Intermediate Science 7

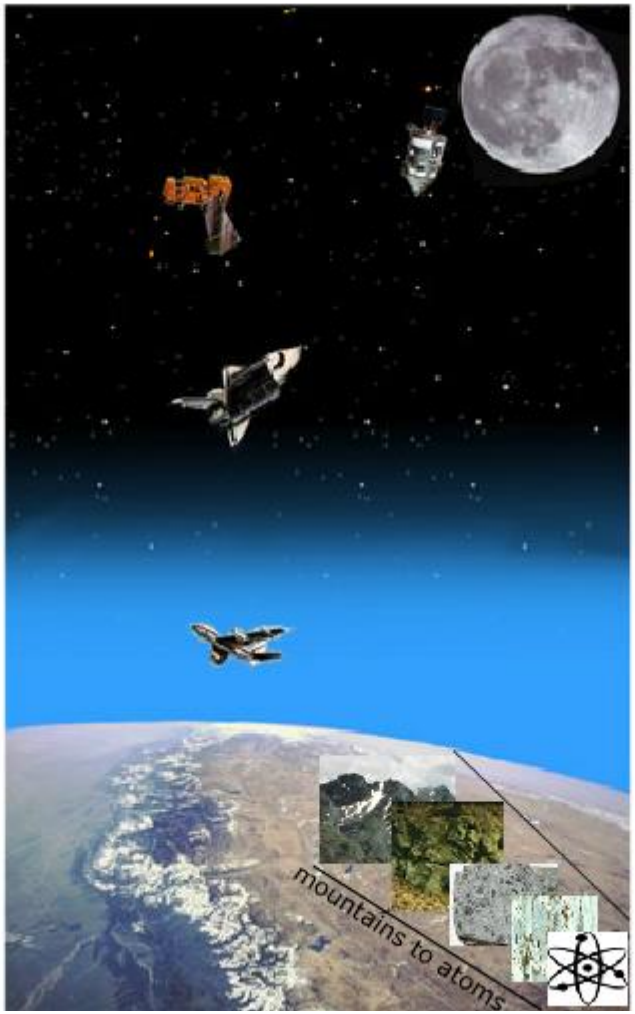
UNIT 4

EARTH'S CRUST

Intermediate Science 7

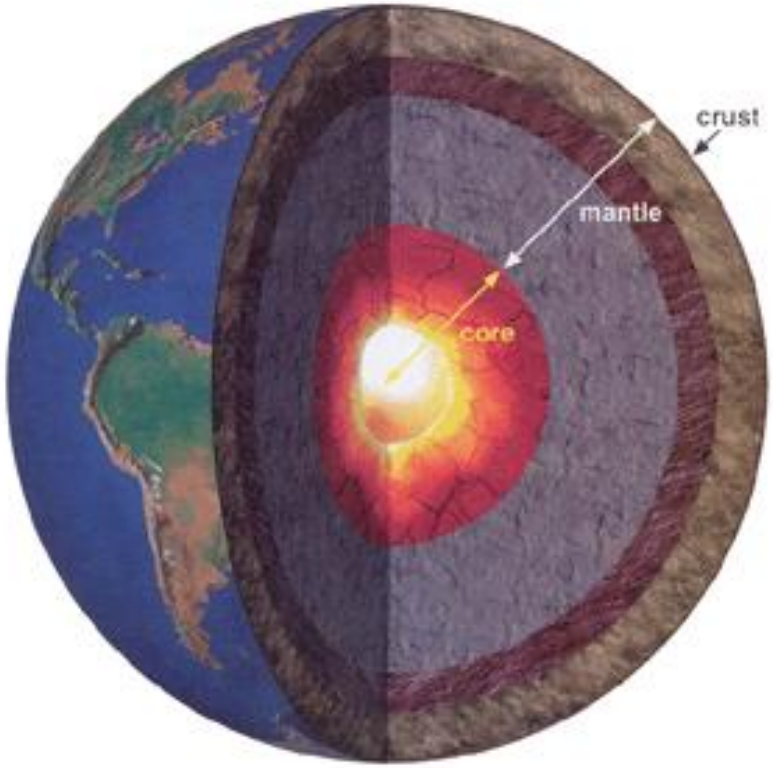
UNIT 3
EARTH'S CRUST

TOPIC 1: STRUCTURE OF THE EARTH


mountains to atoms

Only in the last 100 years have scientists been able to investigate the interior of our planet. No one has ever descended more than 3.5 kilometres beneath the earth's surface and the deepest drillings have penetrated less than 16 kilometres into the earth's 6.5 thousand kilometer deep interior.

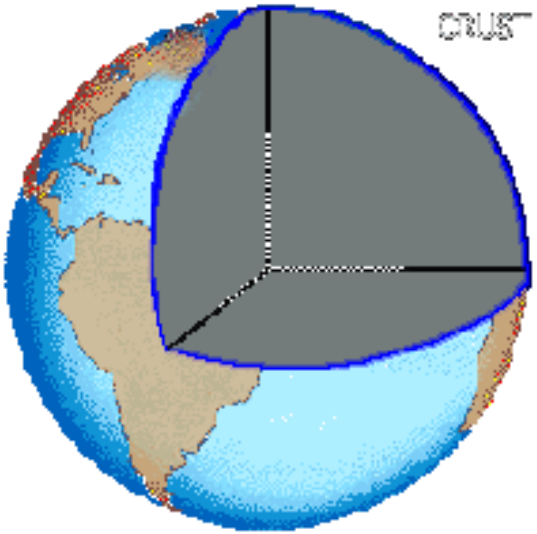
By analogy, if the earth were an apple we have not yet penetrated its skin. By using an assortment of modern equipment and computer simulation models, geologists have been able to construct a general picture of the earth's structure.
The earth can be divided into there major sections based on its composition: the crust, the mantle , and the core



THE EARTH'S CRUST

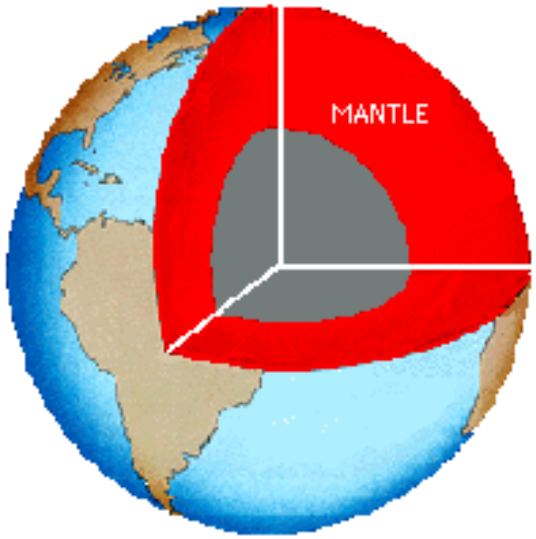
GEOLOGY: the study of the materials of the earth crust.

The earth has three main levels

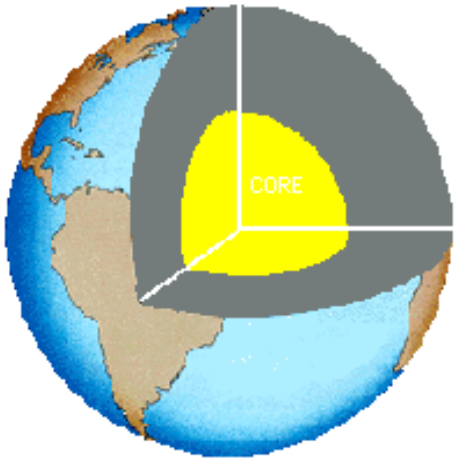


CRUST: The out layer of the earth, from 5- to 60 km thick. Buried within the crust are all the metals, oil, gems, coal and gas that our society depends on. Also, rocks found in the crust can provide information about our history (previous forms of life, info about earthquakes and volcanoes).

Mantle: the region just below the crust and extending all the way down to the Earth's core.

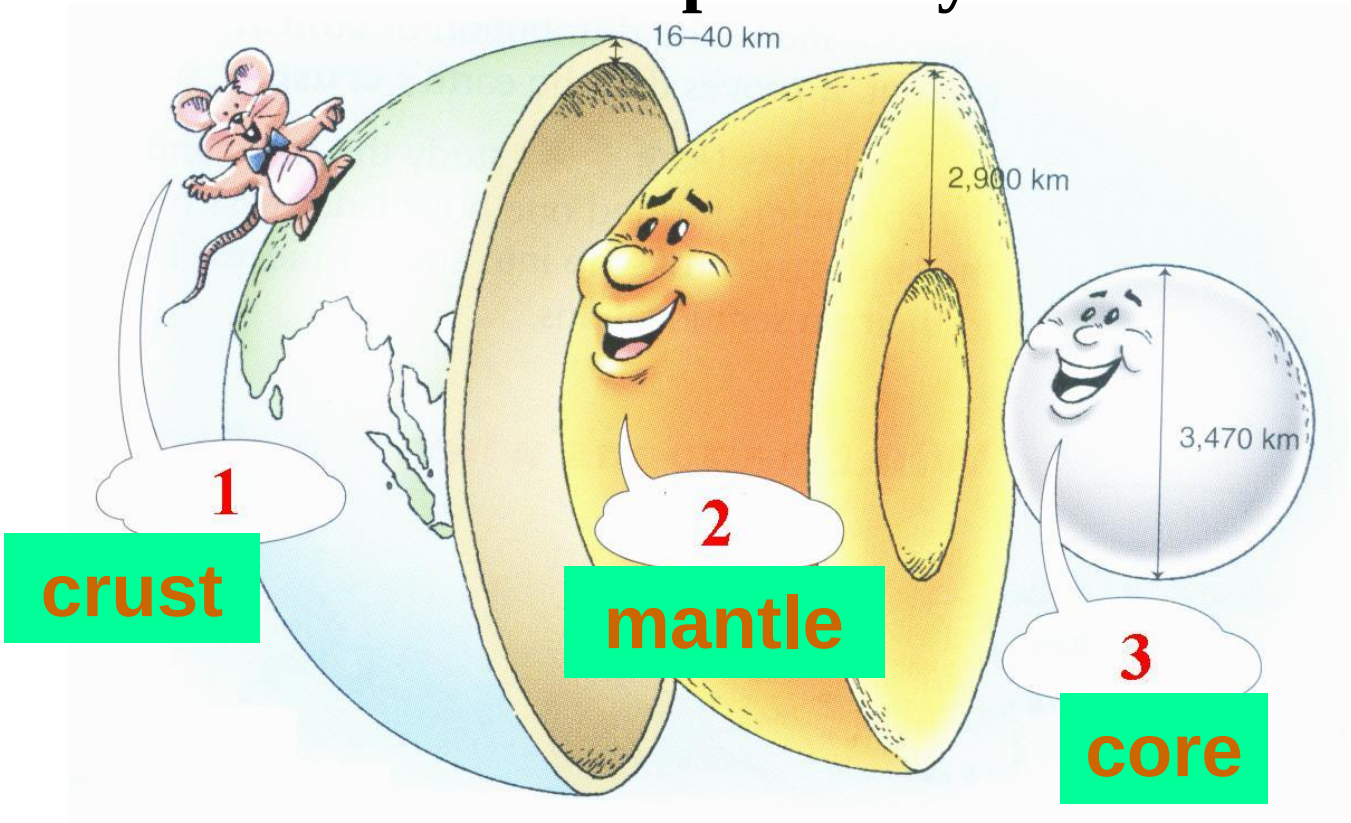


Core consists of a fluid outer core and a solid inner core. Because the outer core contains iron, when it flows it generates a magnetic field. This is the source of the Earth's magnetic field.



What Makes Up The Earth's Crust?

- **The earth is made up of 3 layers:**



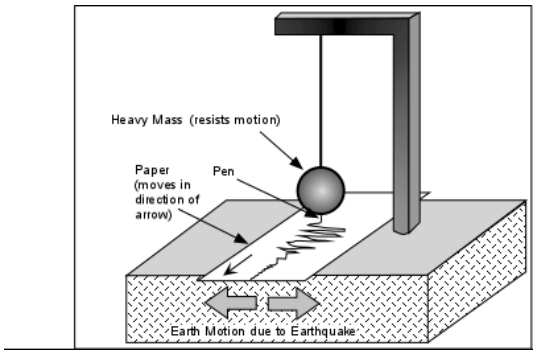
- **The earth's crust is made up of** rocks **and** soil**. They form the** continen ts **and** ocean **floors.**

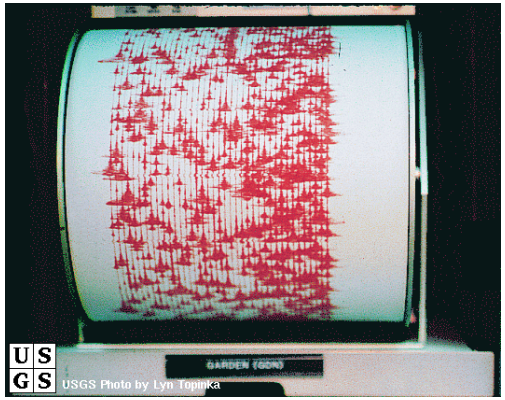
How Do We Know?

Technologies that are used to gather info...

1. Satellite Imaging: images of Earth or other planets collected by imaging satellites

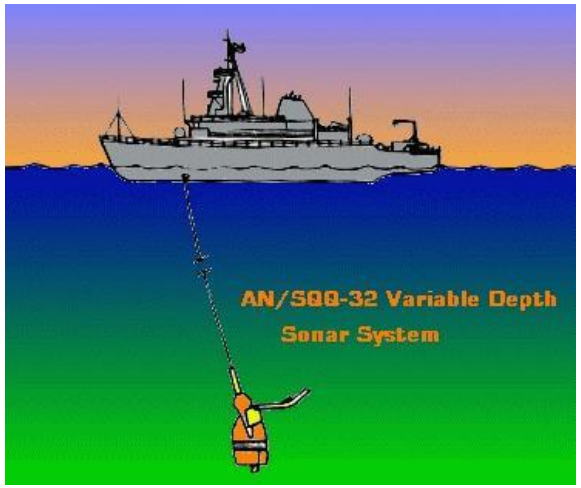
2. Seismographs an instrument used to detect and record earthquakes





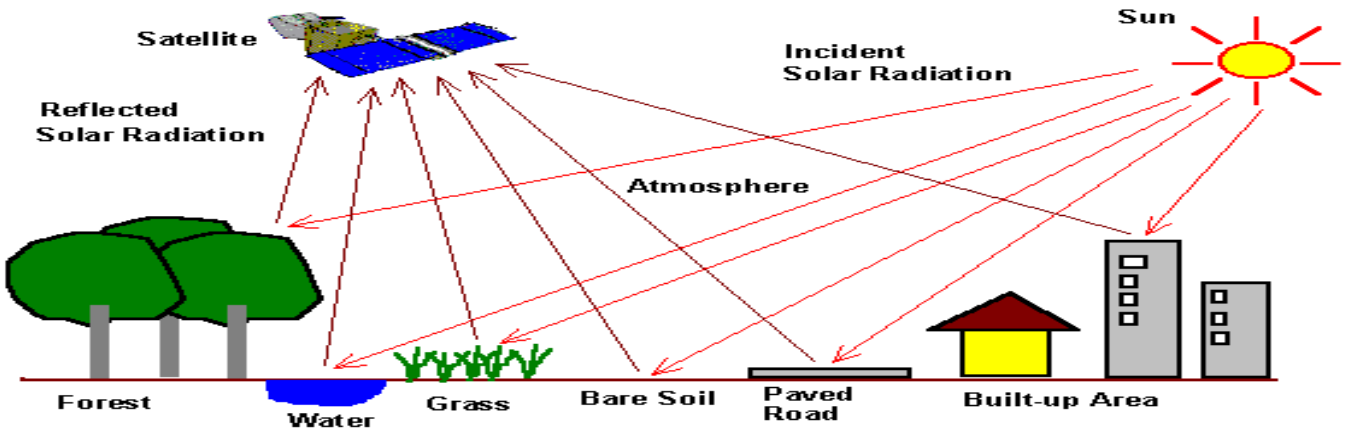
3. Magnetometers

an instrument used for measuring magnetic forces, especially the earth's magnetism.



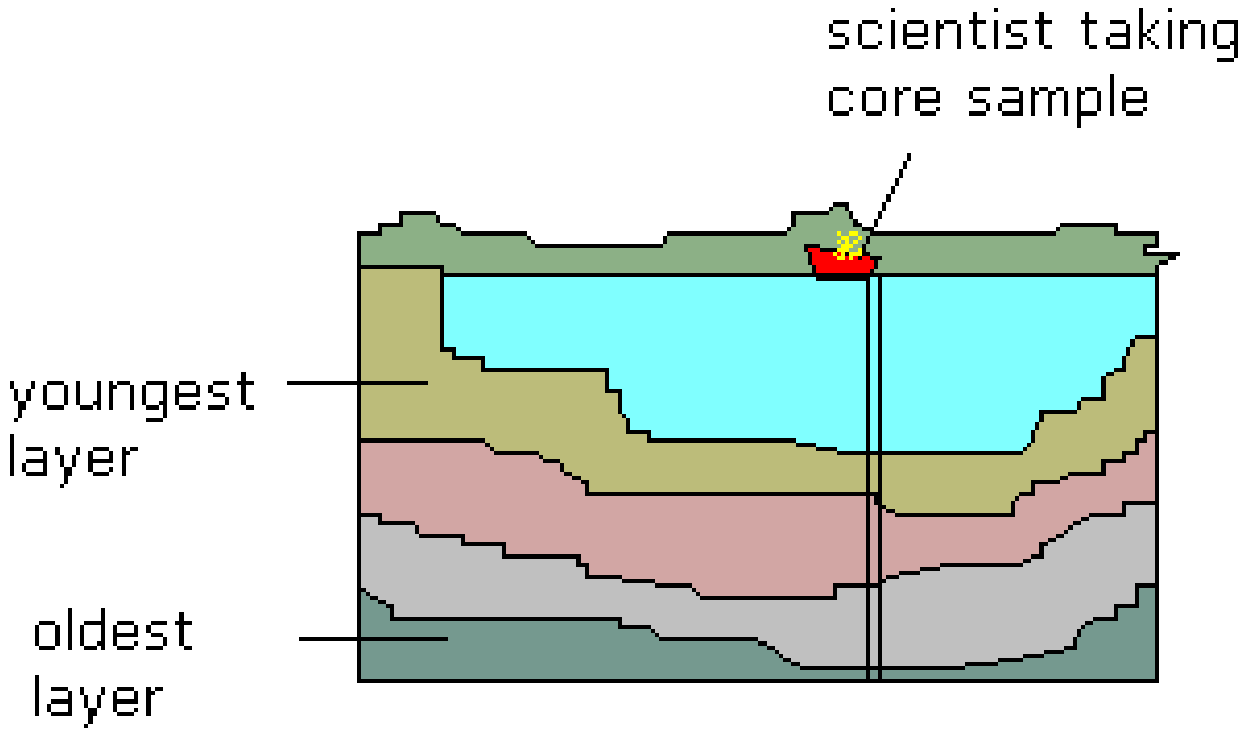
4. Remote Sensing

the scanning of the earth by satellite or high-flying aircraft in order to obtain information about it.



5. Core Sampling

a roughly cylindrical piece of subsurface material removed by a special drill and brought to the surface for examination.



Layers increase in age from top to bottom.

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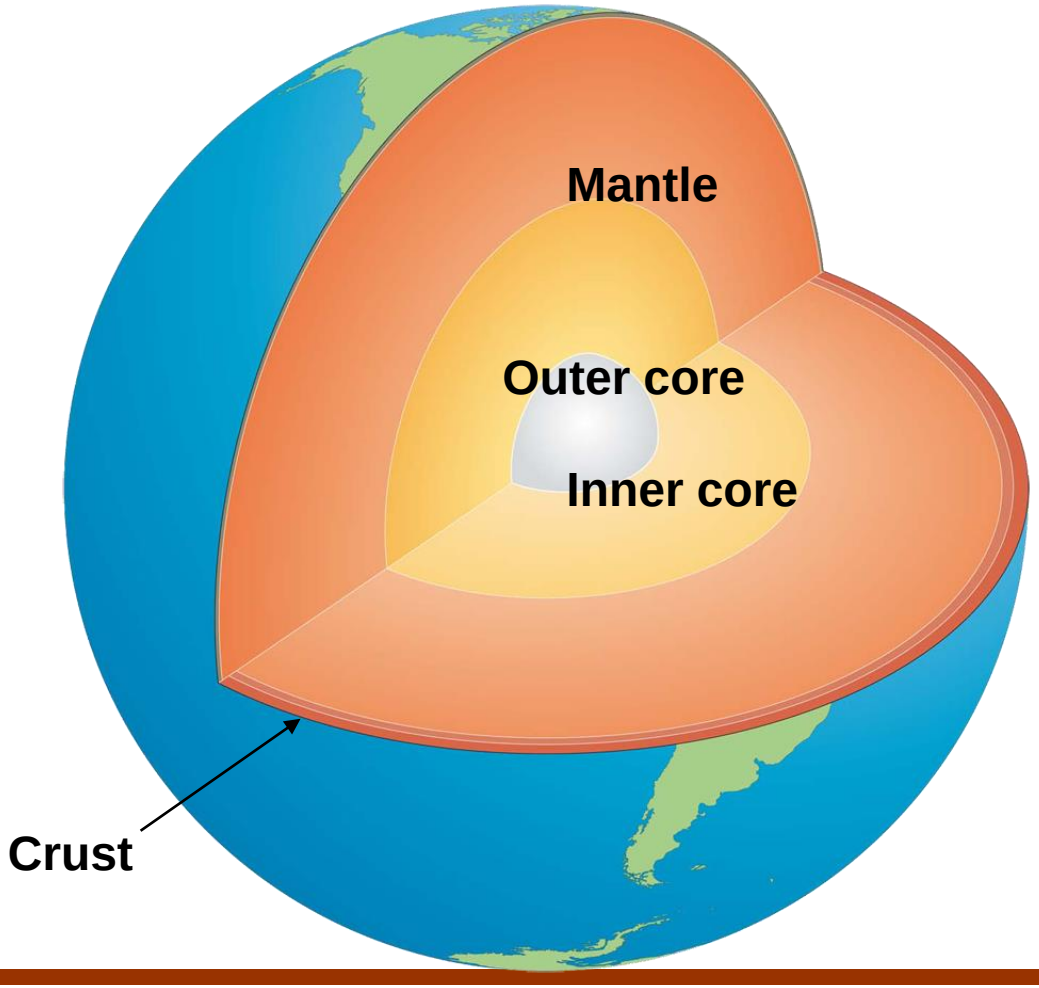
UNIT 3
EARTH'S CRUST

TOPIC 2: TECTONIC PLATE THOERY

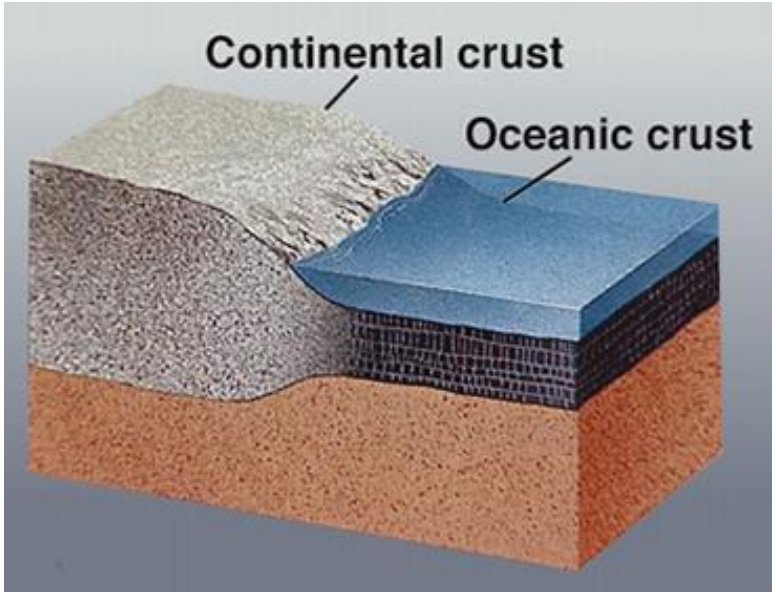
Structure Of The Earth

- The Earth is made up of 3 main layers:
  - Core
  - Mantle
  - Crust



The Crust

- This is where we live!
- The Earth's crust is made of:



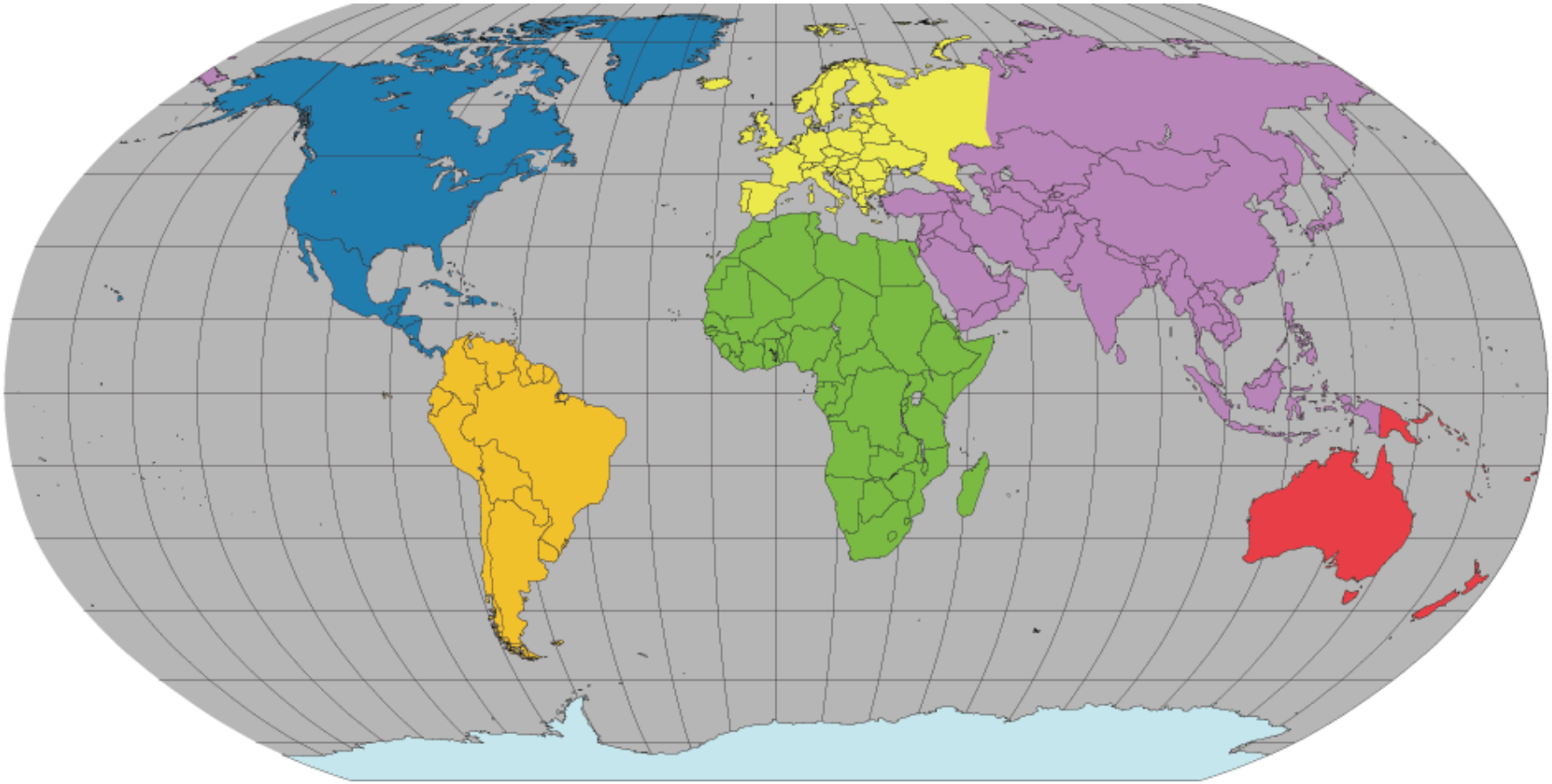
Continental Crust

- thick (10-70km)
- buoyant (less dense than oceanic crust)
- mostly old

Oceanic Crust

- thin (~7 km)
- dense (sinks under continental crust)
- young

What do you notice about the continents?



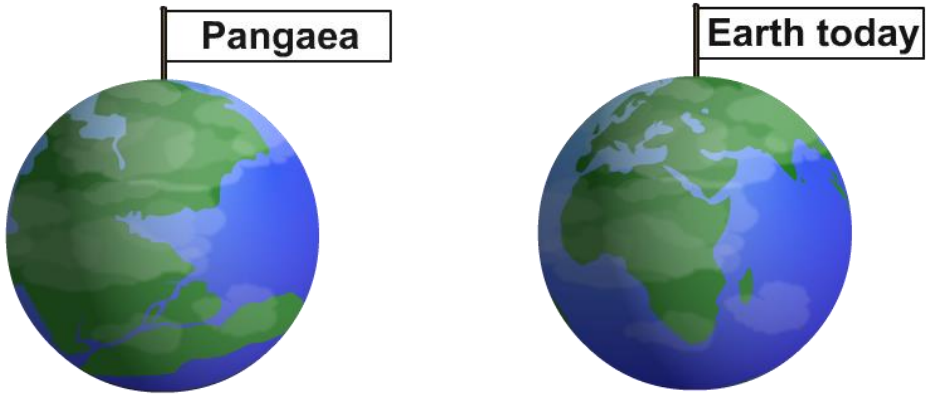
- If you look at a map of the world, you may notice that some of the continents could fit together like pieces of a puzzle.

“Puzzle Pieces”

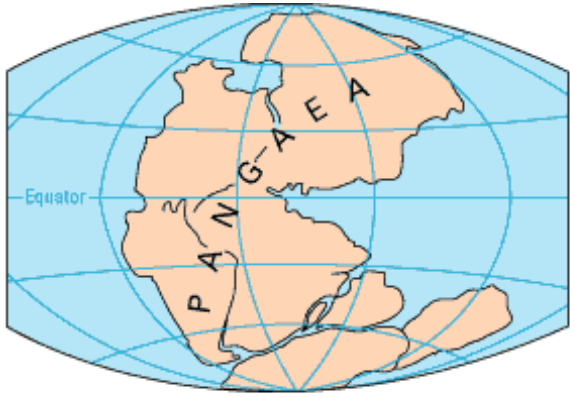
- Continents look like they could be part of a giant jigsaw puzzle

The Theory Of Continental Drift

- **Alfred Wegener** proposed this theory in 1915
- He said that at one time all continents were joined together in one large land mass, he called Pangaea.
- He proposed that this super-continent broke apart 200 million years ago.

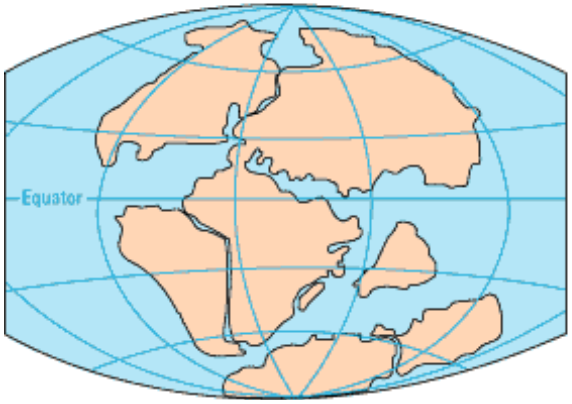


- His Theory suggested that the continents change position slowly by a few cm a year.
- He could not explain how

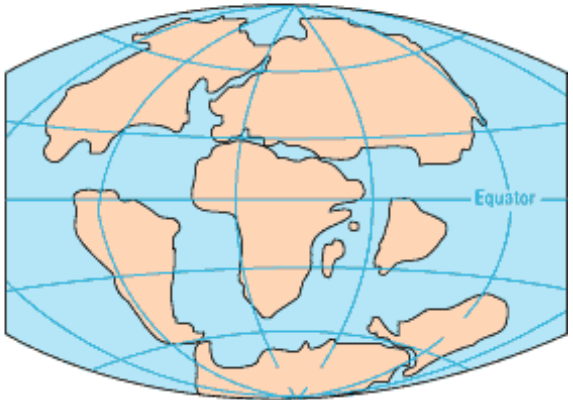


Permian 225 mya

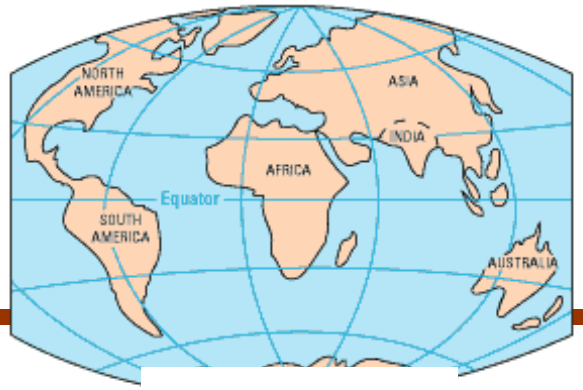
Triassic 200 mya



Jurassic 135 mya



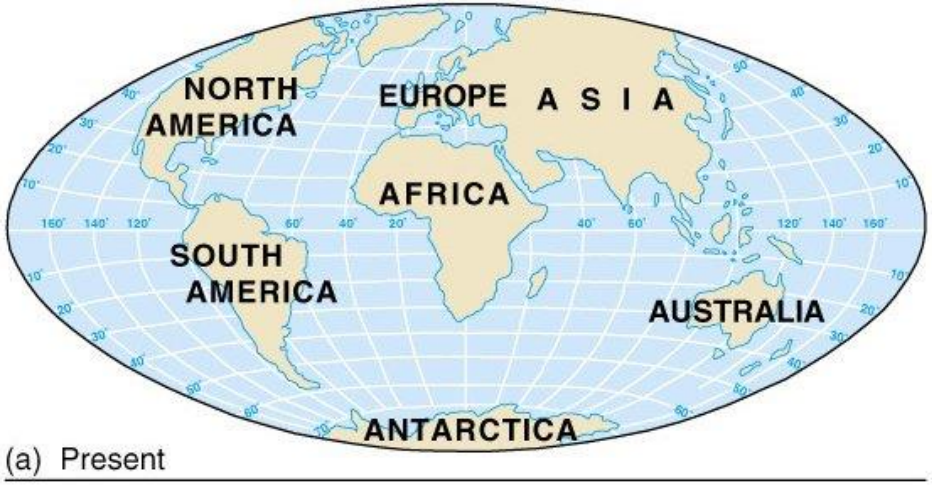
Cretaceous 65 mya



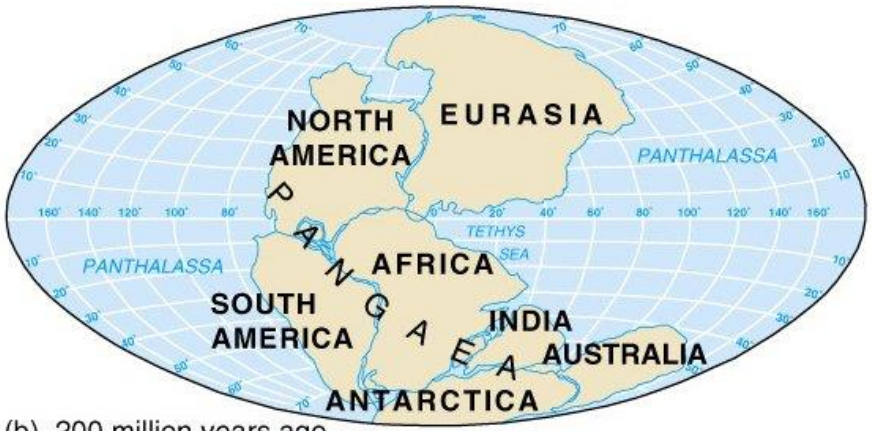
Present Day

Evidence For Continental Drift

1)Matching coastlines on different continents



(a) Present



(b) 200 million years ago

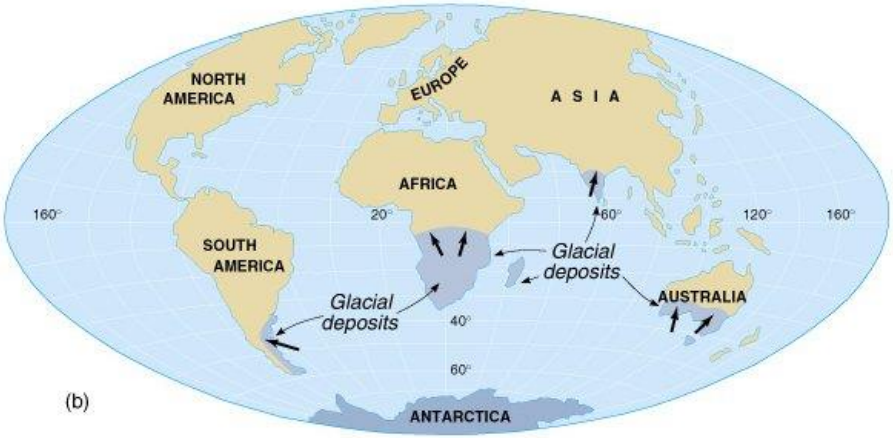
2) Matching mountain ranges across oceans

Geologists found rocks that were similar on both sides of the Atlantic Ocean. The ages of these rocks are also the same.

Today

300 million years ago

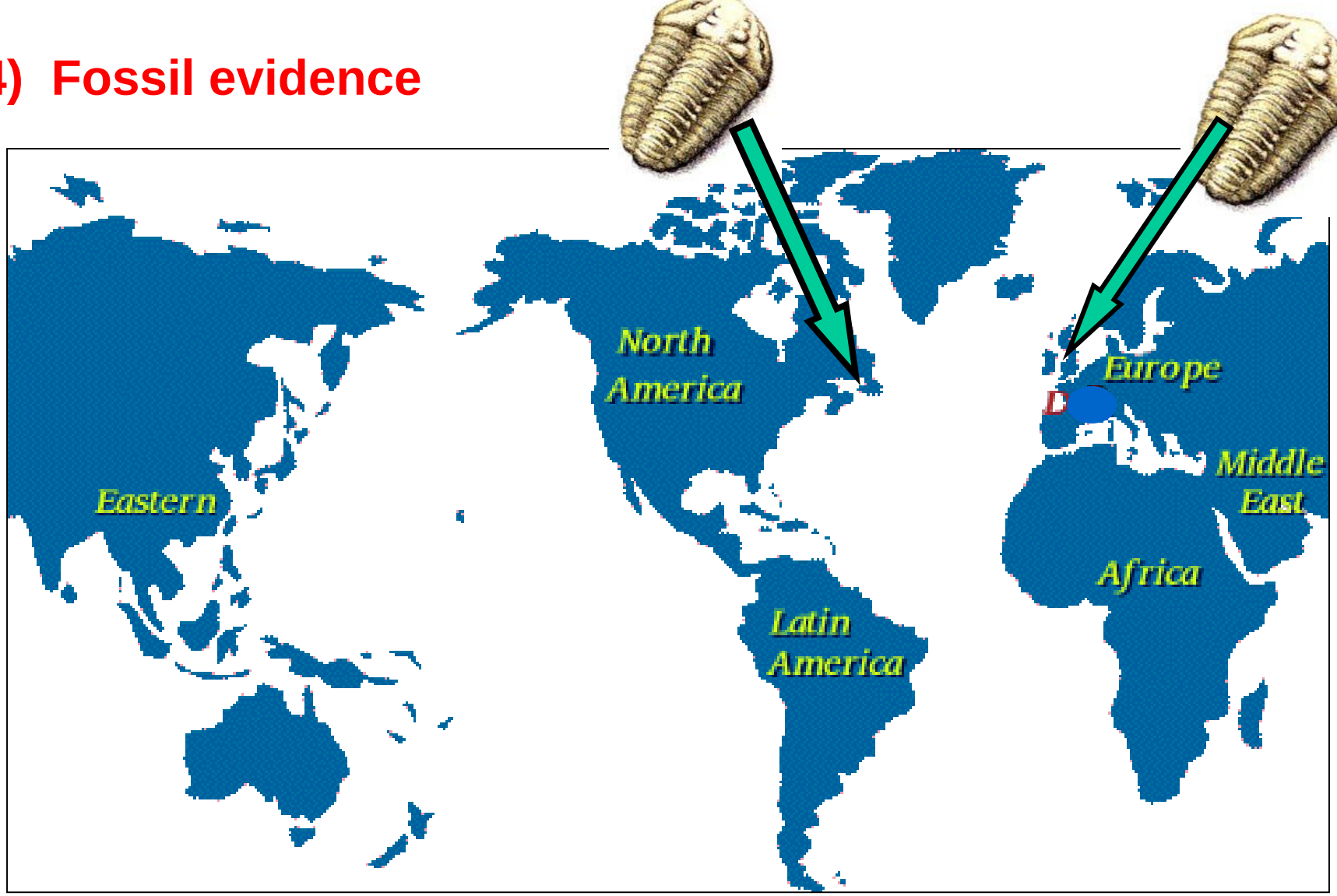
3)Glacial ages and climate evidence



There are warm areas that show evidence that they were once covered in glaciers.

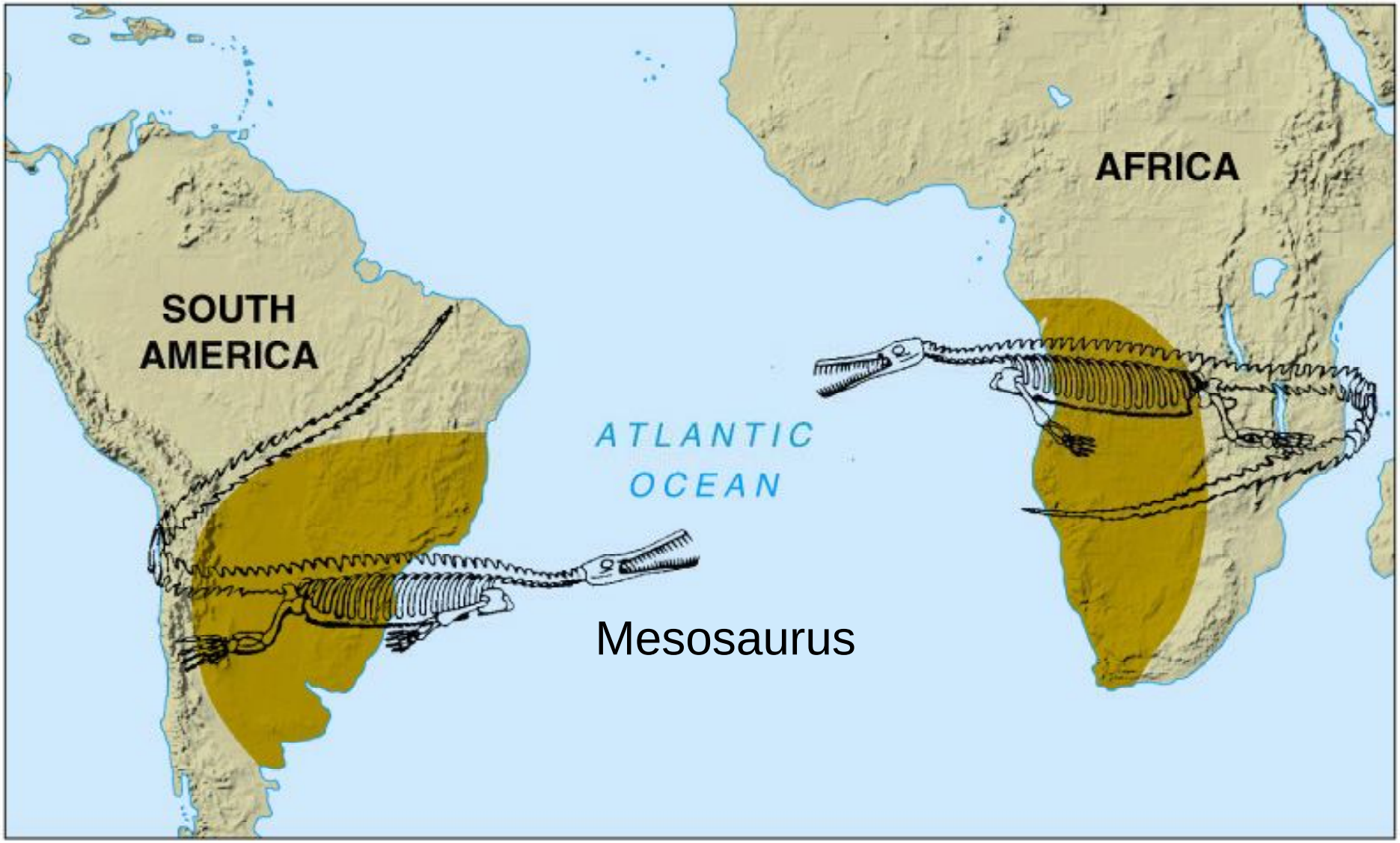
Location of coal beds. These should be found in tropical, swampy area BUT have been found in cold and moderate climates.

4) Fossil evidence



Similar fossils found on one continent have been found on others. Ex. NL and Wales

Distribution of fossils such as *Mesosaurus*

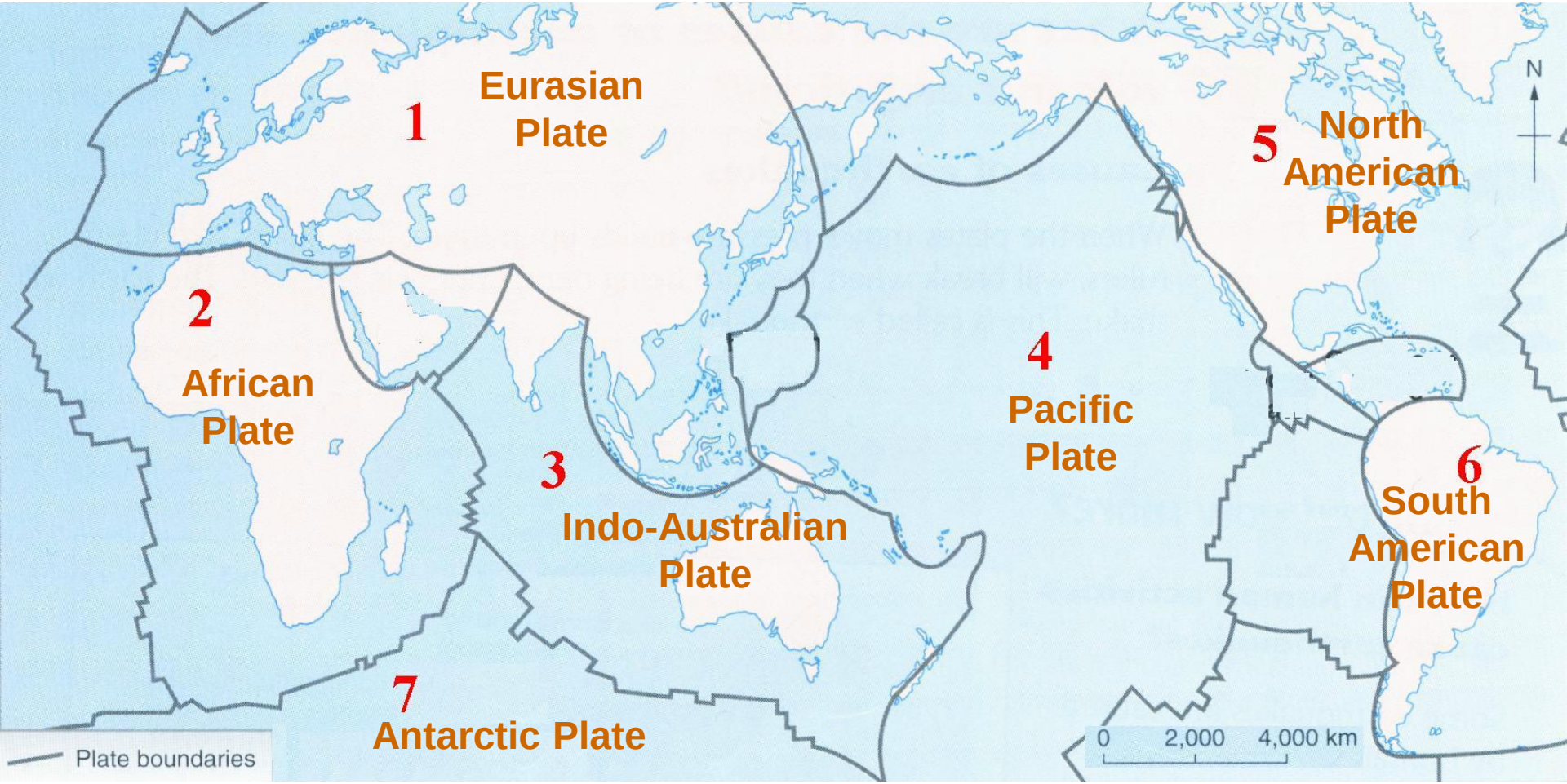


Accepted or Rejected?

Because he was unable to explain HOW the continents move, his theory was rejected by the scientific community.

Why does the crust move?

- The earth's crust is made up of plates.
- Name the plates marked 1 to 7 in the map below.



What Is The Theory of Tectonic Plates?

- This explanation for how the continents move came as the result of observations of the seafloor spreading and other effects

- According to this theory, the Earth's crust is like a jigsaw puzzle made up of giant sections called **tectonic plates**

- These plates 'float' on top of the mantle and so can move around the Earth's surface.

The Earth's crust is divided into 12 major plates which are moved in various directions.

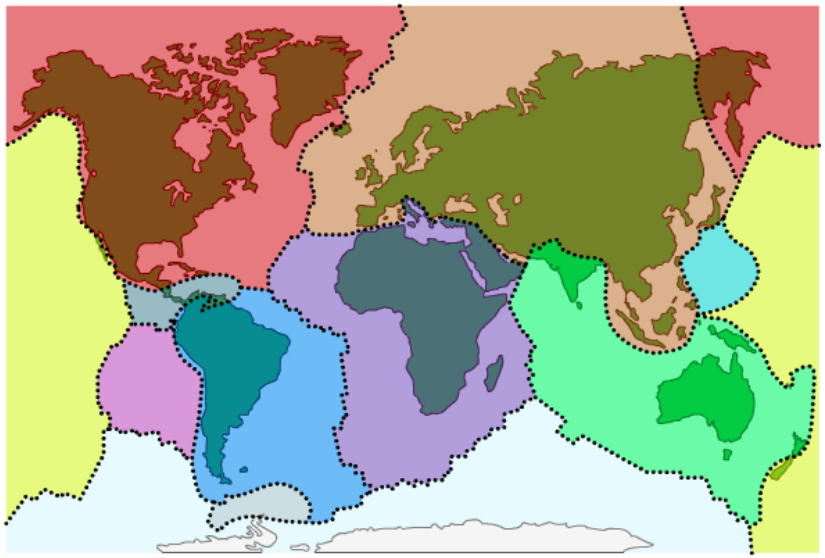
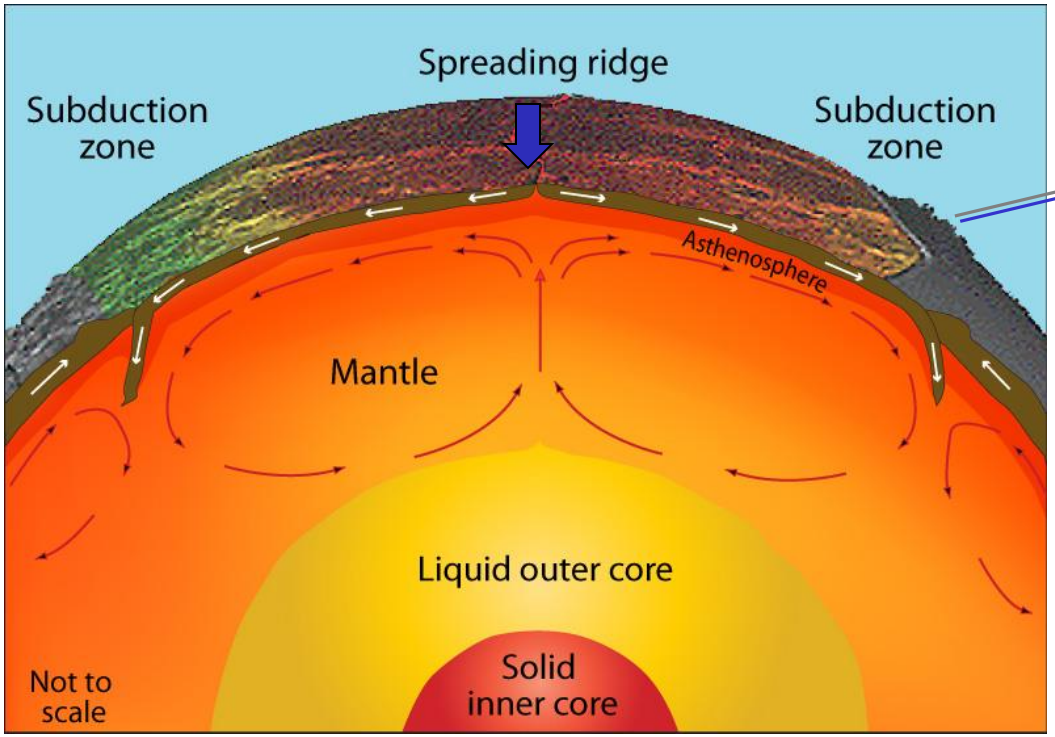


Plate Movement

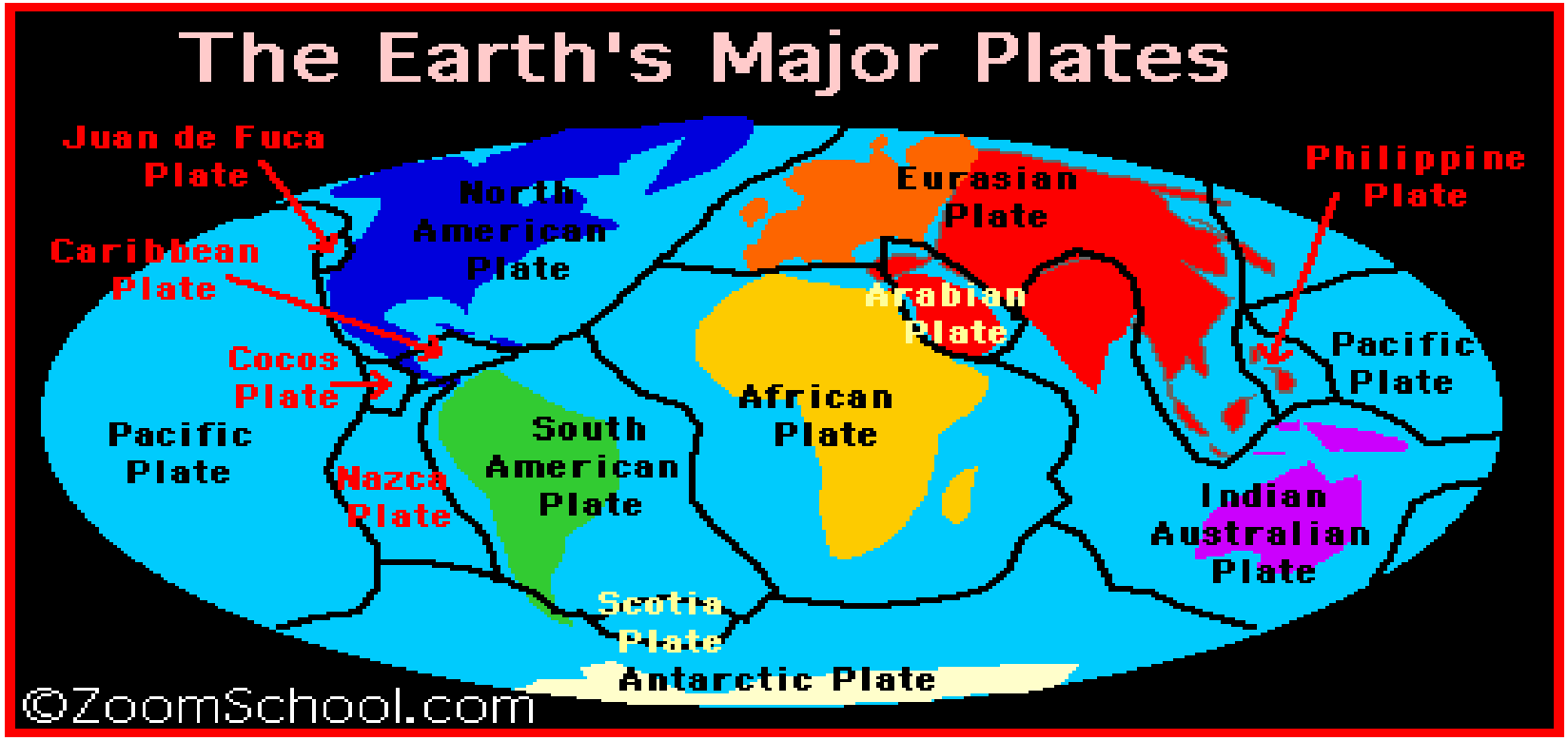
Plates are driven by cooling of Earth (convection)
Gravity provides additional force to move plates.



Modified from USGS Graphics

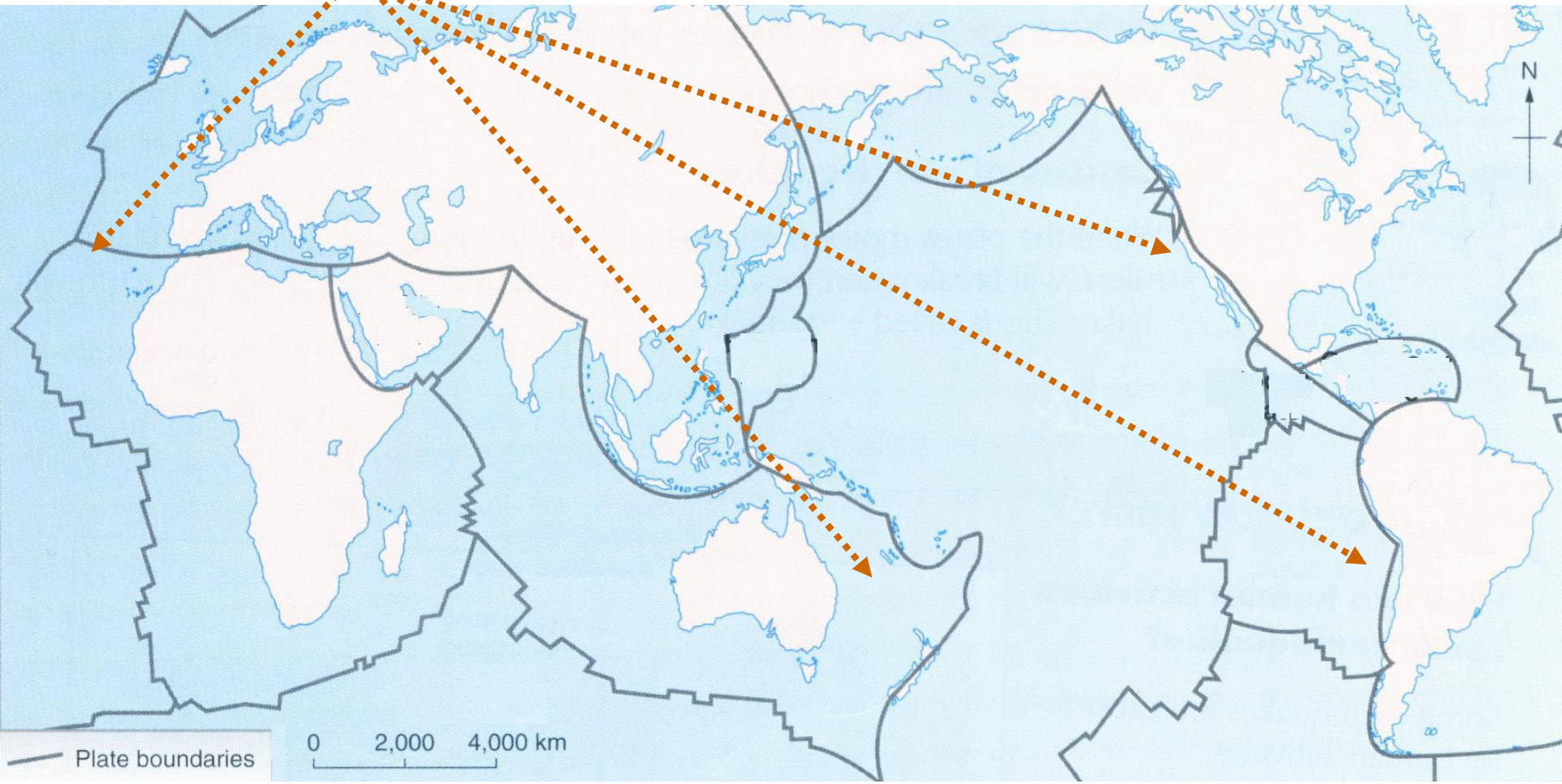
Convection is like a boiling pot. Heated soup rises to the surface, spreads and begins to cool, and then sinks back to the bottom of the pot where it is reheated and rises

- The plates are not anchored in place but slide over a hot and bendable layer of the mantle.



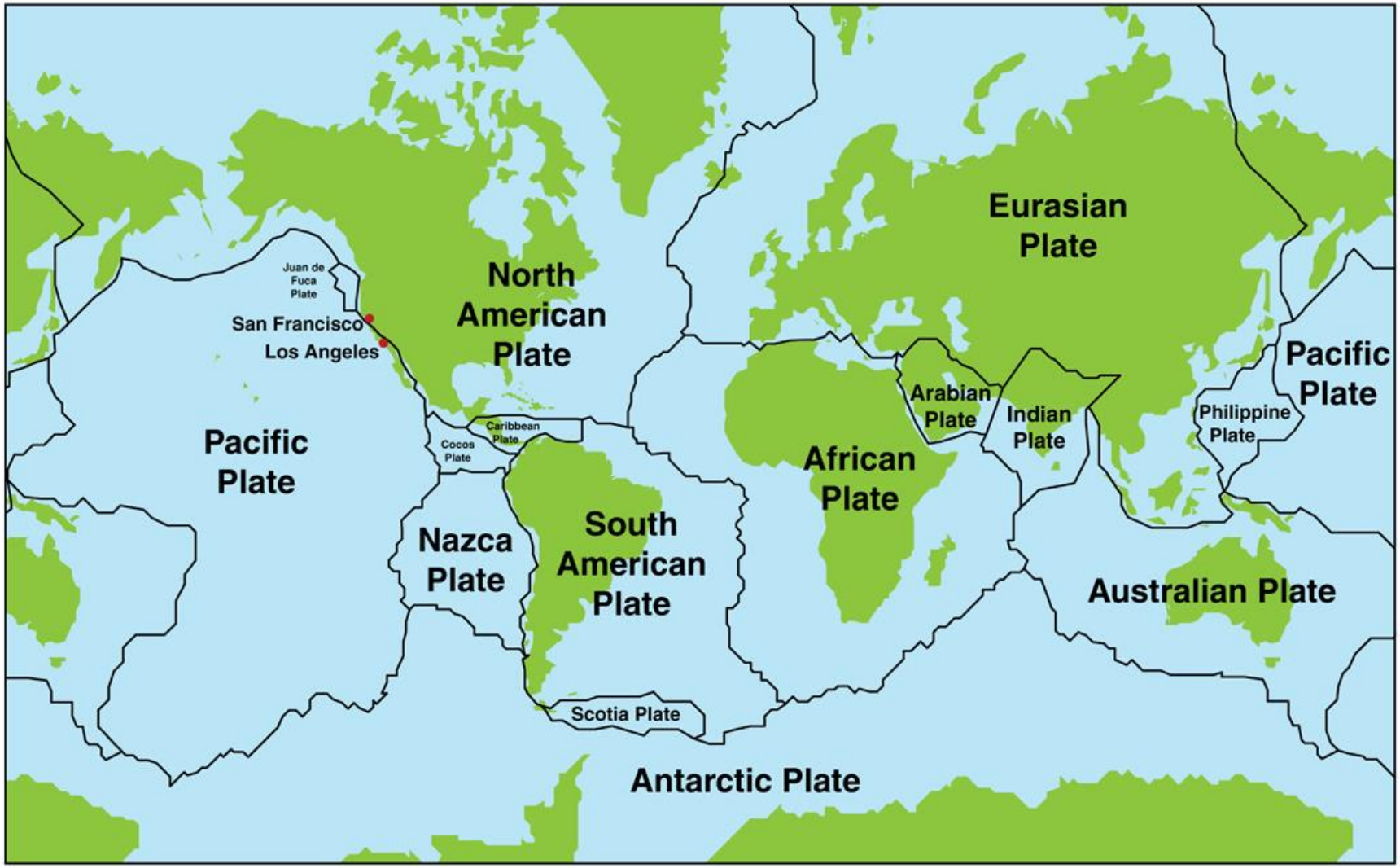
Why does the crust move?

- **The plates are moving very slowly along plate boundaries .**



- The land on the surface of the earth is like bread floating in soup (Mantle)

Names of Plates




LOADING...

How Fast Do Plates Move?

The plates move at different rates.

The Nazca and Pacific plates are moving apart at a rate of 18cm per year while the Eurasian and North American plates are moving apart at a rate of 3cm per year.

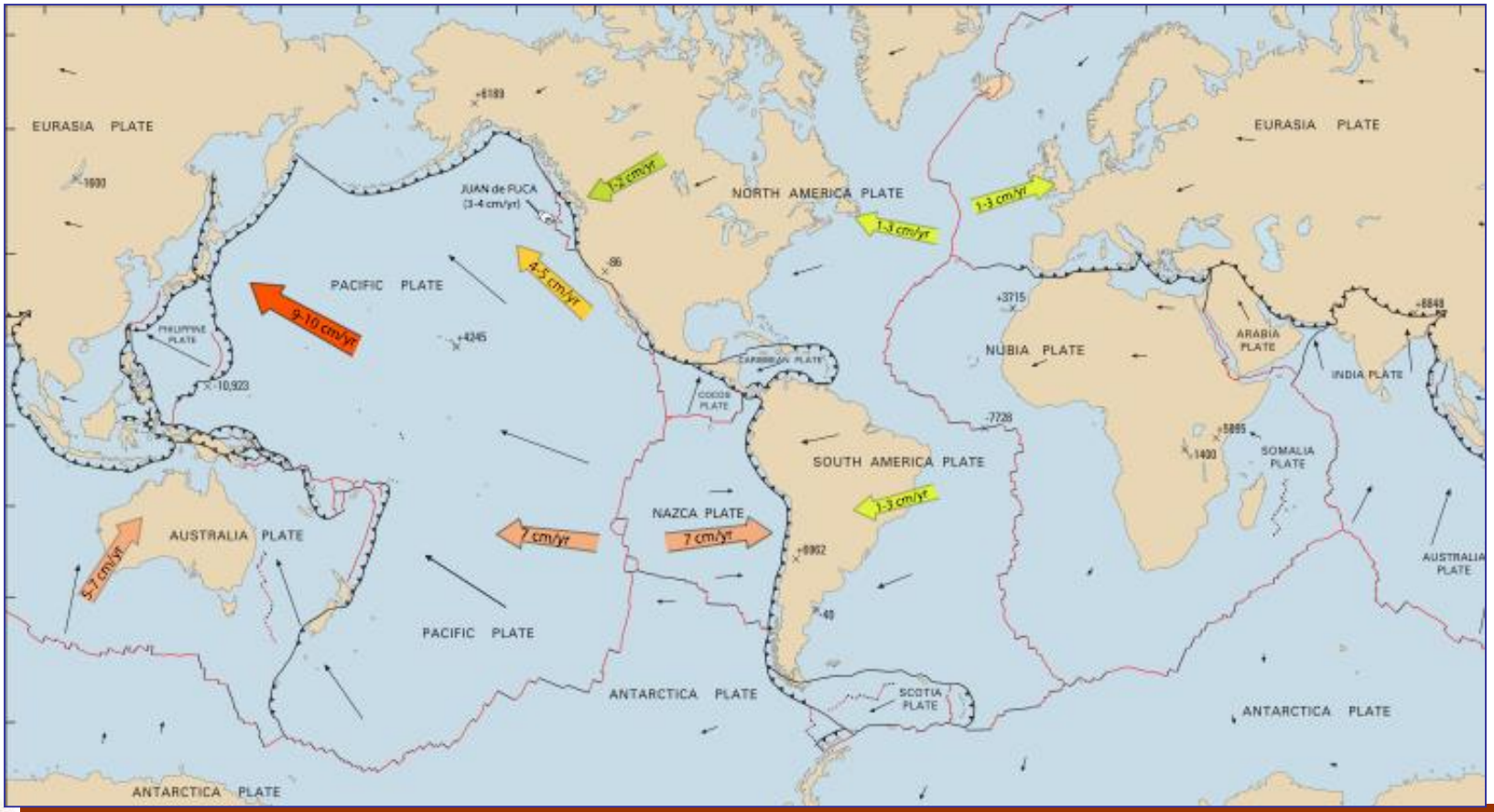
To the nearest metre, how far will the Nazca and Pacific plates have moved over the next 200 years?

6 metres | 36 metres | 200 metres | 928 metres

Tectonic Plates

How fast are the plates moving?

Plates move 1-10 centimeters per year (≈ rate of fingernail growth).



Fingernail growth plotted: http://jclahr.com/science/earth_science/thumbnail/index.html

Modified from USGS Graphics

How Do The Plates Move?

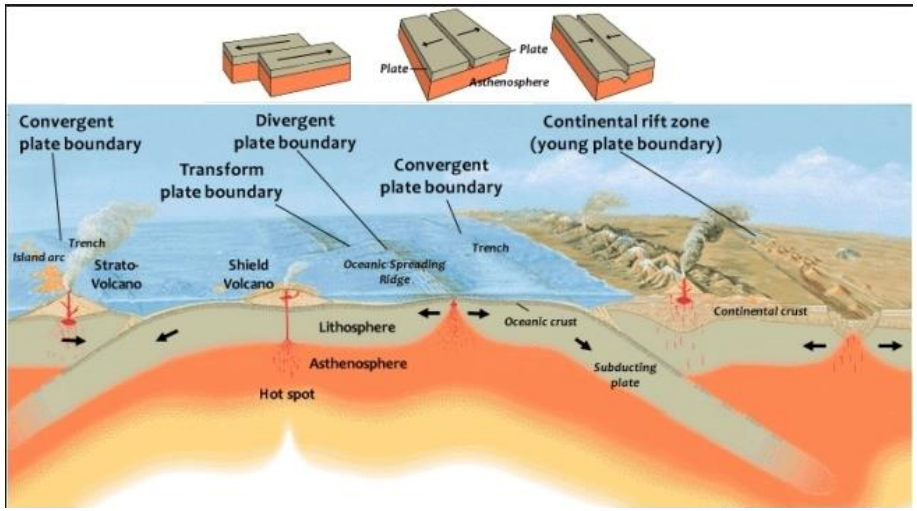
Discoveries on the sea floor showed that magma produces new crust which pushes the plates of the Earth's crust.

The plates can be pushed in three ways

1. Divergent boundaries:

2. Convergent boundaries:

3. Transform Boundaries:

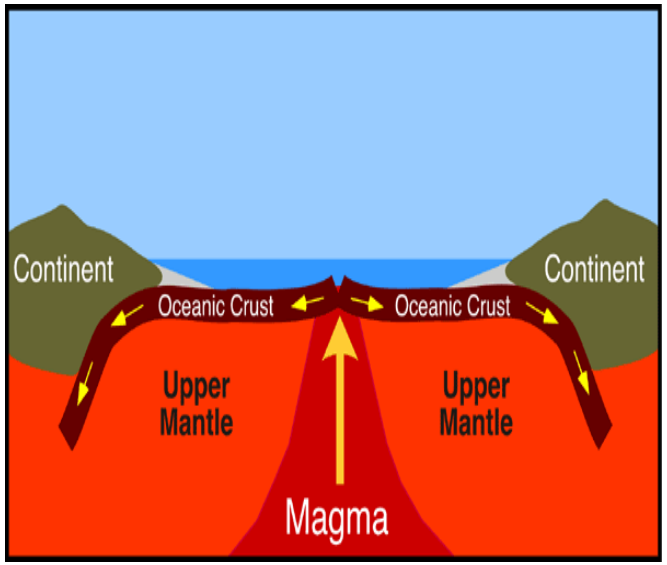


1. Divergent Boundaries:

- Boundary between two plates that are moving apart or rifting

← →

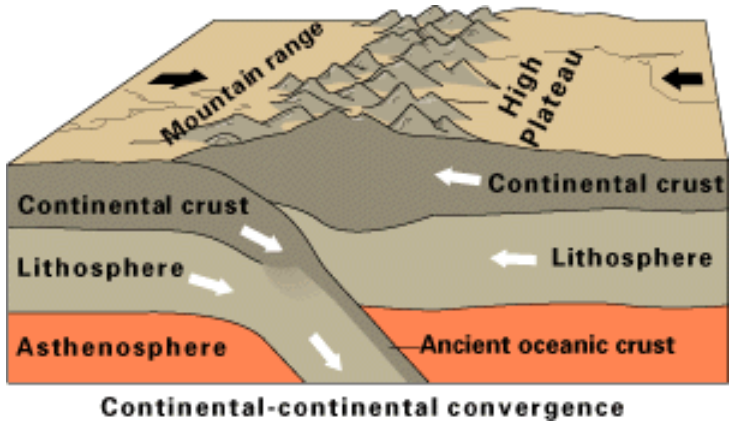
- RIFTING causes SEAFLOOR SPREADING



2. Convergent Boundaries:

Boundaries between two plates that are colliding

→ ←



Continental-continental convergence

3. Transform Boundaries:

Boundary between two plates that are sliding past each other

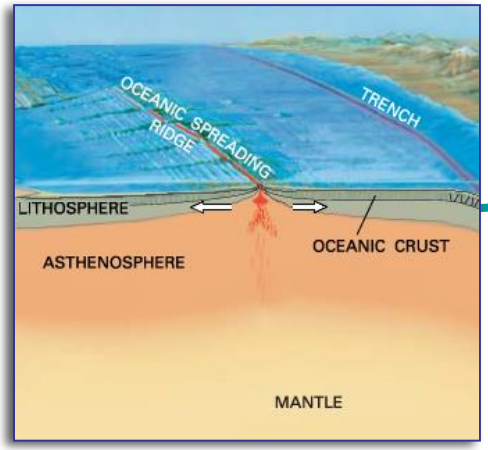
EARTHQUAKES along faults

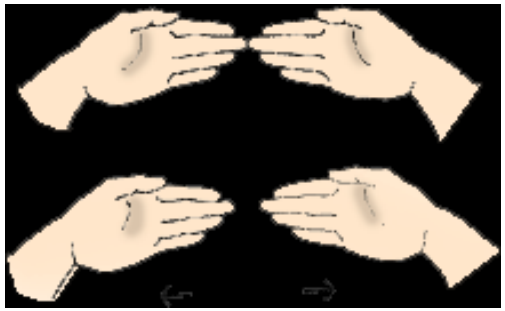
Transform boundary

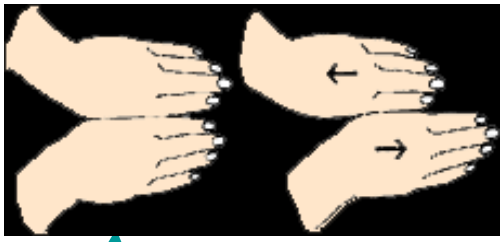
Three Basic Types of Plate Boundaries

Divergent

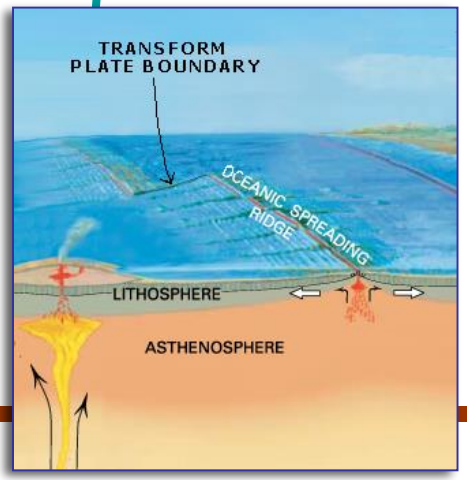
Using hands to show relative motion



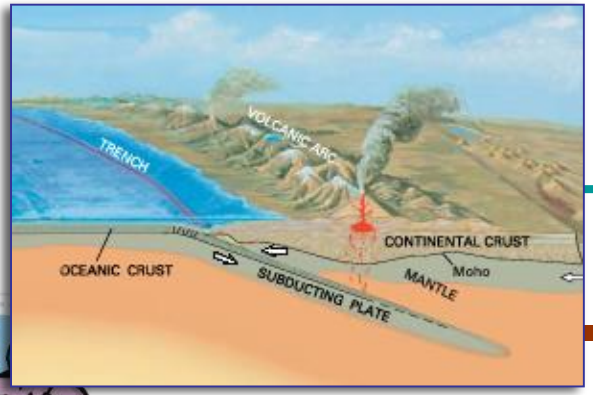


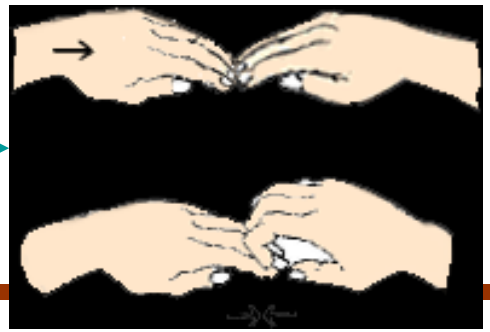


Transform



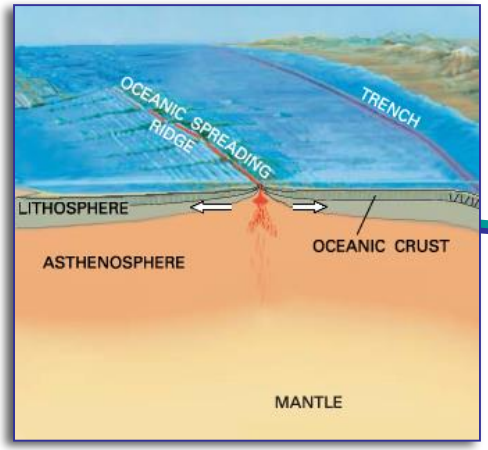
Convergent

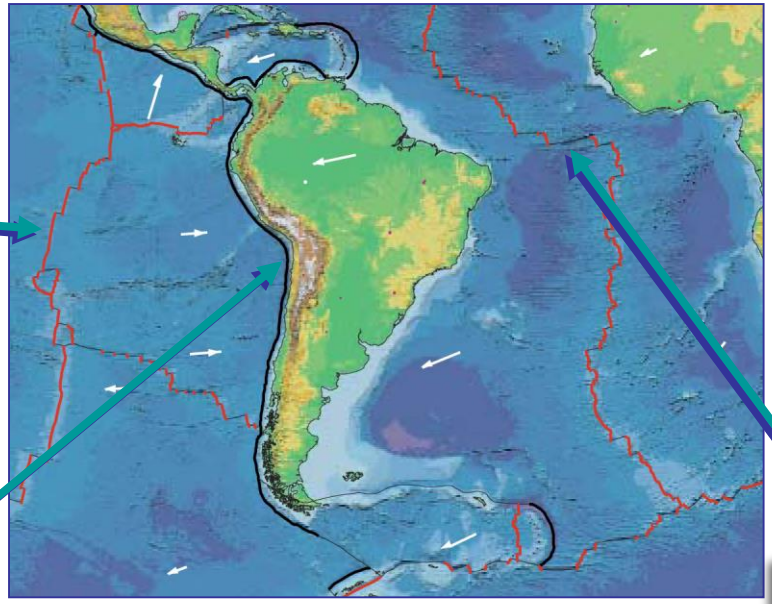




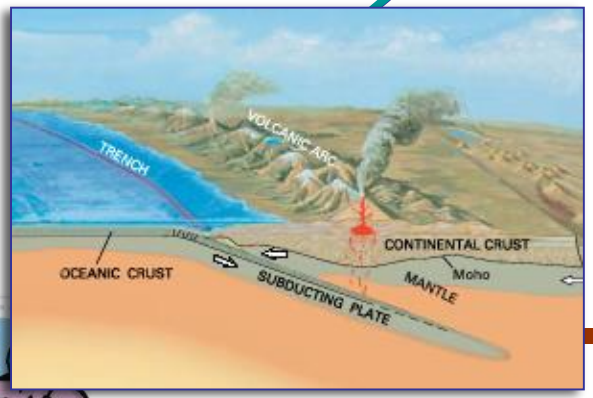
Three Basic Types of Plate Boundaries

Divergent





Convergent



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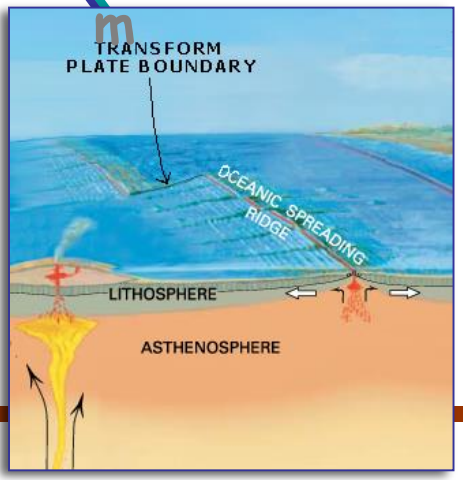


In Summary:

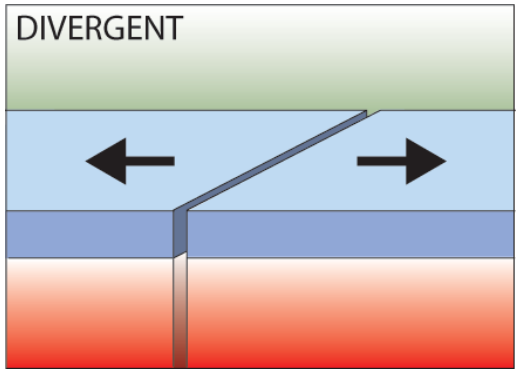
1. The Earth's surface is broken up into plates

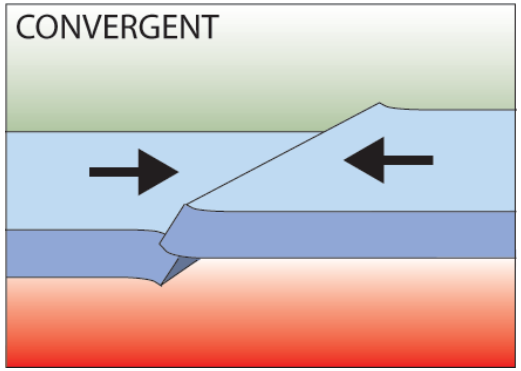
2. The plates move a few centimeters per year in different directions

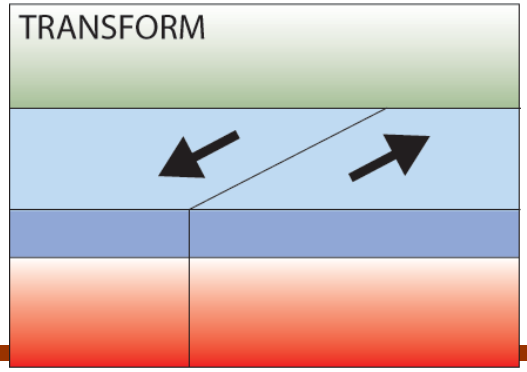
3. The plate boundaries may be classified into convergent or divergent or transform

Three Types Of Plate Boundary

- Divergent
- Convergent
- Transform







Intermediate Science 7

UNIT 3
EARTH'S CRUST

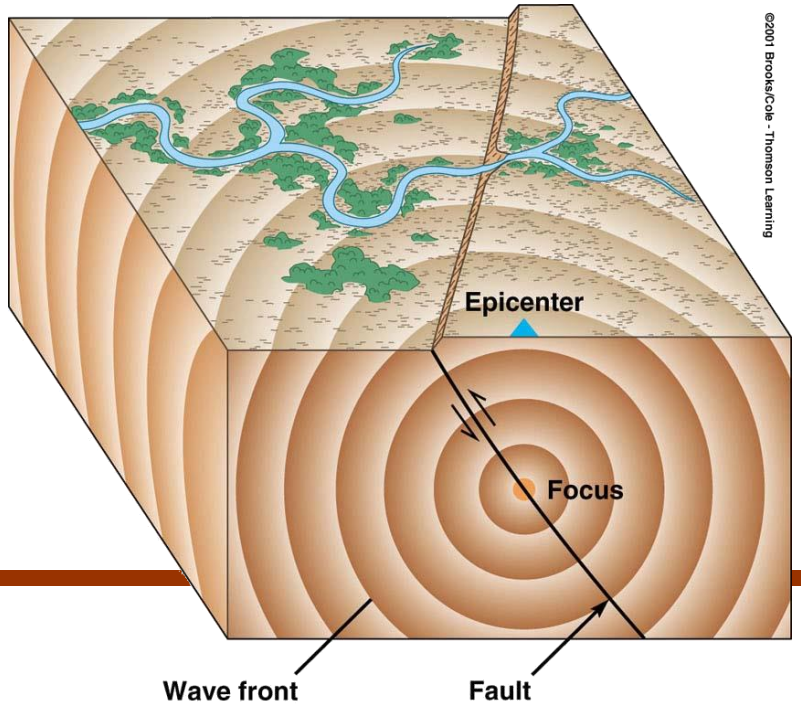
TOPIC 3: Earthquakes, Volcanoes and Mountains

What Is An Earthquake?

Earthquake = Vibration of the Earth produced by the rapid release of energy

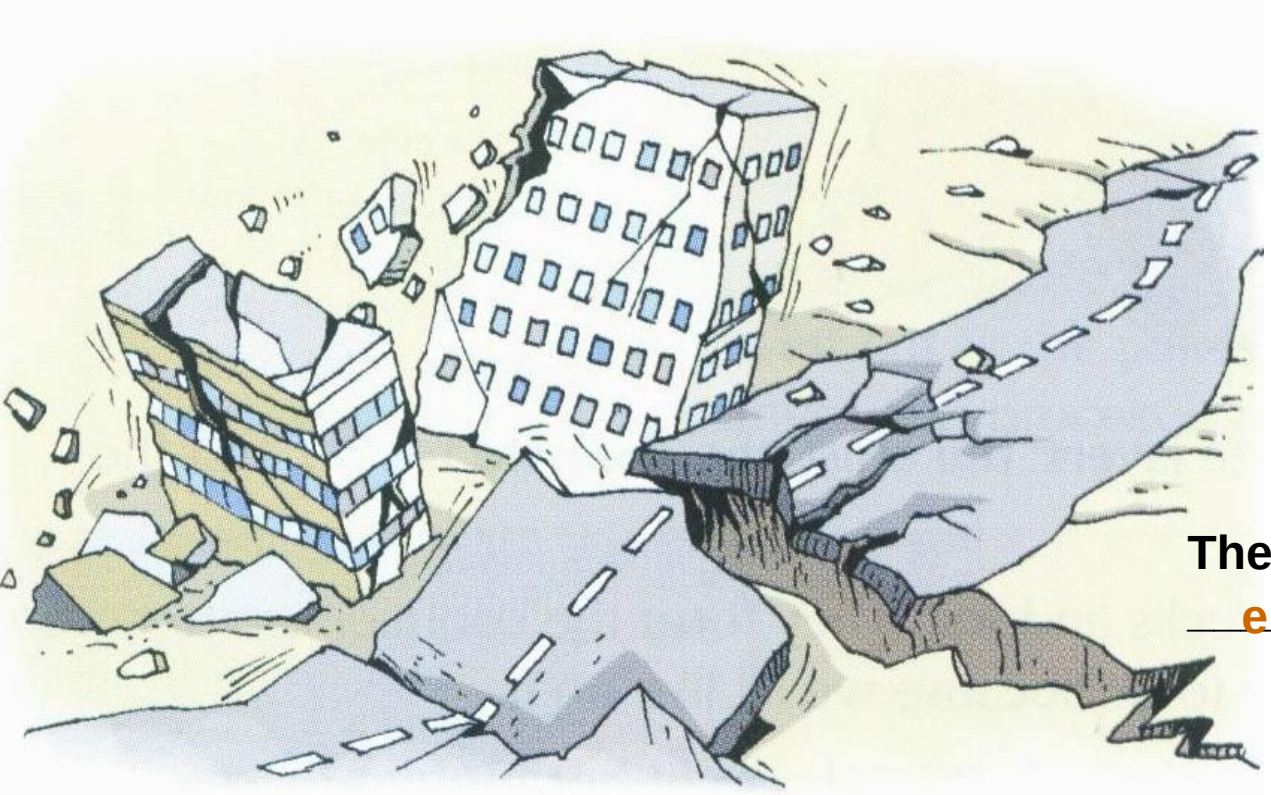
They are the result of energy released from forces built up due to plate tectonics in Earth's crust

When this energy is released, it travels in seismic waves.



What are the causes of earthquakes?

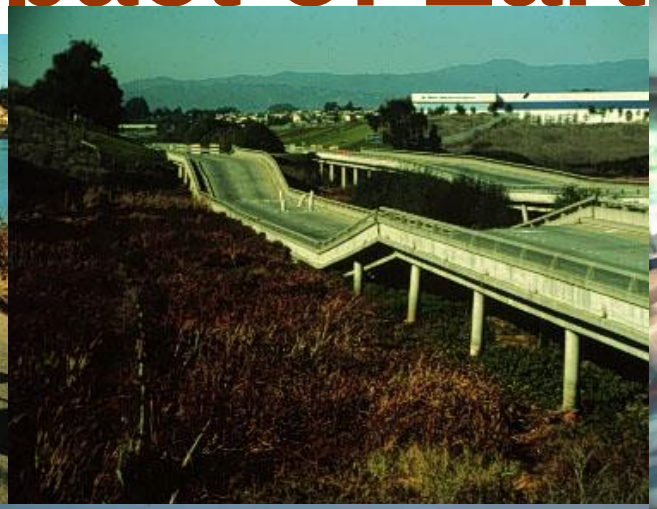
The earth will shake. This is called _____earthquake_____.

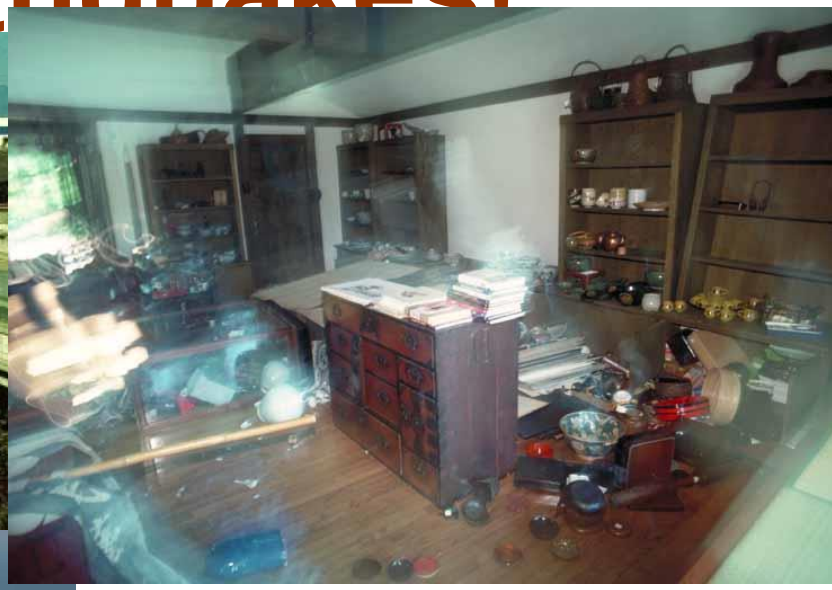


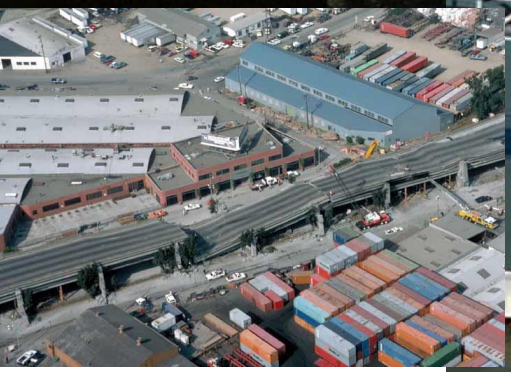
The plates will break and ___energy___ is released.

When the plates move, __pressure__ builds up in them.

Impact of Earthquakes!







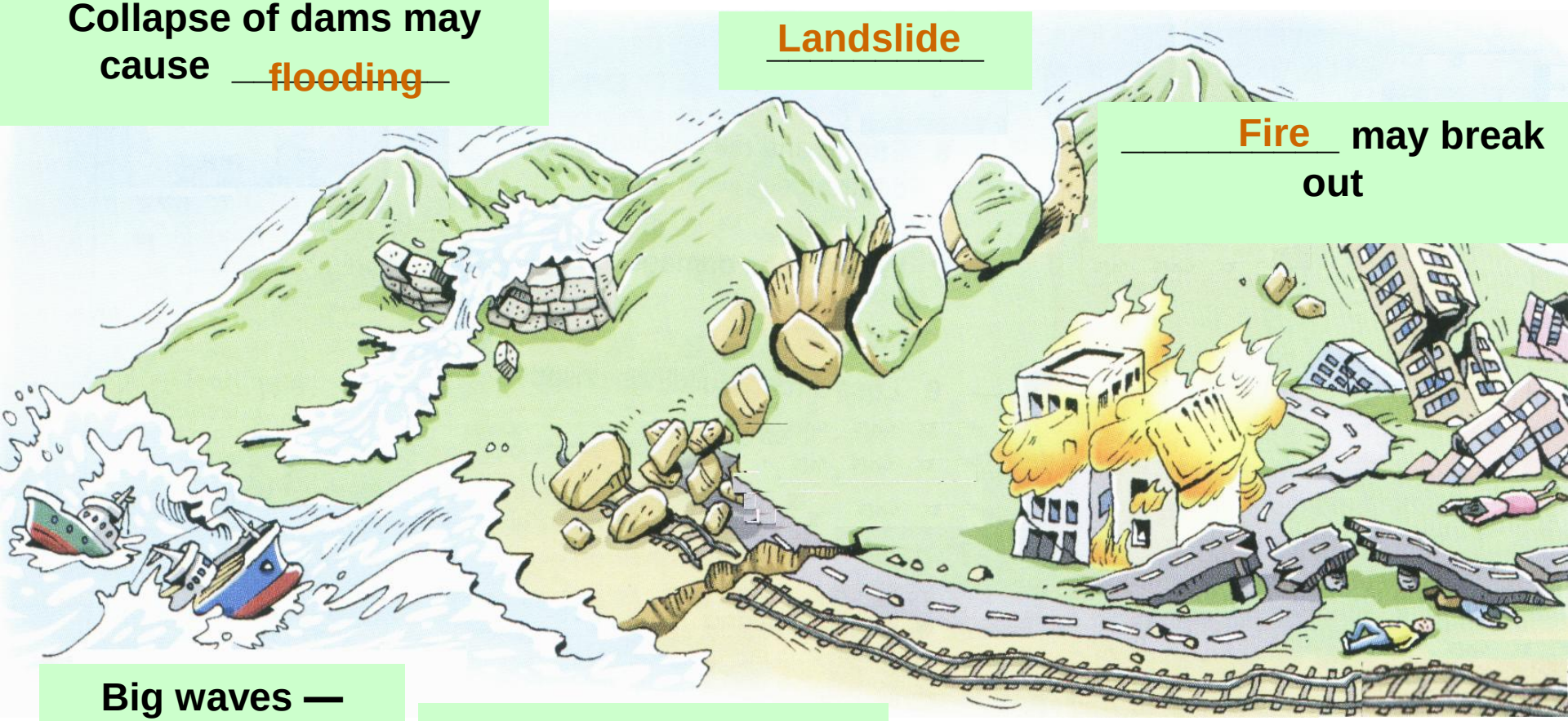
rth's
Crust

What are the harmful effects of earthquakes?

Collapse of dams may cause ~~flooding~~

Landslide

Fire may break out

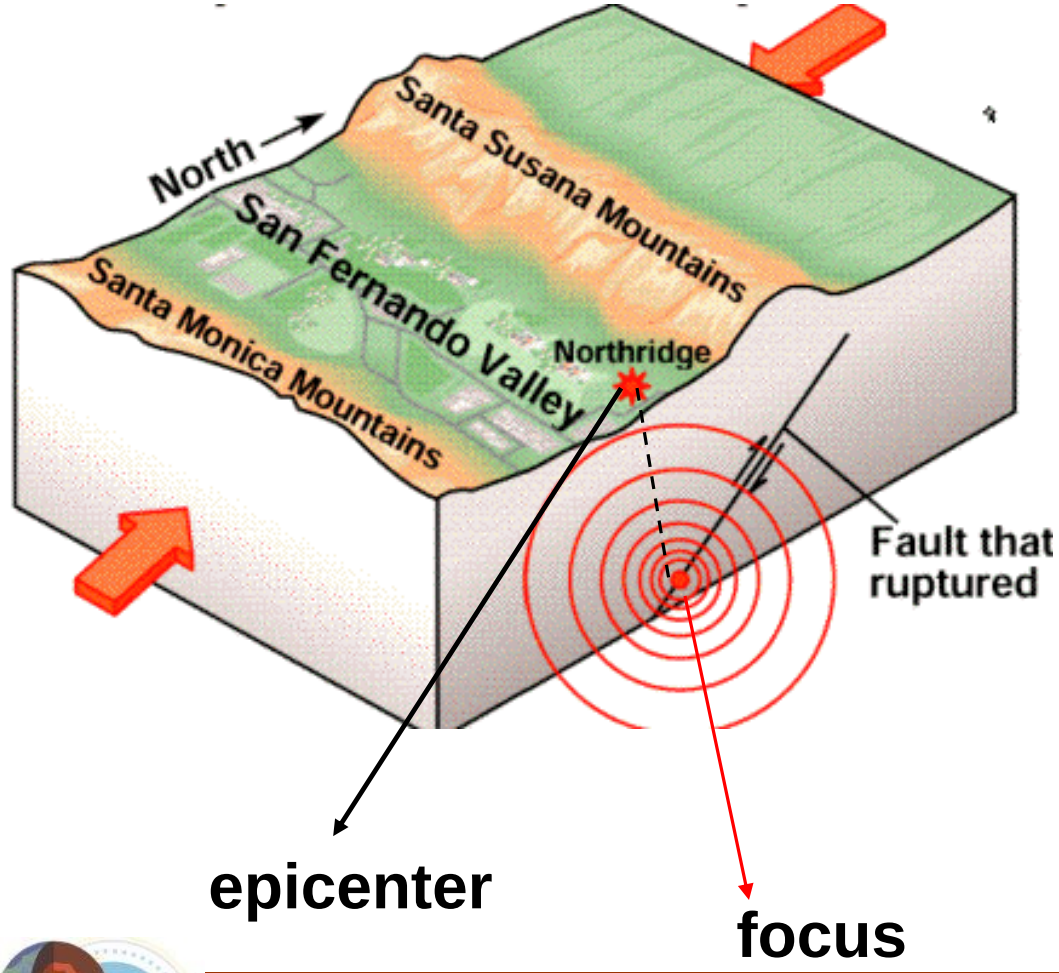


Big waves — tsunamis

Buildings, bridges, roads and railways collapse

People are killed and injured

Why do earthquakes occur?

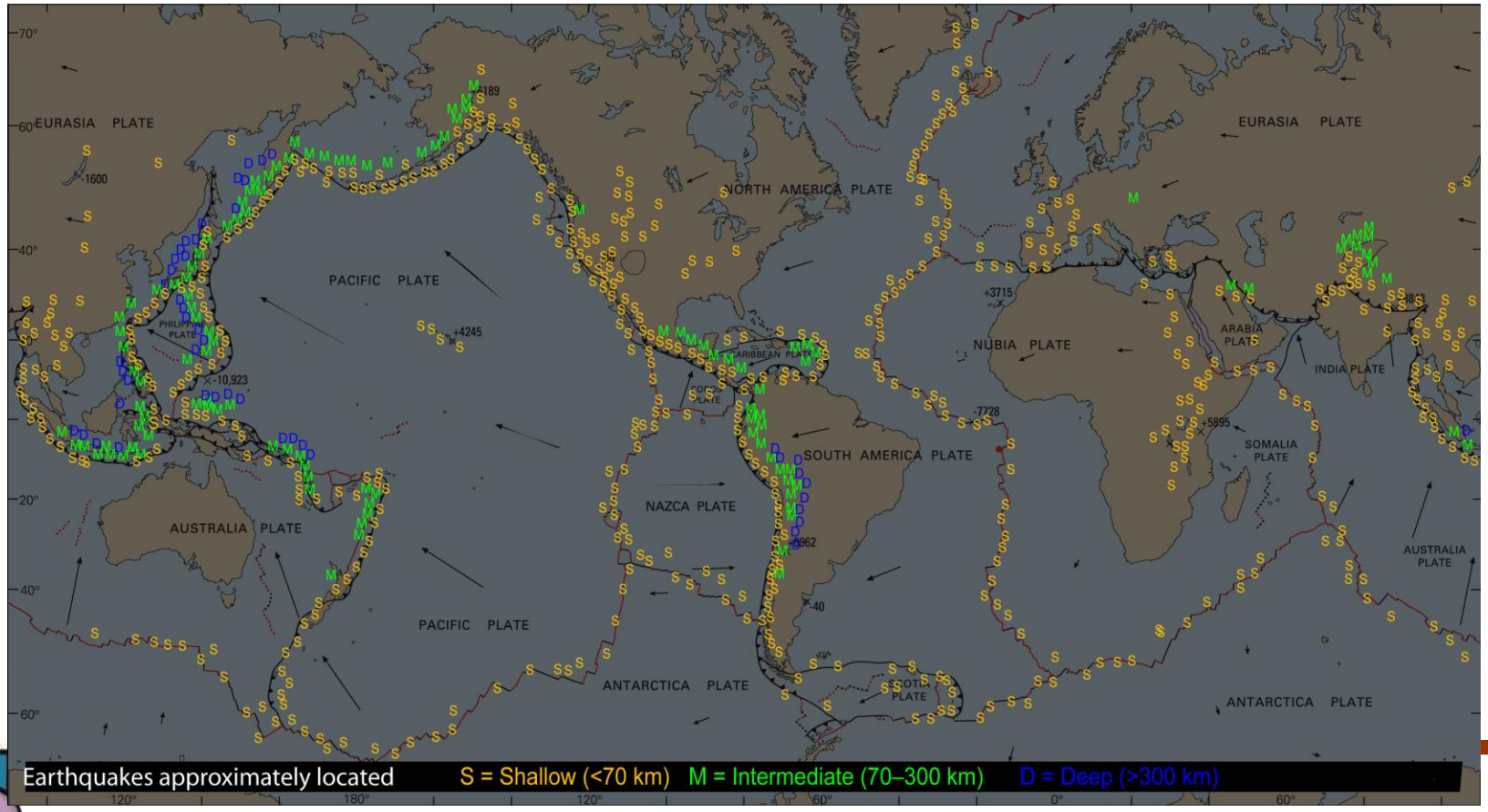


- *Fractures, faults*
- Energy released and propagates in all directions as seismic waves causing earthquakes

Earthquakes & Plate Boundaries

Notice that the earthquakes coincide with plate boundaries, and the deepest quakes (blue) are in subduction zones.

Question: Where would you expect to see volcanoes?

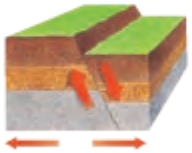
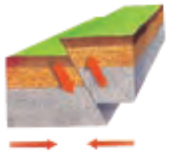
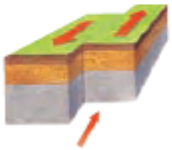


Create your own maps at http://www.iris.edu/quakes/maps.htm

Modified from USGS Graphics

Types of Faults

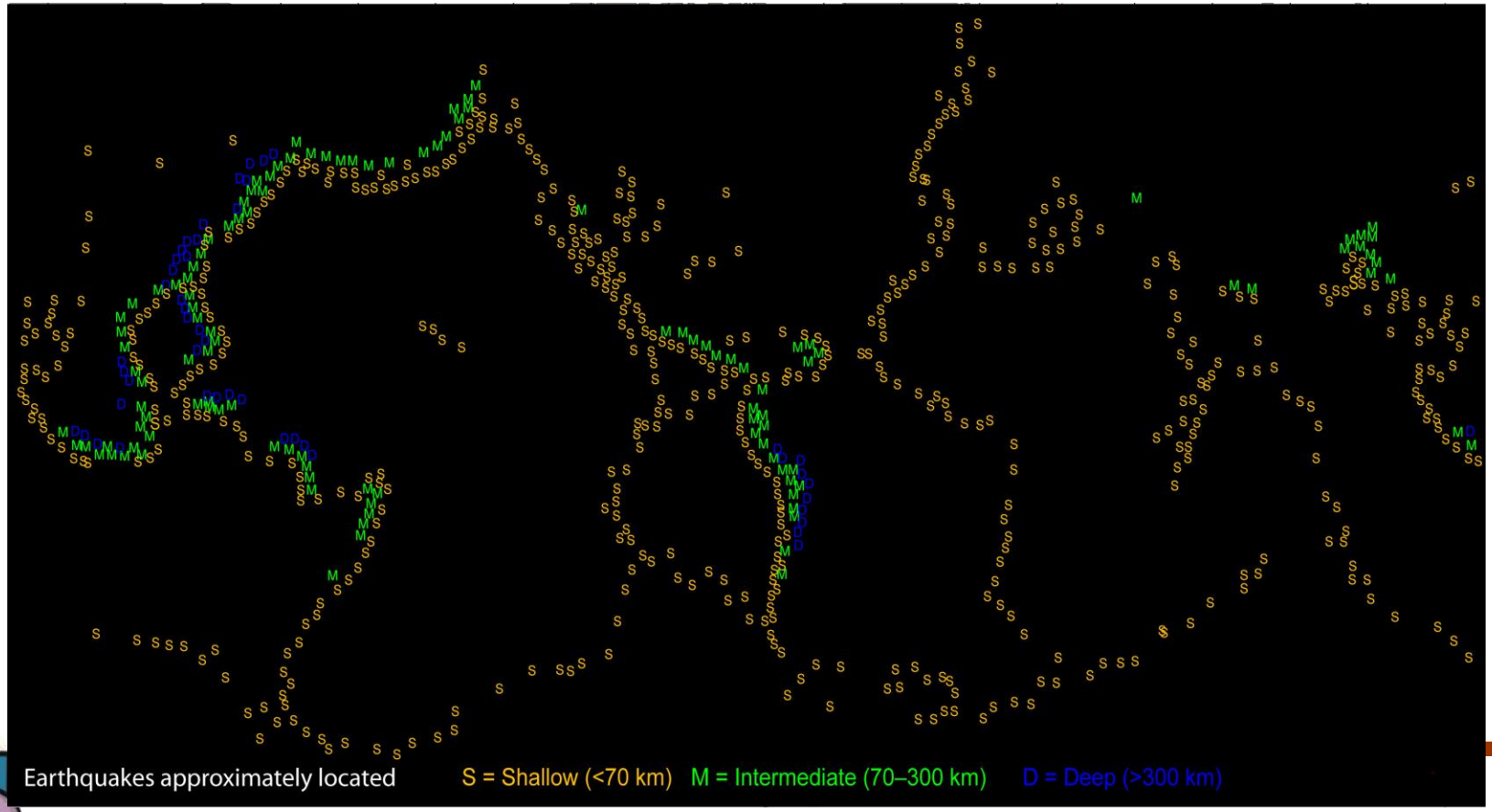
Earthquakes occur on faults. A fault is a thin zone of crushed rock separating blocks of the earth's crust. When an earthquake occurs on one of these faults, the rock on one side of the fault slips with respect to the other.

Fault	Where It Is Produced	How It Is Produced	How the Rock Moves
Normal fault 	divergent boundaries	plates move apart	rock above the fault moves downward
Reverse fault 	convergent boundaries	plates push together	rock above the fault moves up and over rock below the fault
Transform fault 	transform boundaries	plates move sideways past each other	rock breaks as the plates try to slide past each other

Earthquakes

There are thousands of small earthquakes every day
"Strong" earthquakes (~M7) occur once a month. >M8 occur about once/year.

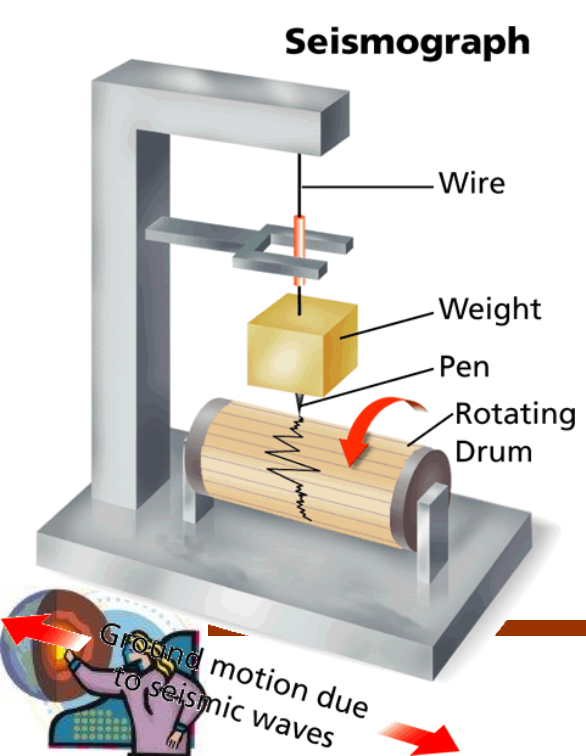
Where are the deepest earthquakes?

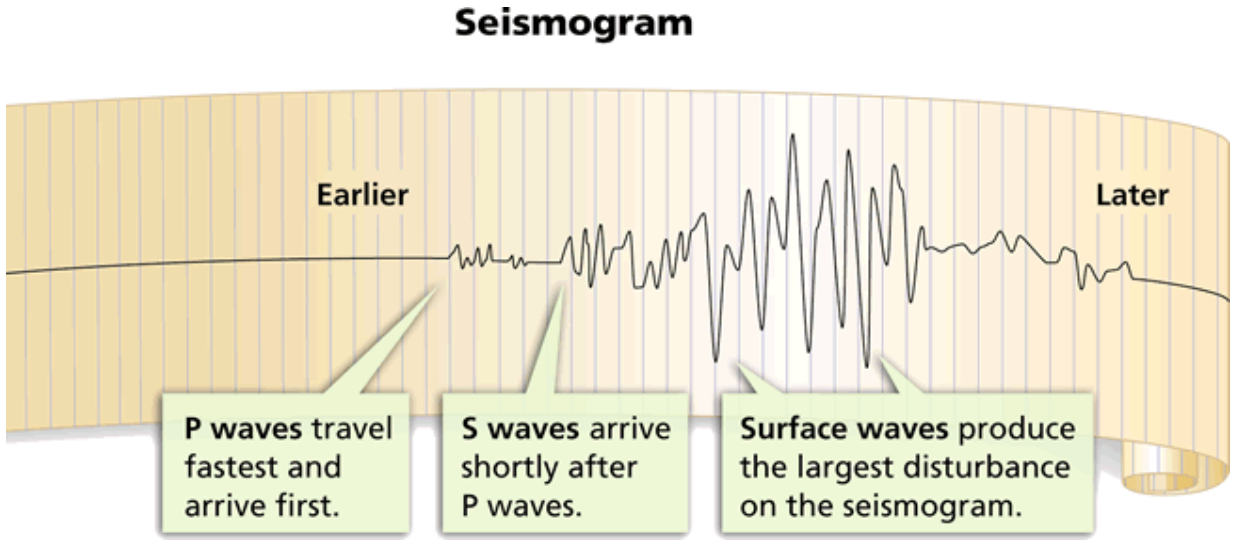


For earthquakes of the past 2 weeks, go to http://www.iris.edu/seismon/

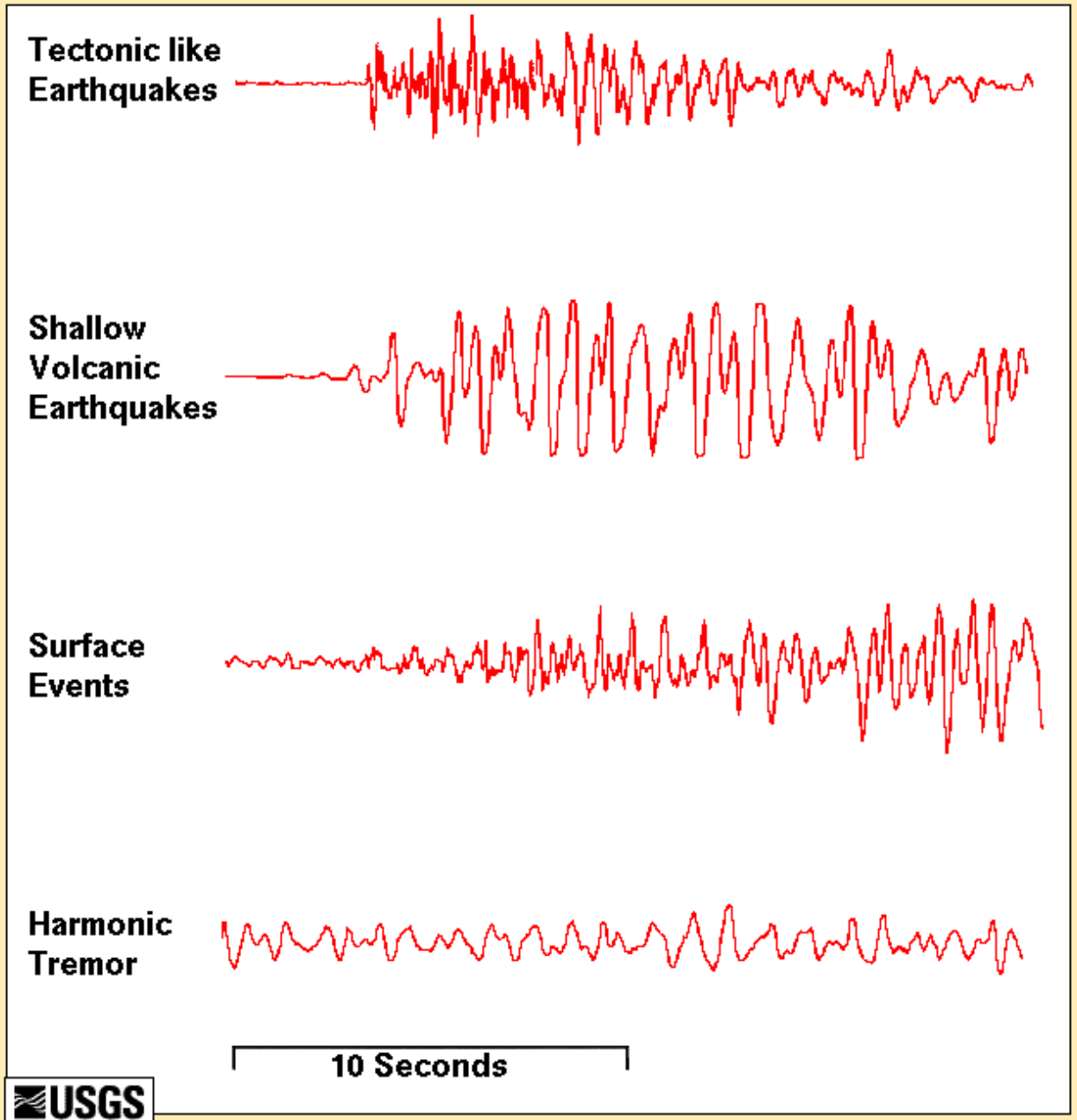
What is a Seismograph

- Seismograph is a device used to measure earthquakes
- Seismic waves cause the seismograph's drum to vibrate. But the suspended weight with the pen attached moves very little. Therefore, the pen stays in place and records the drum's vibrations.





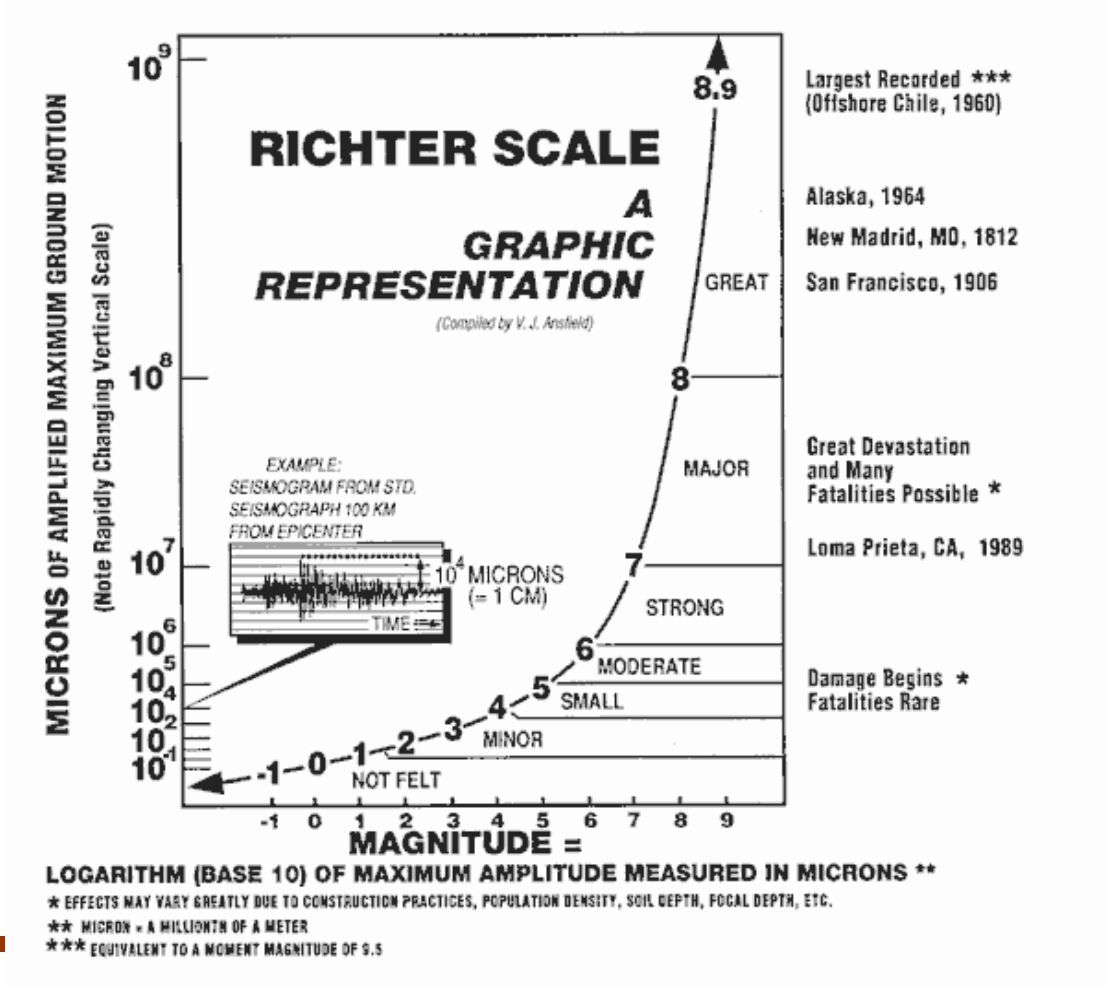
Four Major Types of Seismograms



Topinka, USGS/CVO, 1997, Modified from: Brantley and Topinka, 1984, Earthquake Information Bulletin

Richter Scale

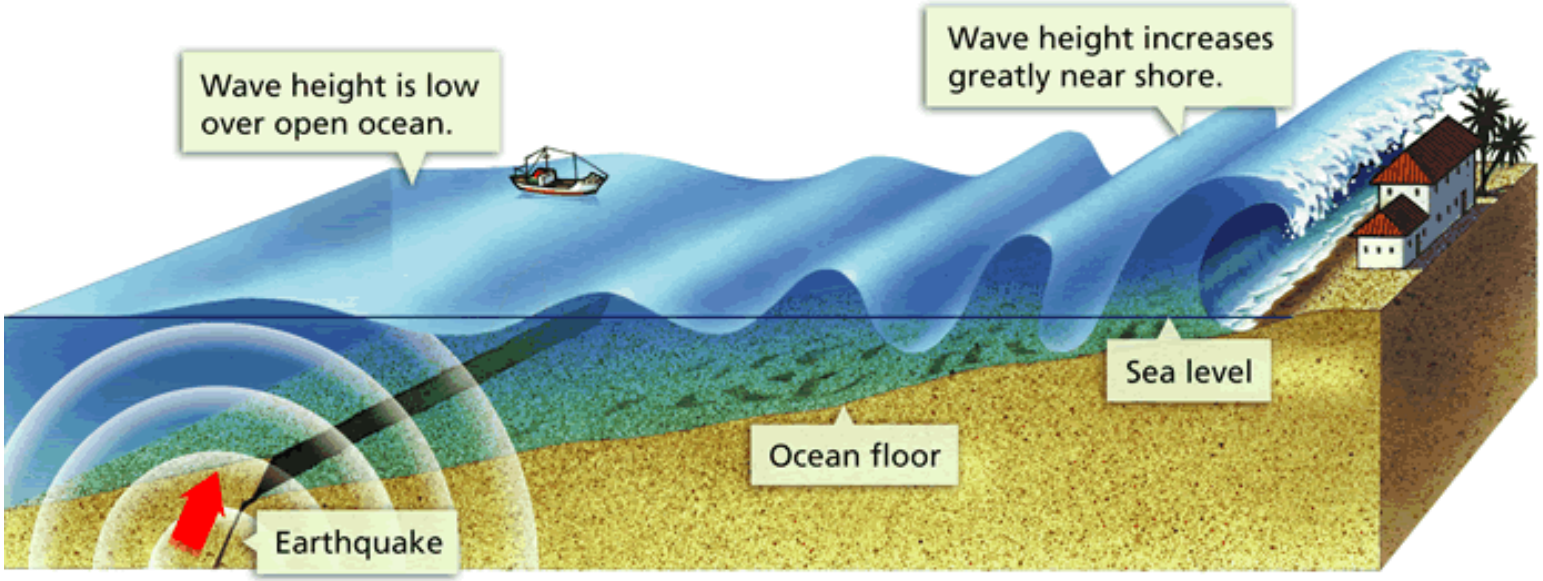
The Richter Scale measures the strength of the earthquake



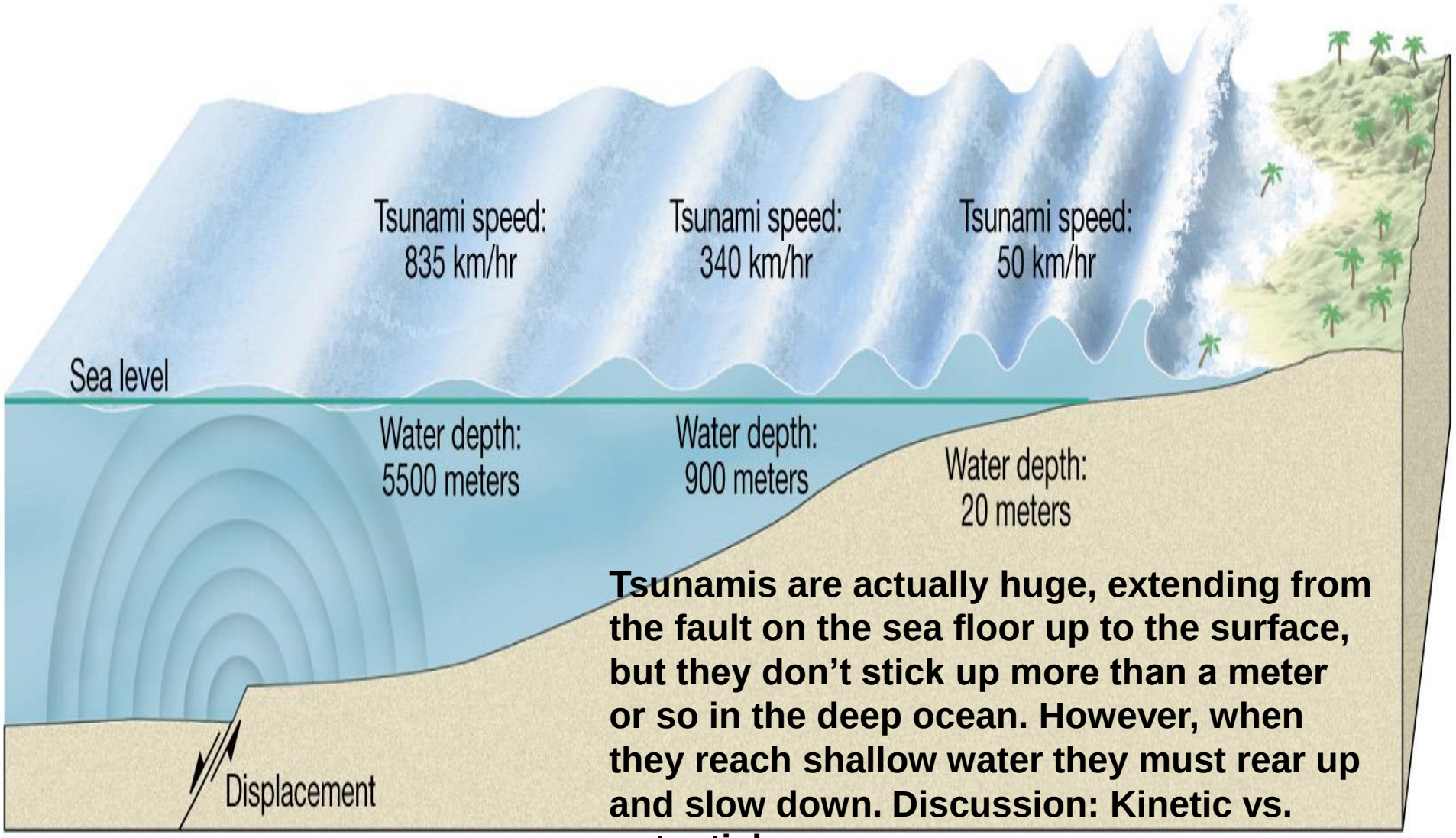
Richter Magnitude	Earthquake effects
0-2	Not felt by people
2-3	Felt little by people
3-4	Ceiling lights swing
4-5	Walls crack
5-6	Furniture moves
6-7	Some buildings collapse
7-8	Many buildings destroyed
8-Up	Total destruction of buildings, bridges and roads

Earthquakes In the Ocean Damage

A tsunami spreads out from an earthquake's epicenter and speeds across the ocean.



Formation Of A Tsunami



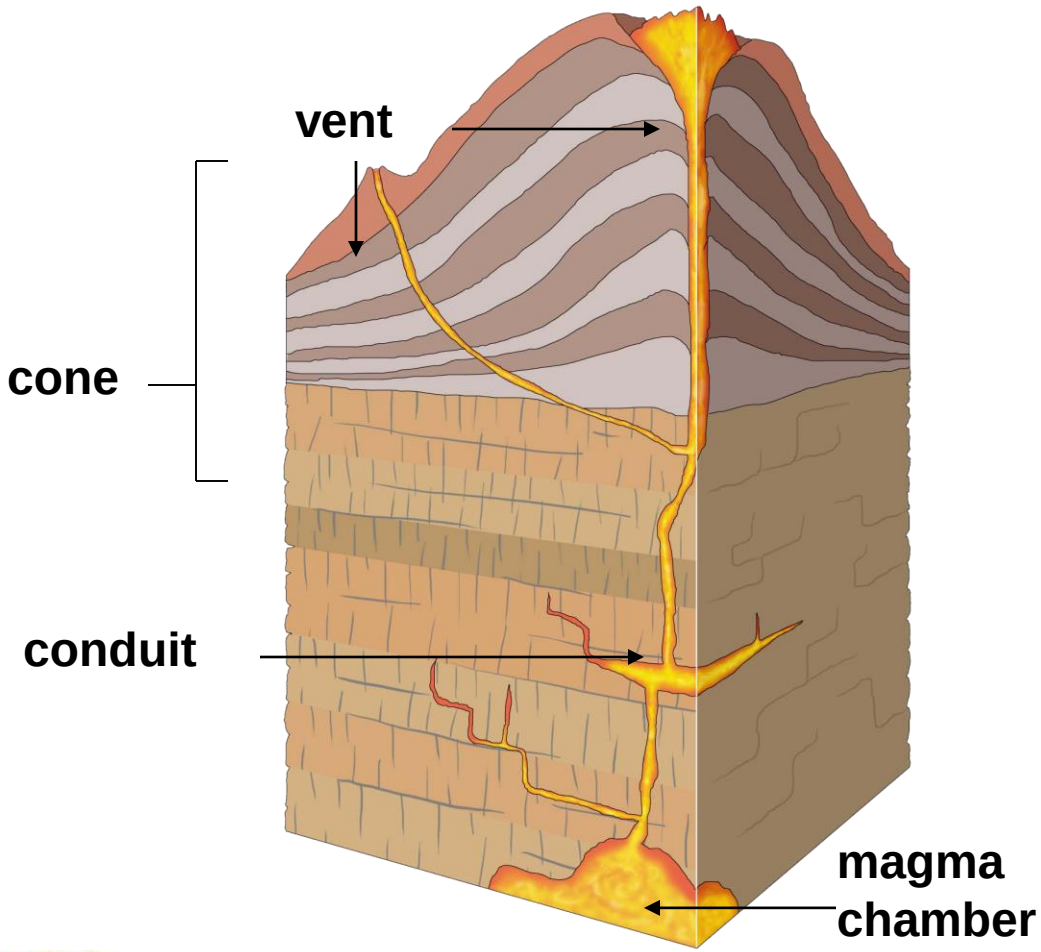
Tsunamis are actually huge, extending from the fault on the sea floor up to the surface, but they don't stick up more than a meter or so in the deep ocean. However, when they reach shallow water they must rear up and slow down. Discussion: Kinetic vs. potential energy

- Burin Peninsula, 1929, tsunami *(pg. 374)*

Earthquake Simulations

- Now, you will have a chance to explore the damage different earthquakes may cause. The damage depends upon many factors.
- Click Here to visit a website that allows you to control various factors about a building and an earthquake in order to determine the amount of damage caused to the building.
  - www.tlc.discovery.com/convergence/quakes/interactives/makeaquake.html

What Is A Volcano?



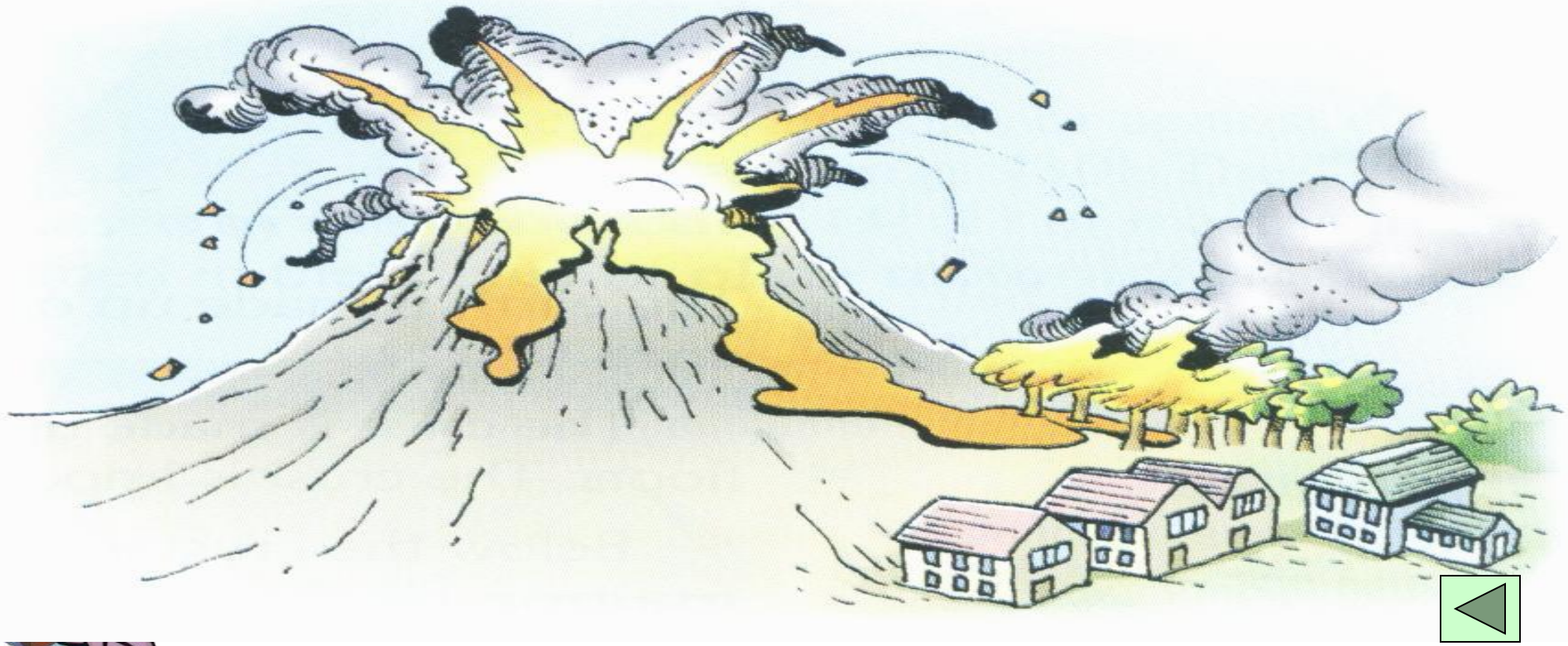
- A volcano is a vent or 'chimney' that connects molten rock (magma) from within the Earth's crust to the Earth's surface.
- The volcano includes the surrounding cone of erupted material.

What are the causes of volcanic eruptions?

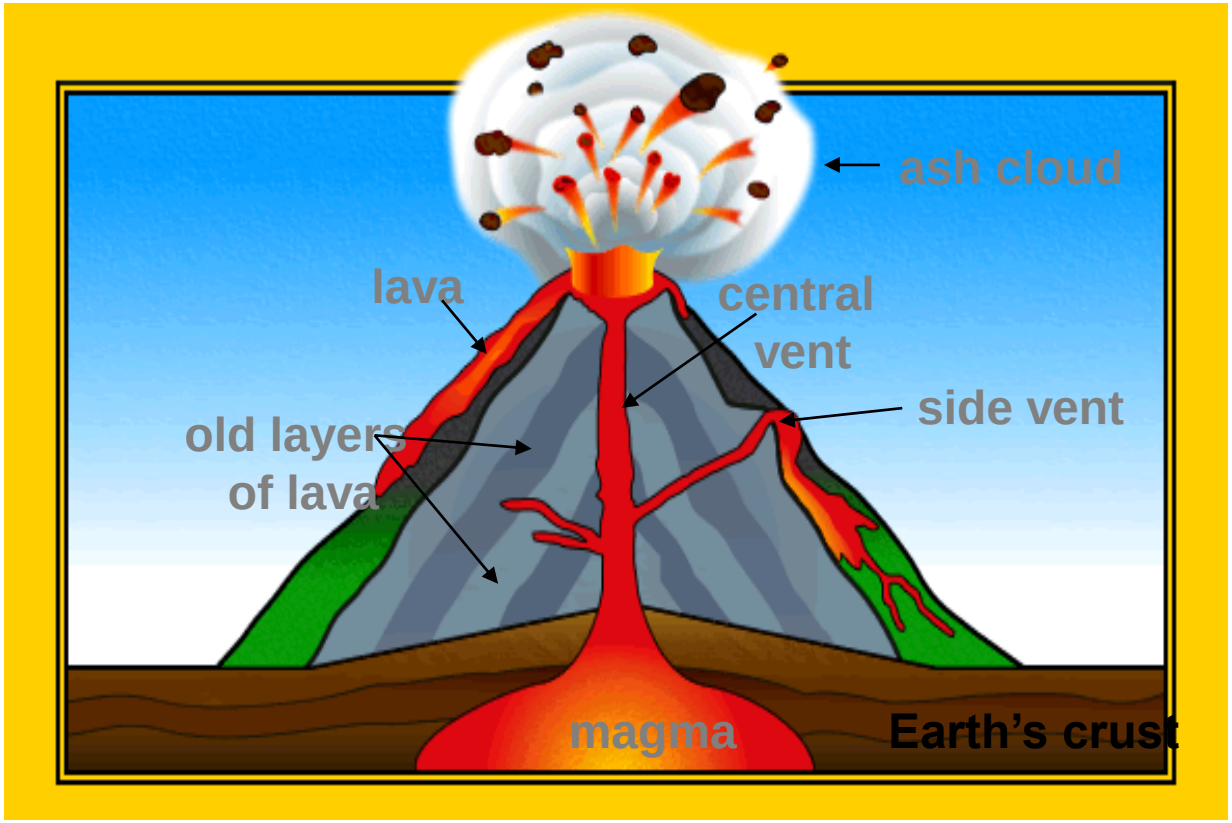
Hot _____magma_____, volcanic _____gases_____ and _____ash_____ are thrown out to the earth surface.

When there is a line of _____weakness_____ in the earth's crust, magma escapes to the surface from the mantle.

This is called volcanic _____eruption_____.



Parts Of A Volcano



Magma Versus Lava

- **Magma** is molten rock below the earth's surface
- **Lava** is molten rock below the earth's surface

LOADING

Mt. Pinatubo

June 1991

Philippians

Paricutin

February 20, 1943

Mexico

Kilauea

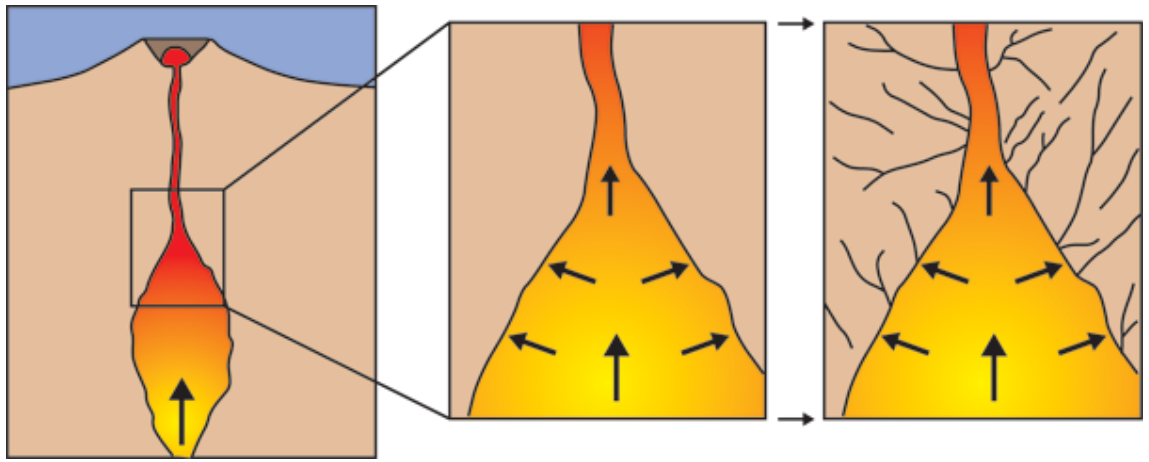
November 24, 2007

Hawaii

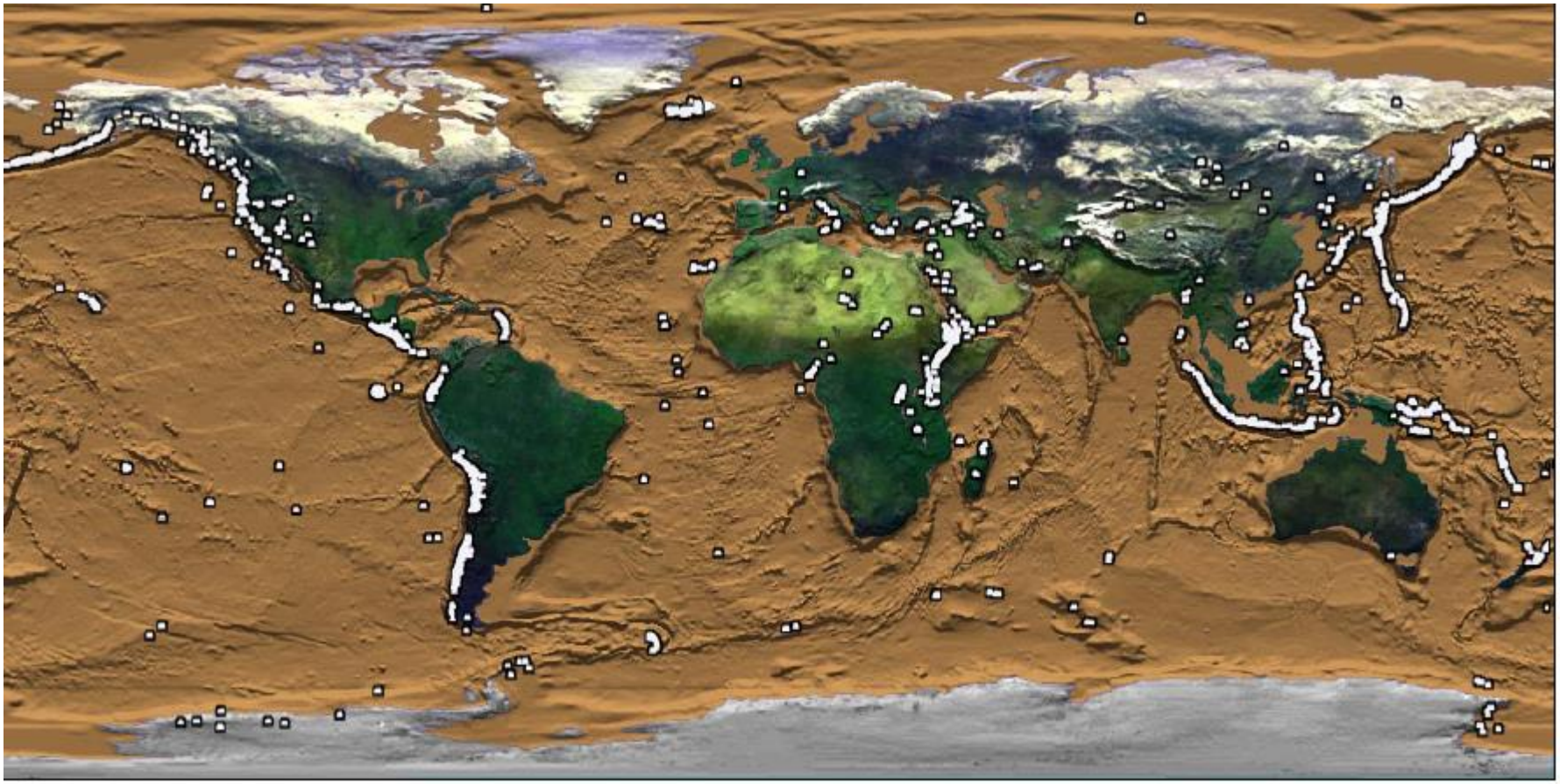
The most active volcano on Earth

Seismic Activity

- Earthquake activity commonly precedes an eruption
  - Result of magma pushing up towards the surface
  - Increase volume of material in the volcano shatters the rock
  - This causes earthquakes



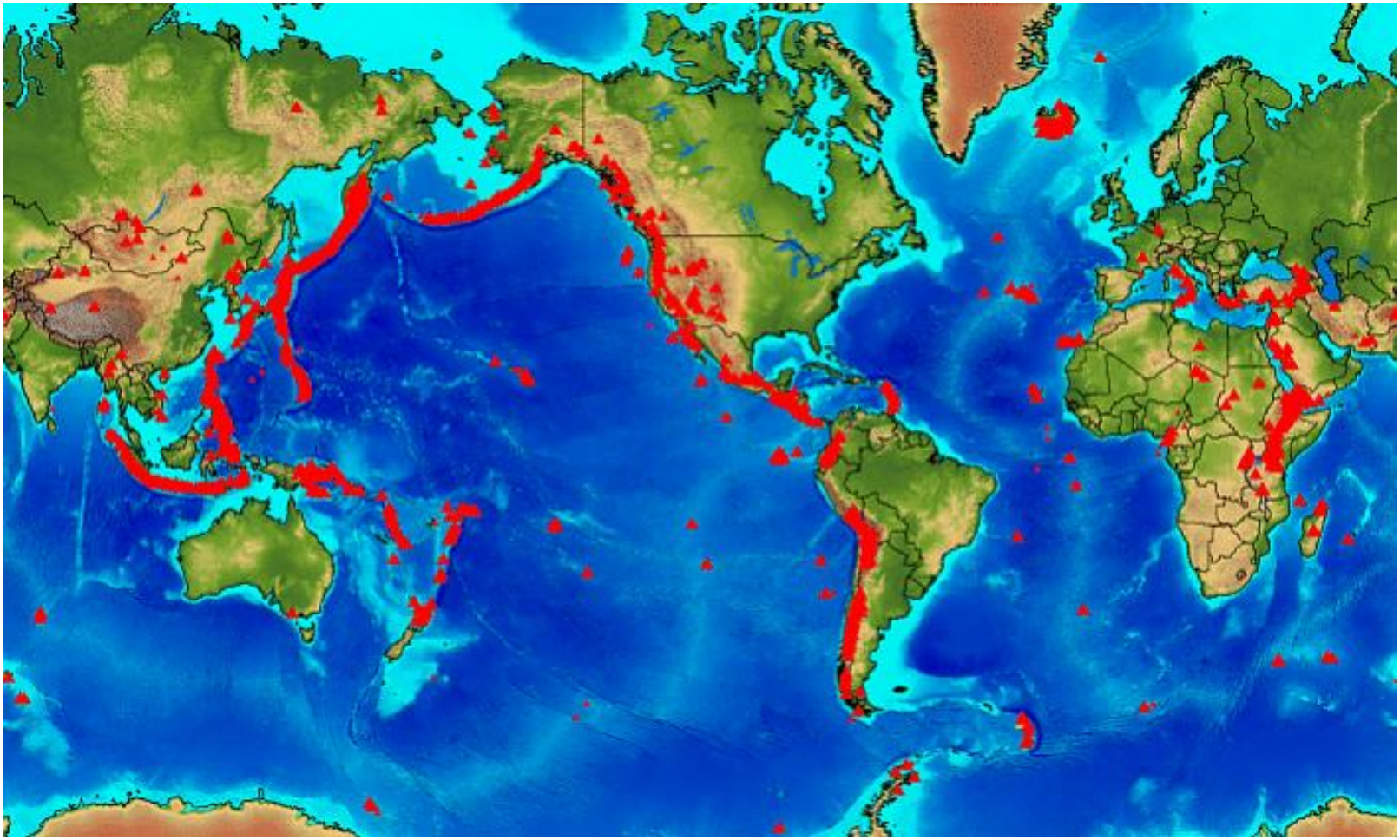
Where Are Volcanoes Located?



☐ White areas with black outlines represent volcanoes

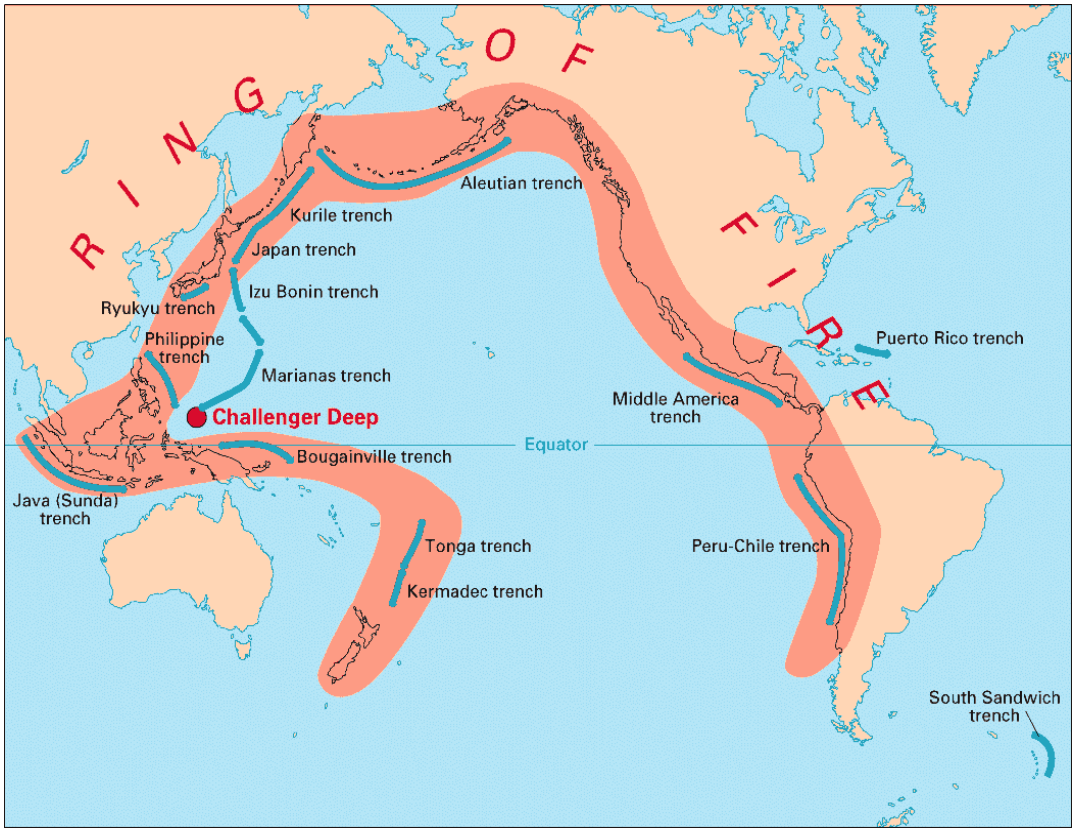
Base Map Courtesy of NASA/Goddard SVS
Volcano Overlay © 2006 UNAVCO

Volcanoes are formed at tectonic plate boundaries



Ring of Fire

The name given to the volcanoes encircling the Pacific Ocean.

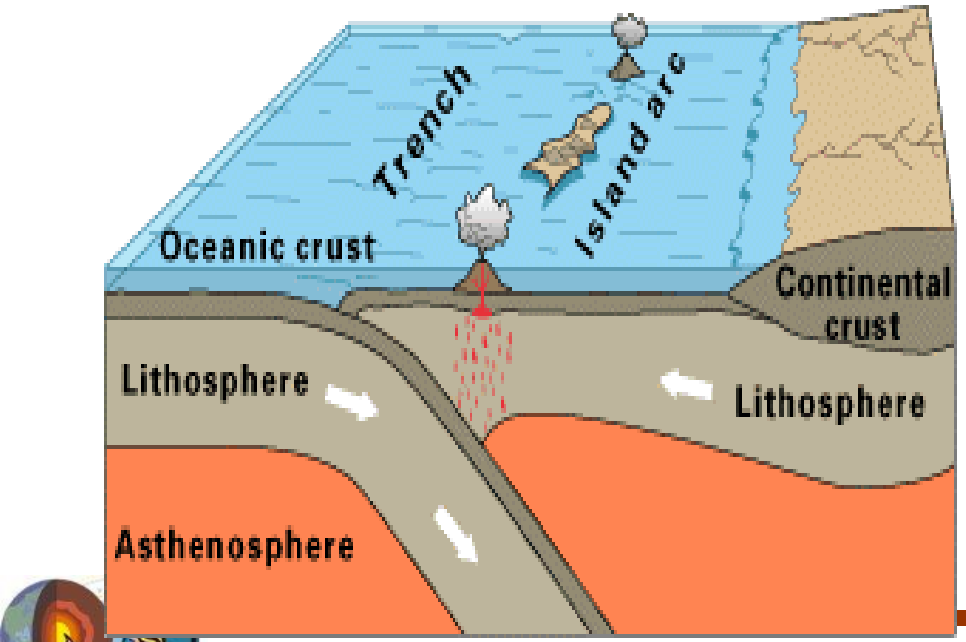


There are currently about 1500 active volcanoes around the world

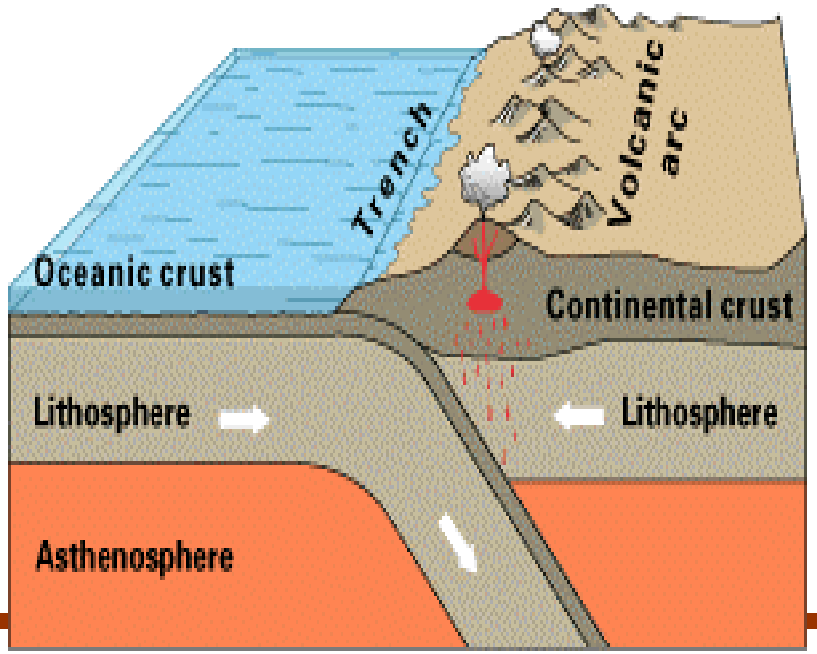
Where Do Volcanoes Form?

1. Volcanoes and Converging Boundaries

- At collision zones intense pressure can melt rock that later flows to the surface as a volcano (the Pacific Ocean is being subducted under Japan)
  - Volcanoes can form when two oceanic plates collide or when an oceanic plate collides with a continental plate.



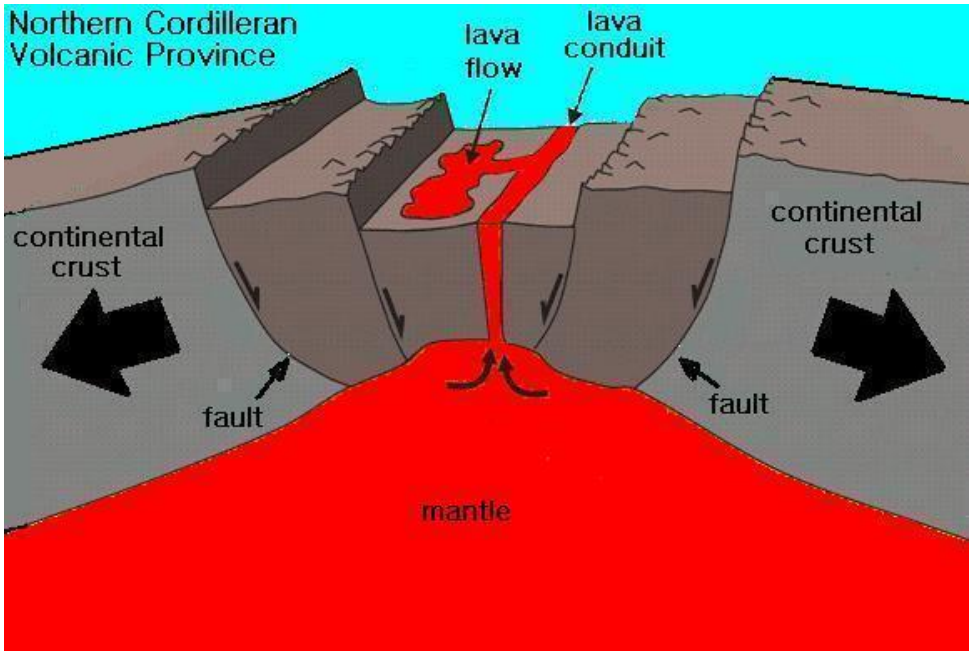
Oceanic-oceanic convergence

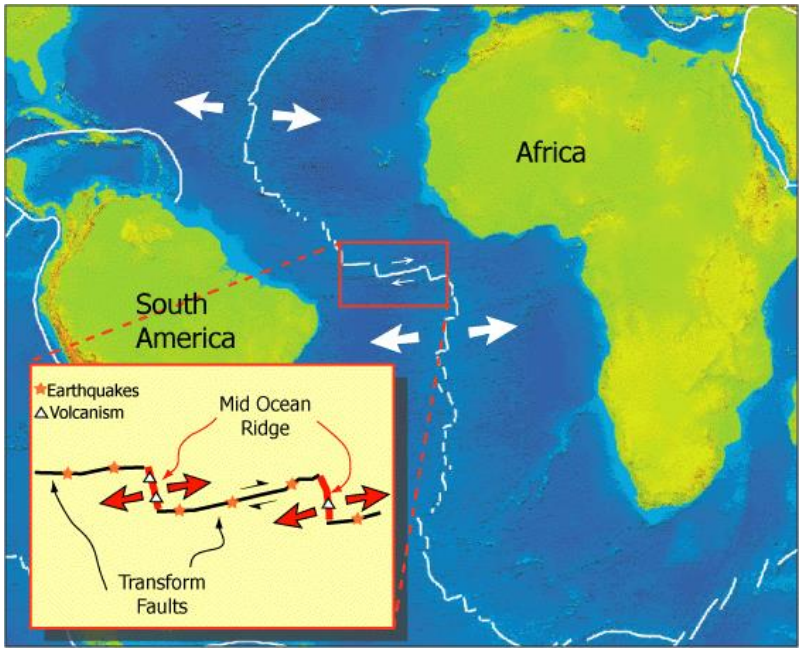


Oceanic-continental convergence

2. Volcanoes and Diverging Boundaries

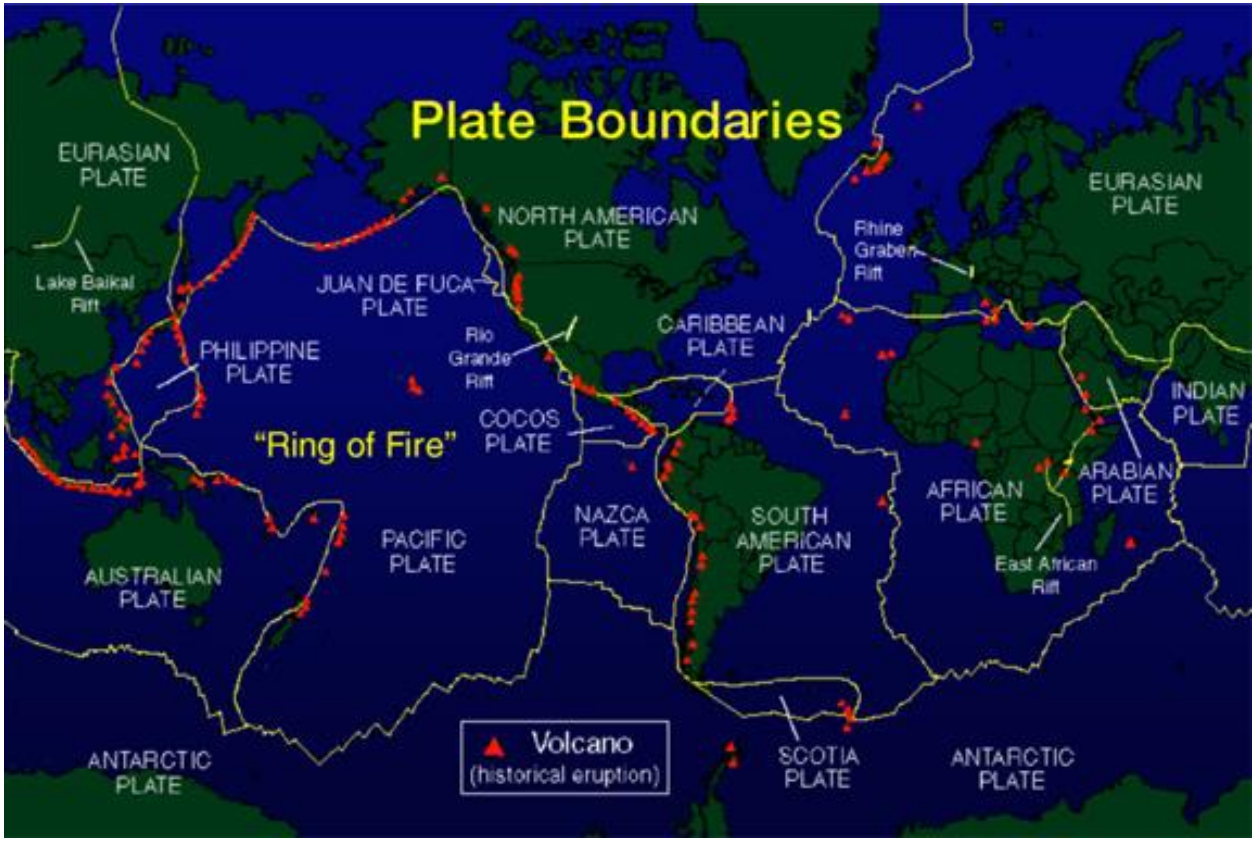
Where plates separate, molten rock flows up to the surface (Mid-Atlantic Ridge)



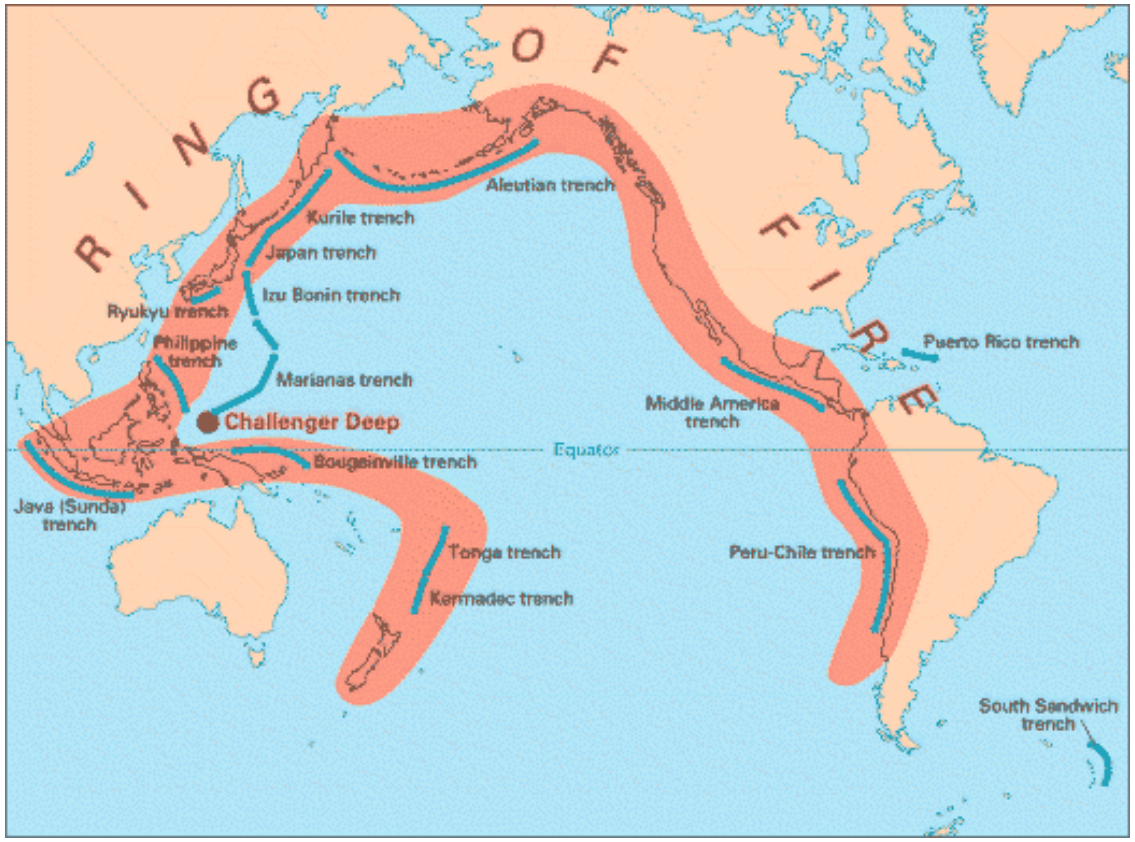


3. Hot Spot Volcanoes

In area where the plates are thin, lava can be forced up through the cracks to the surface. (Hawaiian Islands)



Pacific Ring of Fire



What Is A Mountain?

- **A large mass of rock or landform that rises a great distance above its base (about <u>300</u> meters)**

Mountain Formation

- Due to:

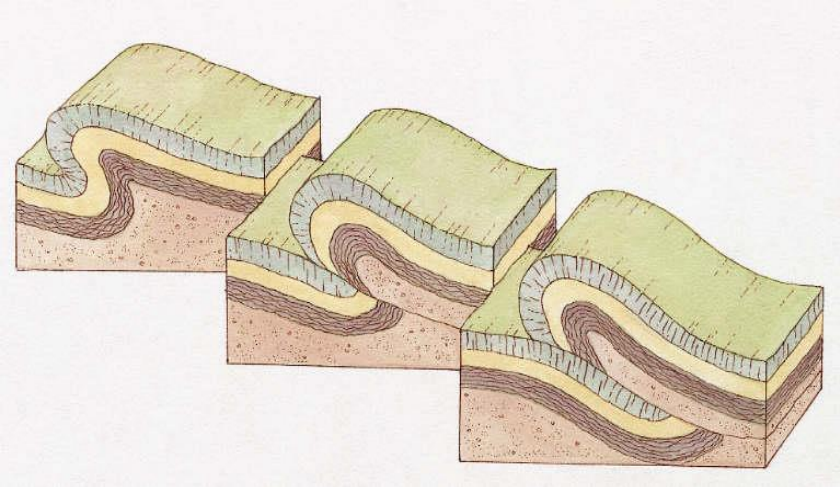
  1. folding

  2. faulting

  3. volcanic eruptions.

1) Fold Mountains

- Most common type of mountains
- A bend in rock layers.
- Created when plates collide at convergent boundaries.
- formed by the folding of rock layers during plate collisions

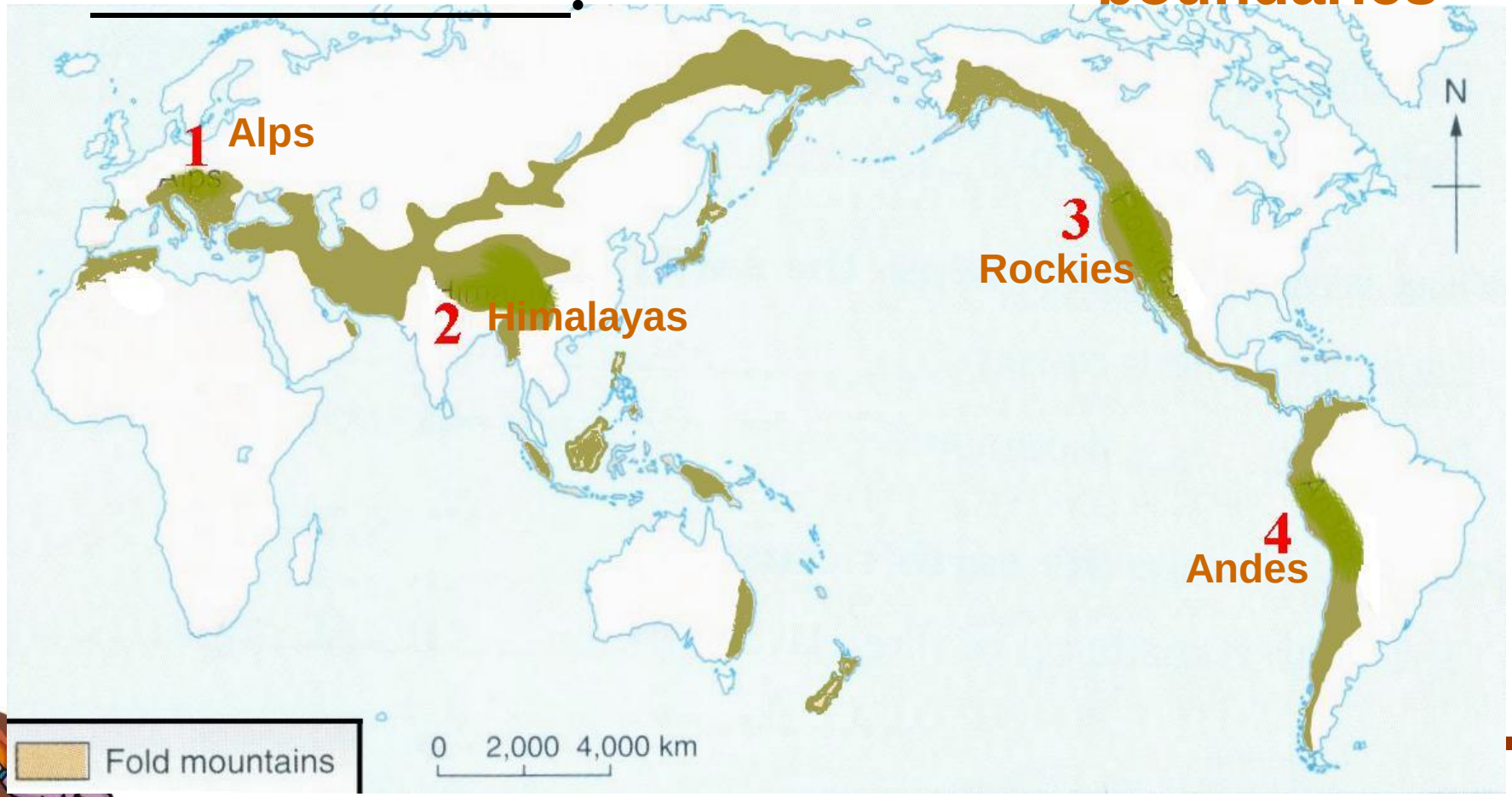


Where are the fold mountains?

1. **Name the fold mountains 1 to 4.**

2. **Fold mountains are usually found at _____.**

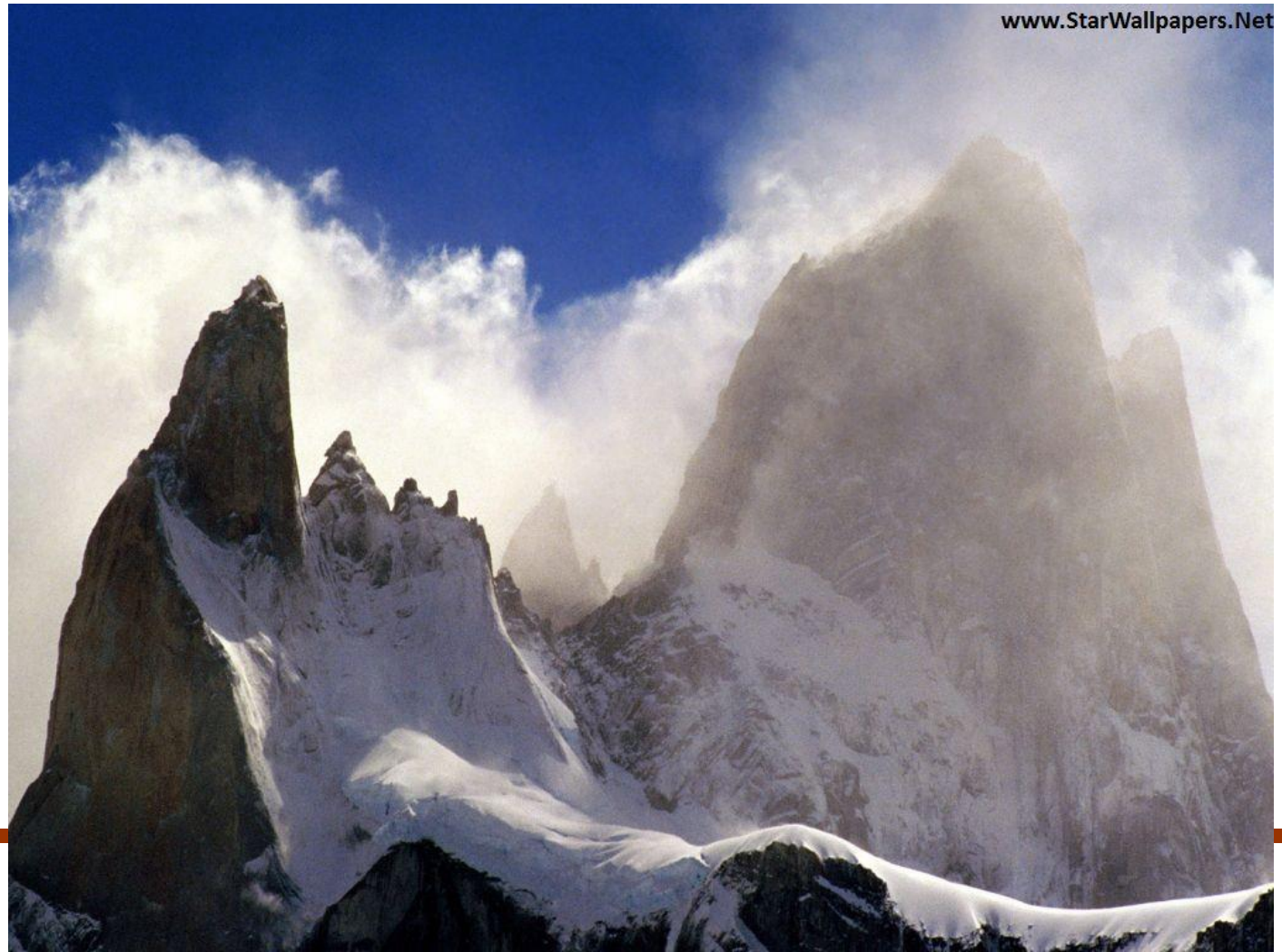
plate boundaries



Himalayan Mountains: Asia

Appalachian Mountains: North America

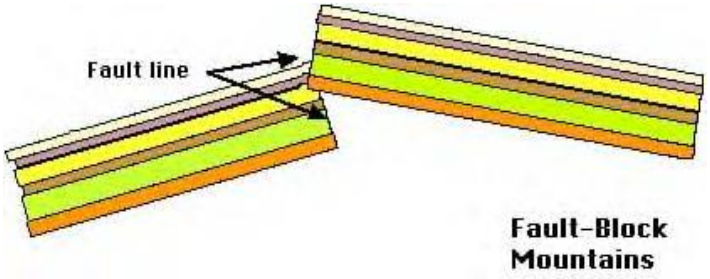
Andes Mountains: South America

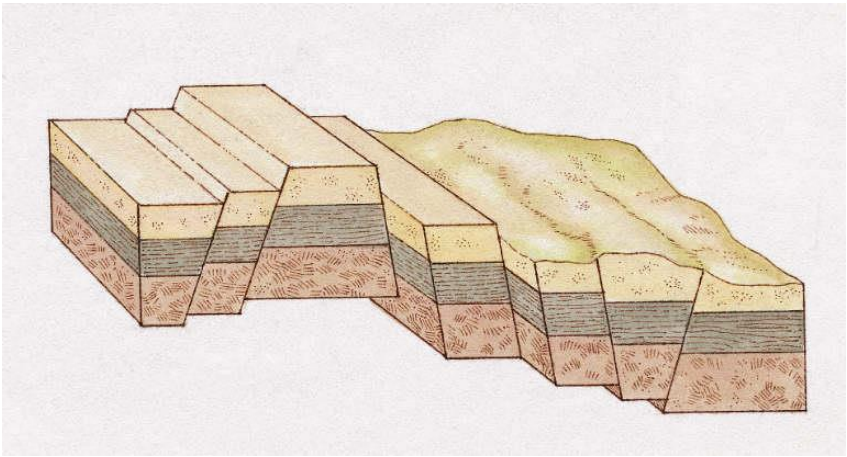


2. Fault Mountains

•These mountains form when faults or cracks in the earth's crust force some materials or blocks of rock up and others down.

Instead of the earth folding over, the earth's crust fractures (pulls apart). It breaks up into blocks or chunks. Sometimes these blocks of rock move up and down, as they move apart and blocks of rock end up being stacked on one another.



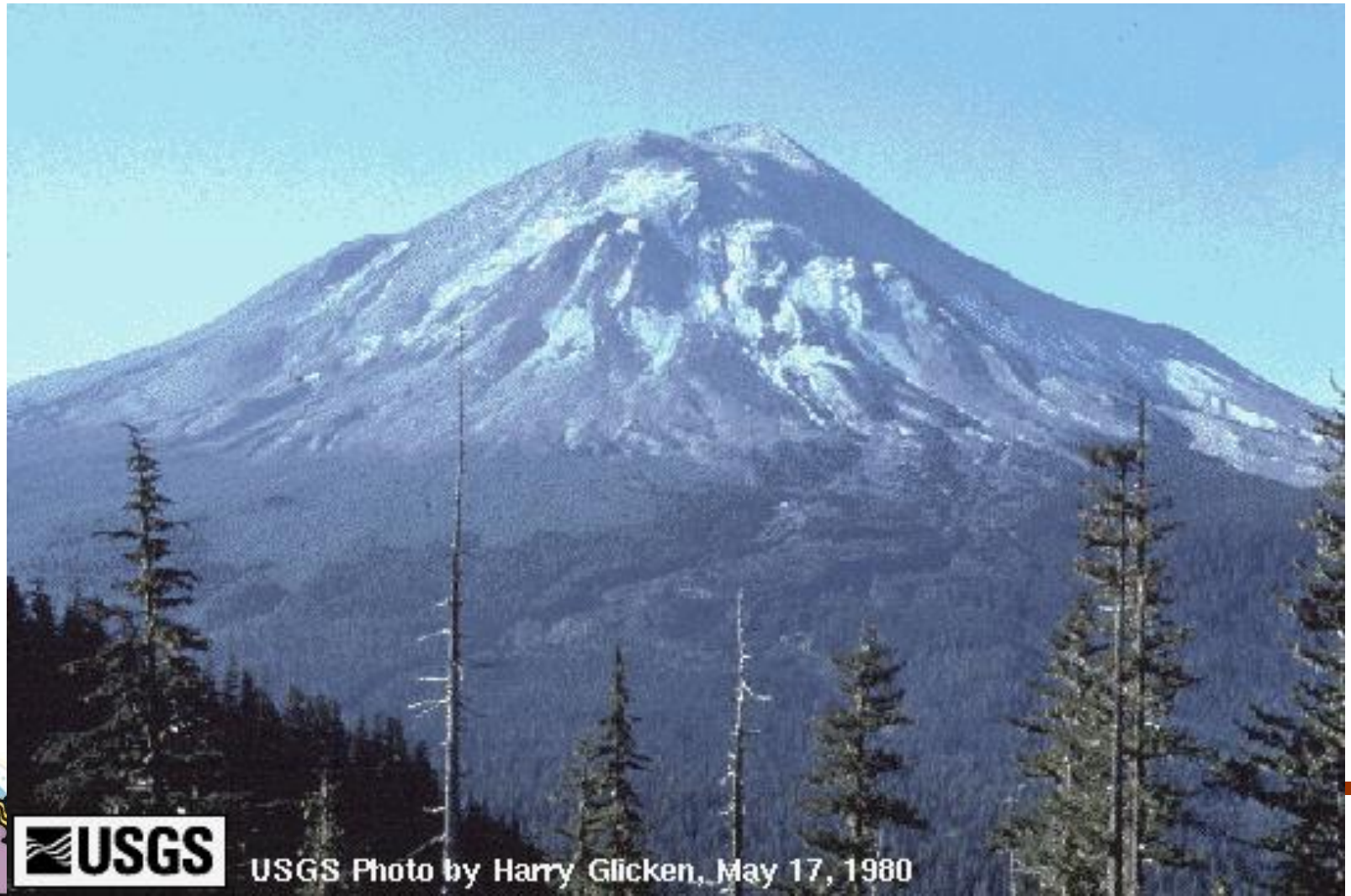


Teton Mountain Range, Wyoming

3. Volcanic Eruptions Mountains

- When magma is forced up by pressure from deep within Earth, it can uplift the rock and create features on the surface. The magma may erupt as volcanoes.

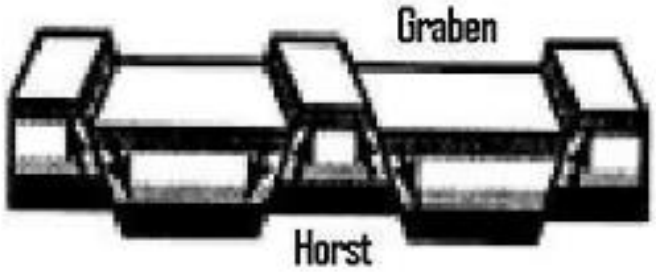
Mount St. Helens: Washington



Mount Pinatubo in the Philippines

Types Of Mountains

Folded Mountains



Fault- Mountains

Volcanic Mountans

Intermediate Science 7

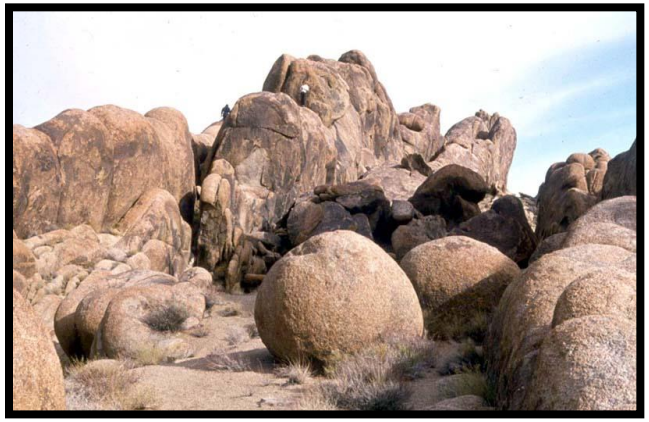
UNIT 3

EARTH'S CRUST

TOPIC 4: Weathering ,Erosion and Soil

What Is Weathering?

Weathering is *the process of breaking or wearing down rocks*.



***There are TWO different types of weathering*:**

1. Mechanical Weathering

2. Chemical Weathering

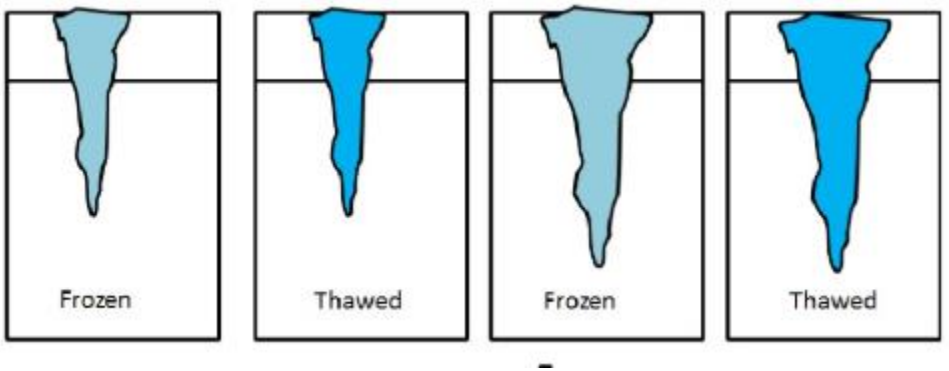
Mechanical Weathering:

1. Mechanical Weathering:

- **processes that break a rock or mineral into smaller pieces without altering its composition**

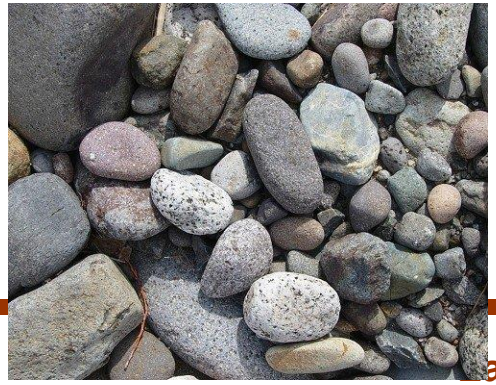
Common Physical Weathering Processes

1. Ice/frost Wedge



2. Action of plants and Animals

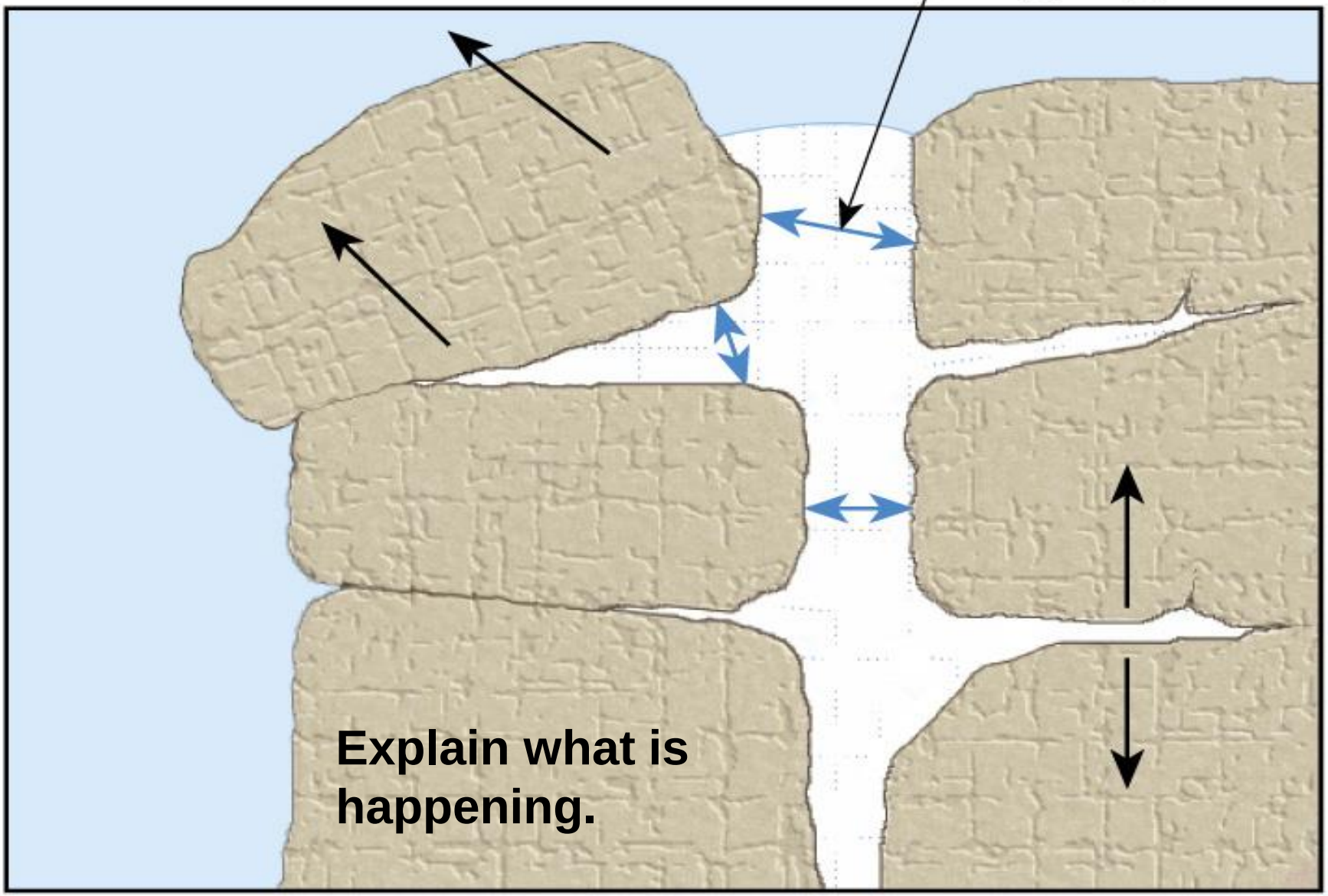
3. Abrasion



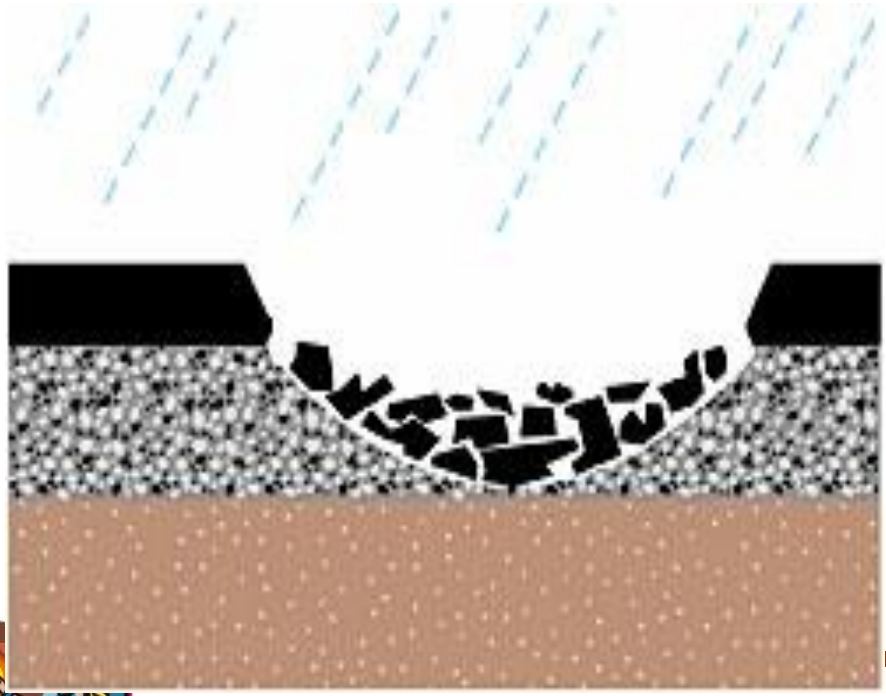
1. Frost (Ice) Wedging

- Process in which **water freezes** in the **cracks** of rock and **wedges (pushes)** it apart because water **expands** when it freezes.
- Occurs where there are frequent freezes and thaws.

Frost wedging

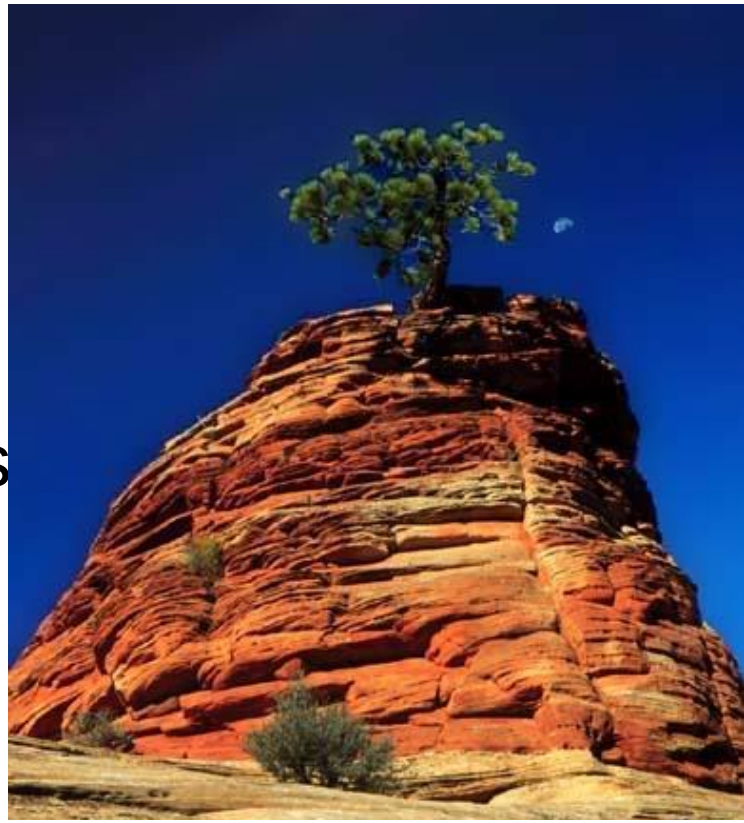


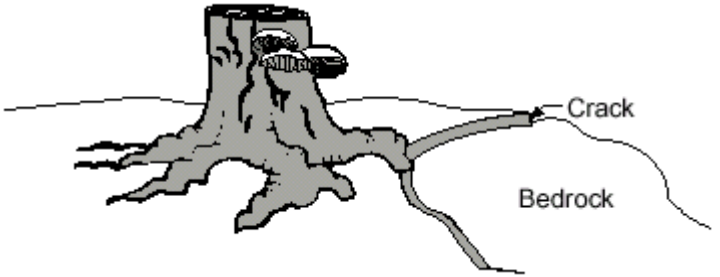
- **Frost/Ice Wedging** can cause **Potholes** to form in pavement

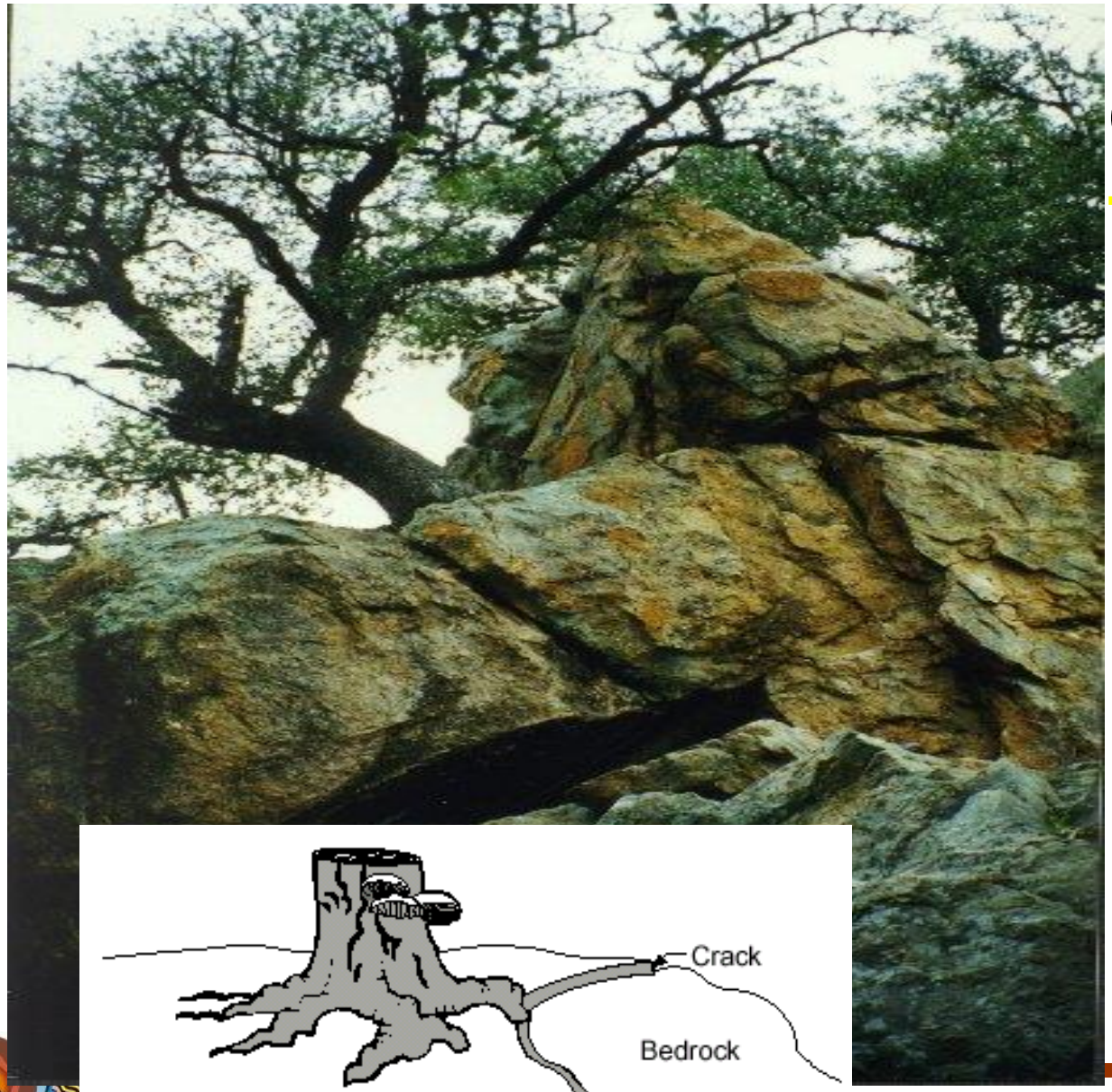


2. Plants and Animals

- **<u>Plant roots</u>** can **<u>split</u>** rock
- Also known as: ***"Root pry"*** **or *"Root action"***
- Animals dig **<u>holes</u>** ,breaks up rocks





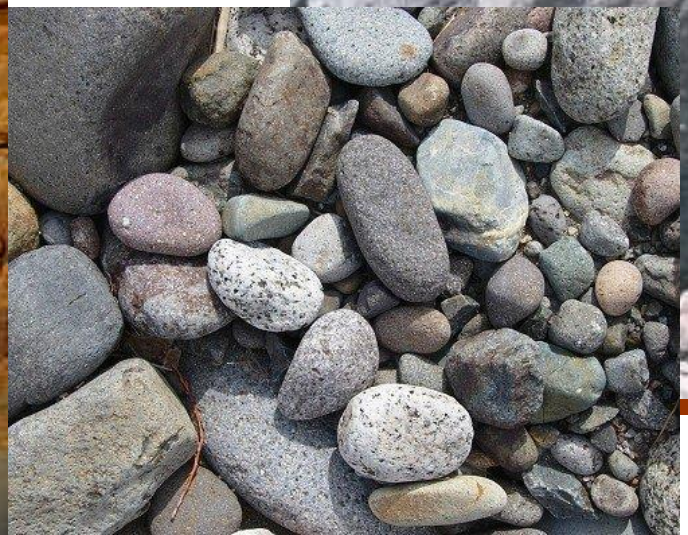


Tree growing out of rock.

Tree roots also break up sidewalks

3. Abrasion

- The **wearing away** of rock material by **grinding** action
- **Usually caused by sediment in Wind, Water, and Glaciers**



Wind <u>sandblasting</u> effect on stationary rocks

Water moving over rocks

Notice the rounded river rocks

2. Chemical Weathering:

- Chemical reactions occur with rocks that create new substances.
- Acid rain will chemically change rocks like salt, gypsum and limestone.

Statues weathered by acid rain

- Lichens produce acids which can weather rocks.

Lichens pitting a rock

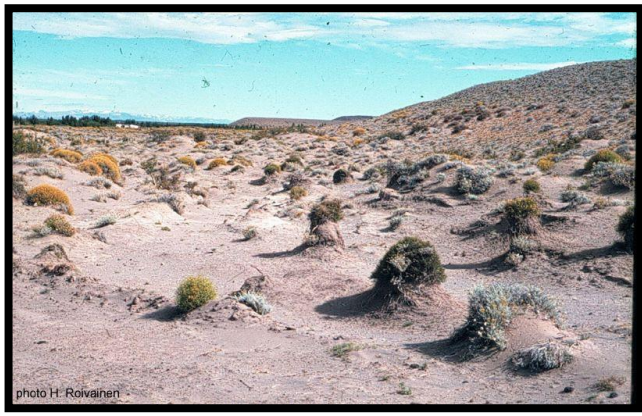
EROSION

Erosion is *the wearing away and movement of weathered materials from place to place.*

There are 4 natural causes of erosion:

- Gravity
- Glaciers
- Water
- Wind
- Waves

The 2 G's and 3 W's



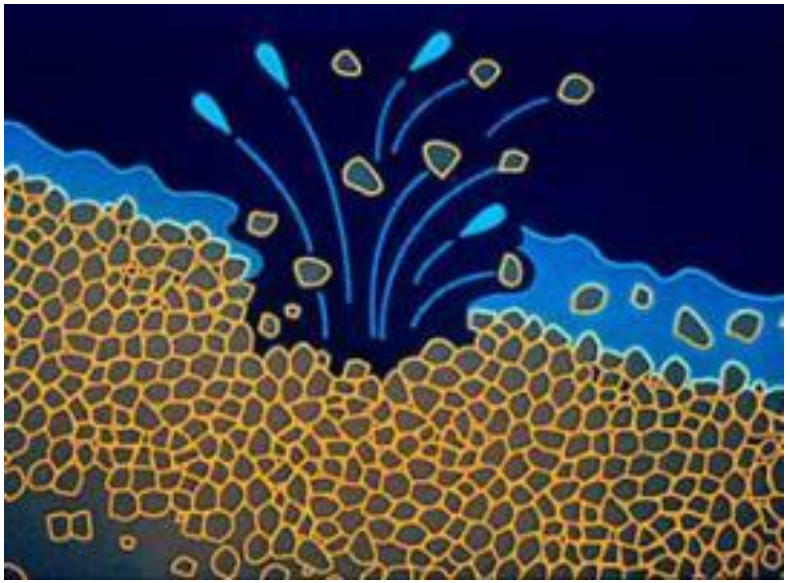
Please note that weathering and erosion are two different things. Many people mistakenly say erosion when they really mean weathering.
Weathering = breakdown.
Erosion = transport.

Agents of Erosion:

1. Water in motion: *Most powerful*

2. Meteorological processes (rain and wind)

Created by wind



Erosion by a rain drop

3. Geological processes (gravity and glaciers)

The Dungeons: Bonavista NL

Weathering

The process of **breaking** large rocks into smaller rocks over time.

Both

- **Wind**
- **Ice**
- **Gravity**
- **water**

Erosion

The **movement** of weathered rock and soil from one place to another

Soil

- Soil includes loose weathered rock, and organic material in which plant roots can grow.
- The first step in soil formation is the weathering of parent rock into smaller pieces.
- Eventually, very small particles from parent rock are mixed in with organic matter to form soil.
- The type of sediment in soil depends on what rocks are in the area. This helps to explain why soils differ from place to place.
- Can take thousands of years to form.

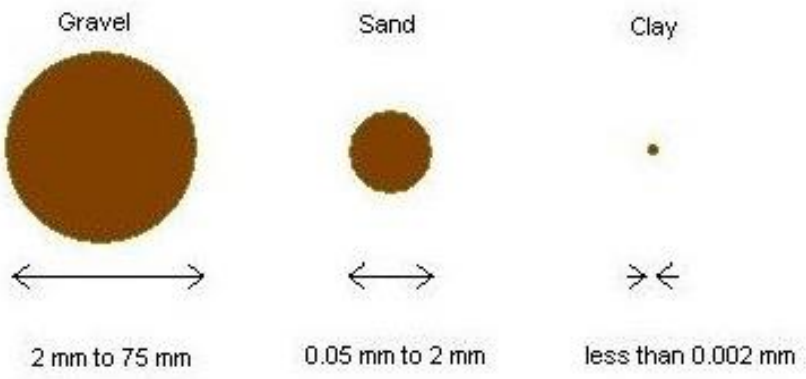
SOIL CLASSIFICATION

Soil can be classified according to such characteristics as:

1) **Size of Particles**
2) **Texture**
3) **Permeability**
4) **Porosity**

1. Size Of Particles :

1. Clay
2. Sand
3. Gravel



The above are listed from the smallest to the largest particle size.

2. Soil Texture

Texture indicates the relative content of particles of various sizes, such as sand, silt and clay in the soil.

Texture can be classified as:

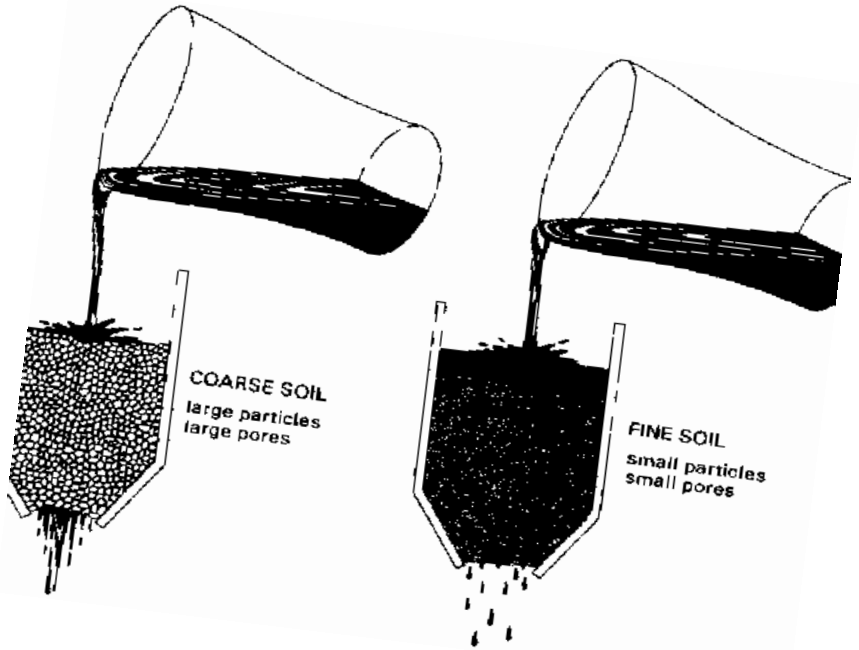
1) Course Texture
2) Medium Texture
3) Fine Texture

Coarse Texture:

- These soils have a sandy/ gravelly texture.
- They feel gritty and can roll between your fingers.
- Grains can be seen with the naked eye.

Coarse Soil

Sand/ Gravel



Medium Texture:

- Also called loam. Farmers preference.

- Composed of sand, silt and clay in nearly equal proportions. May feel gritty and sticky at the same time.

Medium
Grain
Soil

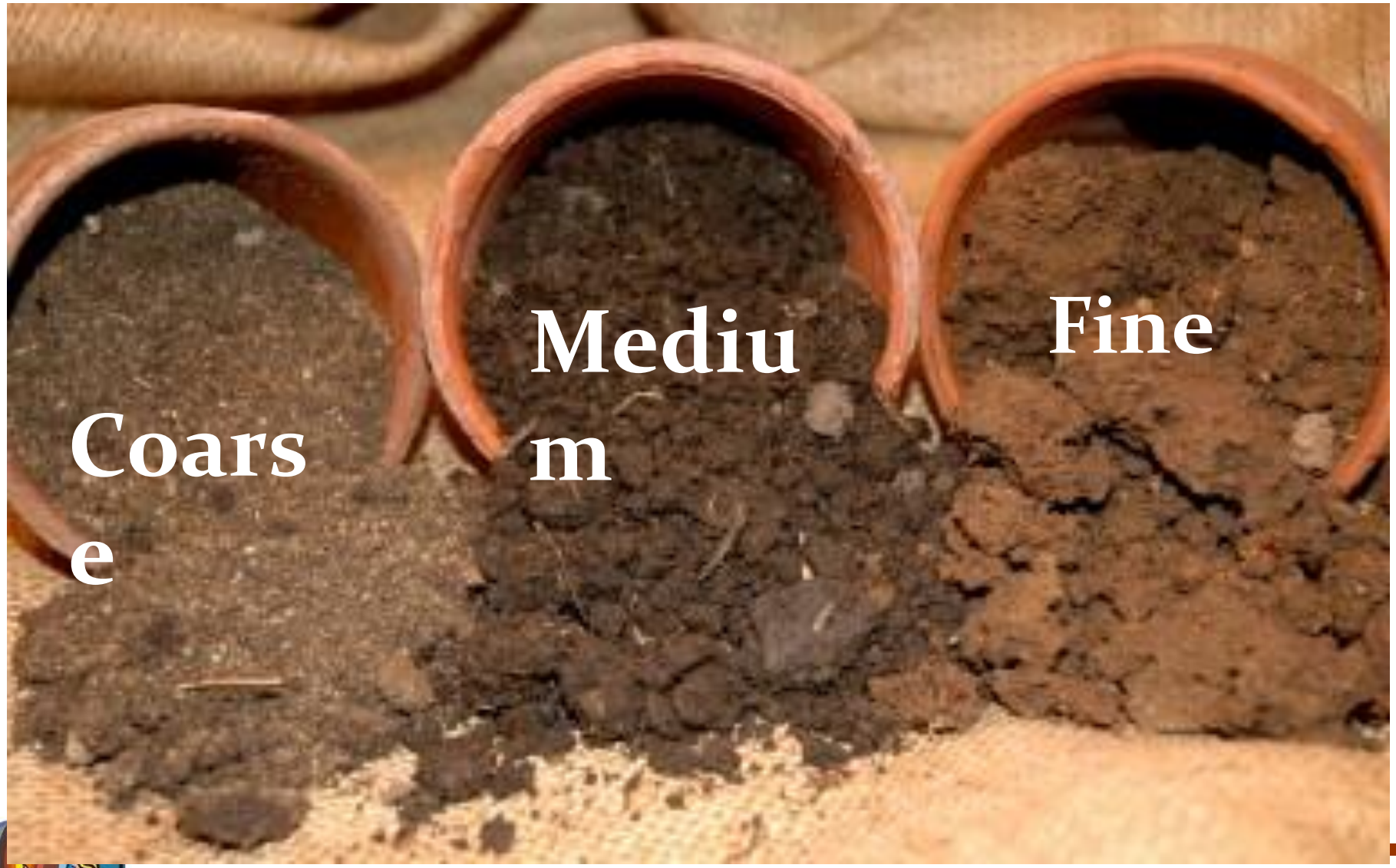
- Loam

Fine Textured:

- Made up of clay.
- Feel greasy or sticky.
- Have little texture when wet.

Fine
Grain Soil

- Clay

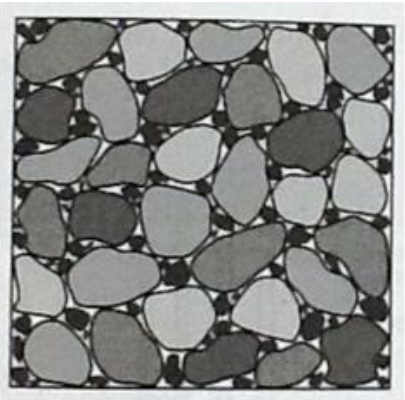

Coarse
Medium
Fine

3. Porosity

The amount of empty space in a soil or rock.

High Porosity

vs.



Low Porosity

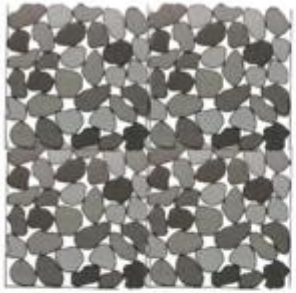
3. Permeability

A measure of the ease with which liquids and gases pass through a soil or rock.

Large Particles

- More permeable
- Water flows easily from space to space

Small Particles

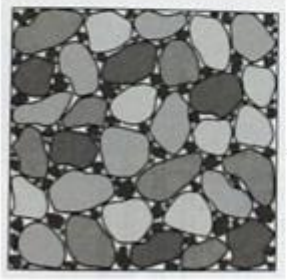


- Less permeable
- It's hard for water to find a path through the soil

Sorted Particles

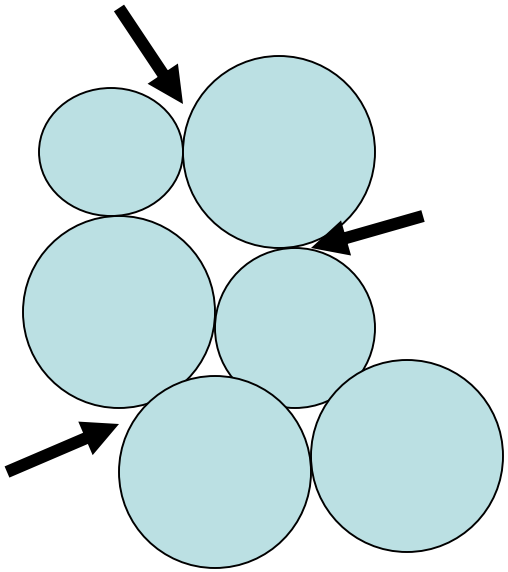
- More permeable
- Plenty of open spaces that connect to each other

Unsorted Particles

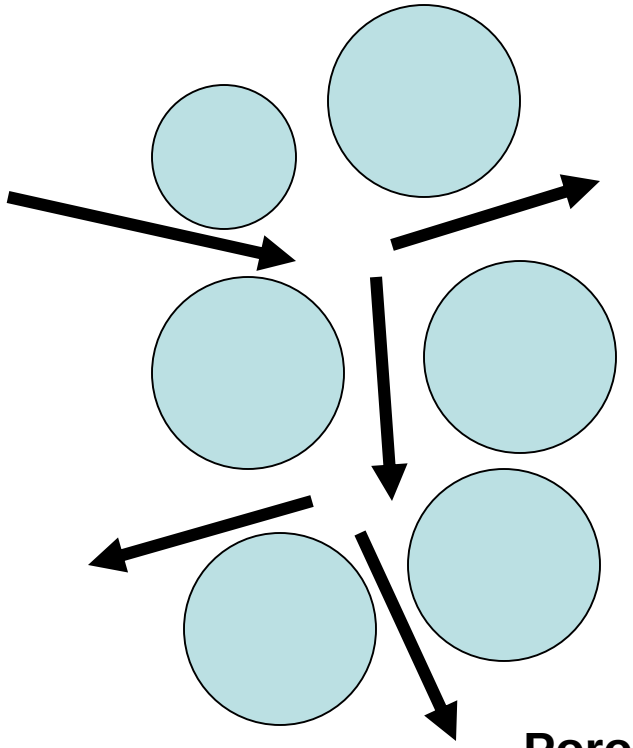


- Less permeable
- Small particles fill up the spaces leaving little room for water to move

Material can be porous without being permeable, but it cannot be permeable without being porous.



Porous, but not permeable



Porous and permeable