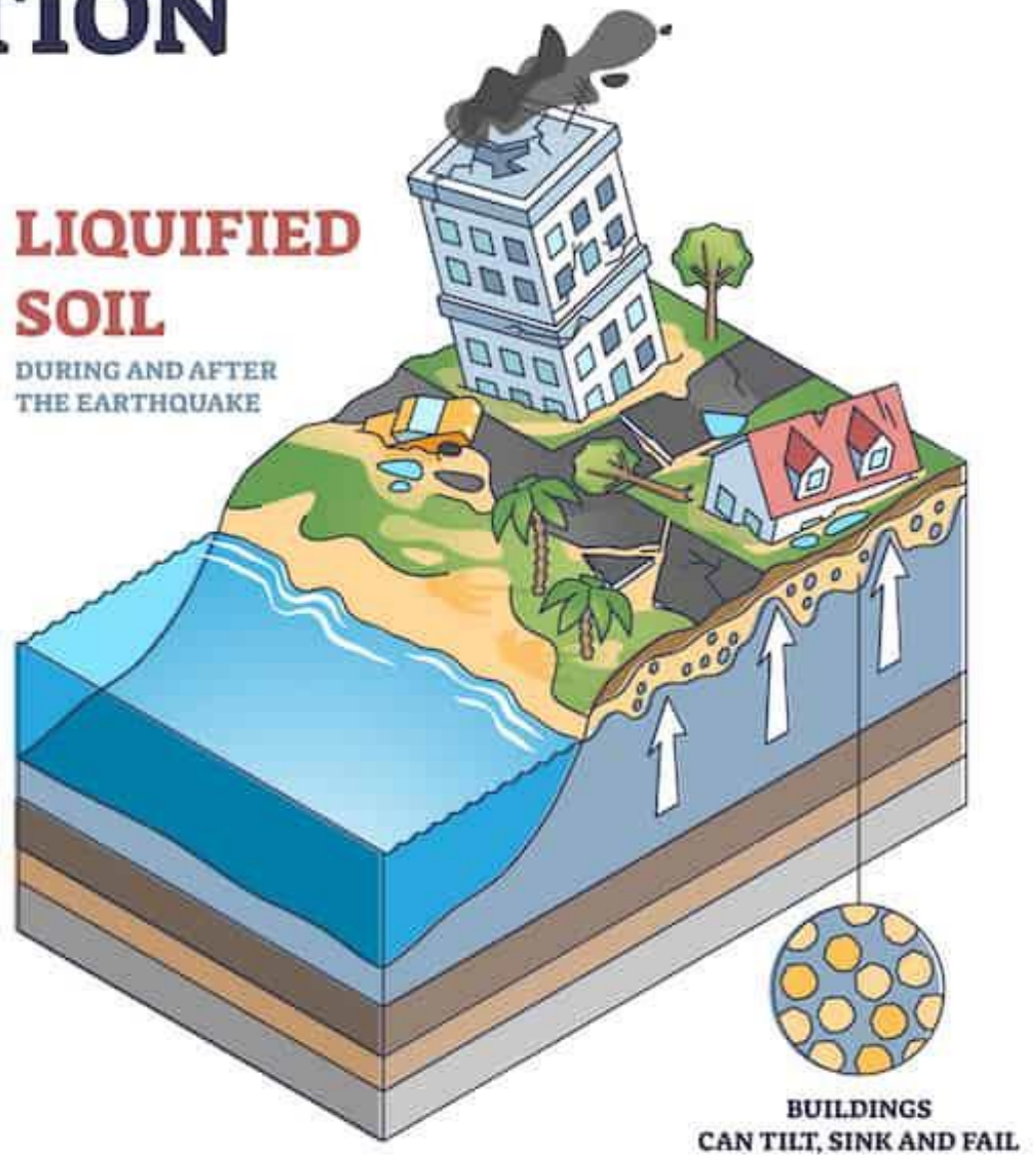
## STABLE SOIL

BEFORE EARTHQUAKE



## LIQUIFIED SOIL

DURING AND AFTER THE EARTHQUAKE



# Types of Soil Liquefaction

- **Flow liquefaction**

Flow liquefaction is a phenomenon in which the static equilibrium is destroyed by static or dynamic loads in a soil deposit with low residual strength. It occurs when the static shear stresses in the soil exceed the shear strength of the liquefied soil.

- **Cyclic liquefaction**

Cyclic mobility is a liquefaction phenomenon, triggered by cyclic loading, occurring in soil deposits with static shear stresses lower than the soil strength.

Deformation due to cyclic mobility develop incrementally because of static and dynamic stresses that exist during an earthquake.

- Flow liquefaction



- Cyclic liquefaction





# Effects of Liquefaction

## 1. Loss of bearing strength



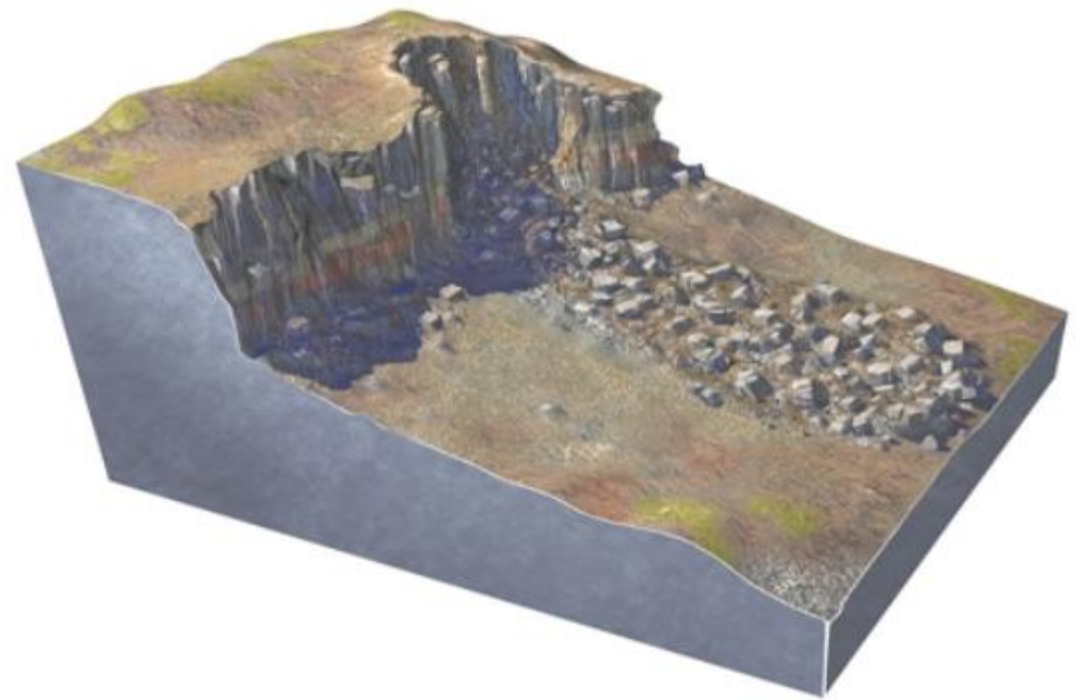
## 2. Lateral spreading



### 3. Sand boil



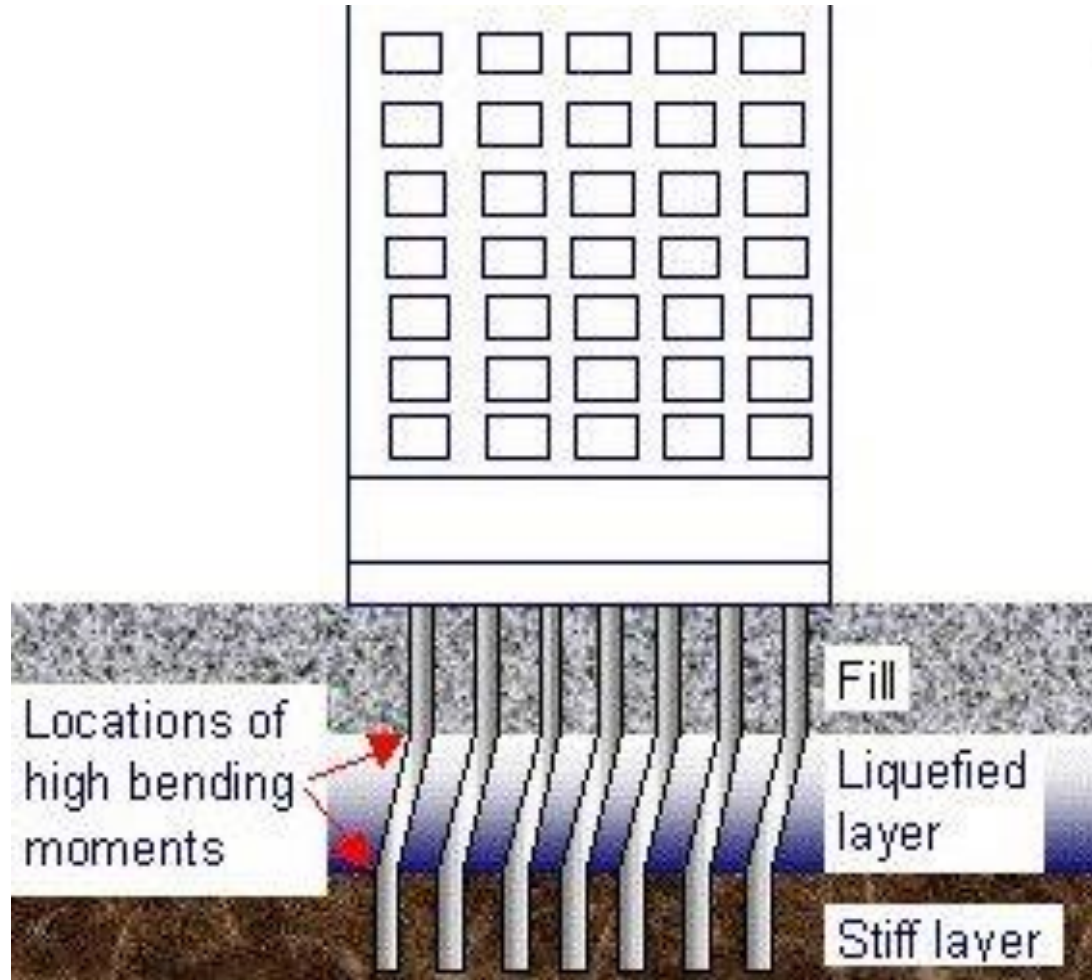
### 4. Flow failures



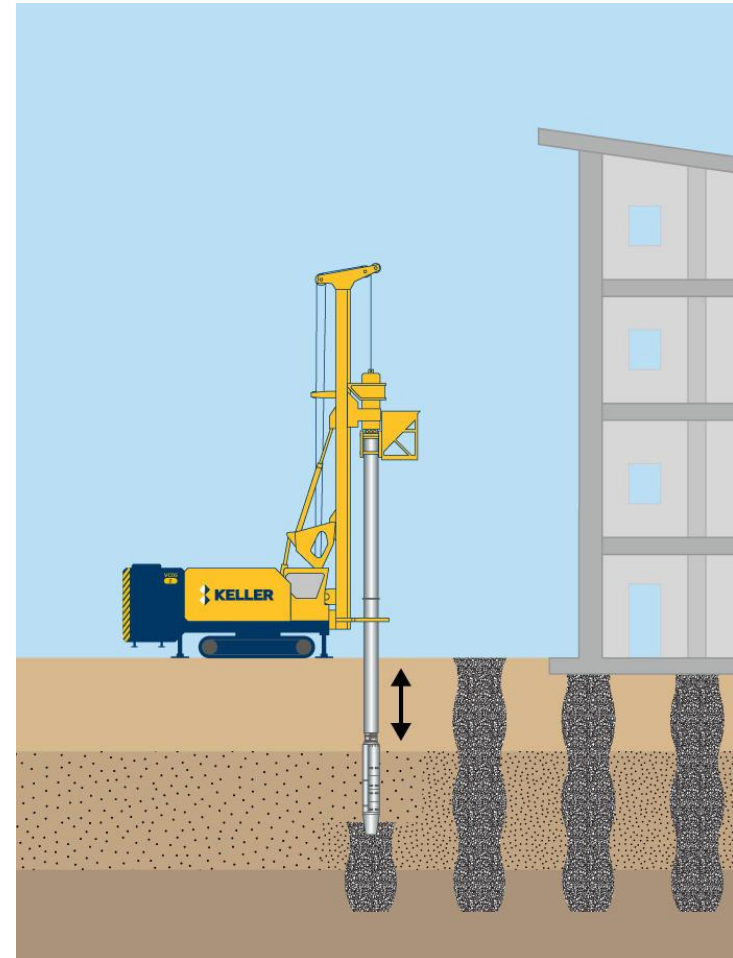
# Methods to Reduce Liquefaction

1. Avoid liquefaction-susceptible soil
2. Build liquefaction-resistant structures
3. **Shallow foundation aspects:** It is important that all foundation elements in a shallow foundation are tied together to make the foundation move or settle uniformly
4. Soil improvement techniques

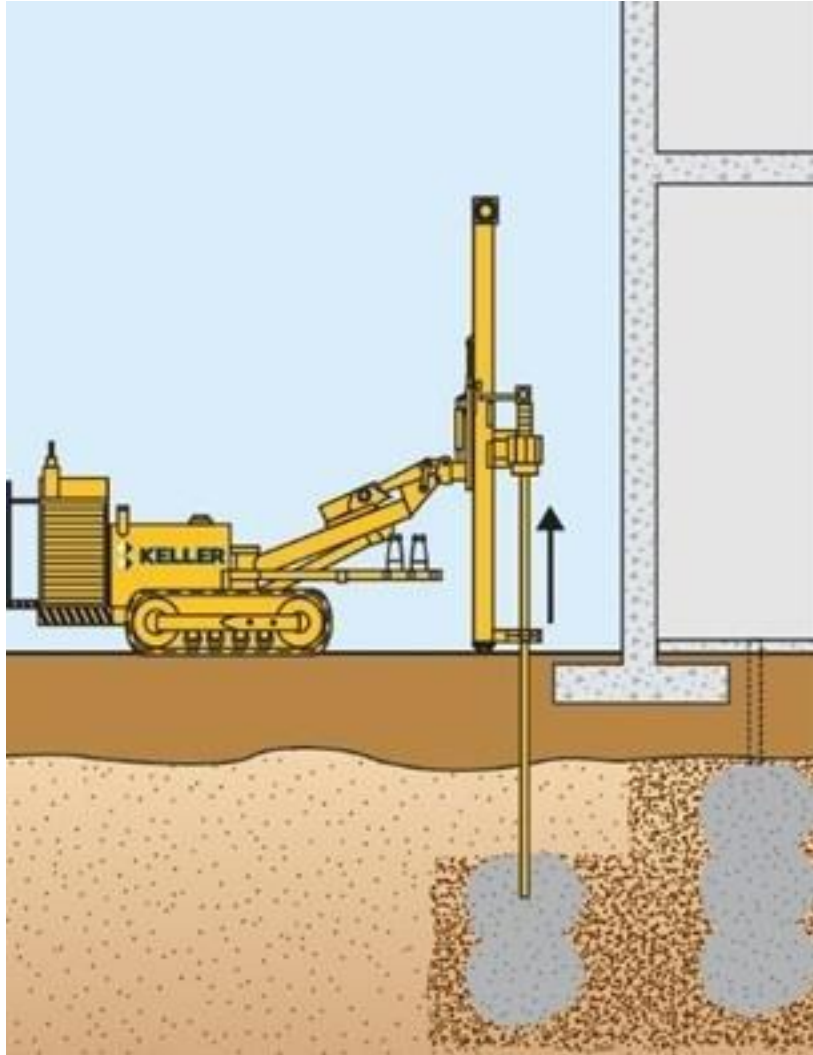
## 5. Deep foundation aspect Liquefaction



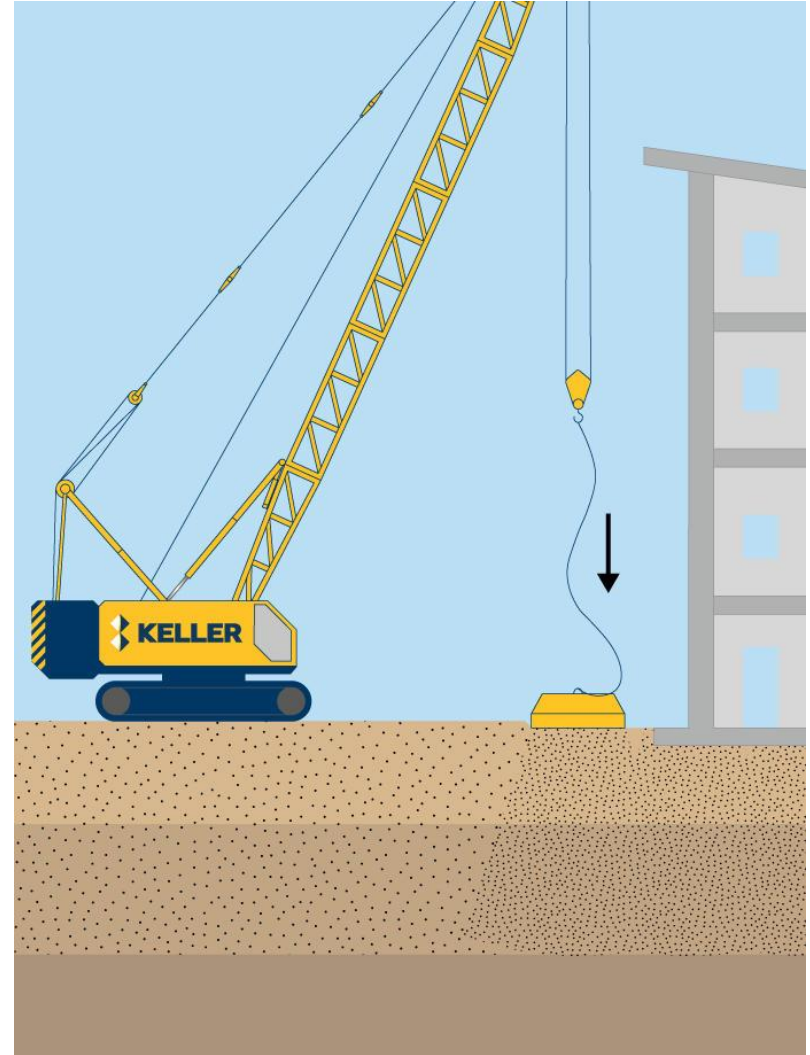
## 6. Stone column



## 7. Compaction grouting



## 8. Dynamic compaction



# Tsunami Hazards



# History

- First tsunami was recorded in 1480 B.C. in eastern Mediterranean.
- A large tsunami accompanied by the earthquake of Lisbon in 1755.
- The Kutch earthquake of June 16, 1819 generated strong tsunami which submerged the coastal areas and damage to ships and country made boats of fishermen.
- North and South American records have dated such events back to 1788 for Alaska and 1562 for Chile. Records of Hawaiian tsunami go back to 1821.
- Tsunami hits the Mona Passage off Puerto Rico in 1918, grand banks of Canada in 1929.

- Tsunamis are giant water waves that usually result from the vertical displacement of the seafloor during an earthquake.
- Tsunamis are usually produced by earthquakes along convergent boundaries since these produce the largest earthquakes and are located in ocean basins.
- Tsunamis may also be produced by large submarine landslides and large meteorite impacts in ocean basins.



# Causes of Tsunami

1. Earthquake
2. Icefall
3. Volcanic eruptions
4. Heavy rainfall
5. Cosmic impacts
6. Landslide

## Japan Tsunami in 2011



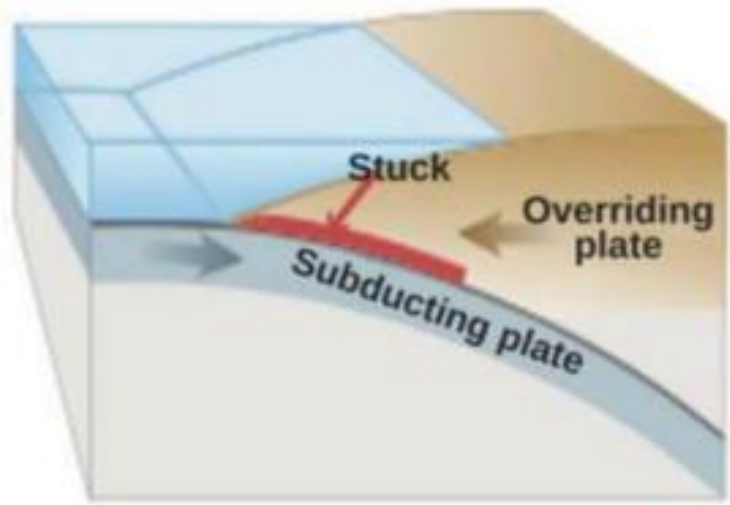
## Indonesia Tsunami



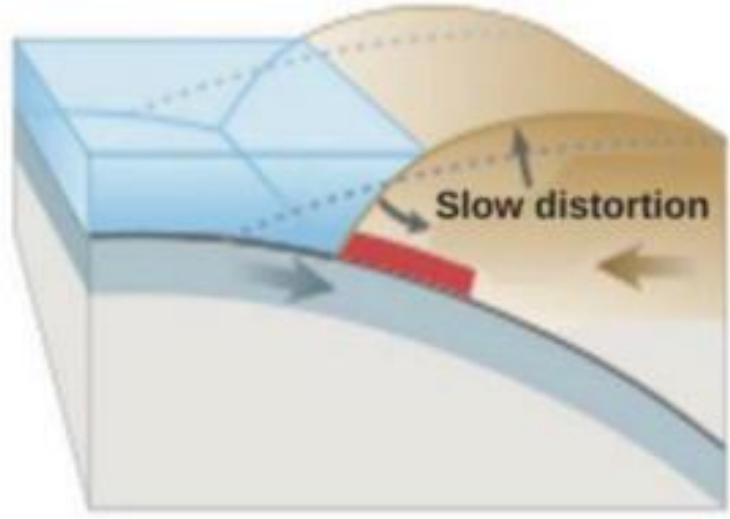
# Tsunami "Wave Train"

- Many people have the mistaken belief that tsunamis are single waves.
- Tsunamis are "wave trains" consisting of multiple waves.

1

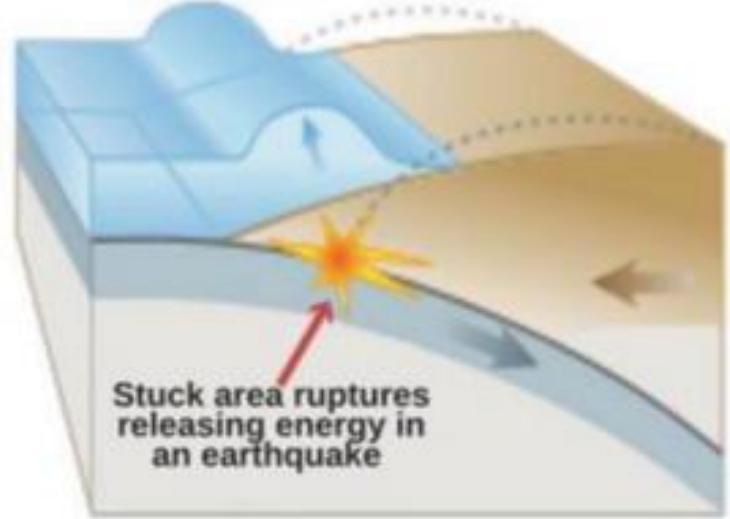


2



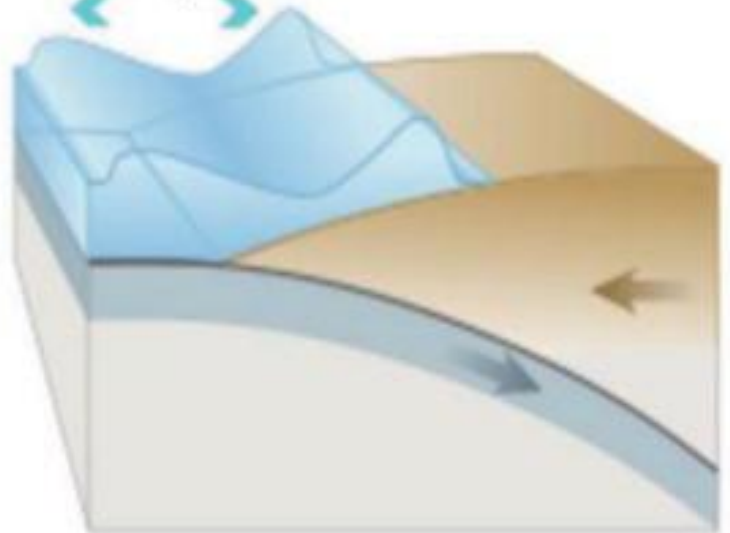
3

*Tsunami starts during the earthquake*

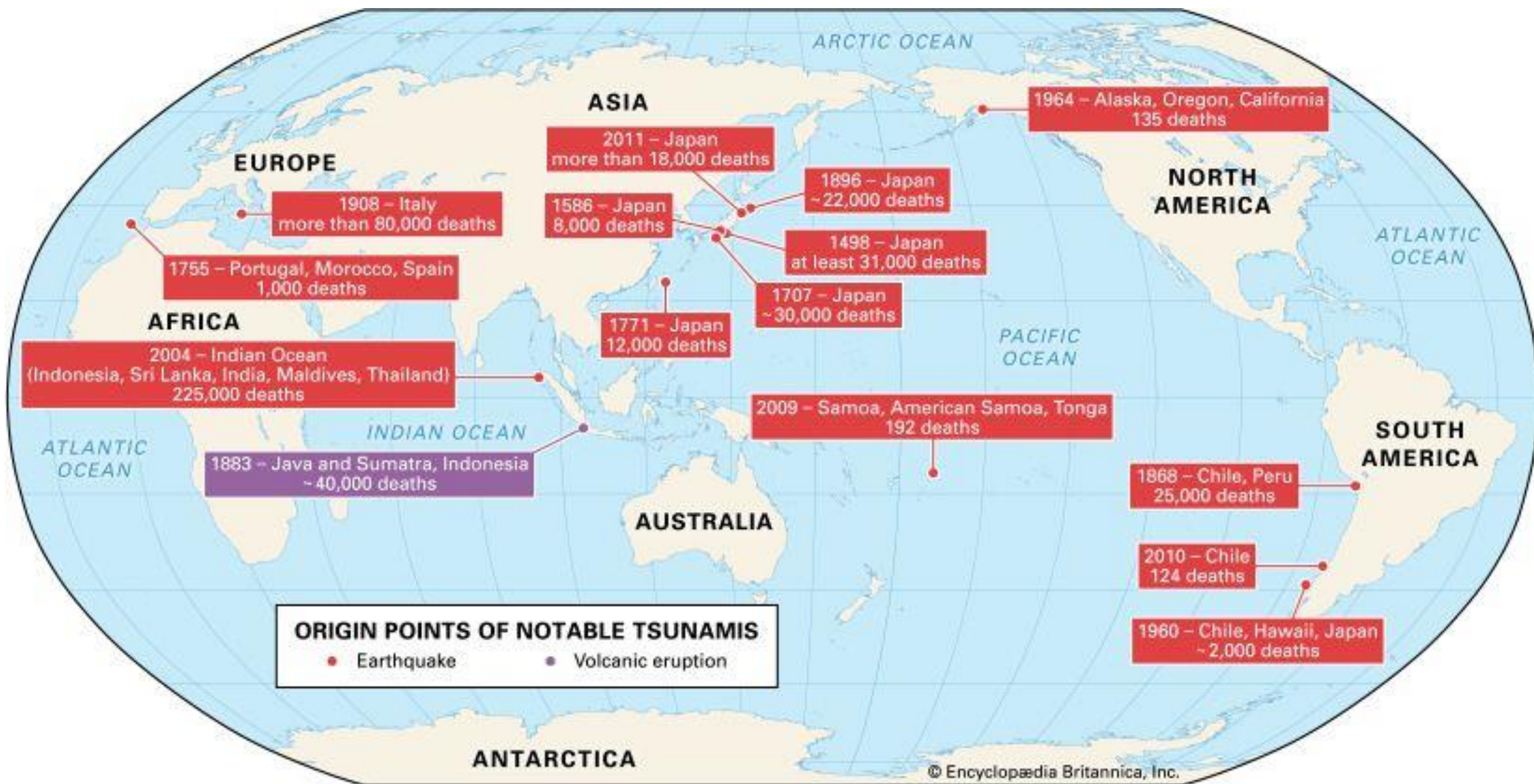


4

*Tsunami waves speed*



# Tsunami Map



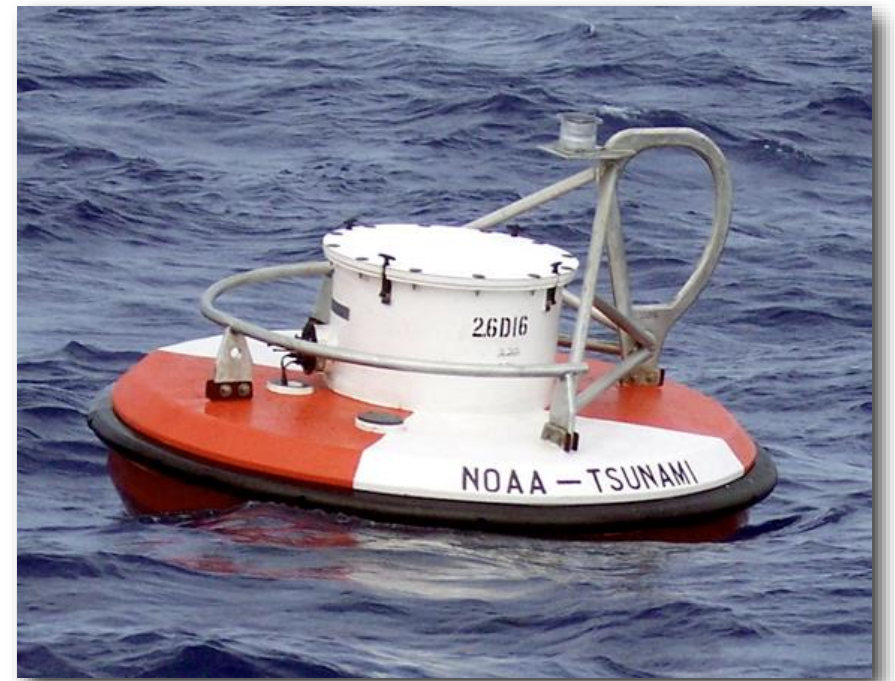
This map shows the global tsunami hazard. Note that the greatest hazard is in coastal regions in the Pacific basin. Japan, Indonesia, Chile, and Peru have a high number of people living in tsunami-prone areas.

# Methods to Reduce Tsunami Hazards

1. Tsunami barriers/walls help protect against waves and reduce inundation.



2. NOAA has deployed a new generation of tsunami detectors called the Deep-ocean Assessment and Reporting of Tsunamis (DART). The detectors can provide data so that a warning can be issued within minutes.



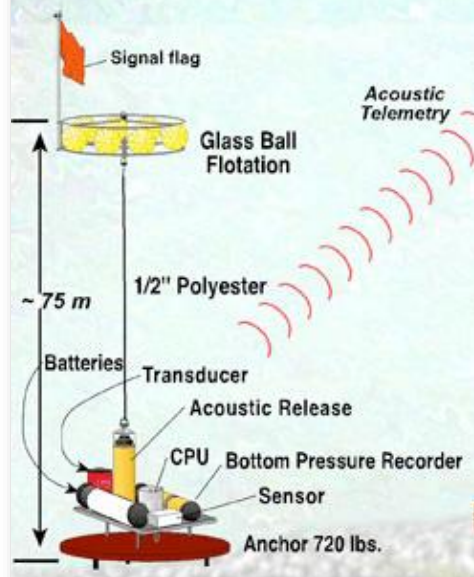
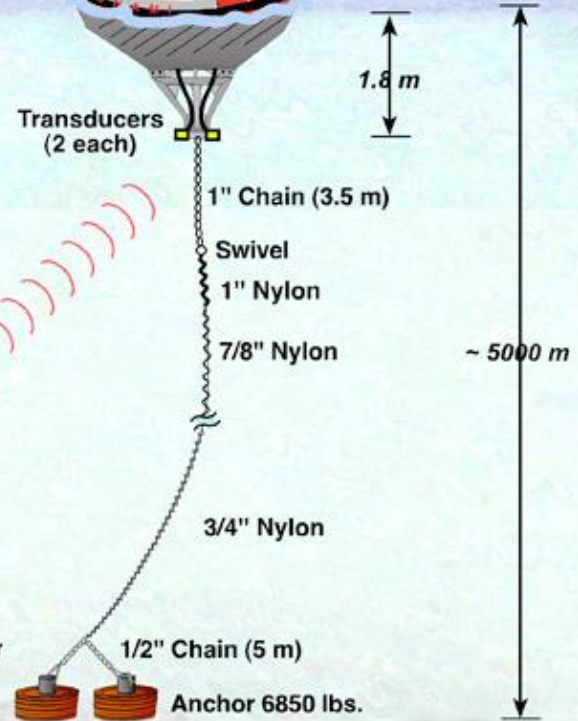
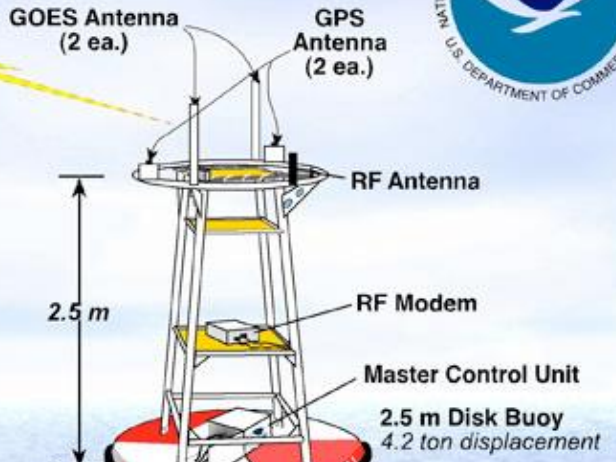


# Tsunami Mooring System



## Optional Sensors

- Wind
- Barometric Pressure
- Seasurface Temp & Conductivity
- Air Temperature/ Relative Humidity



Acoustic Telemetry

3. Evidence from recent tsunamis indicates regions with coastal forests were relatively protected from tsunamis. Some countries are experimenting with planting mangroves and casuarinas along the coast to help absorb the wave and reduce damage from a tsunami.



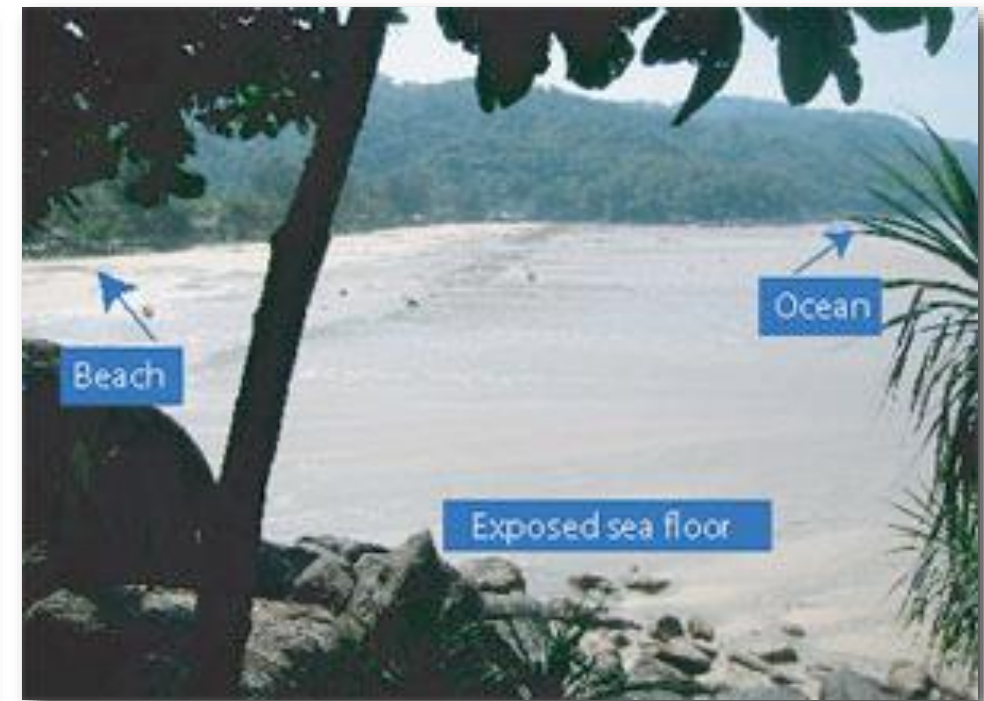
- An earthquake can occur in one area and the tsunami may inundate another thousand of km away.
- The Tōhoku earthquake (2011) caused a 5-8 m up thrust on the seafloor ~60 km offshore from the Tōhoku. This resulted in a major tsunami that propagated across the Pacific.

# The Tōhoku earthquake (2011)

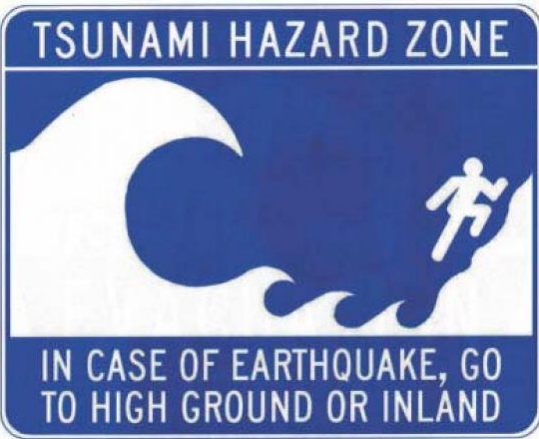


Frequently there is a large withdrawal of the ocean from the shoreline before a tsunami wave hits. These images show the withdrawal.

Tourists are often trapped by the wave since they think that it is a very low tide and follow the water out to search for seashells, etc.



# Signs of Tsunami



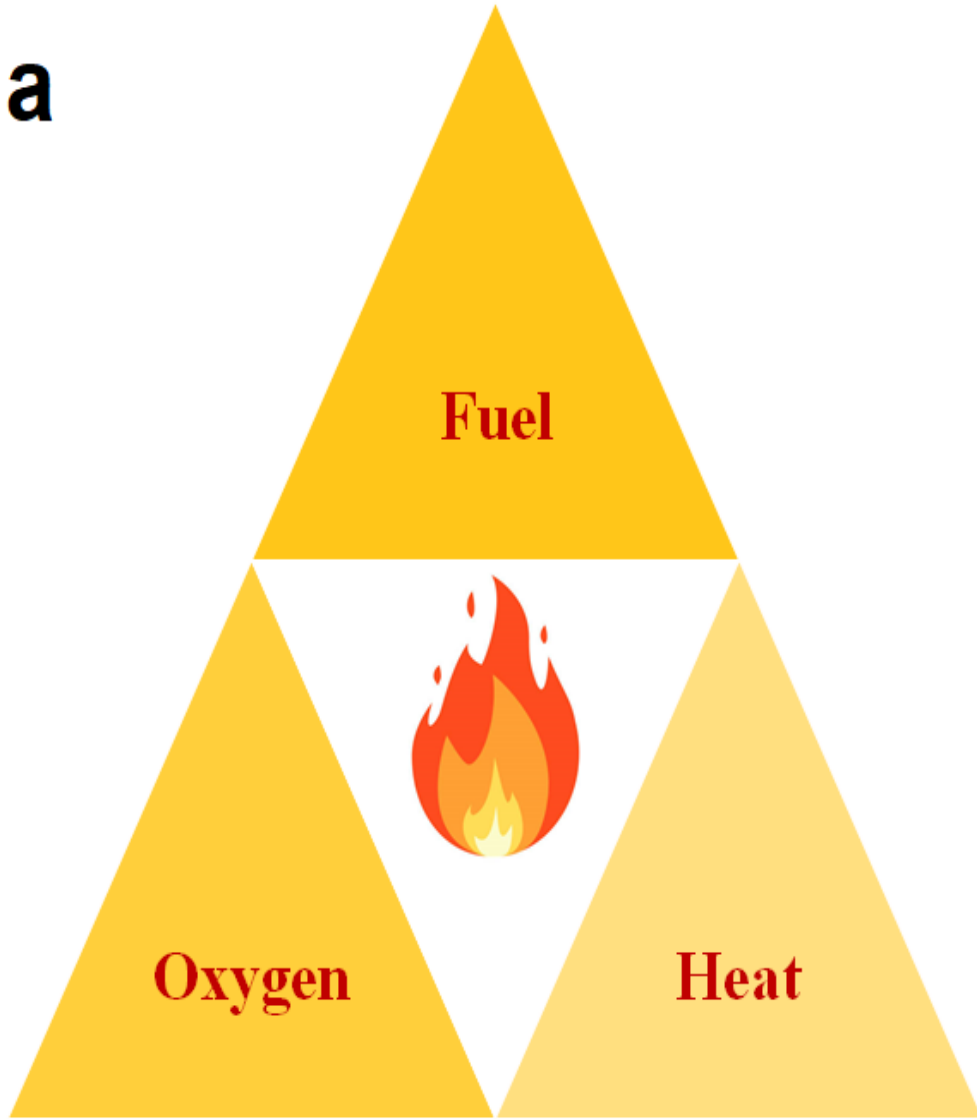
Courtesy of Caltrans

# Fire

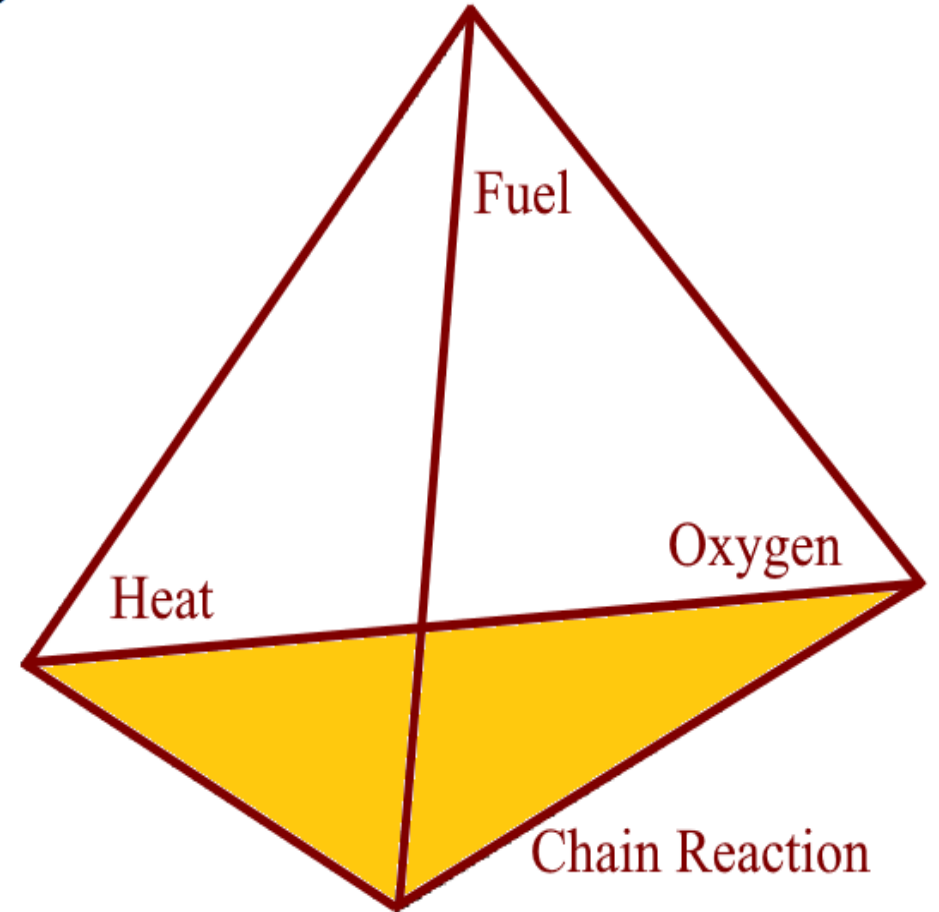
**Fire** is an exothermic chemical reaction where the fuel is oxidized and heat is produced. To describe the fire, there are two main models, (a) fire triangle and (b) fire tetrahedron as shown.

The theory of the fire triangle states that fire takes place when fuel (combustible substances) have the ability to interact with oxidizers when a suitable source of ignition is available.

**a**



**b**





# Fire and Earthquakes

Fires can happen at any time, but following an earthquake, there are extra factors which mean that a fire is more likely to start and can spread more quickly.

- The earthquake causes the ground to shake and move, which can crack gas pipes and damage power lines, electrical wiring and household appliances

- Liquefaction can cause damage to pipes and buildings. This can make firefighting efforts more difficult.
- Earthquake damage can block roads, which may delay the emergency response.
- Damage to buildings can expose flammable materials, such as insulation, which can keep fires burning.
- Debris can fall into gaps between buildings and help a fire to spread more easily.
- A power outage might delay a fire starting. However, damaged household appliances and wiring could start a fire when the power is switched back on.

# Quiz

1. What are the types of earthquake hazard?
2. What are the similarities and differences between ground shaking and ground rupture?
3. How the strength of ground shaking is measured?
4. Define fault and what are the types of fault?
5. Landslides can occur in ....., ..... and ..... environments.
6. What are the cause of landslide?
7. Define the landslide.
8. What are the types of landslide?
9. How to minimize the landslide?

# Quiz

1. Define the soil liquefaction and list the types of soil liquefaction.
2. List the effect of soil liquefaction.
3. Mention five points of methods to reduce the soil liquefaction.
4. Tsunamis are usually produced by .....
5. Frequently there is a large ..... of the ocean from the shoreline before a tsunami wave hits.
6. Tsunamis may also be produced by large submarine .....
7. That the greatest hazard of tsunami is in ..... regions in the Pacific basin.

# Quiz

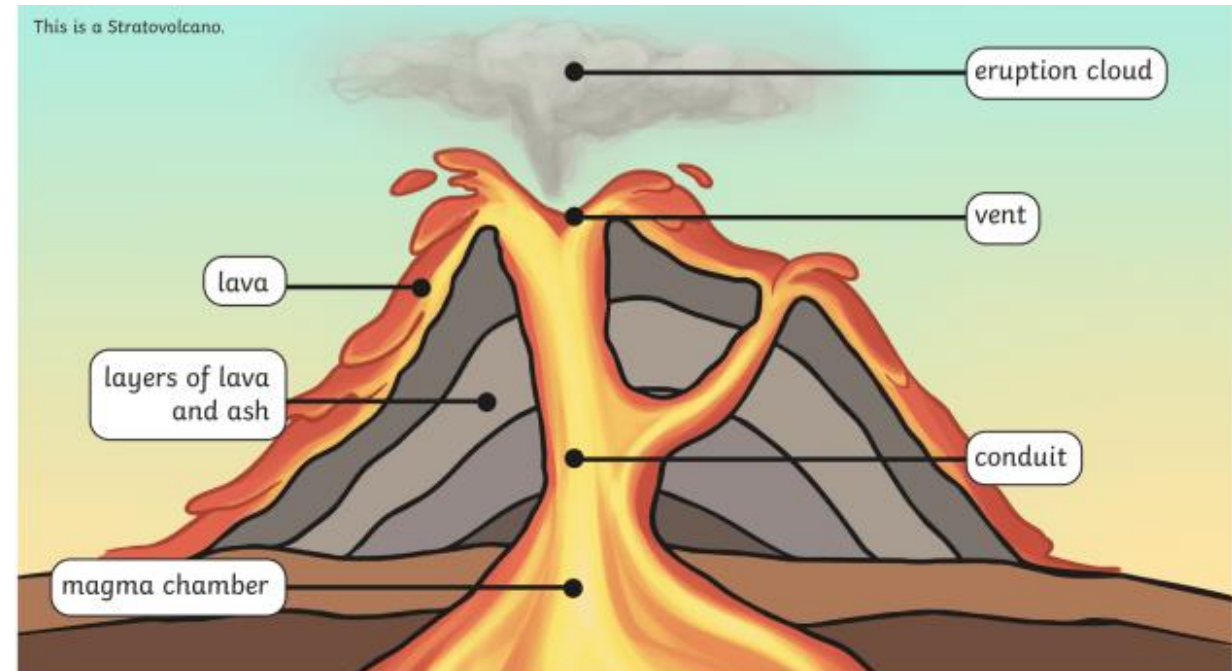
1. An ..... can occur in one area and the ..... may inundate another thousand of km away.
2. .... are "wave trains" consisting of multiple waves.
3. What are the methods to reduce tsunami hazards?
4. What are the causes of tsunami?
5. Define fire and what is the model to describe the fire?

Environmental disasters are  
still on the run

# Volcanoes

Volcano refer to the eruption of hot molten lava from below the surface of earth.

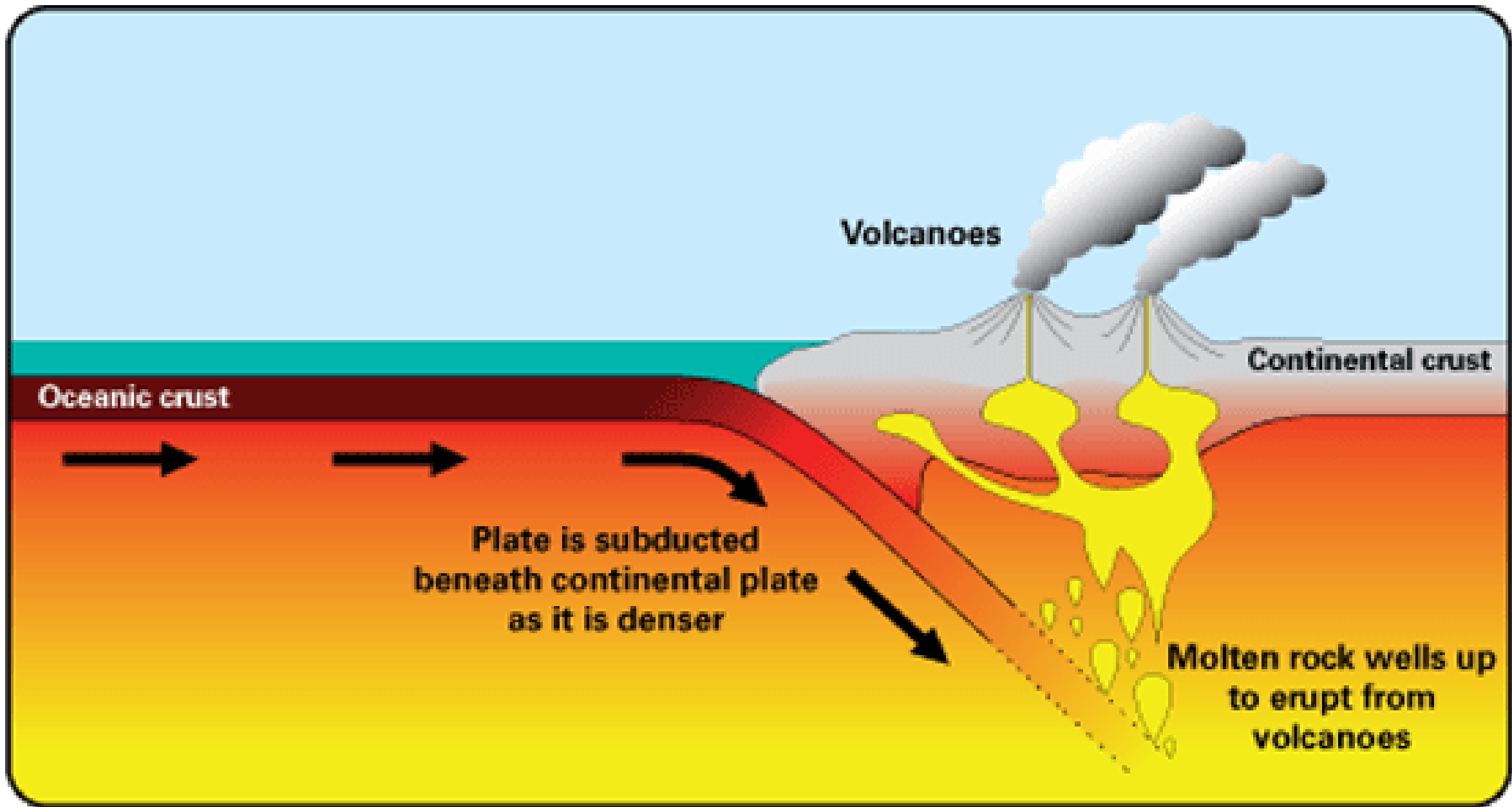
A volcano is a vent in the earth's crust through which Lava, Steam, ashes etc. are expelled



# How are They Formed

- When tectonic plates collide and go through the process of subduction, it sets the foundation for a volcano. The overlapping of the tectonic plates causes the magma to break through the crust, which is the cause of a volcano's birth.
- When temperature and pressure rises, the rock melts and moves through the surface and crust, and releases gases and magma, volcanic eruption occurs.





# Cyclone

- Cyclone refers to any spinning storm that rotates around a low-pressure center.
- Closed low-level atmospheric circulation, strong winds, and a spiral arrangement of thunderstorms that produce a heavy rain.



# Types of Cyclones

The term 'cyclone' actually refers to several different types of storm.

There are three types of cyclones:

1. Tropical Cyclones
2. Polar cyclones
3. Mesocyclones

1. Tropical cyclones occur over the tropical ocean regions. Hurricanes and typhoons are types of tropical cyclones, but they have different names so that it's clear where that storm is occurring. Hurricanes are found in the Atlantic and Northeast Pacific, and typhoons are found in the Northwest Pacific.
2. Polar cyclones are cyclones that occur in polar region like Greenland, Siberia and Antarctica. Unlike tropical cyclones, Polar Cyclones are usually stronger in winter months.
3. Mesocyclone is a cyclone that occurs when part of a thunderstorm cloud starts to spin, which may eventually lead to a tornado. 'Meso' means 'middle'.

# Causes of Cyclones

1. The main source of energy for cyclones is the warm oceans in the tropical regions.
2. To initiate a tropical cyclone the sea- surface temperature generally needs to be above 26.5°C.
3. They lose their source of energy when they move over land or colder oceans causing them to dissipate.

# Flooding

Cyclones can produce flooding in two ways. First, tropical cyclone frequently causes a surge in ocean waters causing sea levels to rise above normal. These surges sometimes called tidal waves, can drown people and animals, and are often the greatest killer in cyclone. Cyclones also can bring torrential rains that lead to flooding.



# Other Causes of Flooding

1. Heavy rains
2. Melting of ice during volcano eruption
3. Undersea earthquake
4. Marine landslip

# Drought

Drought is a damage of a ground usually caused by dry weather.





# Causes of Drought

- Droughts occur when there is no rainfall from a long period of time.
- It usually happens in summer, because in summer weather gets hot and ground evaporate water.
- So, ground need more water but it can't get water so drought occurs.

# Prevention

1. First of all, we cannot prevent drought but we should try to prevent droughts as it causes huge damage.
2. To prevent droughts we should preserve as much water as we can, we should use water in limit.
3. We should save rain water in proper ways, and protect under ground water.
4. We should plant as much trees as we can.
5. We shouldn't cut down trees for economic purpose or for any other purpose.

# Quiz

1. Define: Cyclone, Drought, Volcano, Flooding.
2. what are the causes of drought?
3. What are the types of cyclones?
4. What are the causes of flooding?
5. What are the causes of volcano?

# Quiz

1. 4. The overlapping of the tectonic plates causes the ..... to break through the crust.
2. Tropical cyclones occur over the ..... regions.
3. Hurricanes are found in the Atlantic and Northeast Pacific.
4. Typhoons are found in the .....
5. Polar cyclones are cyclones that occur ..... region like Greenland, Siberia and Antarctica.
6. Tropical cyclones, occur in ..... months.