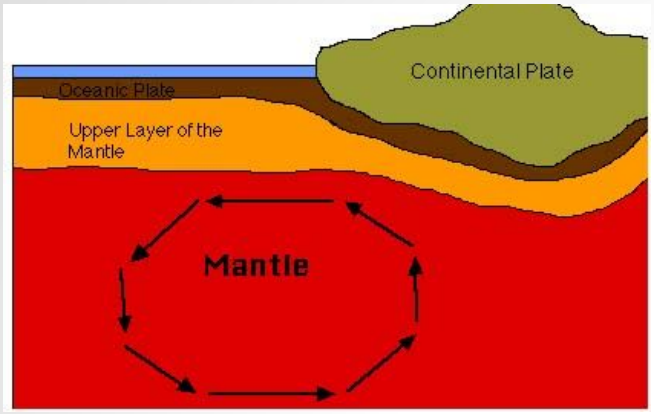
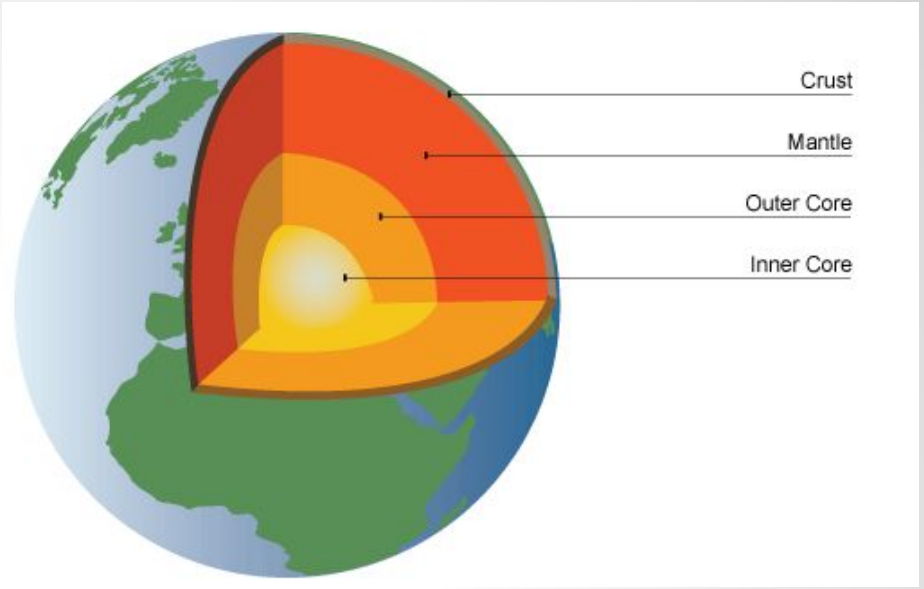
# Earth's Structure, Earthquakes, and Volcanoes

Earth Science

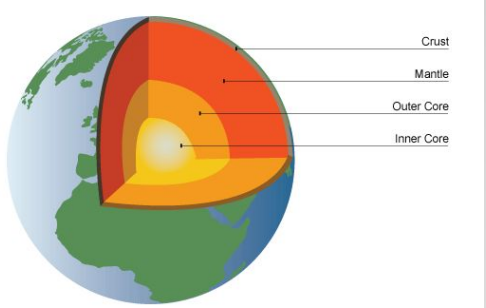
# Earth's Structure



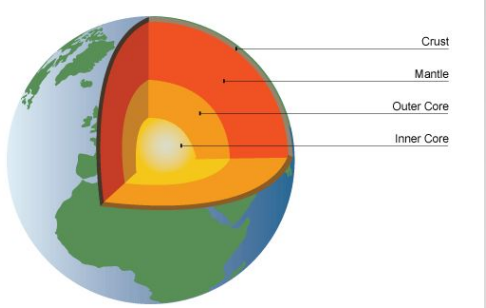

Imagine you could travel from one point on Earth straight through the center of the planet and out the other side. Your journey would be nearly 12,870 kilometers (**8,000 miles**)!The Earth consists of four concentric layers: inner core, outer core, mantle and crust.

# Crust



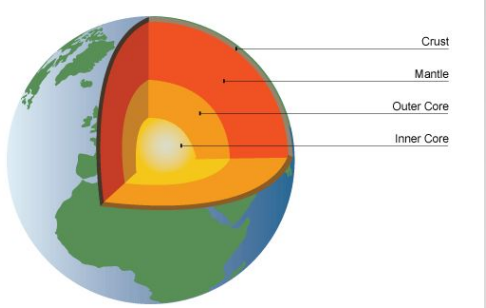

- The rocky surface of Earth is a thin outer shell, much thinner than the other layers.
- The crust is made up of **tectonic plates**, which are in constant motion.
- The land that we see, or **continental crust**, is about 30 kilometers (19 miles) thick. Under the sea, **oceanic crust** is much thinner (8 to 10 kilometers, or 5 to 6 miles thick). But it's also much heavier.
- Earth's crust and the top part of the mantle are broken into ten large plates and many smaller ones.
- Most plates are made of both continental and oceanic crust.

# Mantle

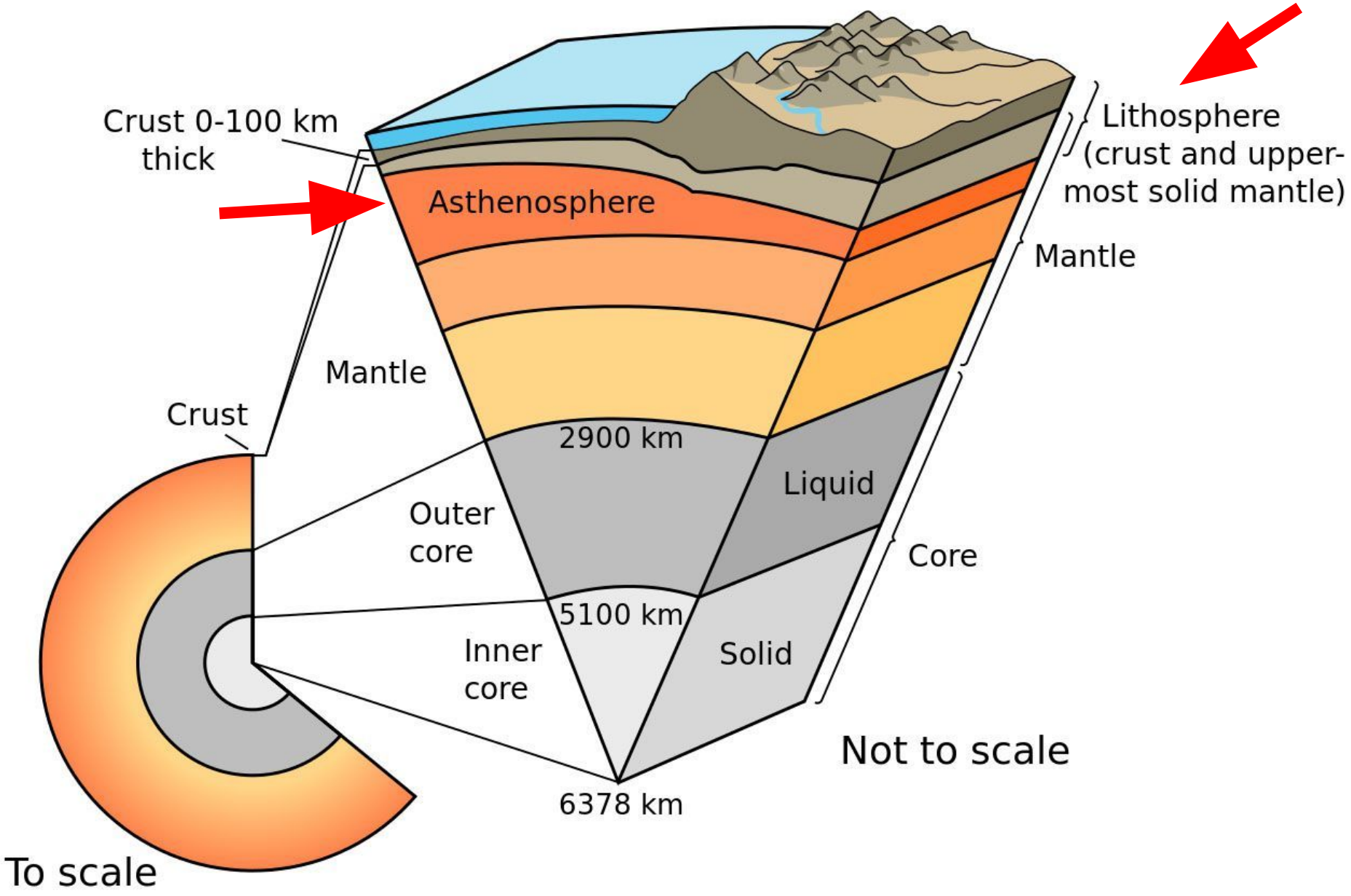



- The crust floats on a thick layer of rock, almost 100 times thicker than continental crust.
- The rock isn't like the rock we know. **Extreme heat makes it move in circles. (convection current)**
- It flows very, very slowly, but it's enough to cause the plates above it to move over long periods of time.
- The plates move about 8 centimeters (3 inches) per year.

# Core




- The core is even thicker than the mantle.
- It's made up of a **liquid metal outer core** that flows around a **solid metal inner core**.
- The motion in the outer core creates a magnetic field around Earth. It's the same field that makes a compass work!
- The **core gives off incredible heat**, which is one of the driving forces that causes the mantle to flow.

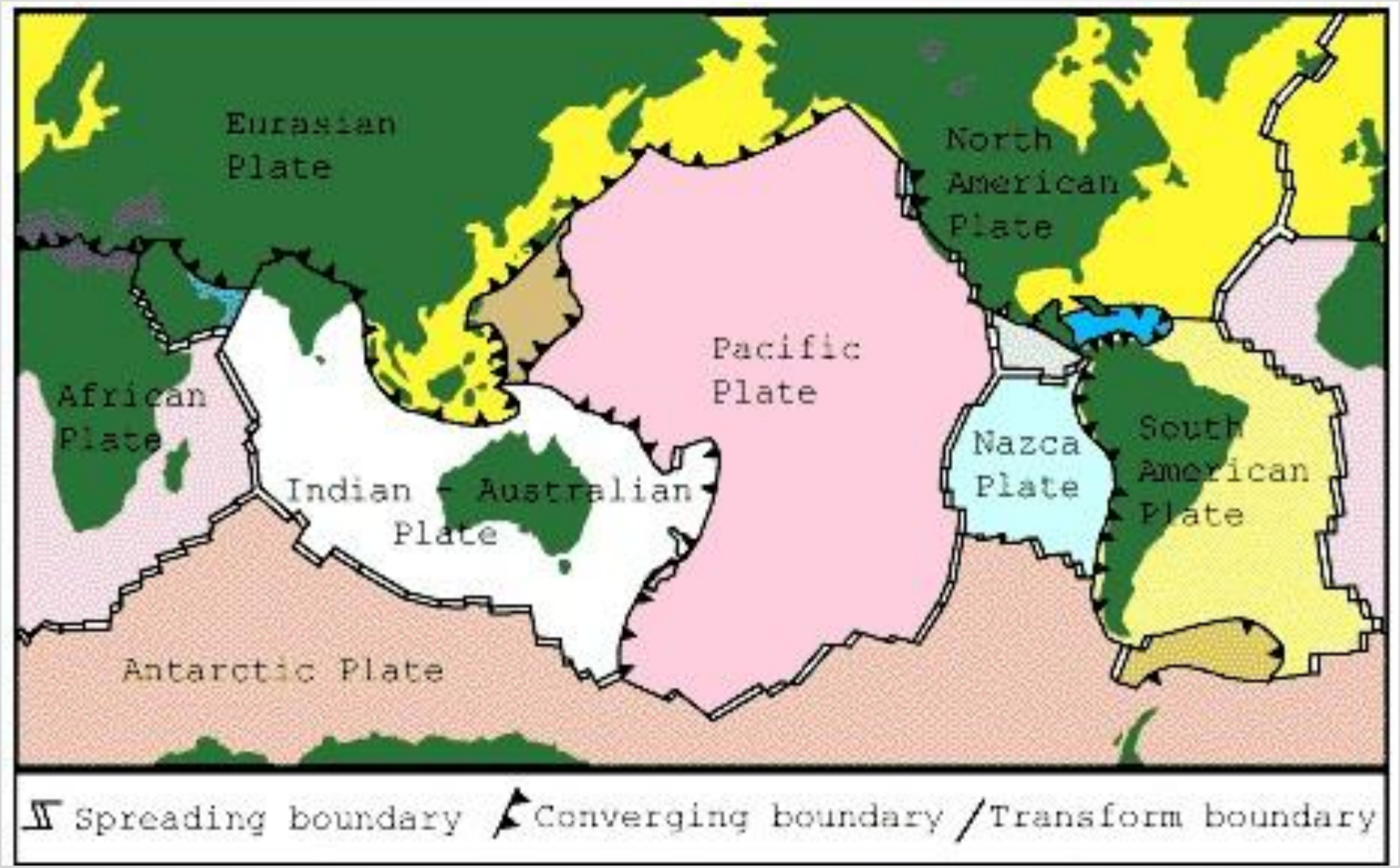

Crust 0-100 km thick
Asthenosphere
Lithosphere (crust and upper-most solid mantle)
Mantle
Mantle
Crust
2900 km
Liquid
Outer core
Core
5100 km
Inner core
Solid
Not to scale
6378 km
To scale

# Plate Tectonics

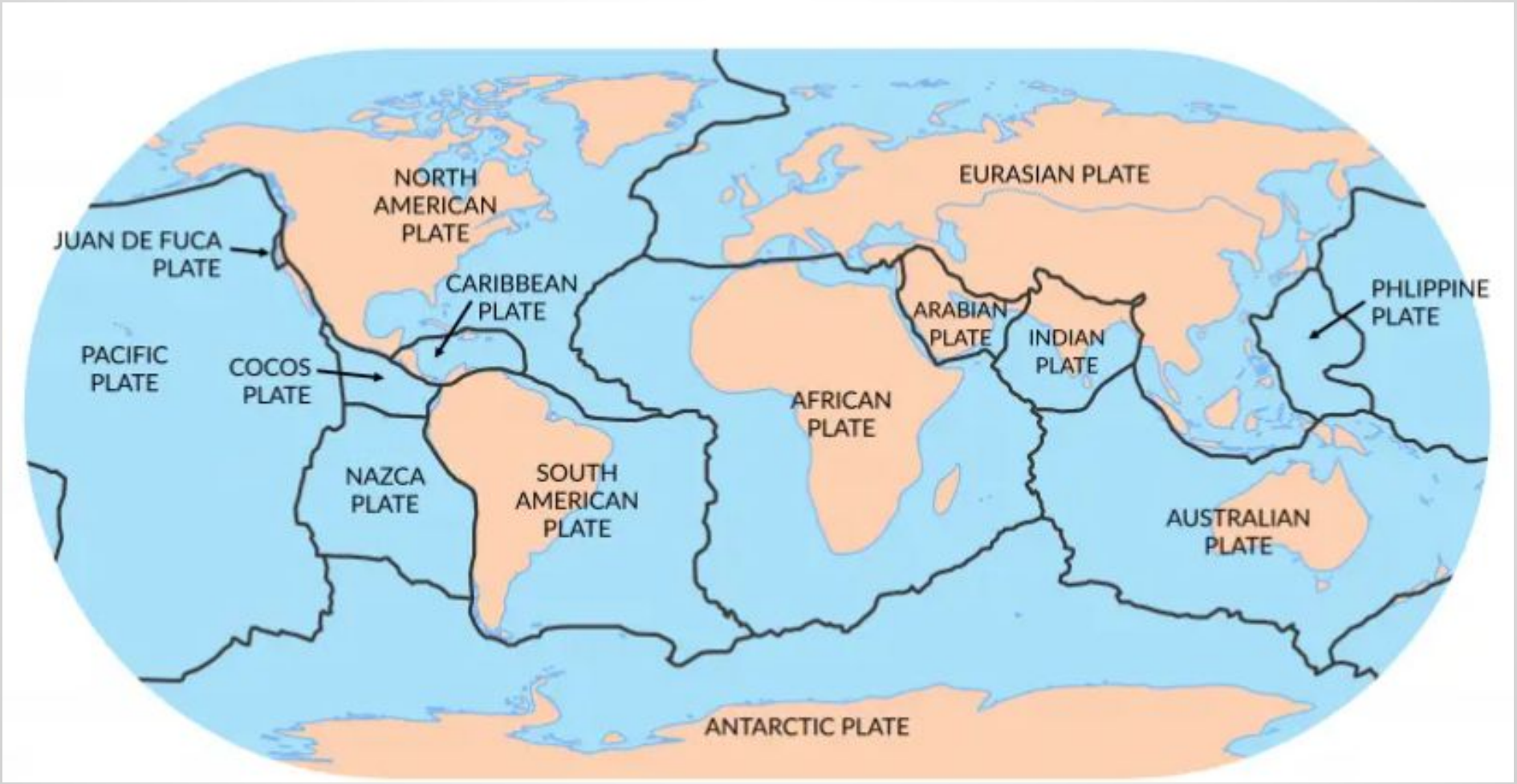
The Earth is always changing. Mountains form and erode away. Volcanoes erupt and grow larger. Earthquakes shift the land. Oceans grow and even continents move. What causes all this activity?

The Earth's thin, fragile outer shell is broken into large pieces called "plates." These plates slowly move, floating on a layer of hot mantle below. This movement, or tectonic activity, is constantly changing the surface of the Earth.

# Plate Boundaries



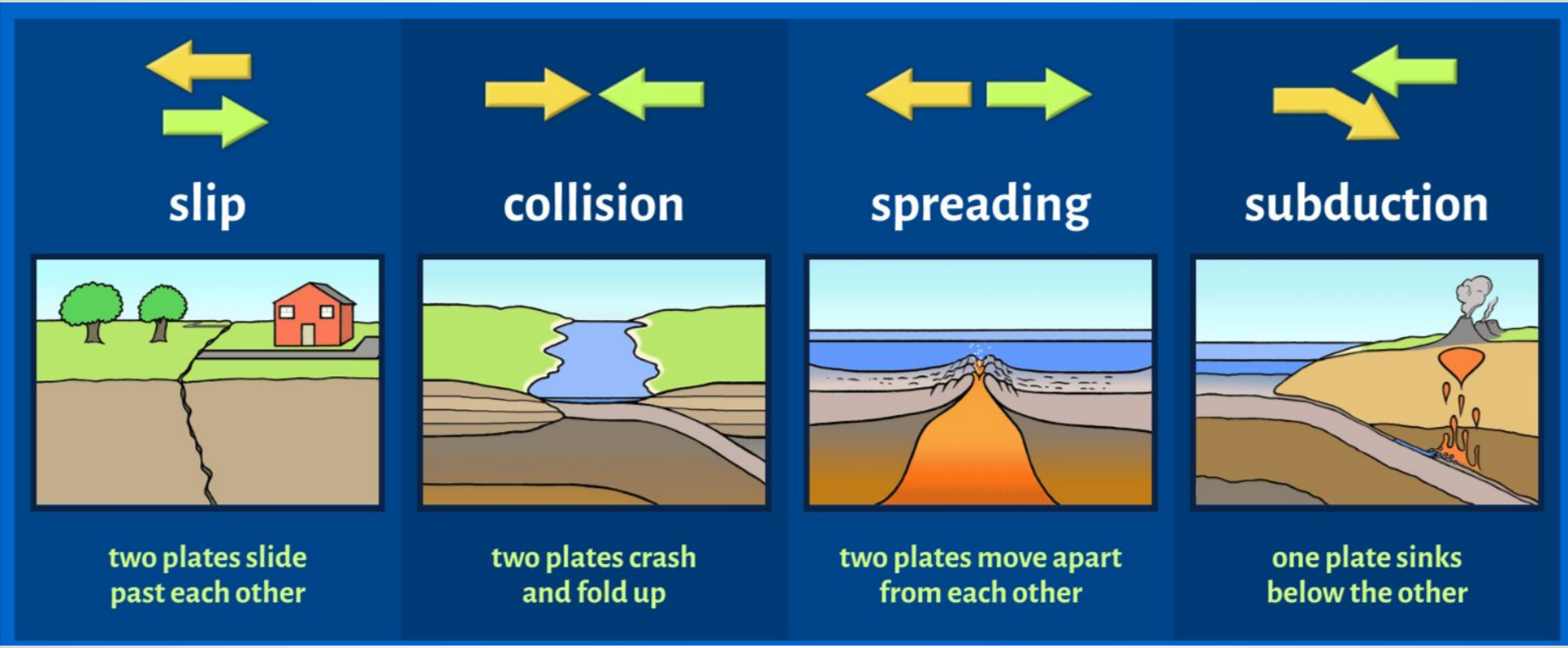
# Tectonic Plates with Names



# Types of Plate Boundaries

- Convergent (uplifting, subducting)
- Divergent (moving away)
- Transform (sliding/slipping past)

# Plates on the Move




The flow of the mantle causes tectonic plates to move in different directions. When the edges of plates meet, four things can happen: Convergent plates **collide**. Divergent plates **divide**. Transverse plates **slide**.

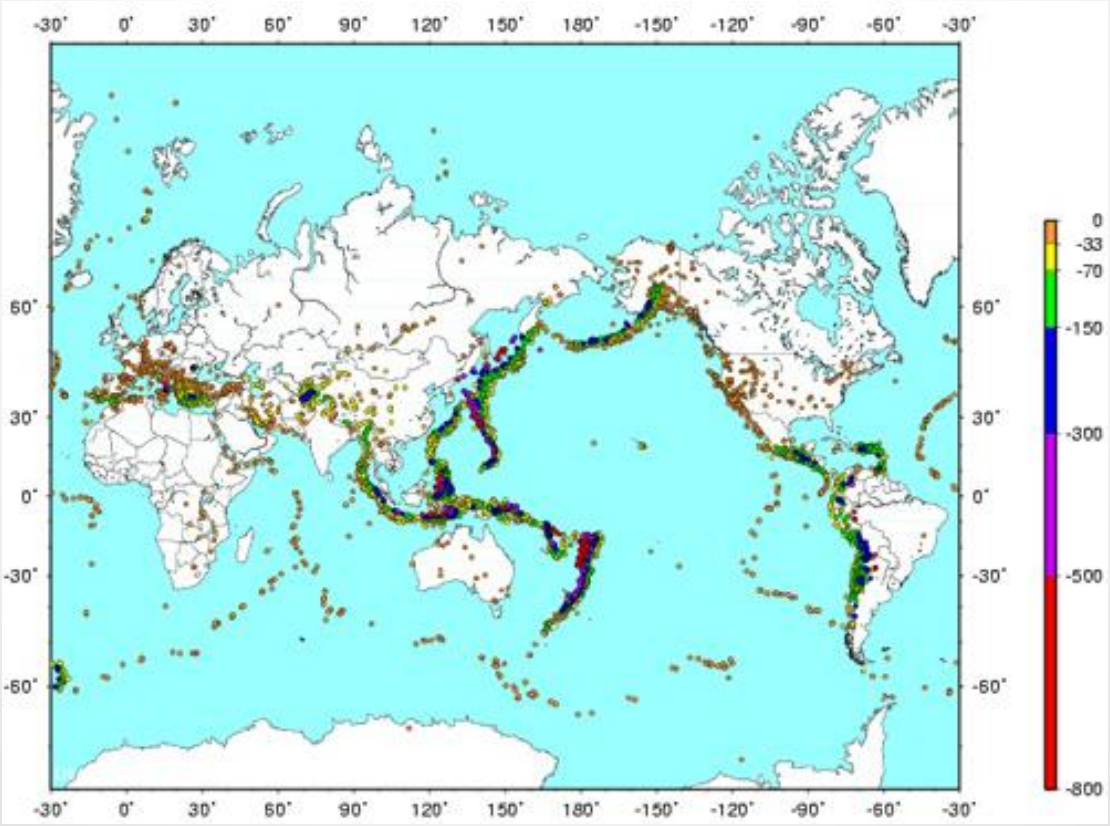
# Earthquakes

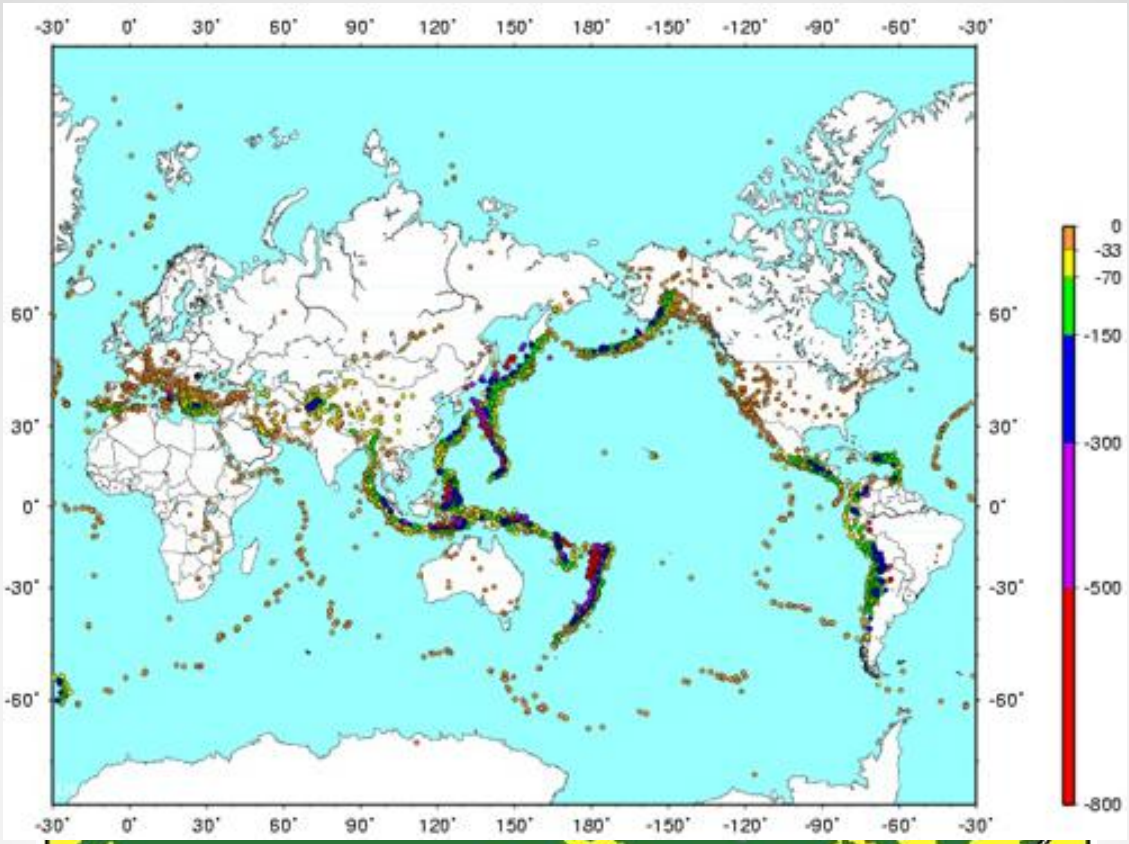
- What causes an earthquake?
- How do earthquakes change the surface of the earth?
- How are tsunamis related to earthquakes?

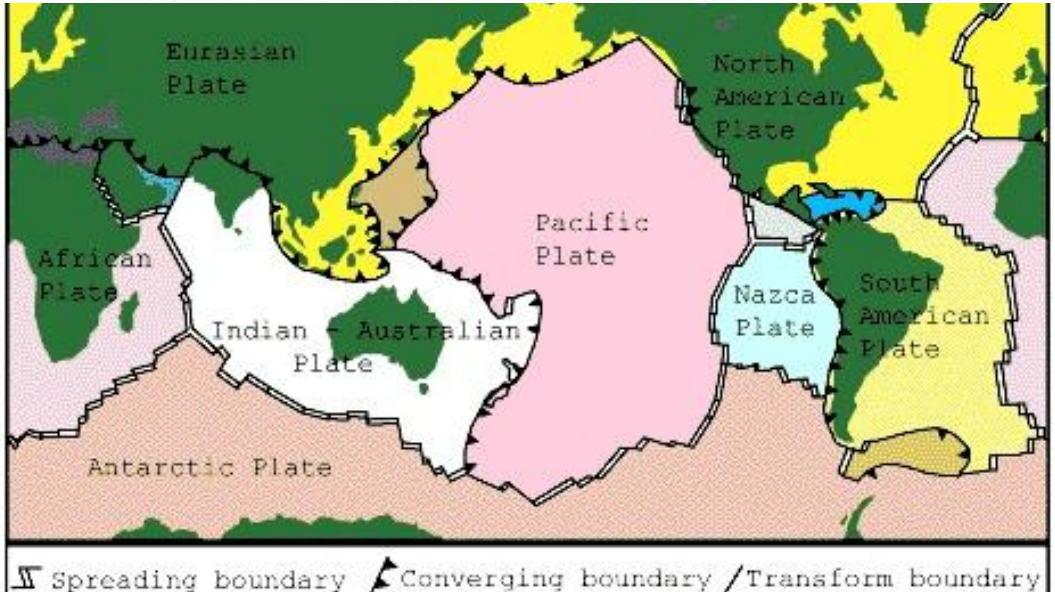
# Earthquakes 101 Video

# Earthquake Map (USGS)

http://earthquake.usgs.gov/earthquakes/map/



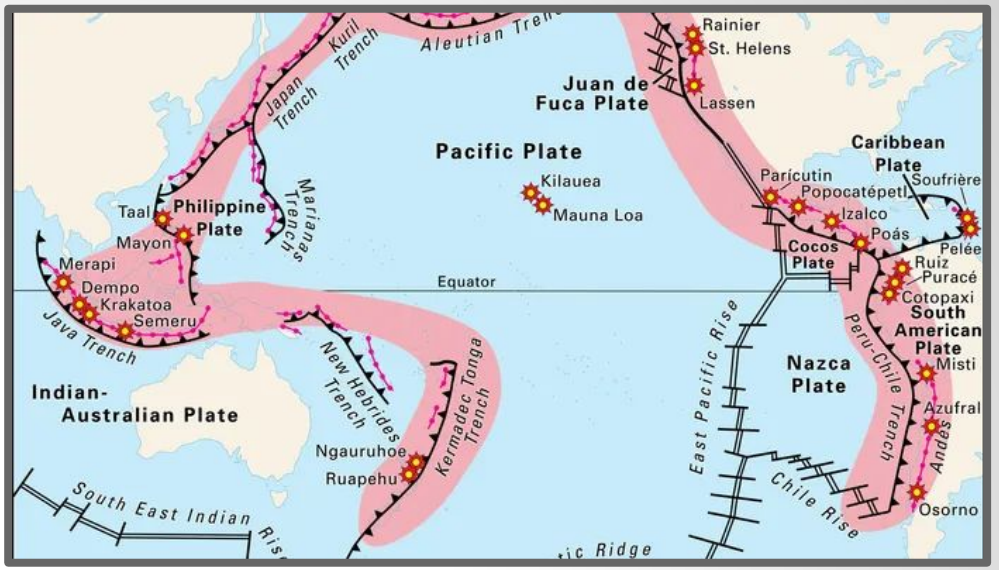

-30° 0° 30° 60° 90° 120° 150° 180° -150° -120° -90° -60° -30°
60°
30°
0°
-30°
-60°
0
-33
-70
-150
-300
-500
-800


Eurasian Plate
North American Plate
Pacific Plate
African Plate
Indian - Australian Plate
Nazca Plate
South American Plate
Antarctic Plate
Spreading boundary
Converging boundary
Transform boundary

# Extreme Science Video

Can We Stop Earthquakes?

# The Ring of Fire




- The Ring of Fire is a region around much of the rim of the Pacific Ocean where many volcanic eruptions and earthquakes occur.
- The Ring of Fire is a horseshoe-shaped belt about 40,000 km long and up to about 500 km wide.
- A series of deep ocean troughs frame the belt on the oceanic side, and continental landmasses lie behind.
- Most of the world's earthquakes, the overwhelming majority of the world's strongest earthquakes, and approximately 75 percent of the world's volcanoes occur within the Ring of Fire.

# Vocabulary (Words to Know)

| | | | | |
|---|---|---|---|---|
| asthenosphere | earthquake | lithosphere | outer core | subduction |
| continental drift | fault | mantle | plate | trench |
| convergent boundaries | hotspot | mid-ocean ridge | seafloor spreading | volcano |
| aftershock | divergent boundary | inner core | ocean crust | seismic waves |
| continental crust | epicenter | magma | Pangea | transform boundary |
| convection currents | folding | mesosphere | rift valley | tsunami |

# The Richter scale

Measures energy waves emitted by earthquake

**0 - 1.9** Can be detected only by seismograph

**2 - 2.9** Hanging objects may swing

**3 - 3.9** Comparable to the vibrations of a passing truck

**4 - 4.9** May break windows, cause small or unstable objects to fall

**5 - 5.9** Furniture moves, chunks of plaster may fall from walls

**6 - 6.9** Damage to well-built structures, severe damage to poorly built ones

**7 - 7.9** Buildings displaced from foundations; cracks in the earth; underground pipes broken

**8 - 8.9** Bridges destroyed, Few structures left standing

**9 and over** Near-total destruction,waves moving through the earth visible with naked eye

260302

AFP

# Intraplate Earthquakes

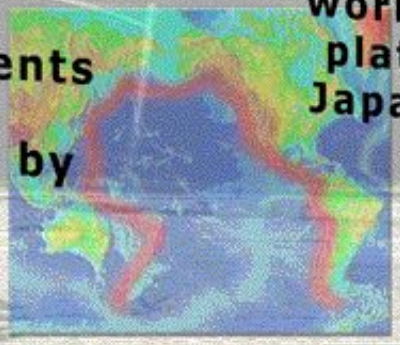
Nearly all earthquakes (98%+) happen at the plate boundaries, but there are some anomalous events, called ***intraplate earthquakes***, that happen far from the boundaries.

Scientists have theories as to why earthquakes occur away from plate boundaries. The areas where they occur have high ***seismic*** activity (a sudden release of energy).

# EARTHQUAKES

## What is an earthquake?

An earthquake is the vibration of the earth's surface that follows a release of energy in the earth's crust. This energy can be generated by a sudden dislocation of segments of the crust, by a volcanic eruption, or event by man-made explosions.

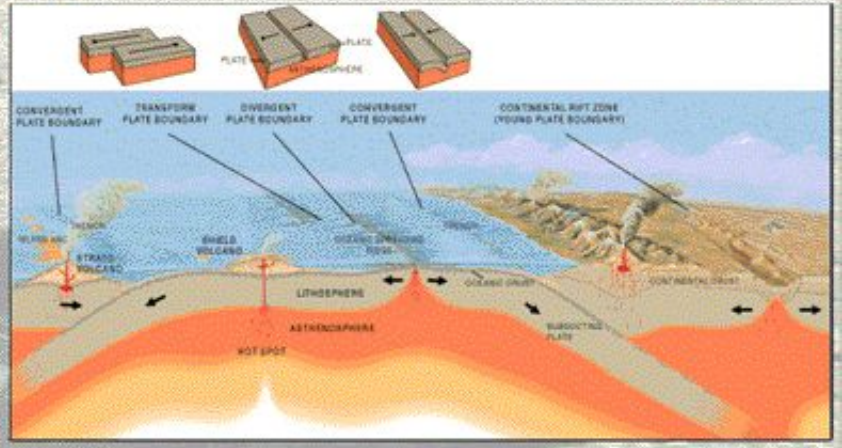


## Which areas are prone to earthquakes?

Most earthquakes occur at the circum-Pacific seismic belt known as the "Rim of Fire". 95% of all the world's earthquakes occur at active plate boundaries. The Philippines, Japan, California, Alaska and South America are all on the plate boundaries.

## What causes an earthquake?

The earth's outer surface is broken into pieces called tectonic plates. These plates constantly move away from, towards or past each other. As the continents are part of these plates, they will also move. An earthquake occurs when the stresses caused by plate movements are released.



# Earth Video

## Earth Videos

### What is an Earthquake?

Ever wanted to know what an earthquake actually is? Well now you can find out thanks to this informative educational video.

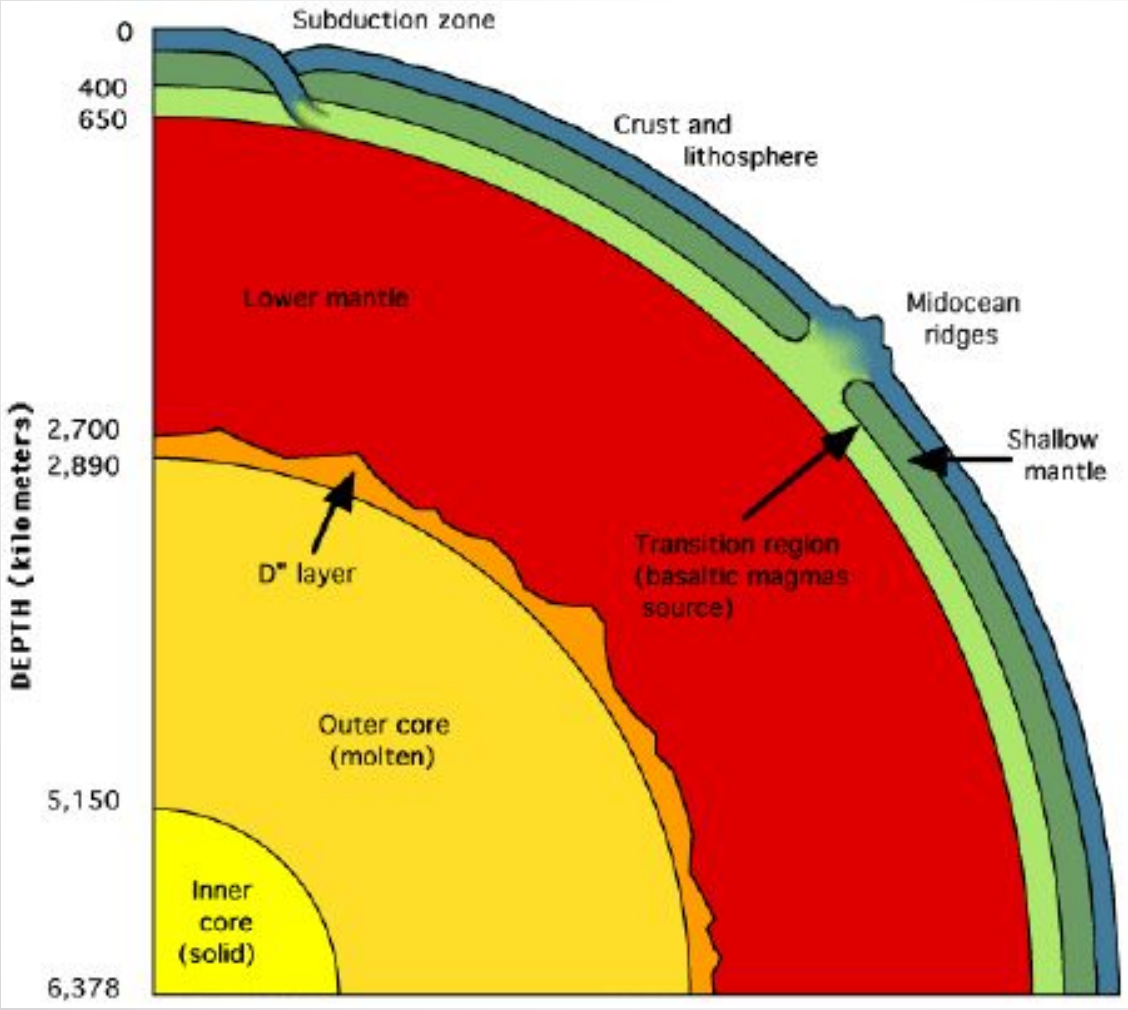
Learn about the Earth's tectonic plates and how they slowly move under, over or past each other. At times they get stuck and a large amount of pressure builds until all of a sudden they rip past each other and release a tremendous amount of energy which creates the seismic waves we feel as earthquakes. Understand fault lines, where earthquakes are most likely to occur and much more.

# Volcanoes

# Essential Questions

- What is a volcano?
- What determines the way a volcano erupts?
- How do scientists classify volcanoes?
- How do volcanoes change Earth's surface?

# Cross Section of Earth



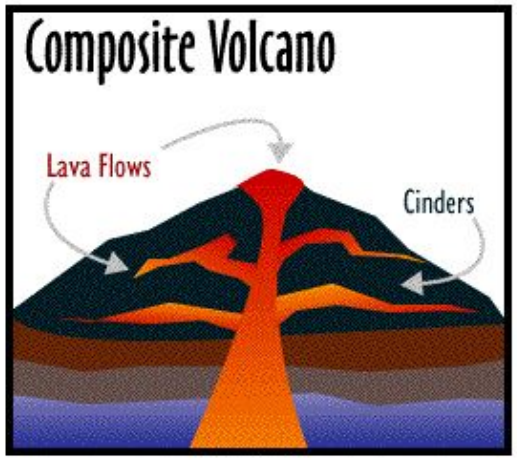
# Volcanoes 101

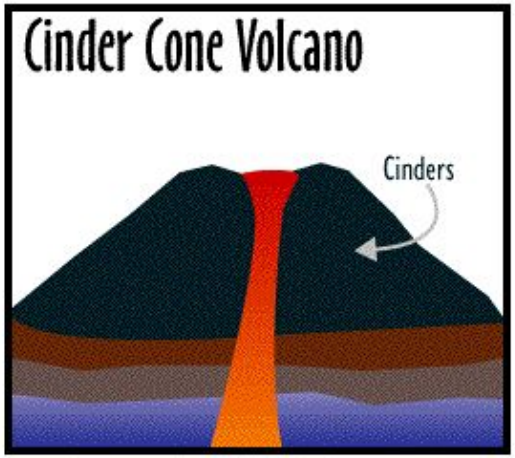
# Types of Volcanoes

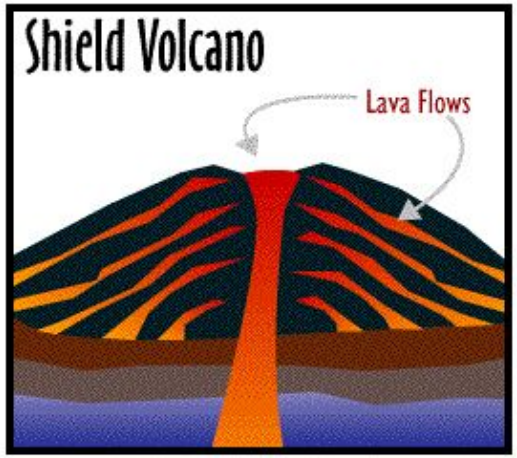
**Shield**

**Cinder Cone**

**Composite**



# Types of Volcanoes

## Types of Volcanoes

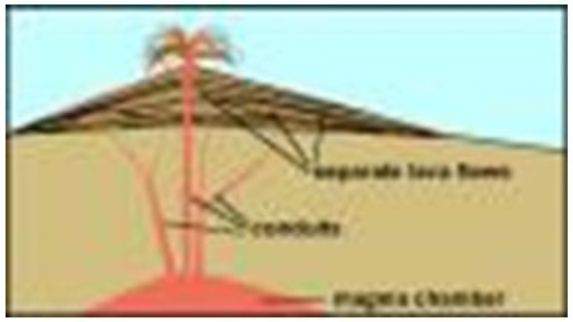
- There are 3 types of Volcanoes:

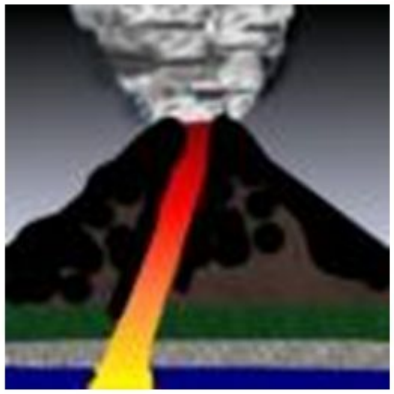
***Shield***

***Cinder Cone***

***Composite***

- They are classified by how they form.



# Shield Volcano

# Cinder Cone Volcano

# Composite Volcano (Stratovolcano)

# Mount St. Helens
## (composite volcano)

# US Volcanic Activity

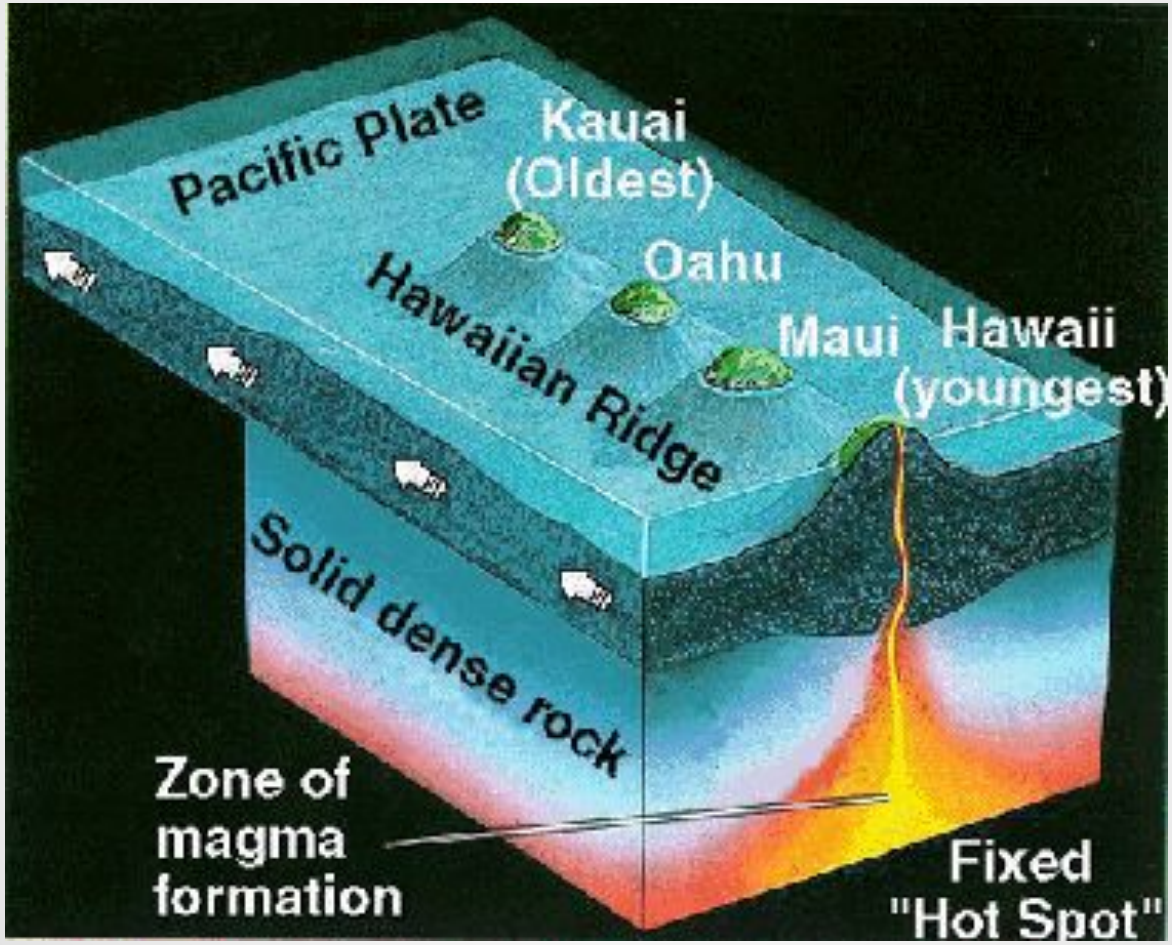
World Volcanic Activity Map

US Map of Volcanic Activity

Kilauea Volcanic Dome Vent

Kilauea Volcanic Dome Vent (Thermal)

# Hotspot


Pacific Plate
Kauai
(Oldest)
Oahu
Maui
Hawaii
(youngest)
Hawaiian Ridge
Solid dense rock
Zone of
magma
formation
Fixed
"Hot Spot"

# Hotspot

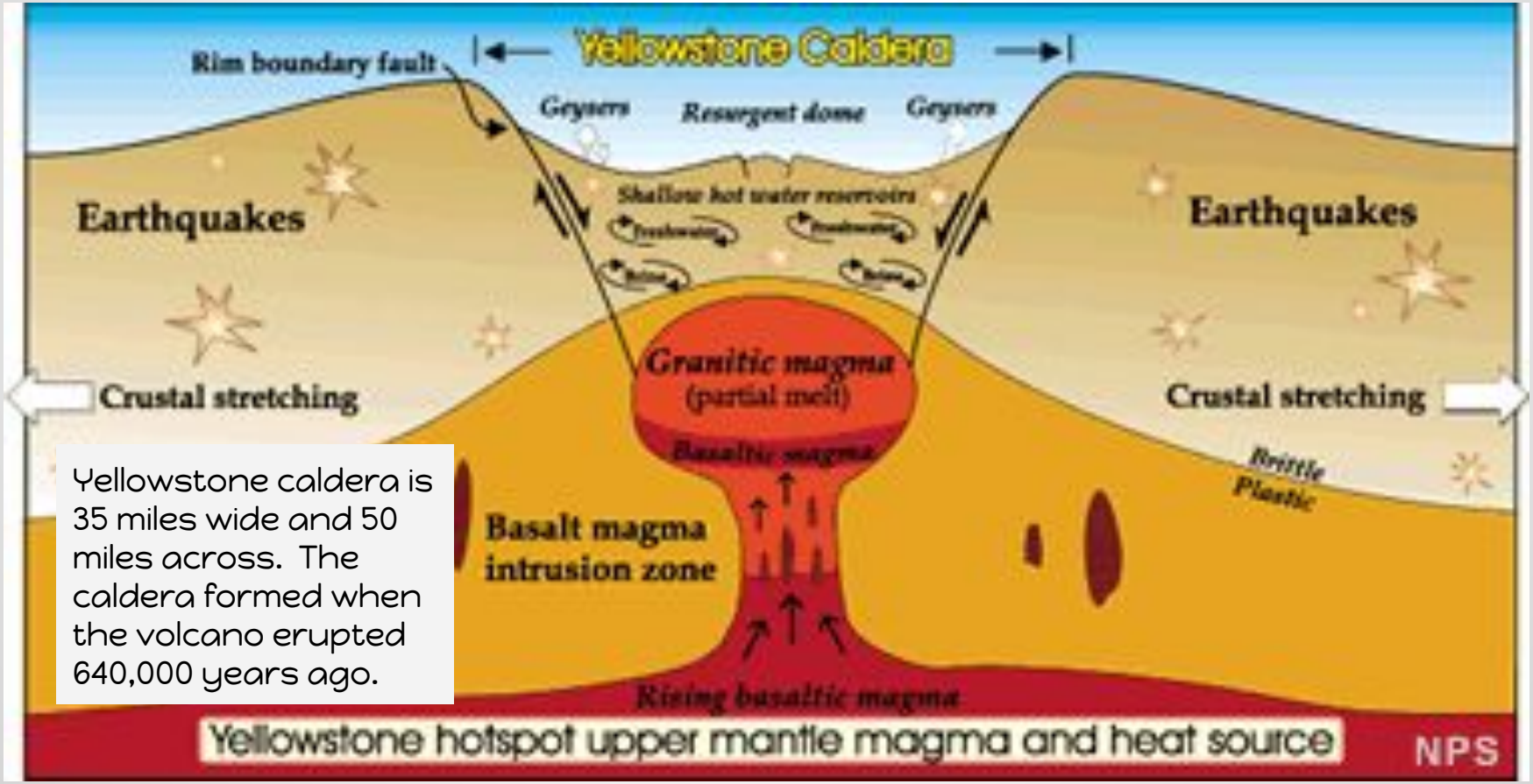
A place deep within the Earth where hot magma rises to just underneath the surface, creating a bulge and volcanic activity. The chain of Hawaiian Islands is thought to have been created by the movement of a tectonic plate over a hotspot.

# Yellowstone Hotspot

Tracking the hotspot

Plate Movement

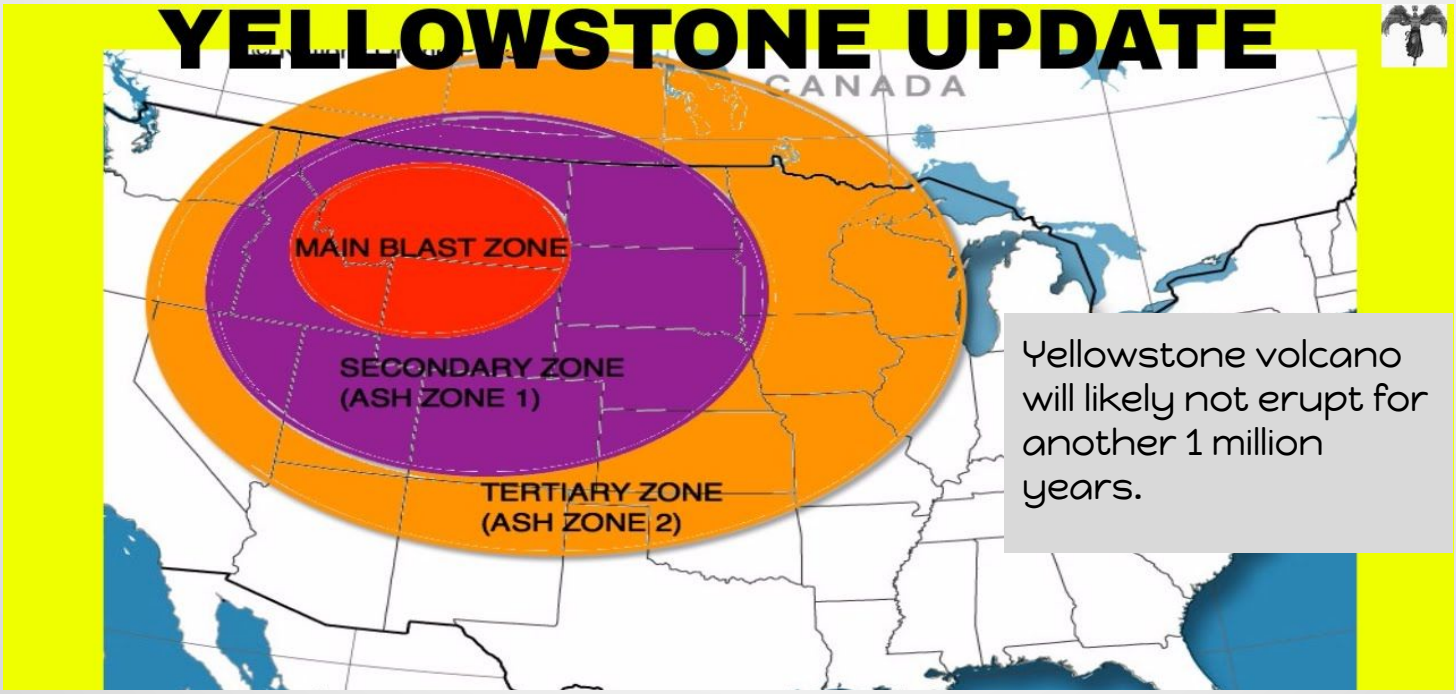
# Yellowstone Hotspot




Yellowstone caldera is 35 miles wide and 50 miles across. The caldera formed when the volcano erupted 640,000 years ago.

# Yellowstone Supervolcano

A super volcano can be **1,000** more powerful than a regular volcano.




Gardiner
Silver Gate
MONTANA
WYOMING
Mammoth Hot Springs
Tower Junction
MONTANA
WYOMING
Magnitude 7.5
August 18, 1959
YELLOWSTONE
NATIONAL PARK
West Yellowstone
Norris
Madison
Canyon
CALDERA RIM
Magnitude 6.1
June 30, 1975
Fishing Bridge
Old Faithful
Yellowstone
Lake
Lake Butte
West Thumb
CALDERA RIM
10 MILES
IDAHO
WYOMING
USGS
Topinka, USGS/CVO, 1997, Modified from: Dzurisin, Christiensen, and Pierce, 1995

# Yellowstone Supervolcano

What if Yellowstone's Supervolcano Erupted?

USGS
science for a changing world

# The U.S. is one of Earth's most volcanically active countries

*Since 1980, there have been 120 eruptions and 52 episodes of notable volcanic unrest at 44 U.S. volcanoes.*

## What makes a volcano dangerous?

**Exposure**
people, property, infrastructure at risk to volcanic phenomena including aviation

**Volcanic Threat**
qualitative risk of a volcano to people, property and national airspace

**Volcanic Hazards**
dangerous natural phenomena produced by a volcano

## The Volcanic Threat Assessment scores U.S. volcanoes and assigns threat levels

| 21 | 34 | 49 | 39 | 18 |
|---|---|---|---|---|
| Very Low | Low | Moderate | High | Very High |

## USGS monitors volcanoes and provides timely warnings of volcanic activity in the U.S.

| 161 | 5 | 24 | 14 |
|---|---|---|---|
| Volcanoes | Observatories | Hazard / Risk Factors | States / Territories |


*Research*


*Monitoring*


*Hazard Assessment*


*Community Preparedness*

## Volcanoes
*by location*


U.S. Department of the Interior
U.S. Geological Survey
Volcano Hazards Program

2018 Update to the U.S. Geological Survey National Volcanic Threat Assessment is available at pubs.er.usgs.gov/publication/sir20185140

# Does Colorado have any active volcanoes?

The small Dotsero maar in NW Colorado, 2 km NE of the small town Dotsero, near the junction of the Colorado and Eagle Rivers west of the Gore Range, is the only volcano in Colorado that has had activity in the past 10,000 years.

# What is volcanology?

**Volcanology** is a branch of geology that deals with *volcanism* (the study of volcanoes). Scientists that study volcanology are called ***volcanologists***.

# Volcanology

- What contributed to the large numbers of dead at Pompeii?
- What have scientists learned about volcanoes that might have helped the citizens of Pompeii?
- Would you choose to live near an active volcano? Why or why not?