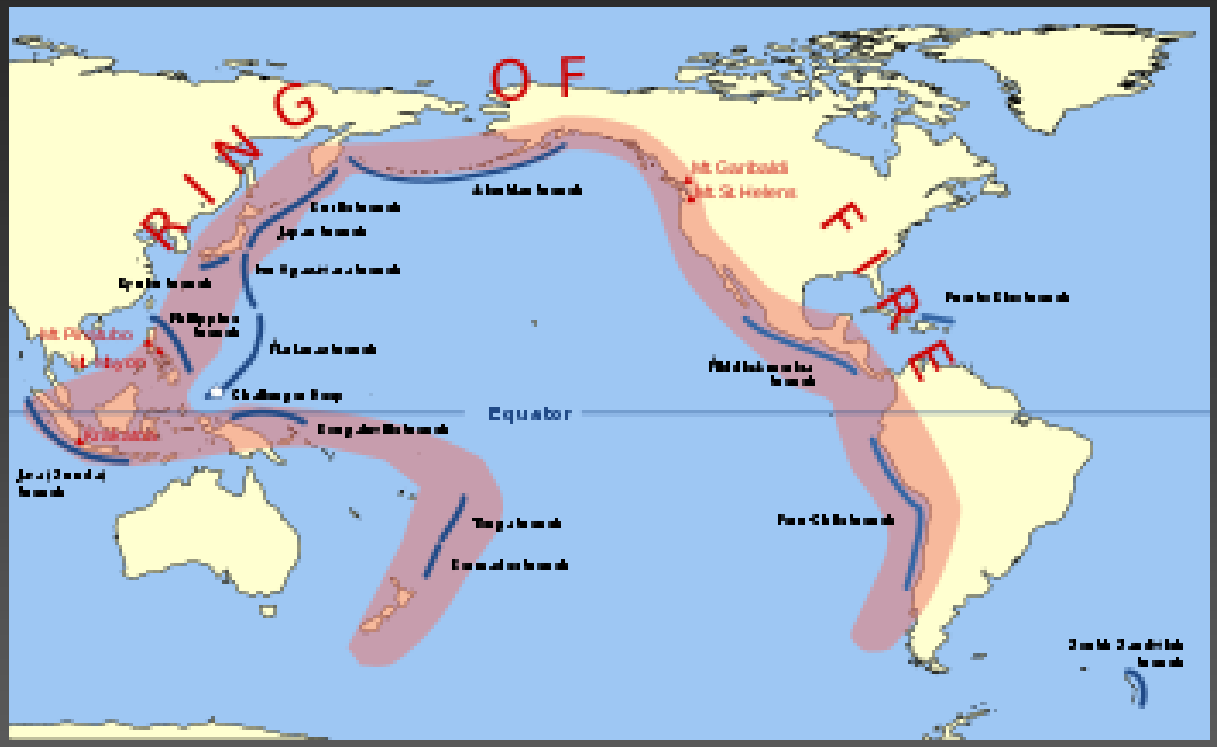
Lesson 1 - Mountain Ranges and Systems

- Earth's two major mountain belts are the circum-Pacific belt and the Eurasian-Melanesian belt.

Where are the Mountain Belts



- The circum-Pacific belt forms a ring around the Pacific Ocean (a.k.a. – Ring of Fire) and includes:

- The Andes (South America)

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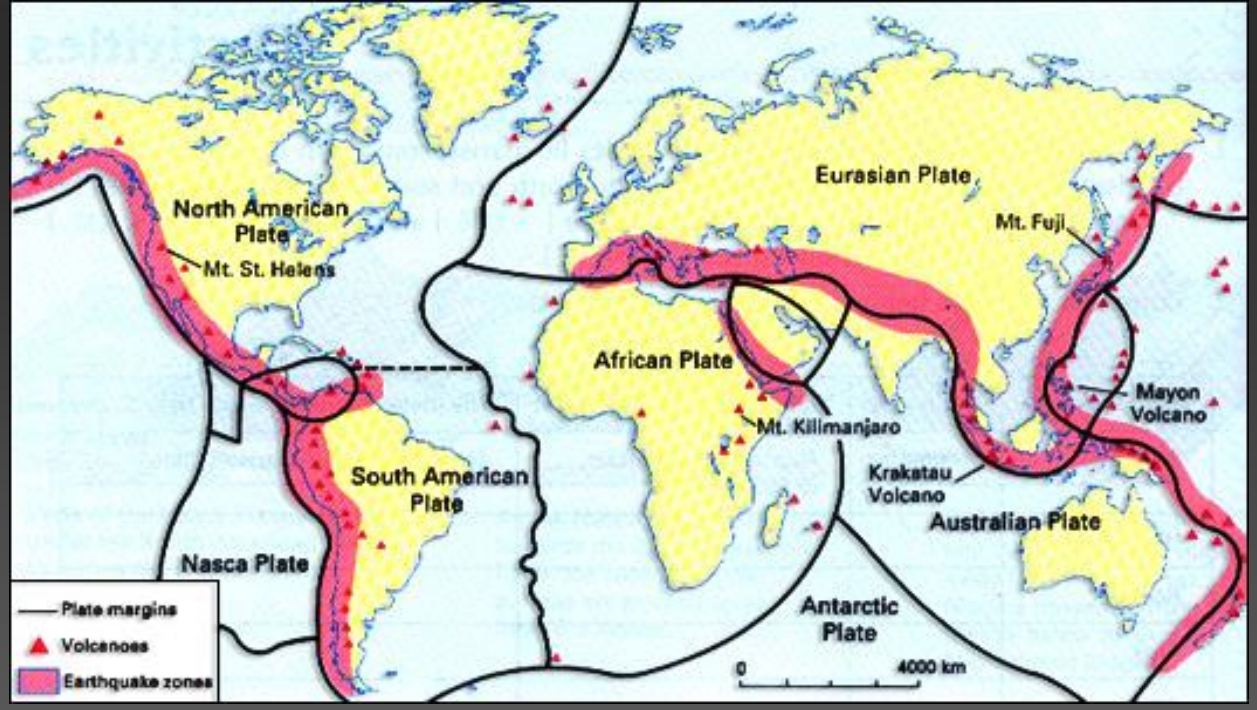
Where are the Mountain Belts



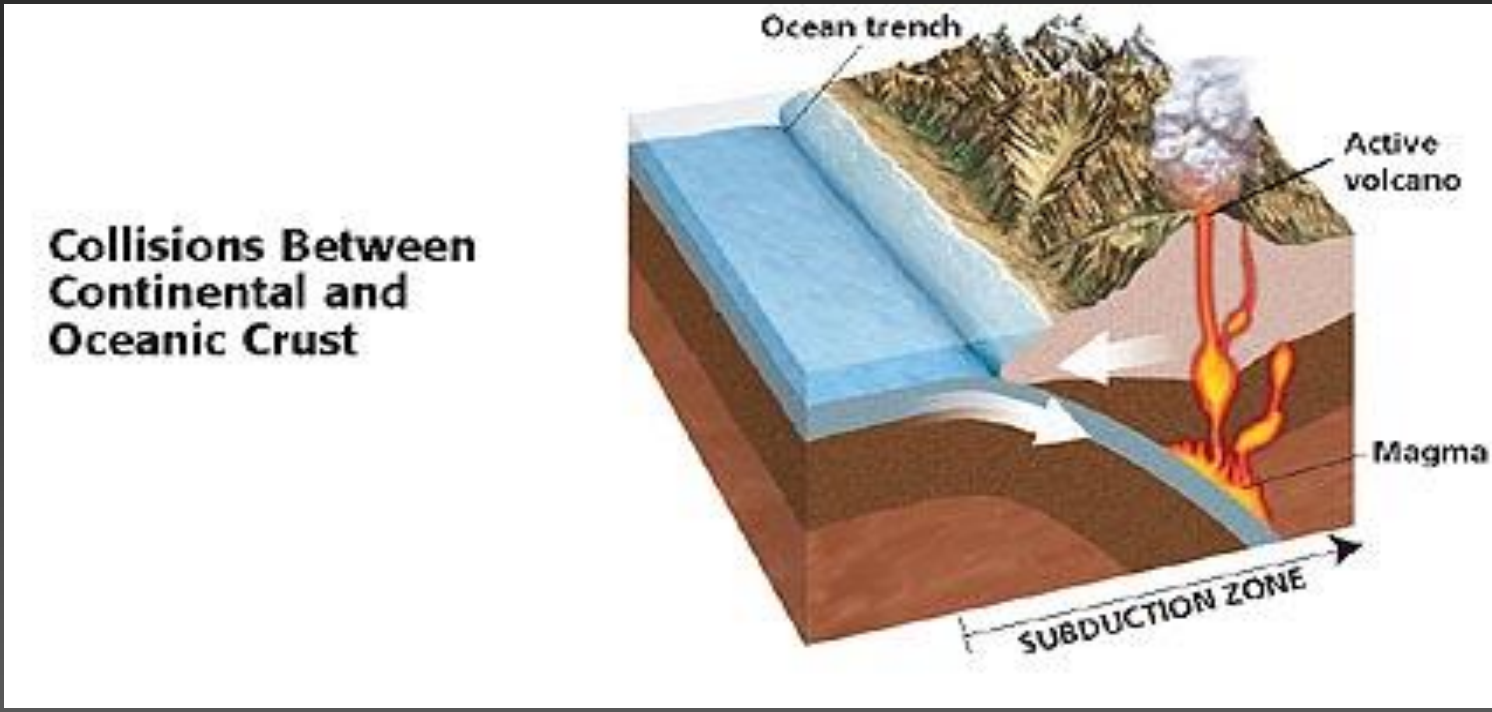
- The Eurasian-Melanesian belt runs from the Pacific islands through Asia and southern Europe and into northwestern Africa and includes:
- The Alps of Europe
- The Himalaya's of Asia

- Mt Baldy 10,000. Mt. Whitney 15,000, Mt. Everest 26,000

- Mountains form as a result of collisions between tectonic plates at convergent boundaries.
- There are 3 types of boundaries in which these collisions happen and unique characteristics that go with each:

Plate Tectonics and Mountains

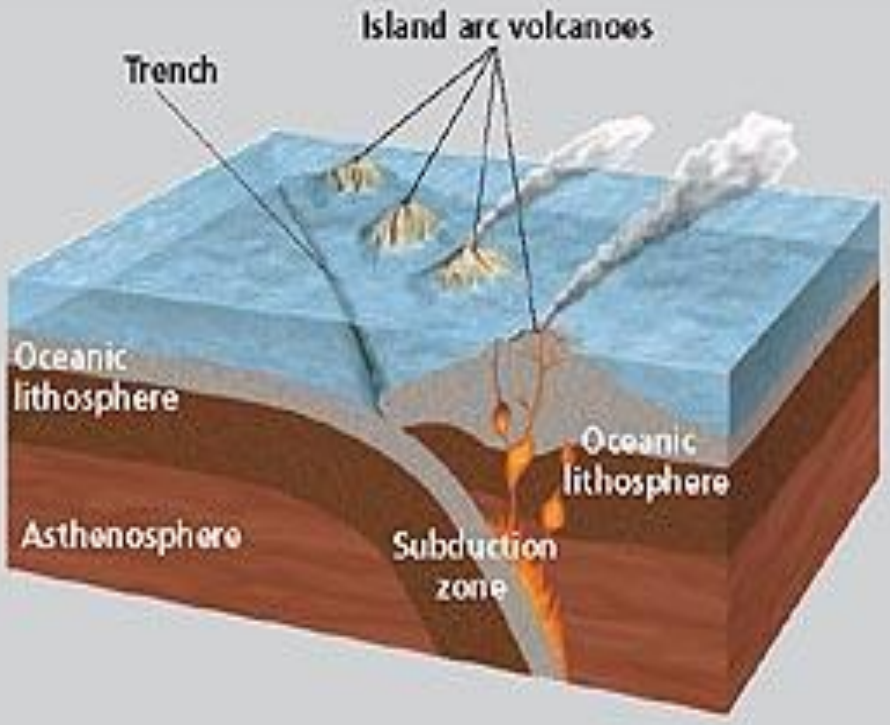
Plate Tectonics and Mountains



- (1) Collisions between continents and oceanic crust

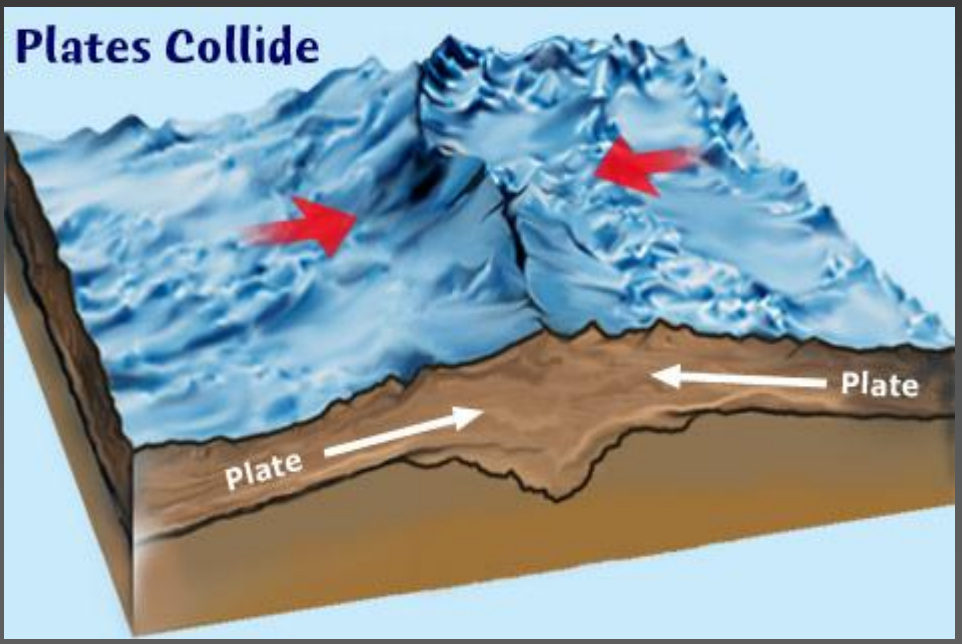
Plate Tectonics and Mountains

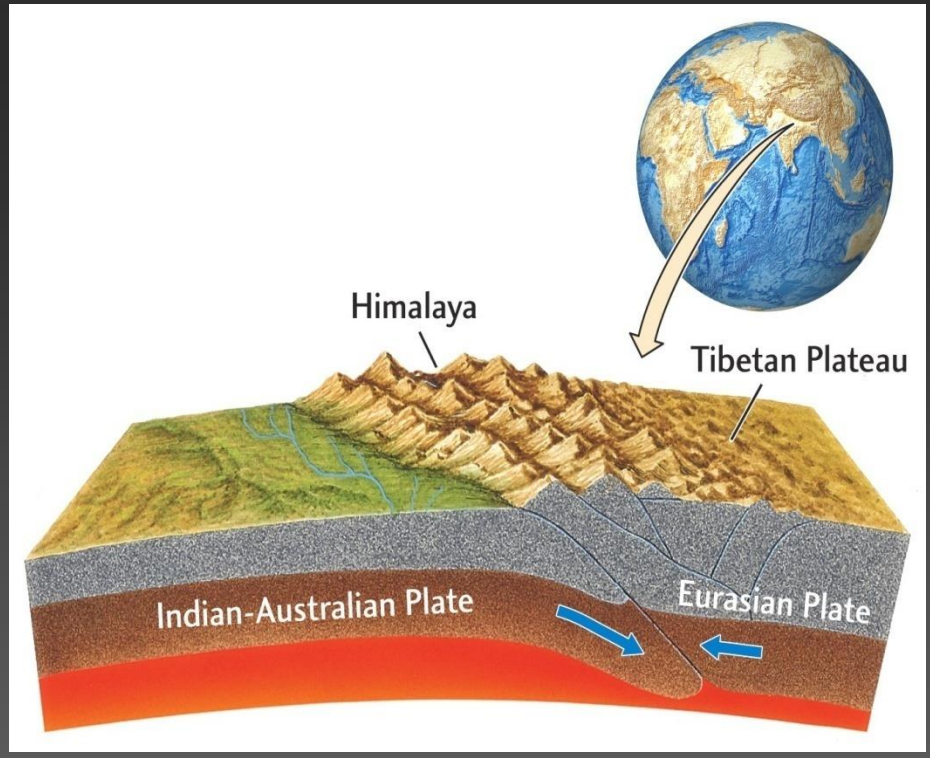
Collisions Between Oceanic Crust and Oceanic Crust



(2) Collisions between oceanic crust

Plate Tectonics and Mountains





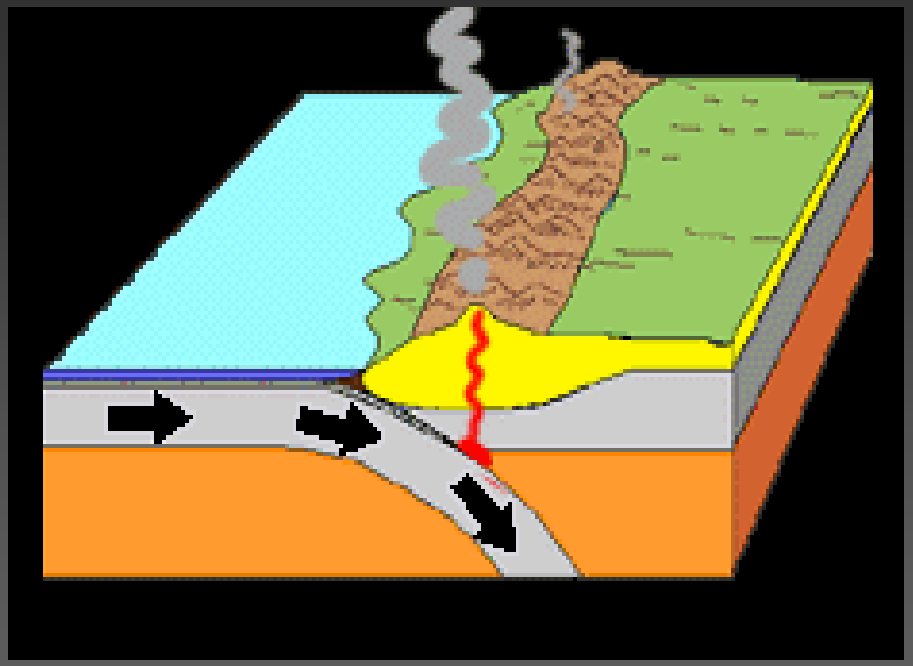
(3) Collisions between continents

- When oceanic lithosphere and continental lithosphere collide at convergent plate boundaries the denser oceanic lithosphere subducts beneath the continental lithosphere.

- This produces large-scale deformation which uplifts high mountains.

1) Collisions between Continental & Oceanic Crust

- Also, the subduction of the oceanic lithosphere causes partial melting of the overlying mantle and crust.



1) Collisions between Continental & Oceanic Crust

- This melting produces volcanic mountains.
- Examples include the Cascades and Andes.

1) Collisions between Continental & Oceanic Crust

- Volcanic mountains commonly form where two plates whose edges consist of oceanic lithosphere collide.

2.) Collisions Between Oceanic Crust & Oceanic Crust

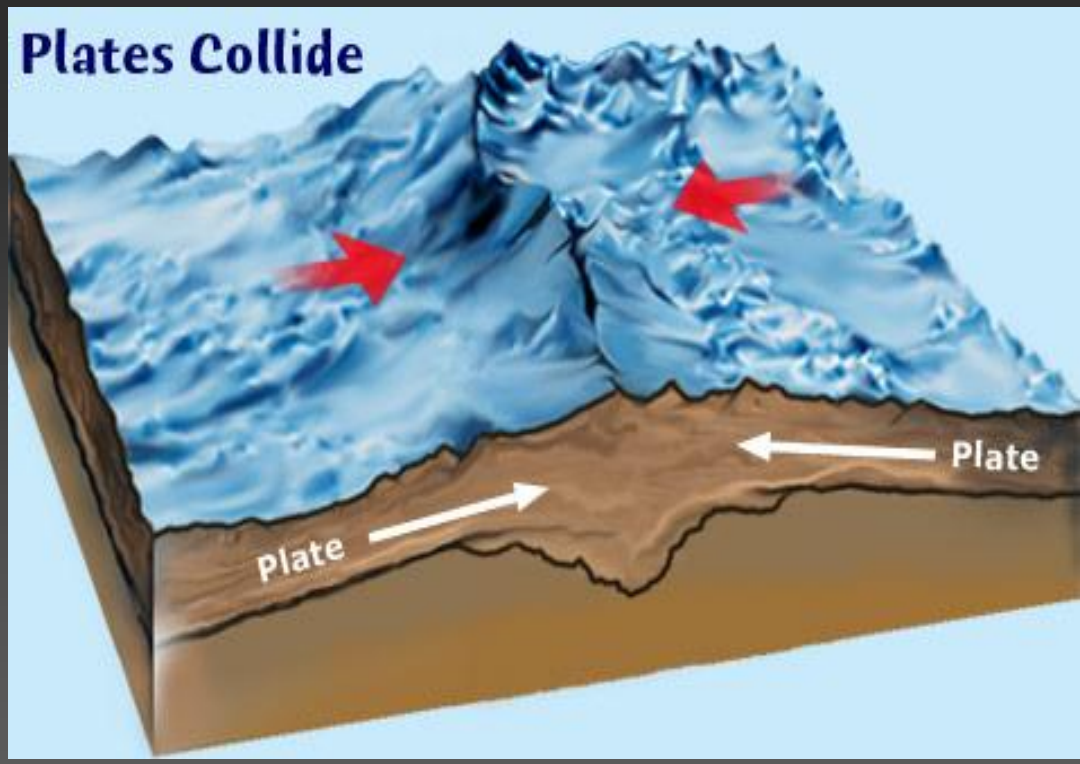
- In this collision, the denser, colder oceanic plate subducts beneath the other oceanic plate.

2.) Collisions Between Oceanic Crust & Oceanic Crust

- Subduction again leads to volcanism and these eruptions of magma form an arc of volcanic mountains.
- Examples include the Philippine Islands Japan, New Zealand and Indonesia.

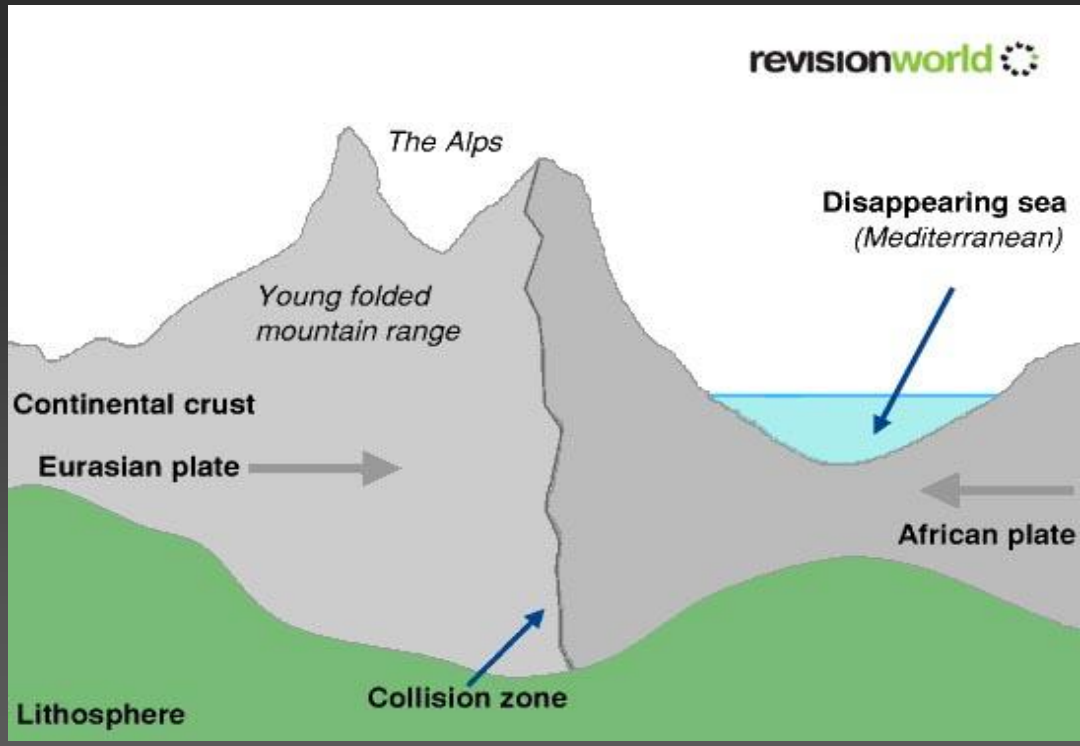
2.) Collisions Between Oceanic Crust & Oceanic Crust

- Mountains can also form when two continents collide.
- When the continental lithosphere of both plates collide, subduction is stopped because both plates have the same densities, the collision continues in a upward motion.



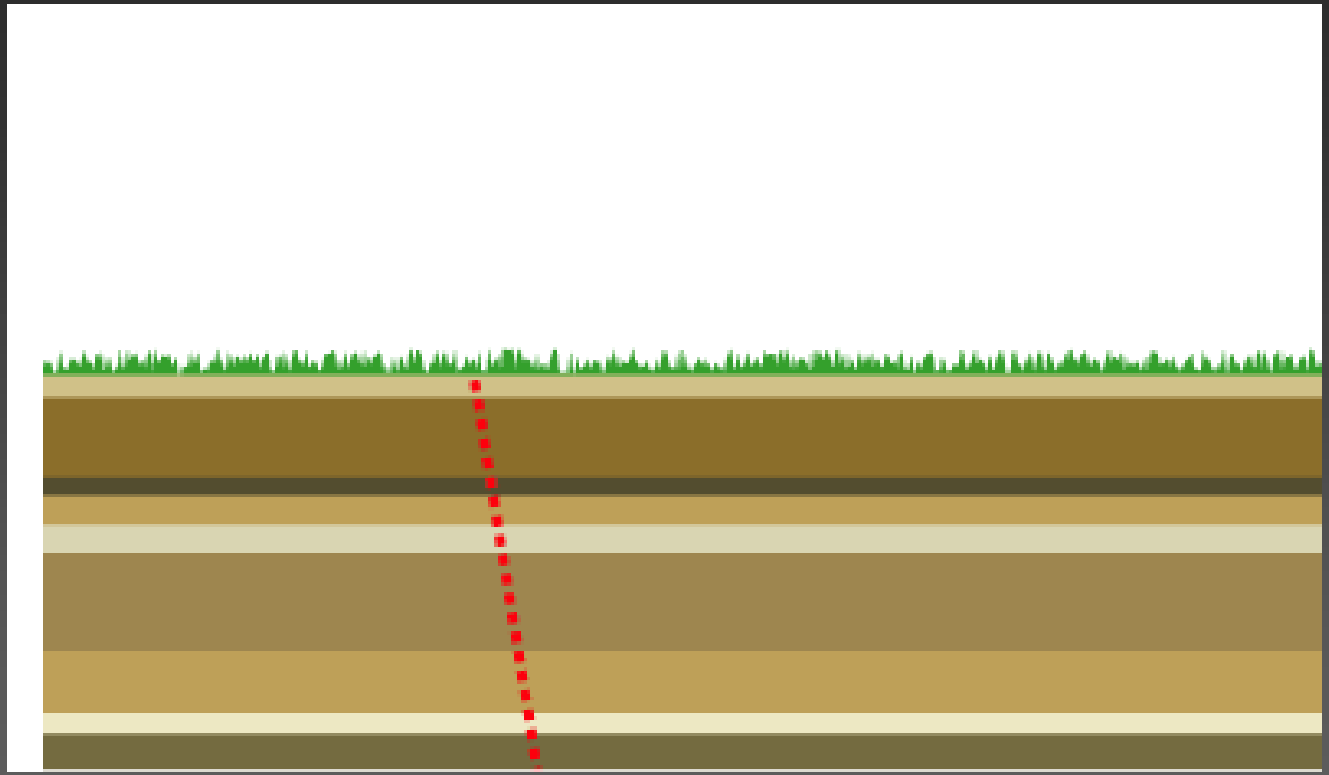
3.) Collisions Between Continents

- An example of this type of collision is the formation of the Alps in Europe and the Himalaya Mountains in Asia.



3.) Collisions Between Continents

Collisions Between Continents



- The intense deformation that resulted from the collision uplifted the Himalaya's, which are growing taller.

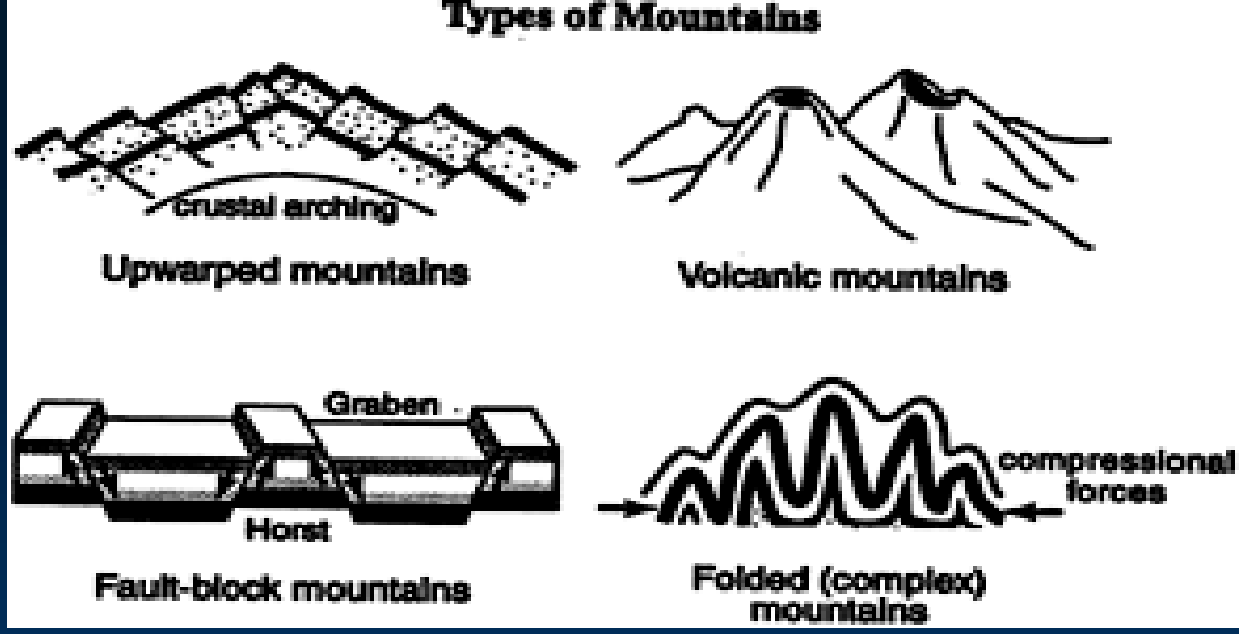
Check for Understanding

- What are the two major mountain belts and what mountains ranges are associated with each?
- How are mountains formed?

How Mountains are Made
Chapter menu
Resources

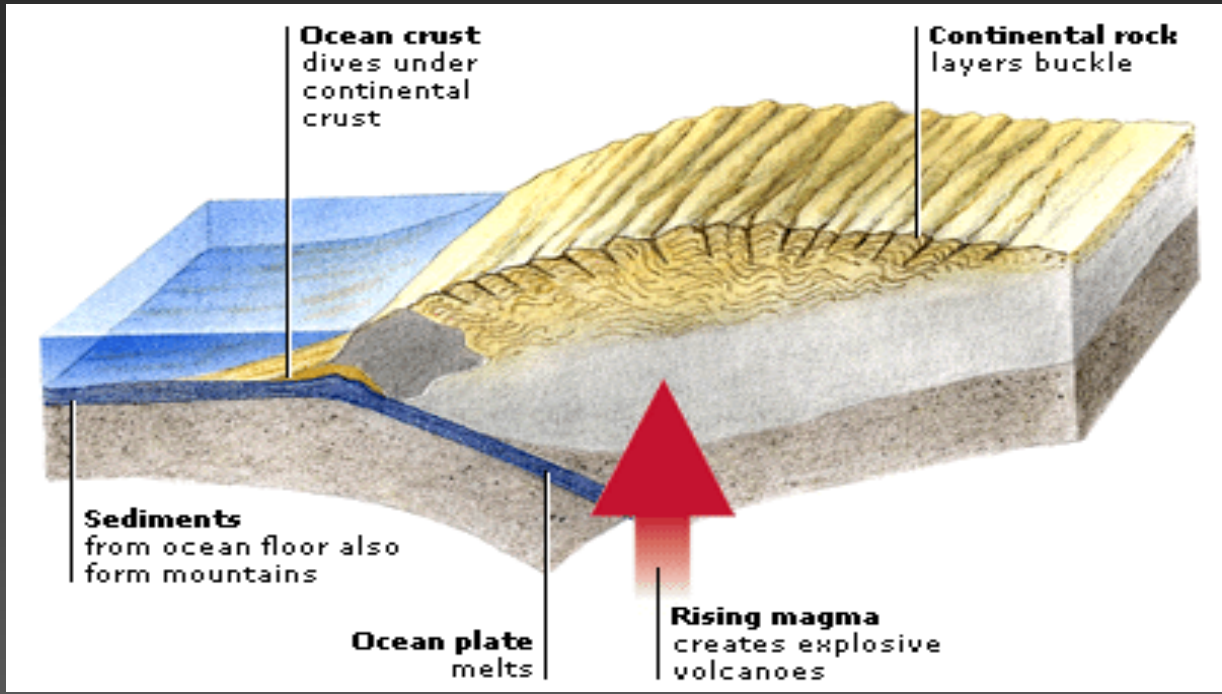
Lesson 2 – Types of Mountains

What is a Mountain?



- Scientists classify mountains according to the way in which the crust was deformed.

Four Types of Mountains

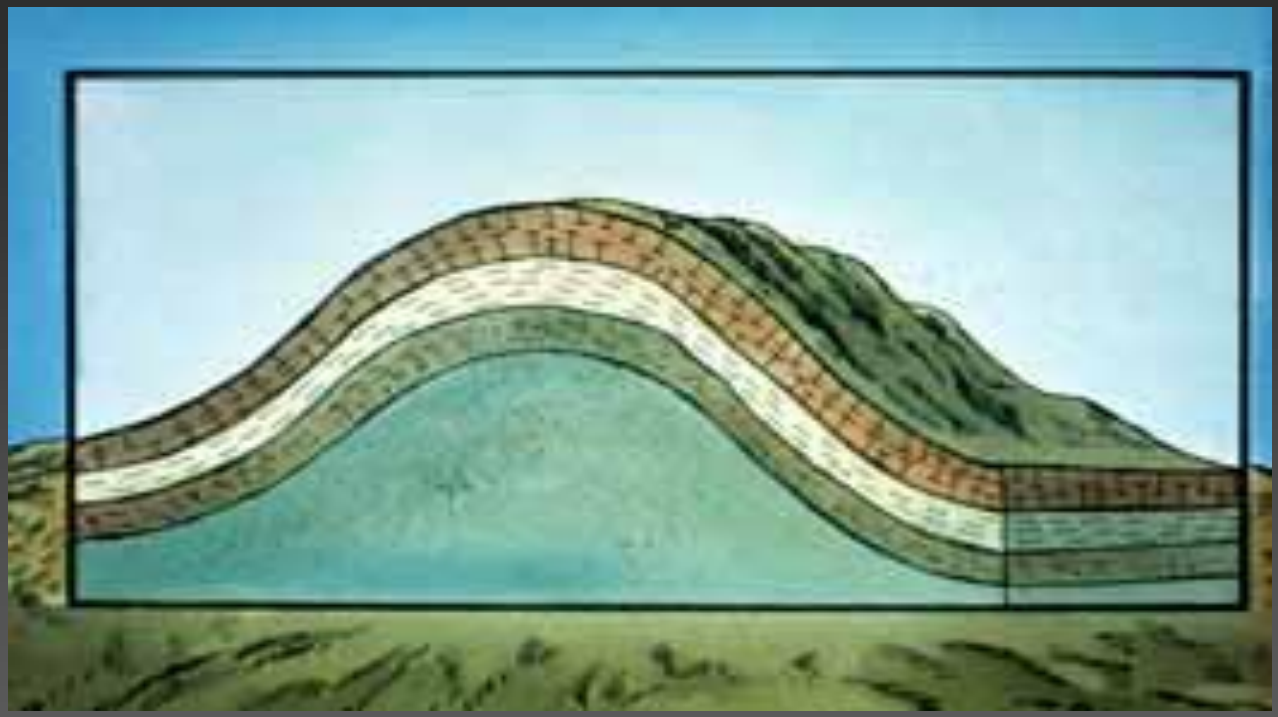


- (1) Folded Mountains

Types of Mountains

- (2) Fault-Block Mountains

Types of Mountains



- (3) Dome Mountains

Chapter menu Resources

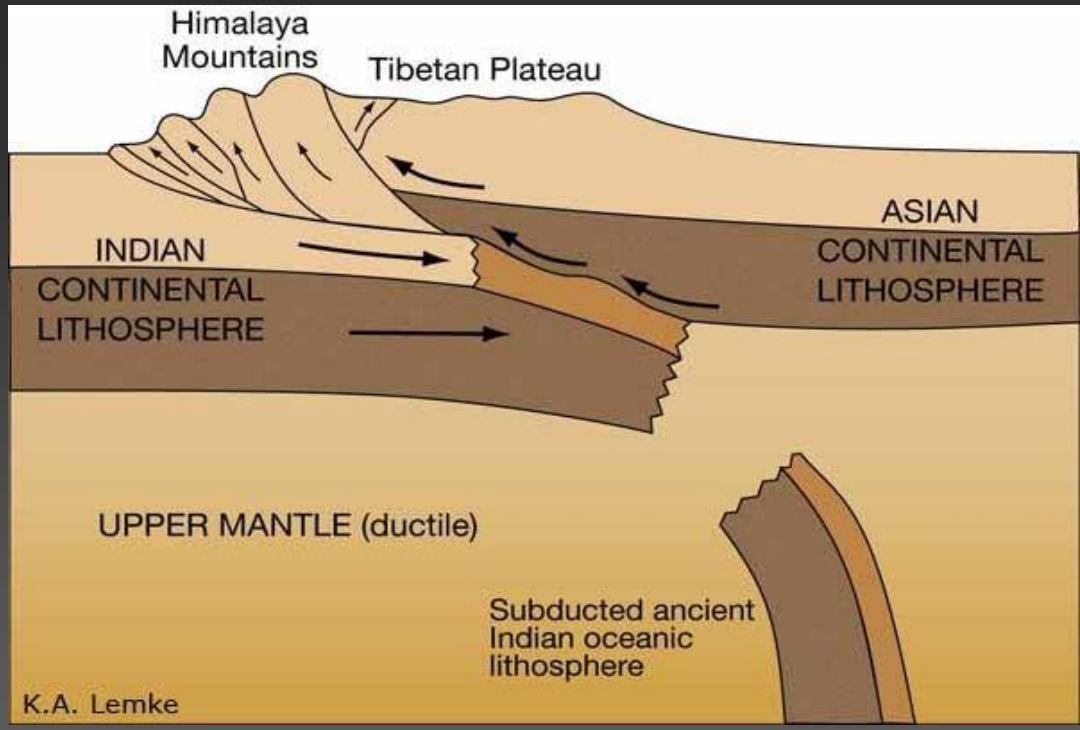
NYIRAGONGO LAVA LAKE

Types of Mountains

- (4) Volcanic Mountains

1. Folded Mountains

- A folded mountain is a mountain that forms when rock layers are squeezed together and uplifted.
- The highest mountain ranges in the world consist of folded mountains that form when continents collide.
- Boundary type: Convergent



- The same stresses that form folded mountains also uplift plateaus.

1. Folded Mountains

- Plateaus are large, flat areas of rock, high above sea level and located near mountain ranges.
- Plateaus can form where large areas of rock are eroded or when a large portion of flat earth is pushed up from the earth.

Plateaus

- A butte (French) is an isolated hill with steep, often vertical sides and a small, relatively flat top; it is smaller than mesas, and plateaus.


Merrick Butte, Arizona

Types of Plateau - Butte

End Of Slide

Chapter menu

Resources

- A mesa (Spanish – table) a flat-topped mountain or hill.

Types of Plateau-Mesa

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Chapter menu

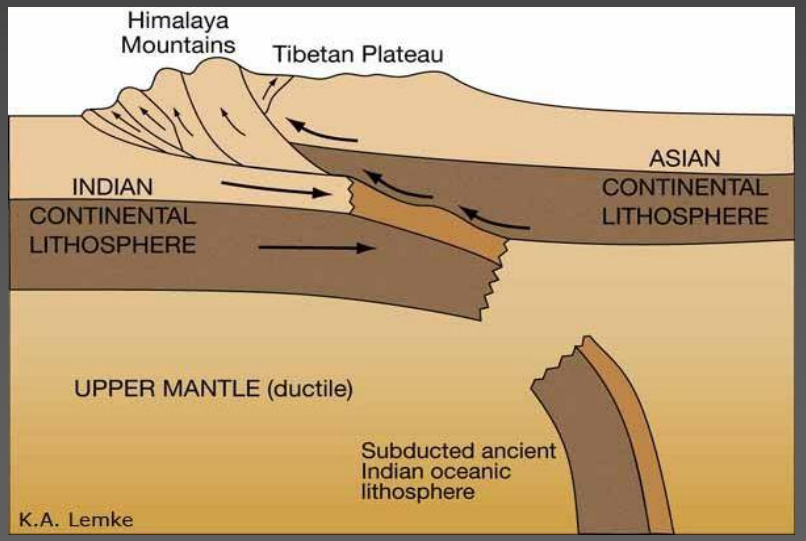
Resources

Check for Understanding

- Describe

the geological characteristics

of a fold mountain.



- At what type of plate boundary does a fold mountain form?

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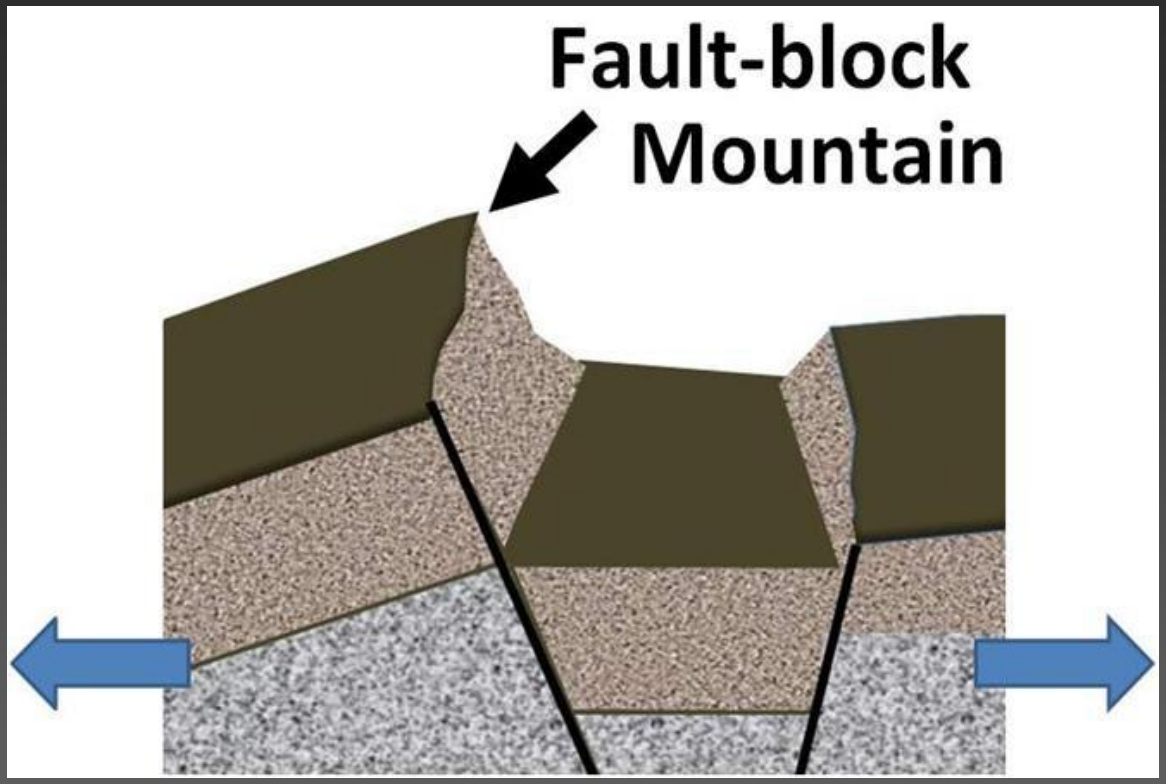
Chapter menu

Resources

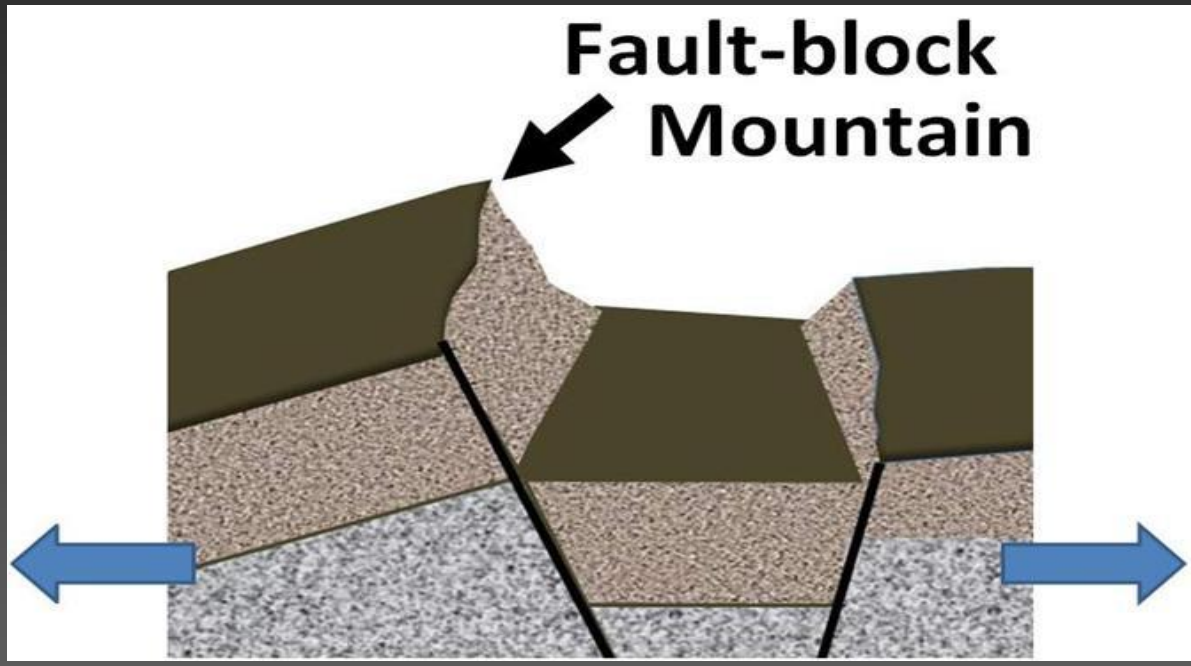
- Fault-block mountains form when enormous underground pressure forces a whole rock mass to break away from another.

- Boundary Type: Transform or Divergent



2. Fault-Block Mountains

- On one side of this break, the rocks rise; on the other side, they sink down.

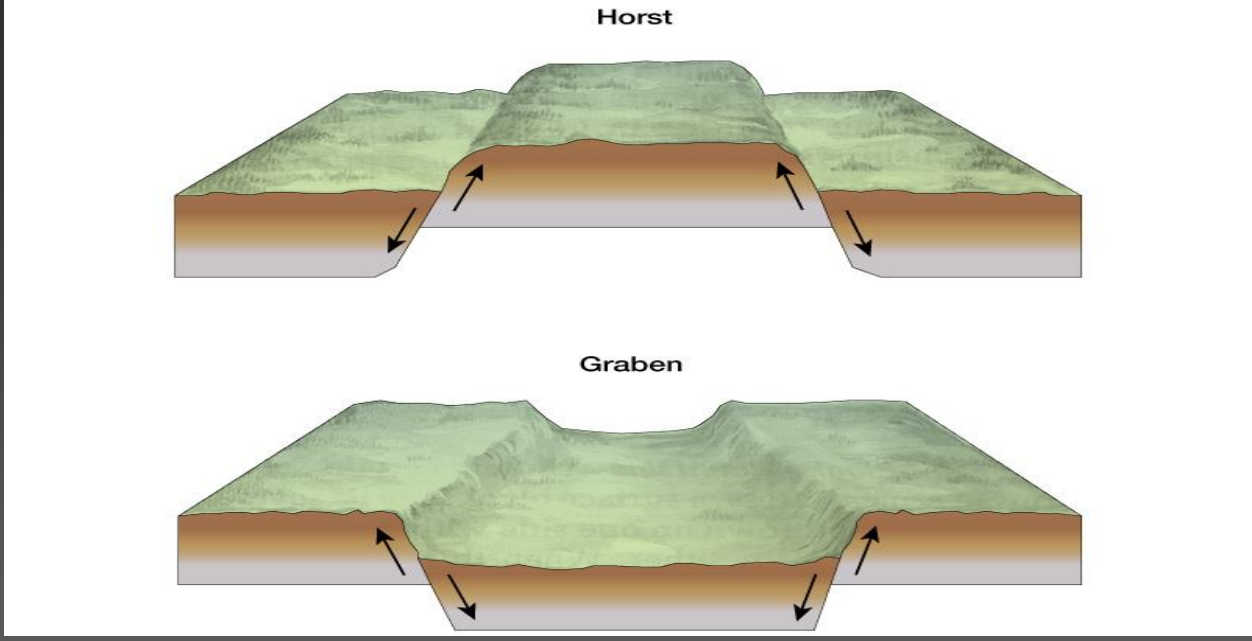


Fault-Block Mountains

- Example: The great rock walls of the Sierra Nevada which are actually the sides of huge tilted fault blocks.

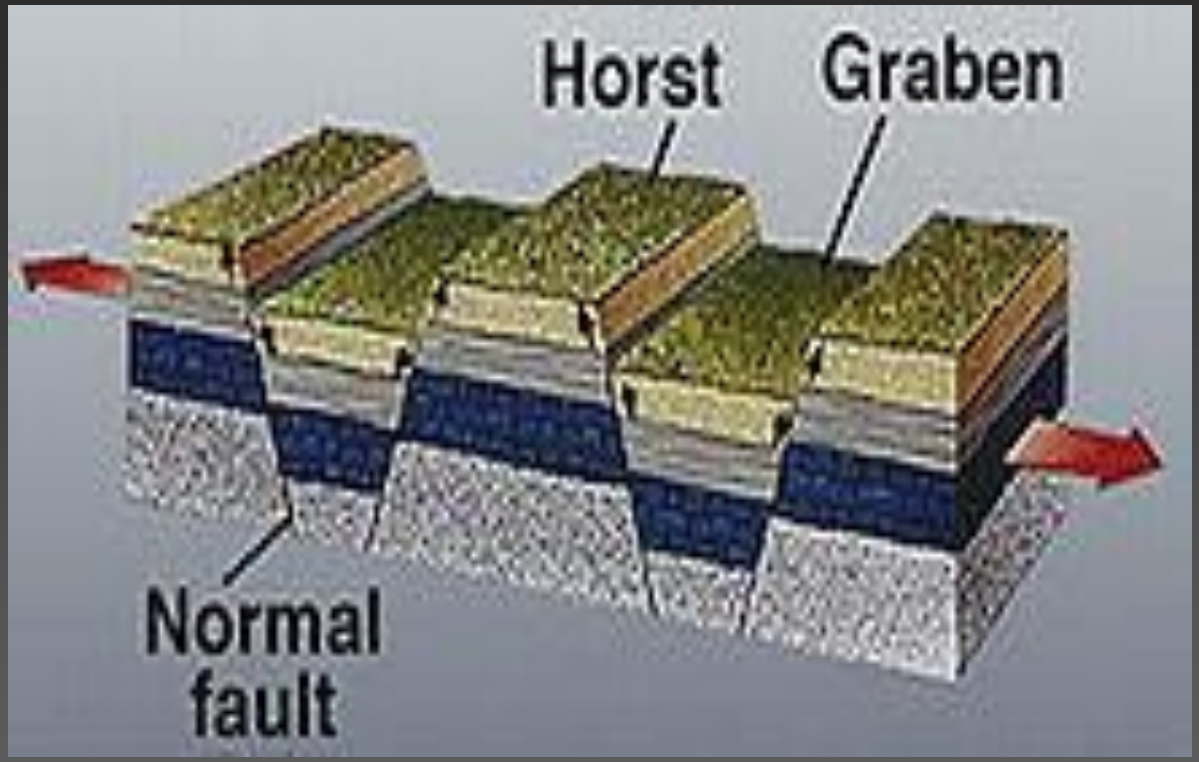
2. Fault-Block Mountains

- The same type of faulting that forms fault-block mountains also forms long, narrow valleys called grabens.



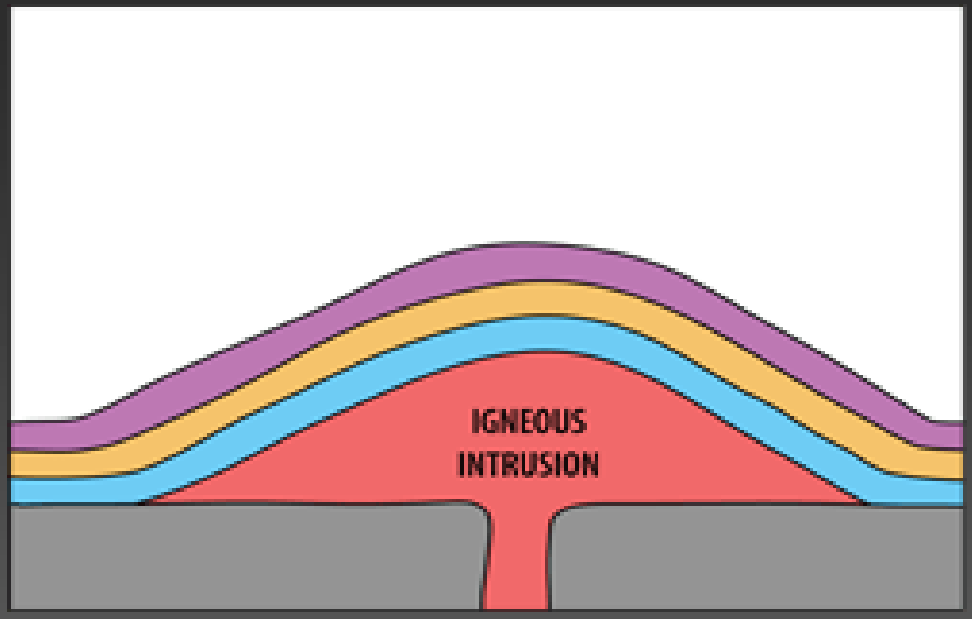
Grabens

- Grabens develop when steep faults break the crust into blocks and one block slips downward relative to the surrounding blocks.



Grabens

- Dome mountains are created when a large amount of magma pushes up from below the Earth's crust, but it never actually reaches the surface and erupts.
- The pushed up rock (now metamorphic) cools and hardens into a dome shape.



3. Dome Mountains

- Since the dome is higher than its surroundings, erosion works from the top creating a circular mountain range.
- Example of this is the Adirondack Mountains in N.Y.

3. Dome Mountains

3. Dome Mountains

- Another example is Half-Dome in Yosemite.

4. Volcanic Mountains

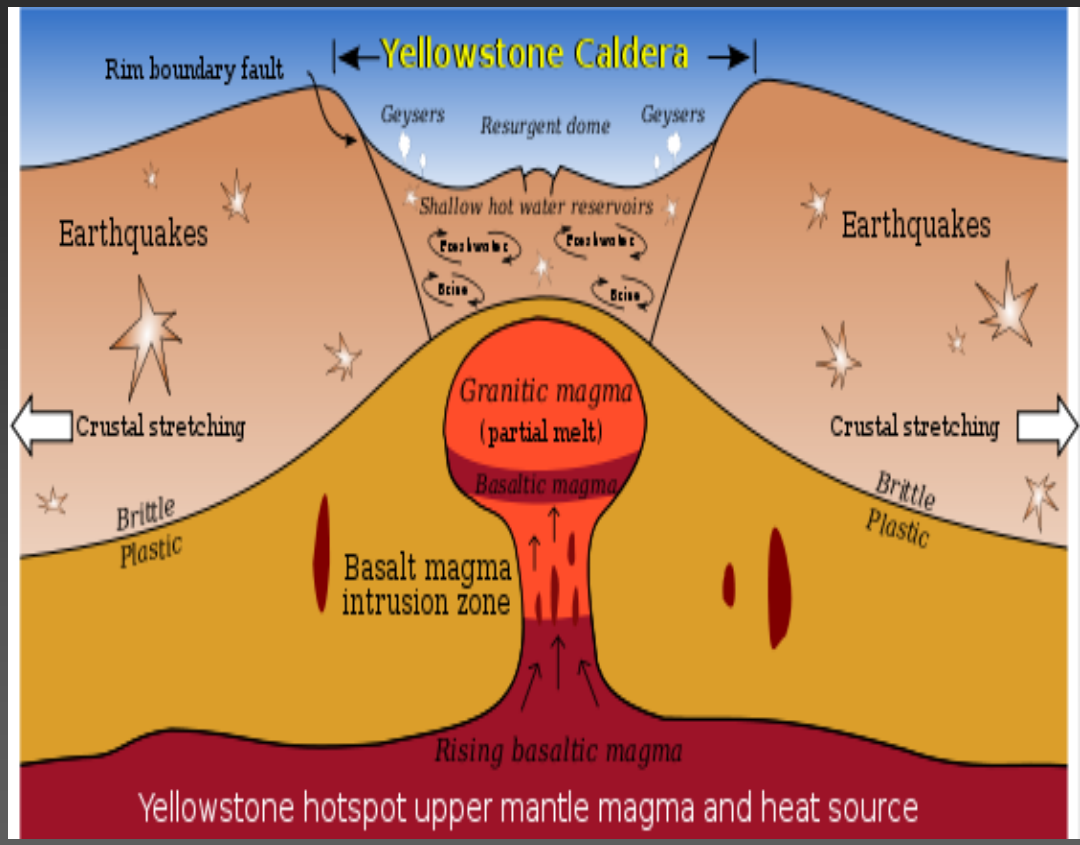
- Volcanic mountains are created when magma from beneath the Earth makes its way to the surface.
- When it does get to the surface, the magma erupts as lava, ash, rock and volcanic gases.

Krakatoa, Indonesia

- This material builds up around the volcanic vent, building up a mountain over time.

4. Volcanic Mountains

- The word comes from Spanish *caldera*, meaning "cooking pot."
- A Caldera is large, circular depression that forms when the magma chamber below a volcano partially empties and causes the ground above to sink



Calderas - demo

Calderas

- Eruptions that discharge large amounts of magma can also cause a caldera to form.
- Calderas may later fill with water to form lakes.

- “Lahar" is an Indonesian word that describes volcanic mudflows or debris flows.
- Lahars have the consistency, viscosity and approximately the same density of concrete: fluid when moving, then solid when stopped.

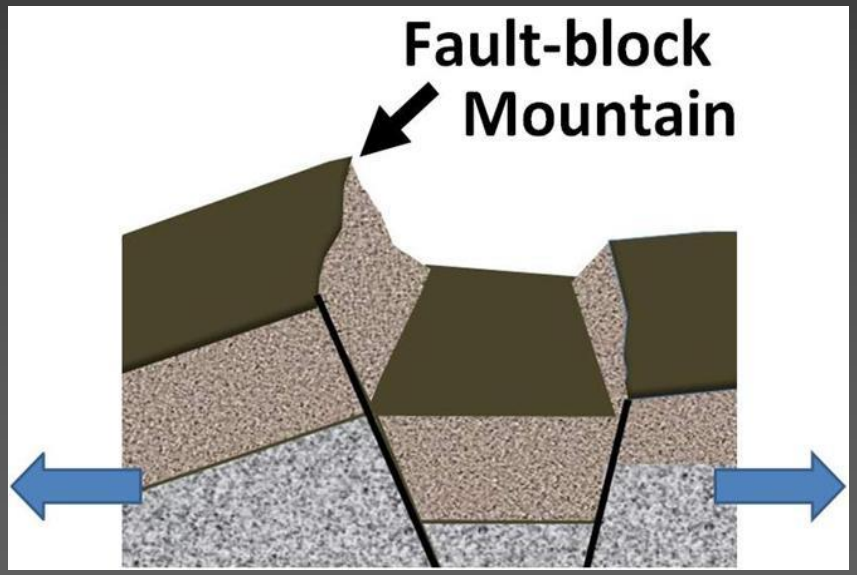
Lahars (Volcanic Ash and Debris Mudflows)

Location of Volcanic Mountains

- Volcanoes can be found at these types of boundaries:
- (1) Convergent subduction plate boundaries (Cascades)
- (2) Divergent plate boundaries (Mid-Atlantic Ridge)
- (3) Hot spots (Hawaii)

Check for Understanding

- What is a fault block mountain and what type of plate boundary are they formed by?
- What is the difference between Horst and Graben?
- Name a region where a fault block mountain is located.



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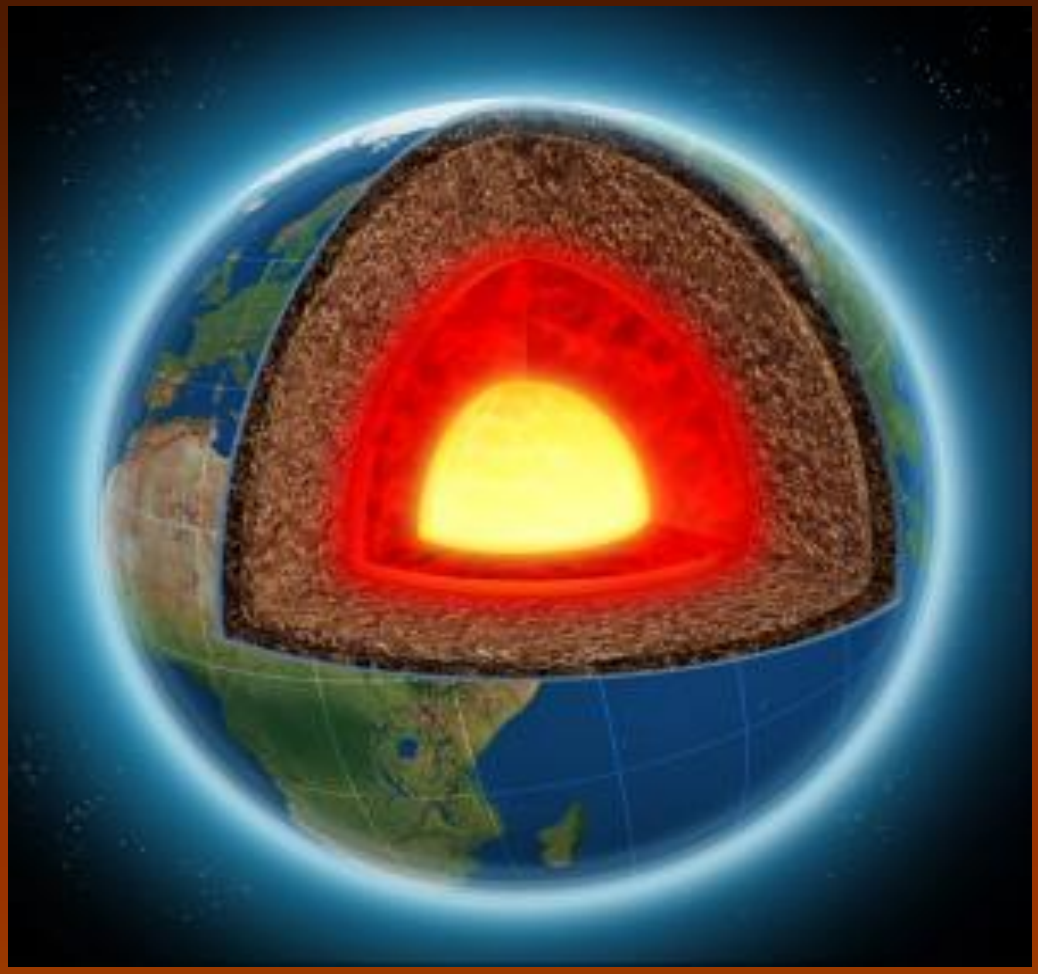
Chapter menu

Resources

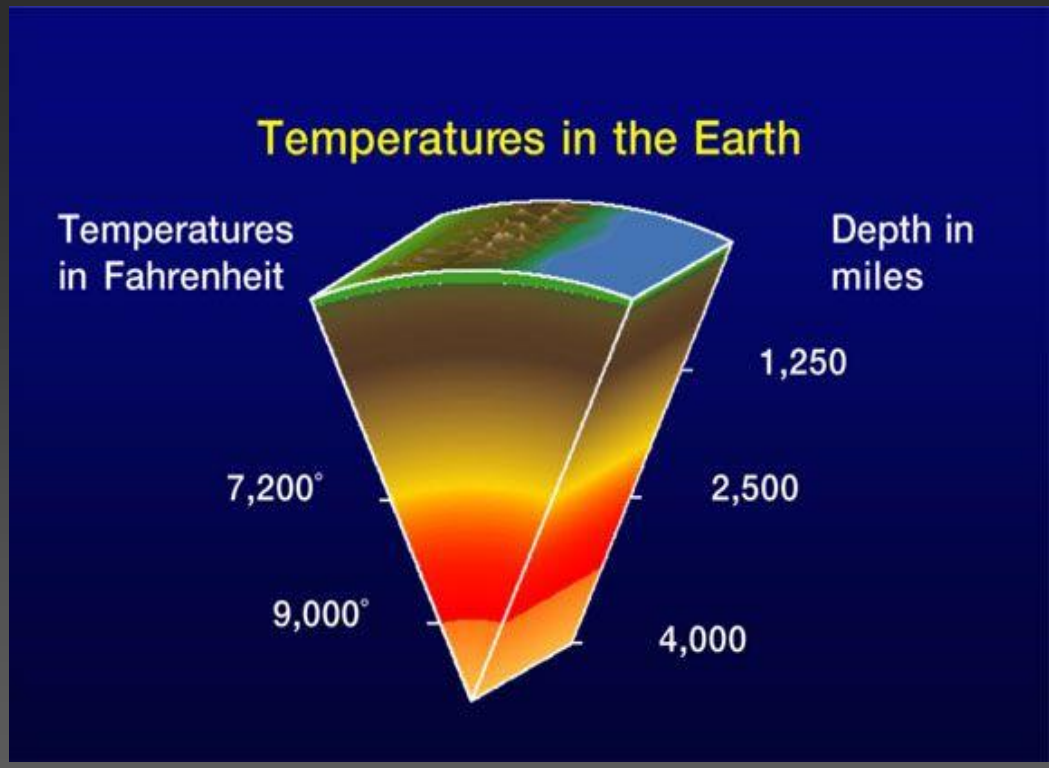
- The cause of many volcanic eruptions is due to the movement of tectonic plates which is driven by Earth's internal heat.



Lesson 3 (Ch13) Volcanoes

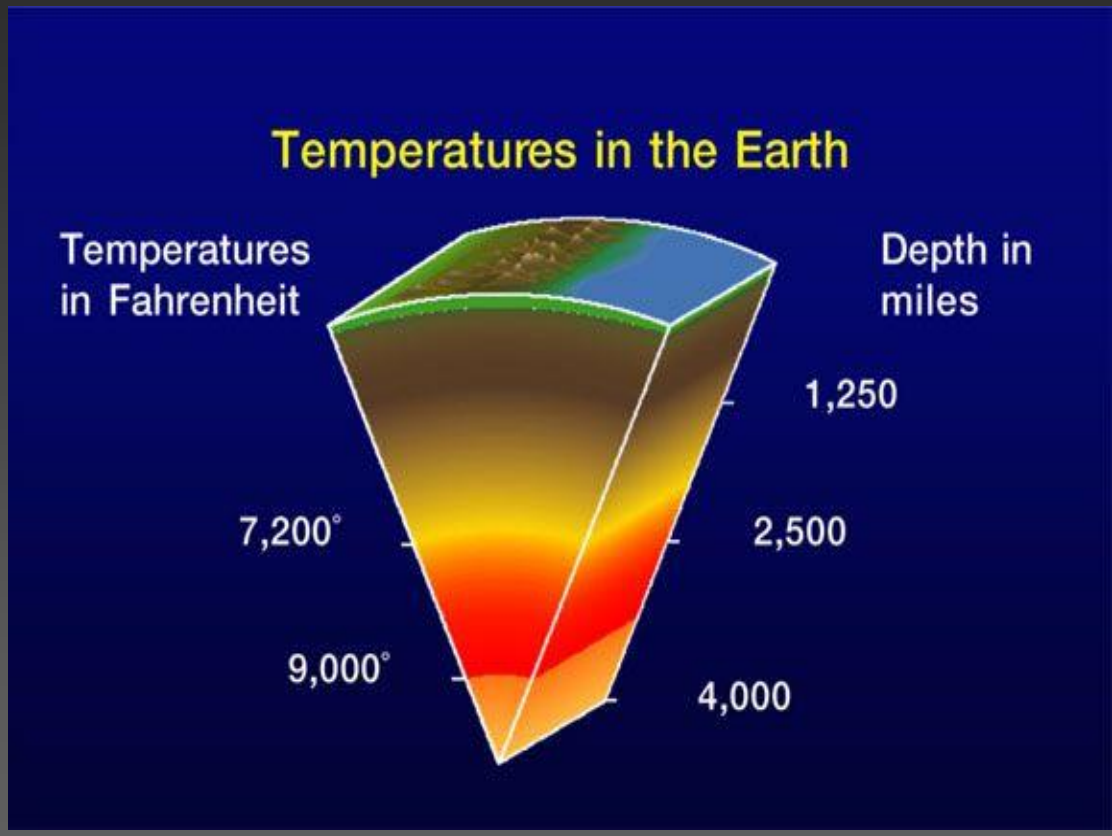
- Pressure and temperature increase as the depth below the earth's surface increases (heat from the core, pressure from overlying rocks, etc.).

- But, because pressure increases along with temperature, the rocks in the mantle remain solid.



Why does Rock Stay Solid

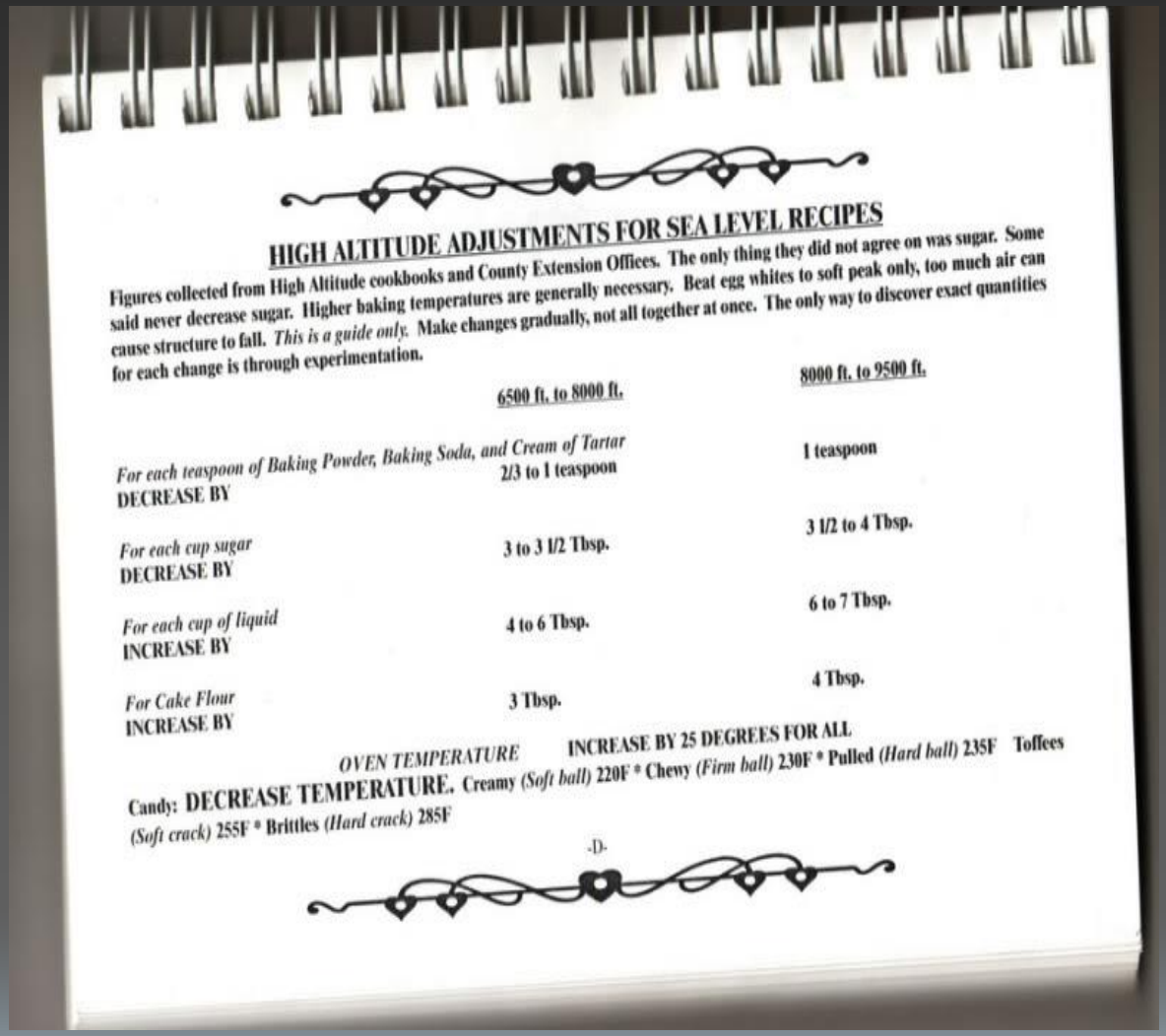
- For example, a rock's melting temperature on the surface might be 1000 ºC, but 200 km below the surface under much higher pressure, the melting temperature of the rock might be 1300 ºC.



Why does Rock Stay Solid

- So if overlying pressure changes then so does the melting point of the rock.
- Take the example of high altitude cooking.

1) Change in Pressure



HIGH ALTITUDE ADJUSTMENTS FOR SEA LEVEL RECIPES

Figures collected from High Altitude cookbooks and County Extension Offices. The only thing they did not agree on was sugar. Some said never decrease sugar. Higher baking temperatures are generally necessary. Beat egg whites to soft peak only, too much air can cause structure to fall. *This is a guide only.* Make changes gradually, not all together at once. The only way to discover exact quantities for each change is through experimentation.

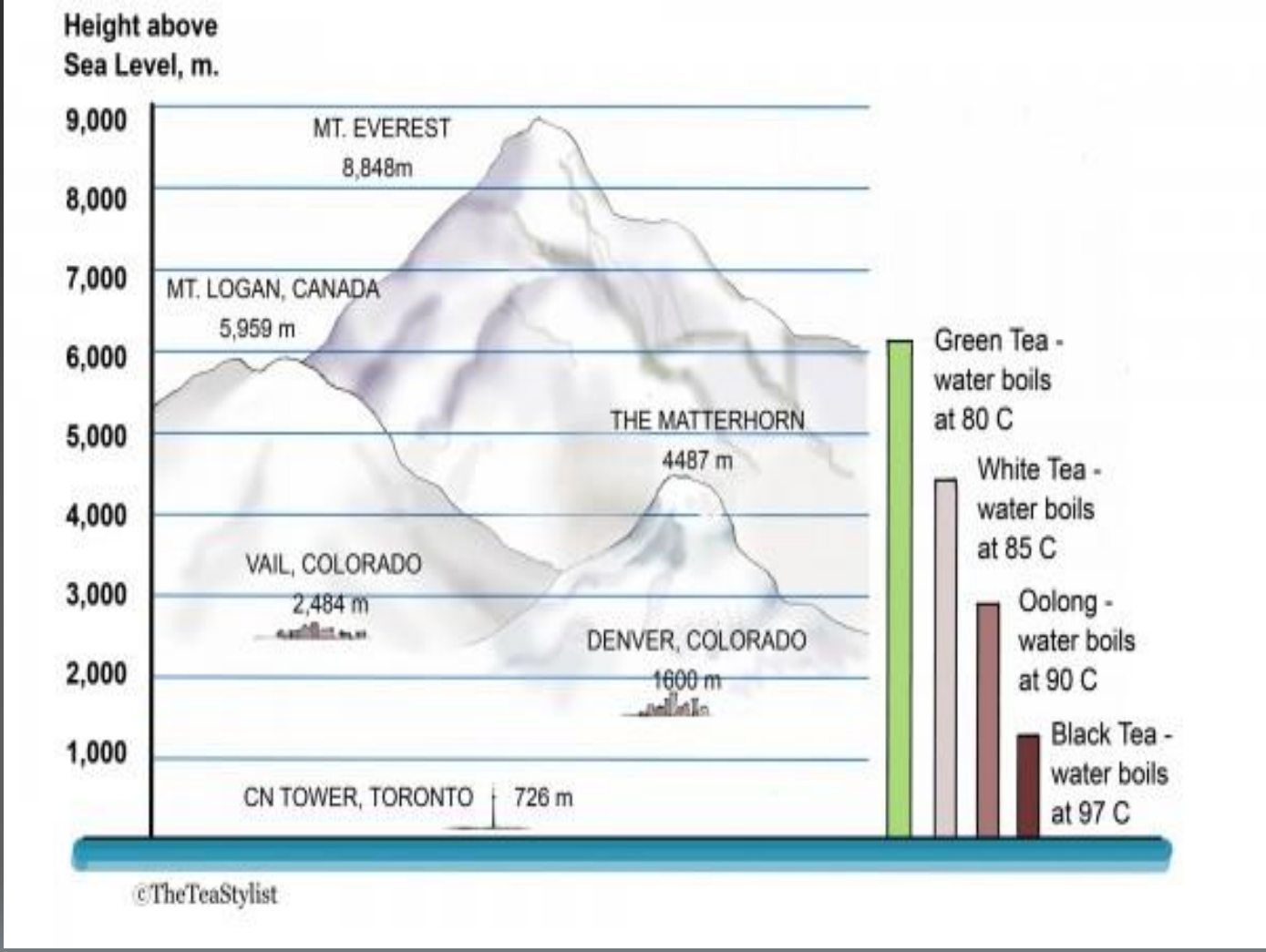
	6500 ft. to 8000 ft.	8000 ft. to 9500 ft.
For each teaspoon of Baking Powder, Baking Soda, and Cream of Tartar DECREASE BY	2/3 to 1 teaspoon	1 teaspoon
For each cup sugar DECREASE BY	3 to 3 1/2 Tbsp.	3 1/2 to 4 Tbsp.
For each cup of liquid INCREASE BY	4 to 6 Tbsp.	6 to 7 Tbsp.
For Cake Flour INCREASE BY	3 Tbsp.	4 Tbsp.

OVEN TEMPERATURE INCREASE BY 25 DEGREES FOR ALL

Candy: DECREASE TEMPERATURE. Creamy *(Soft ball)* 220F * Chewy *(Firm ball)* 230F * Pulled *(Hard ball)* 235F Toffees *(Soft crack)* 255F * Brittles *(Hard crack)* 285F

-D-

- Boiling Tea



1) Change in Pressure

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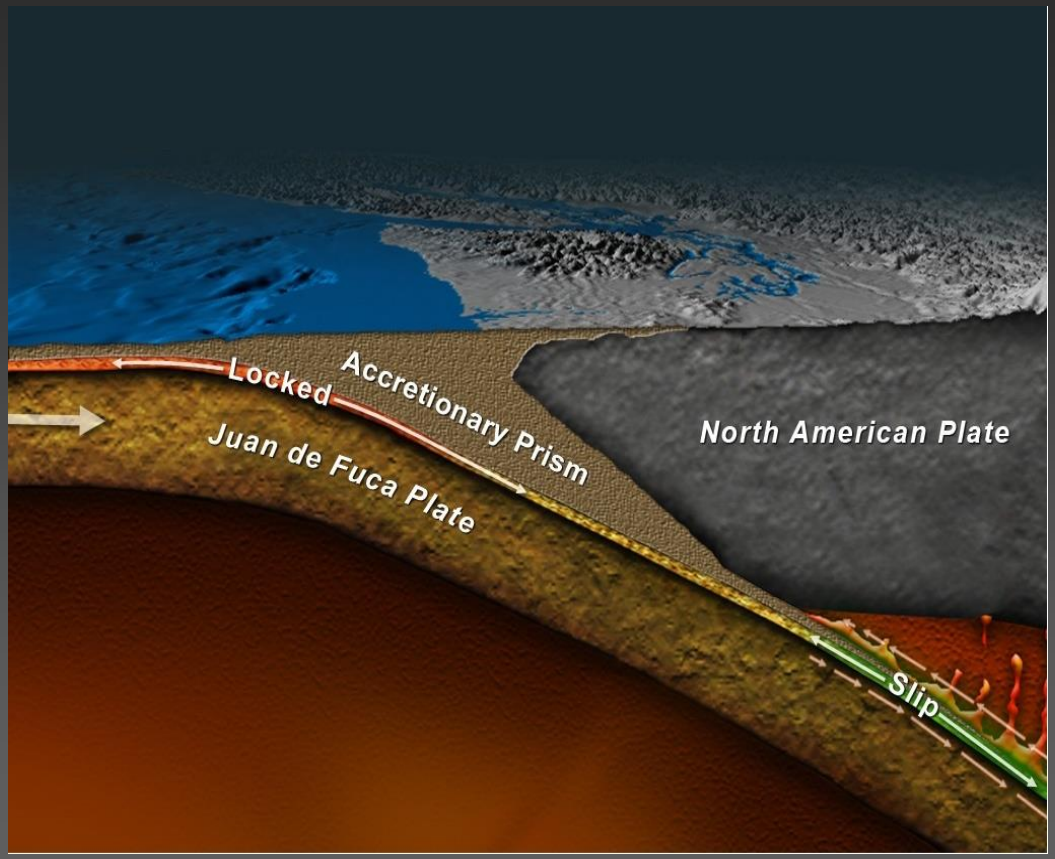
Resources

- The addition of water and volatile contents promote melting by lowering the melting temperature of rocks.

- Thus, a dry rock would have a higher melting point than a rock with water present.



2) Addition of Fluids

- Lastly increasing the temperature of a rock will also cause melting.

3) Increased Temperature

Chapter menu Resources

- Magma is liquid rock produced under earth's surface.
- Because magma is lighter then solid rock it flows upward away from denser rock and when it reaches the surface it is referred to as lava.

Difference between Lava and Magma

- How explosive a volcano is depends on how runny or sticky the magma is.
- The *viscosity*, or resistance to flow, of magma affects the force with which a particular volcano will erupt.

Viscosity

- Because oxygen and silicon are by far the two most abundant elements in magma, it is convenient to describe the different magma types in terms of their silica content (SiO_2).

Types of Magma

- You can think of volcanoes in terms of when we get sick.
- Typically with a cold your nose is runny (mafic).
- However when you have the flu your mucus is thicker (felsic).

Eruptions and the Cold

Gas Factor in Magma

- The amount of dissolved gas in the magma provides the driving force for explosive eruptions.
- The viscosity of the magma, however, is the most important factor in determining whether an eruption will be explosive or non-explosive.

- Mafic magmas, have relatively low silica and high iron (Fe) and magnesium (Mg) contents.
- Mafic volcanoes create a magma that is “Runny like honey”.

Mafic Magma

- Oceanic volcanoes commonly form from mafic based magma.
- Because of mafic magma's low viscosity (thin and runny), magma is hot (above 1700°F) and gases can easily escape from mafic magma.

Quiet Eruptions

- Eruptions from oceanic volcanoes, such as those in Hawaii, are referred to as quiet.

Quiet Eruptions

- Felsic magmas, have relatively high silica and low iron (Fe) and magnesium (Mg) contents.
- Felsic volcanoes create magma that is “Thicky like Skippy”.

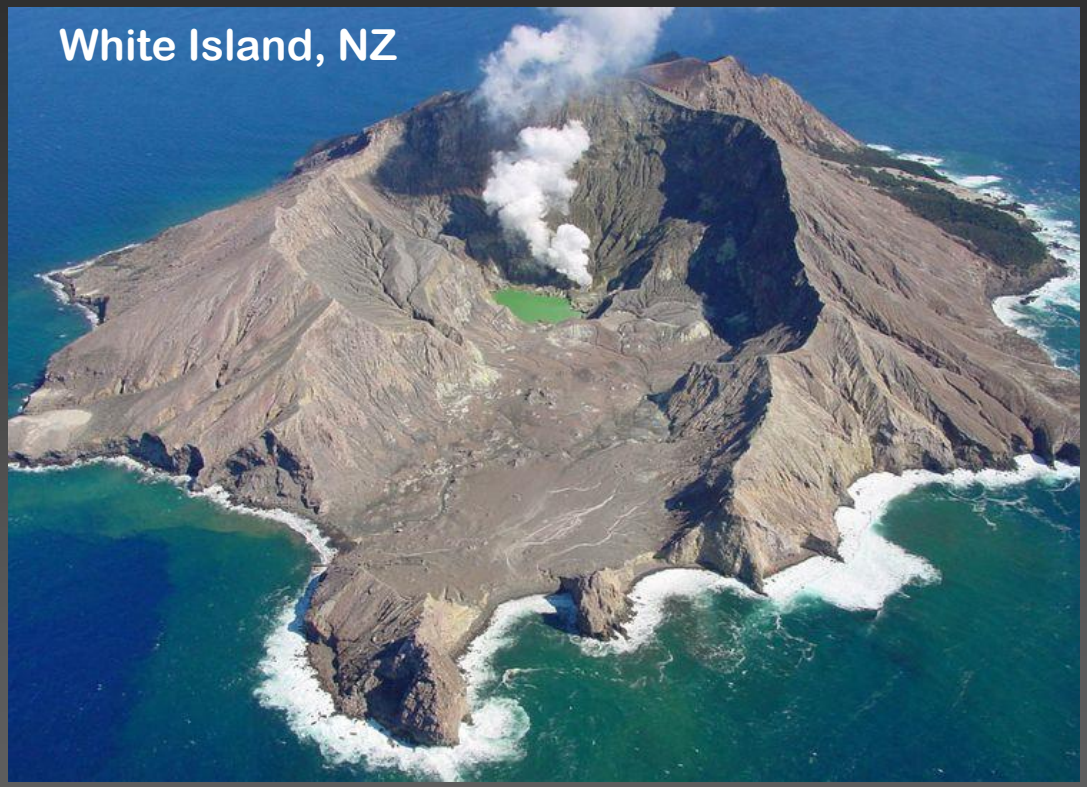
Felsic Magma

- Unlike the fluid lavas produced by oceanic volcanoes, the felsic lavas of continental volcanoes, such as Mount St. Helens, tend to be cooler (1400°F), thicker and stickier.

- If magma is thick and sticky (high viscosity), then gases cannot escape as easily.

Explosive Eruptions

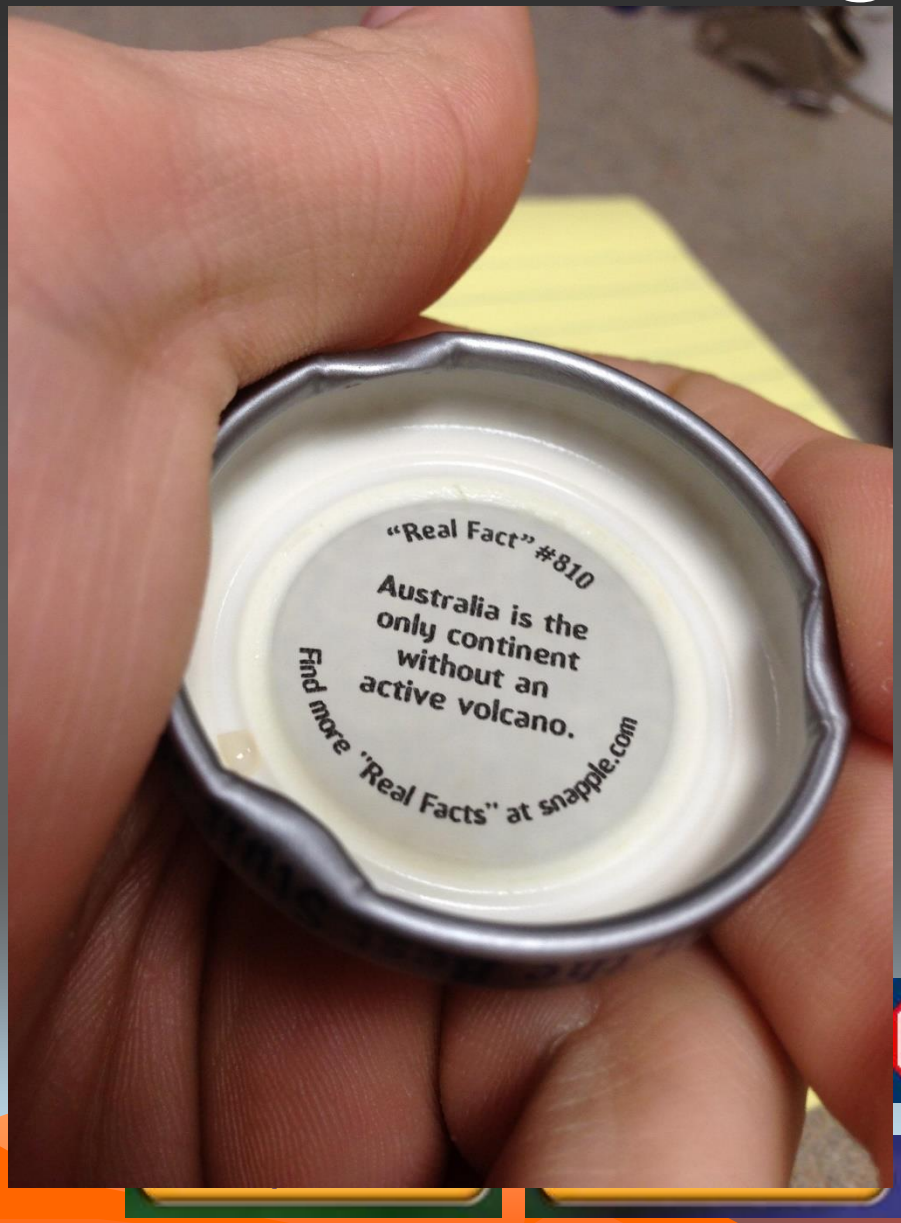
- With felsic based lava pressure builds up until the gases escape violently and explode throwing pyroclastic material into the air.
- Felsic volcanoes are the most dangerous and deadly.



Explosive Eruptions

Check for Understanding

- Explain the difference between mafic and felsic magmas.



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- One of the most important warning signals of volcanic eruptions is an increase in earthquake activity around the volcano.

Predicting Volcanic Eruptions
Warning sign #1 - Earthquakes

- Also the geology may change due to swelling, subsidence and increased gas emissions.

Predicting Volcanic Eruptions
#2 Change in Mtn. Geology

- Predicting the eruption of a particular volcano also requires some knowledge of its previous eruptions.
- Just like the gap theory with earthquakes.

Predicting Volcanic Eruptions
#3 Using past eruptions

- **Mount Rainier**, (14,410 Feet) the highest volcano in the Cascade Range and is potentially the most dangerous volcano.
- Just outside Seattle Washington

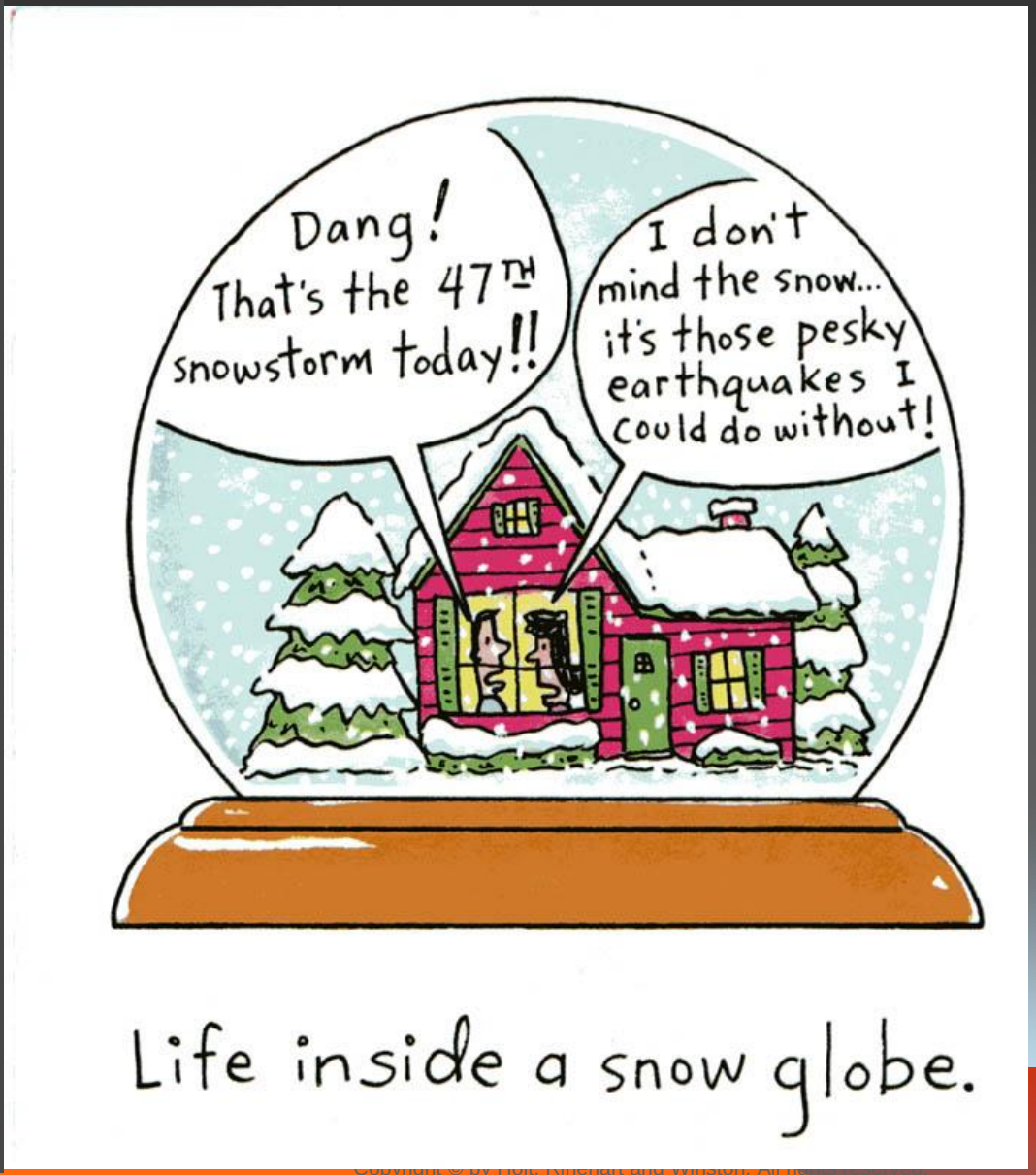
Next United States Volcano is

- Mount Rainier is known to have erupted as recently as in the 1840s, and large eruptions took place as recently as about 1,000 and 2,300 years ago.

Mt. Rainier is considered the next threat in the U.S.

Check for Understanding

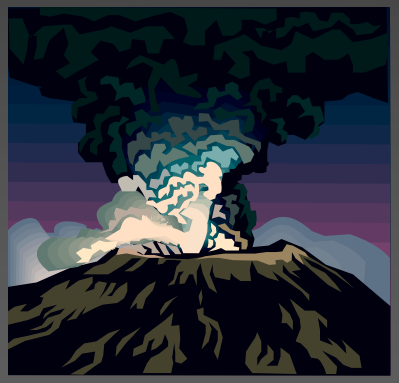
- What are the three precursors to a volcanic eruption?



Highlights

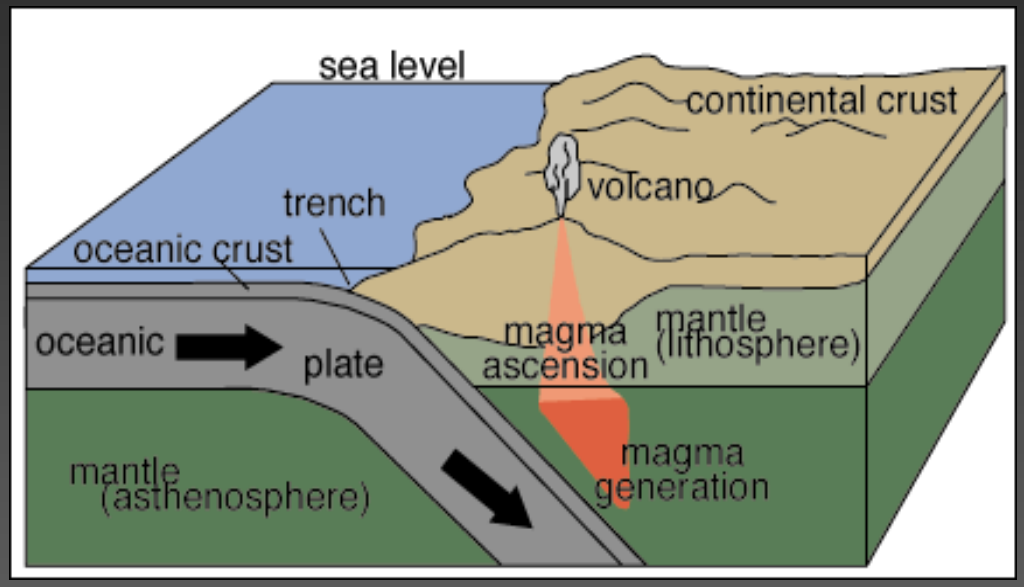
Volcano in Iceland

Krakatoa eruption



Bill Nye Volcanoes

- Like earthquakes, most active volcanoes occur in these 3 major zones:
- 1) Subduction Zones (convergent boundary)
- 2) Mid-Ocean Ridges (divergent boundary)
- 3) Hot Spots



Lesson 4 - Major Volcanic Zones

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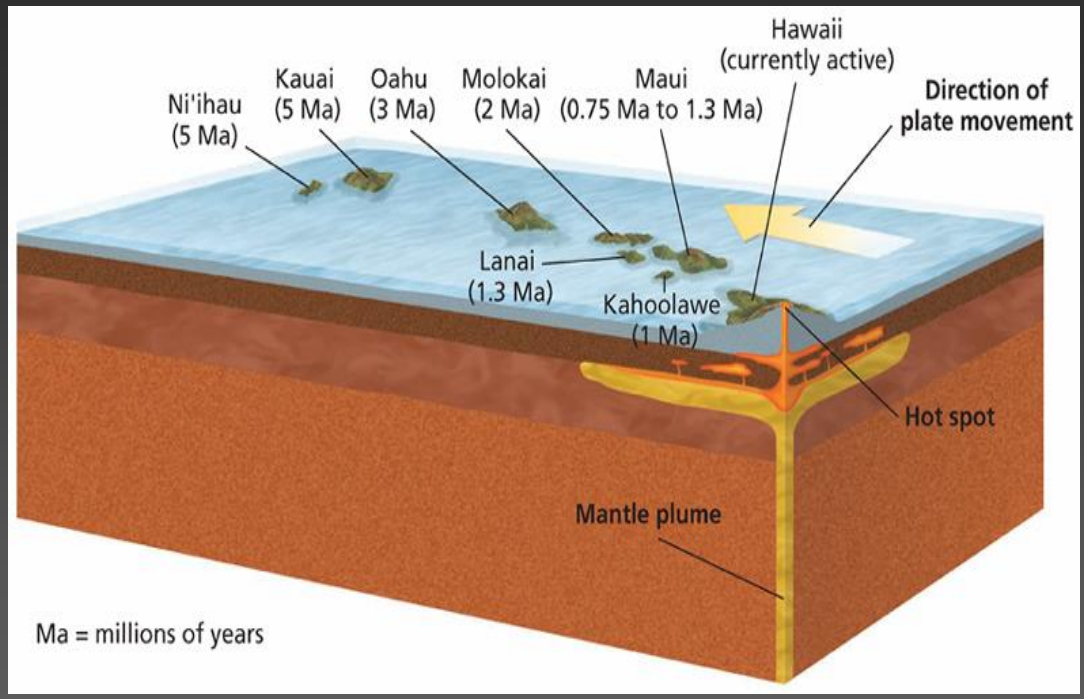
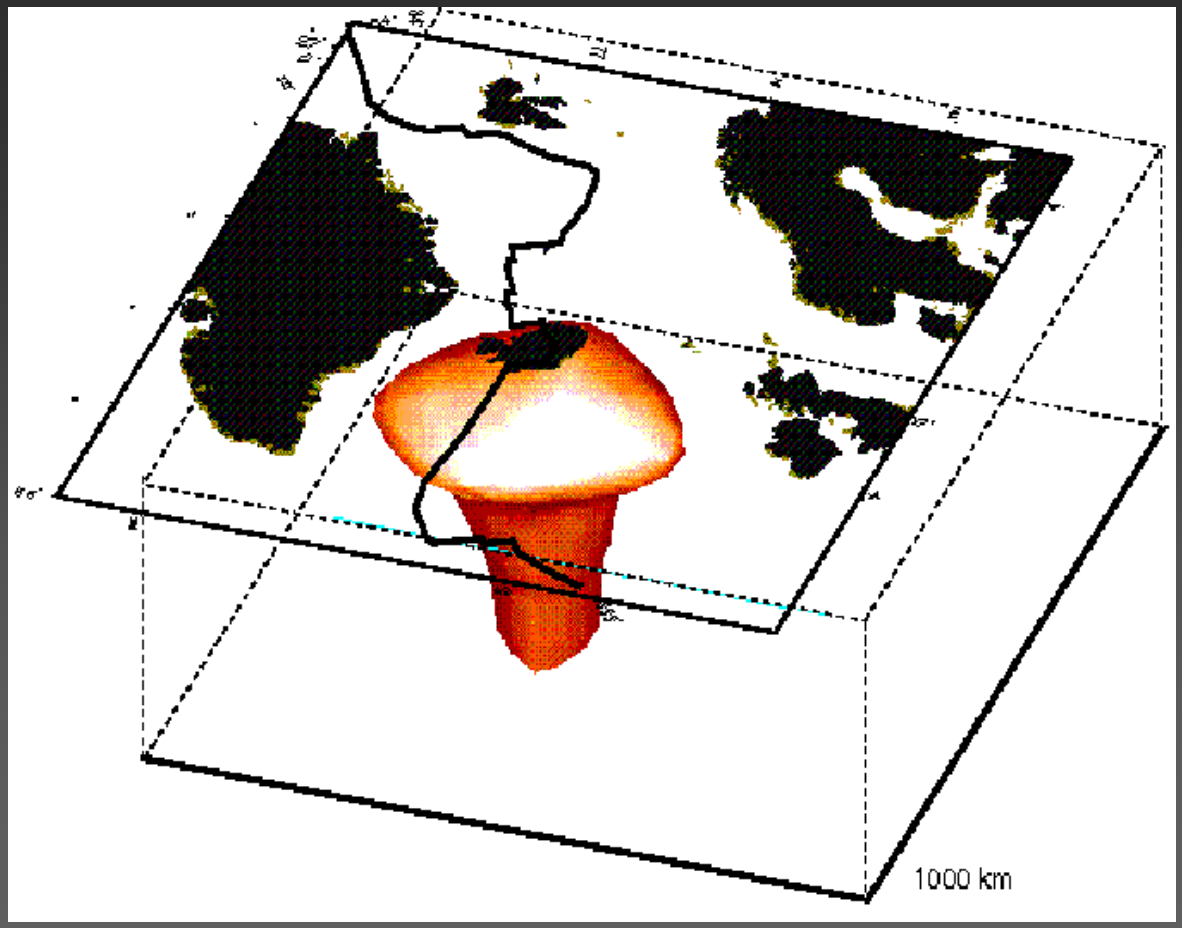
Resources

- A Hot spot is a volcanically active area of Earth's surface, commonly far from a tectonic plate boundary.
- This occurs because hot material, *mantle plumes*, rises and reaches the lithosphere.



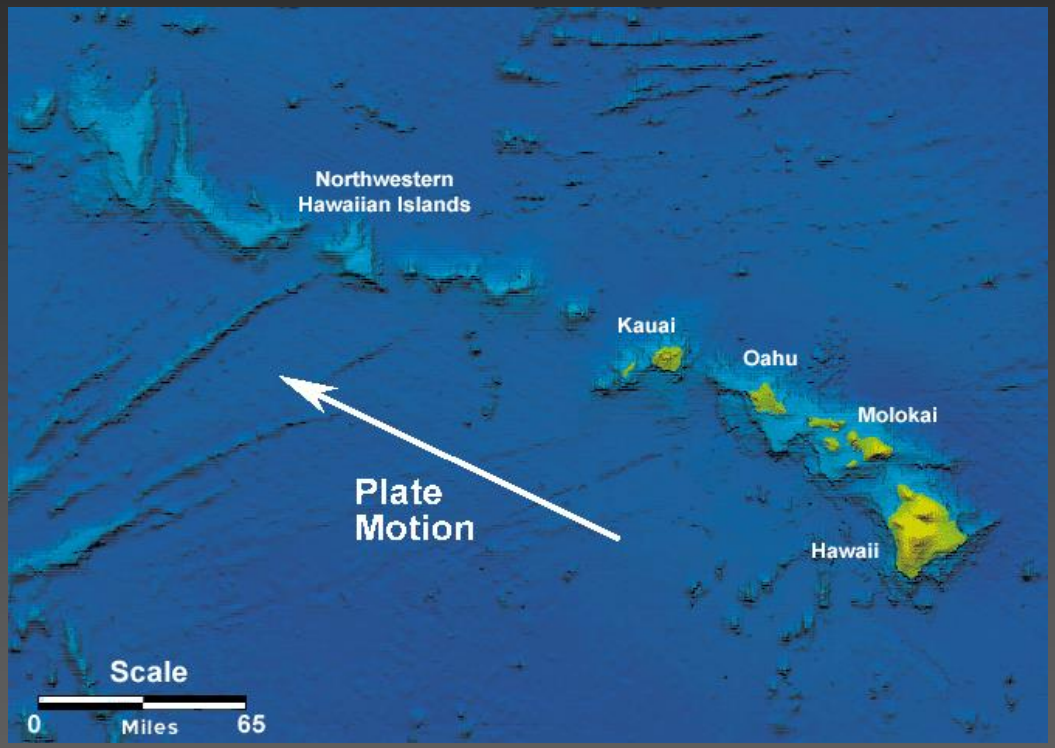
Hot Spots

- As magma rises to the surface, it breaks through the overlying crust creating a volcano.



3) Hot Spots

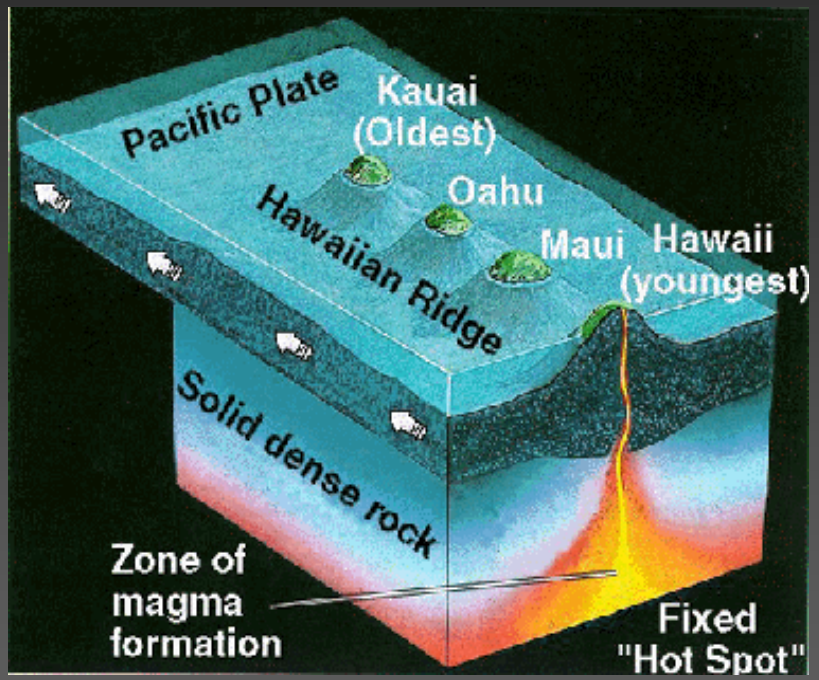
- Evidence suggests that mantle plumes stay stationary while the lithospheric plate above a mantle plume continues to drift slowly.
- So, the volcano on the surface is eventually carried away from the mantle plume.

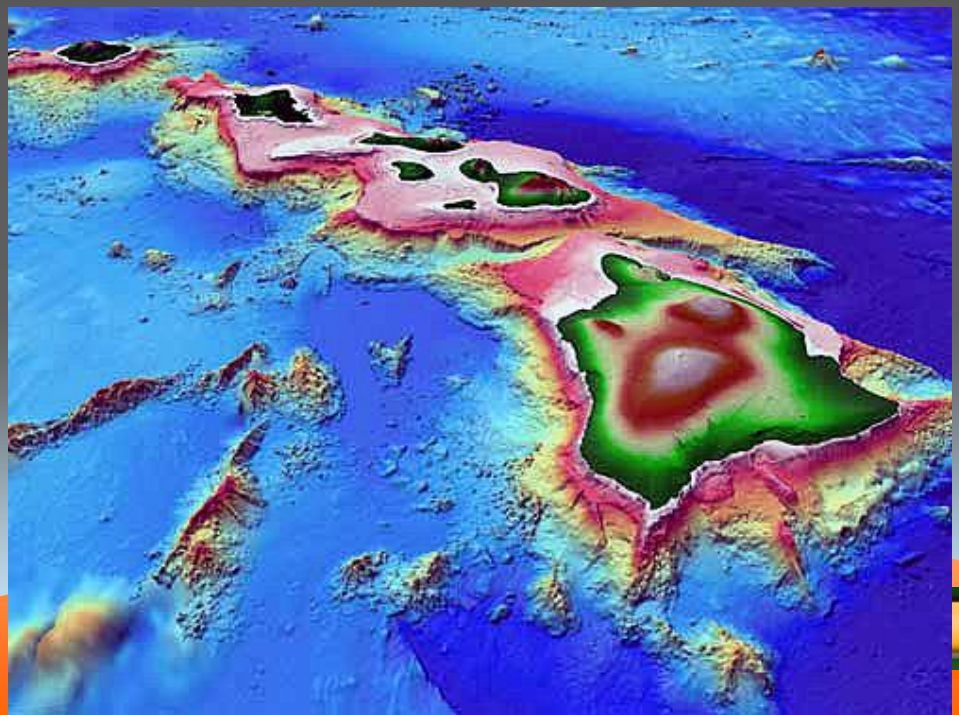


Mantle Plumes

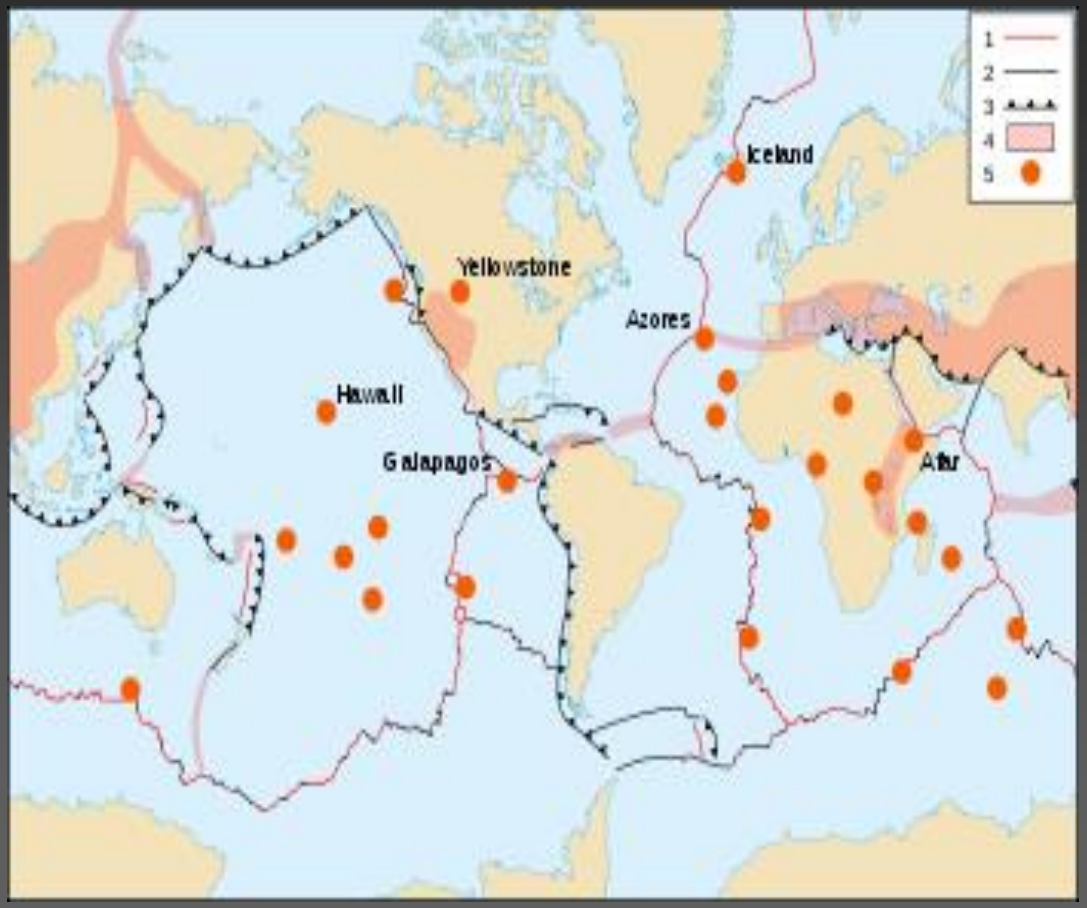
Mantle Plumes

- The activity of the volcano stops because a hot spot that contains magma no longer feeds the volcano.
- However, a new volcano forms where the lithosphere has moved over the mantle plume.





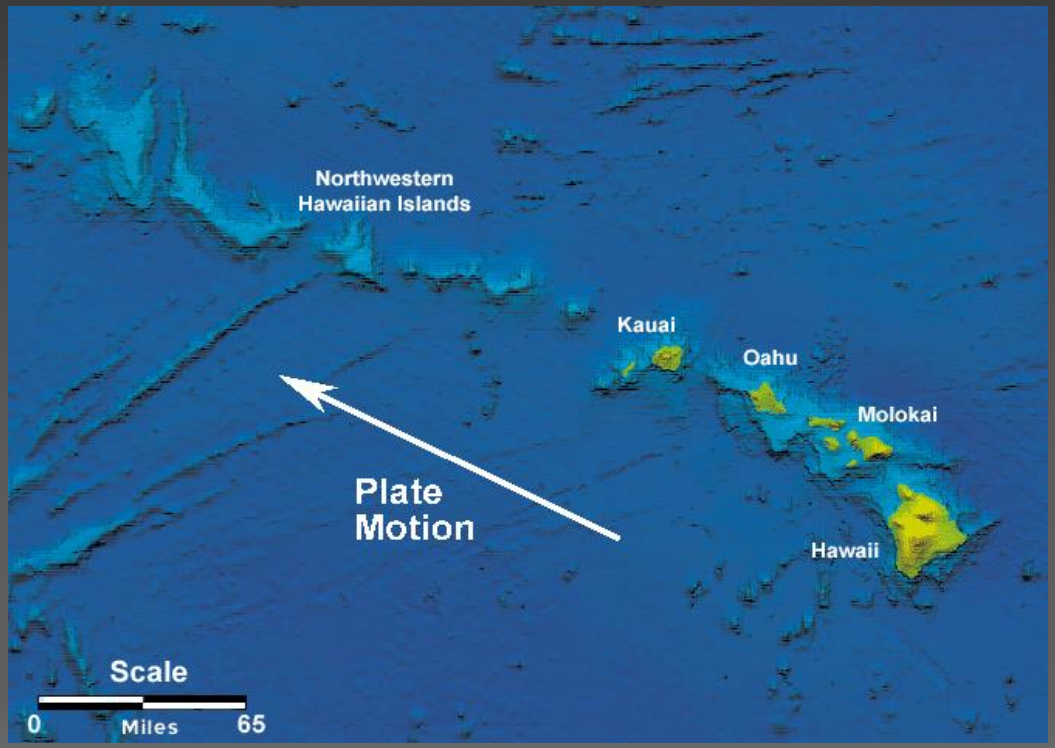
- Geologists have identified some 40–50 such hotspots around the globe, with Hawaii, Yellowstone, and the Galápagos, overlying the most currently active.



Hot Spot Area's Found on Earth

Check for Understanding

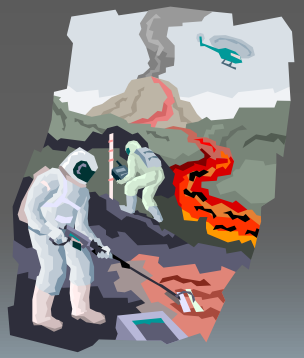
1. Identify the 3 major zones active volcanoes are found
2. Explain the formation of volcanoes from hot spots



Lesson #5 Types of Volcanoes

What is a Volcano?

- An opening in the earth's crust through which molten lava, ash, and gases are ejected.
- A mountain formed by the materials ejected from a volcano.



Volcano classification

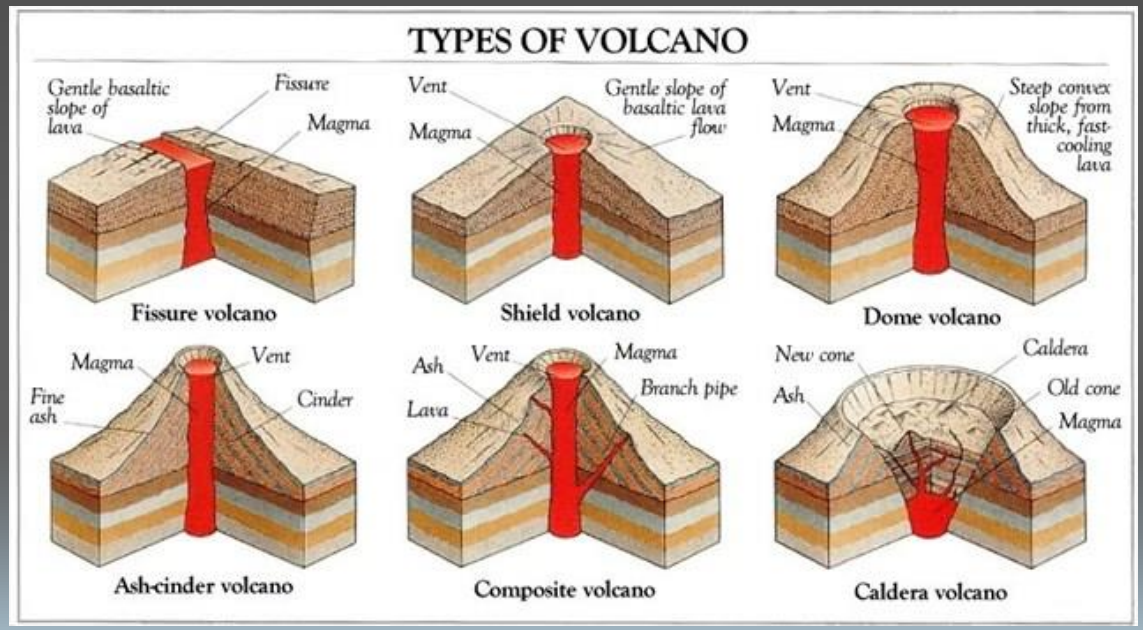
- Volcanoes cannot be classified by their shape, but a rule of thumb is…
- Steep slopes = Strato/composite Volcanoes
  Example Mt. Hood

Mount Hood, Oregon

- Gentle slopes = Shield volcano
  Mauna Loa Hawaii

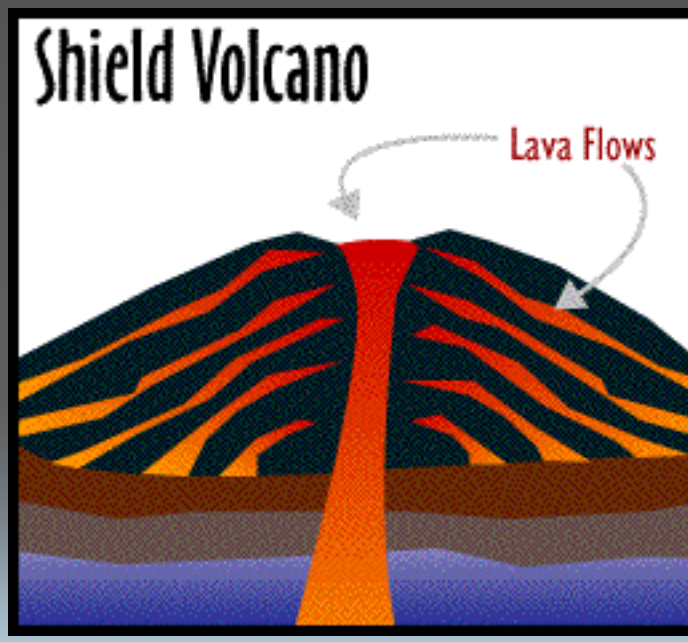
Types of Volcanoes

- Shield Volcano
- Cinder Cone Volcano
- Composite Volcano
- Caldera Volcano
- Fissure Volcano
- Volcanic Hot Spots



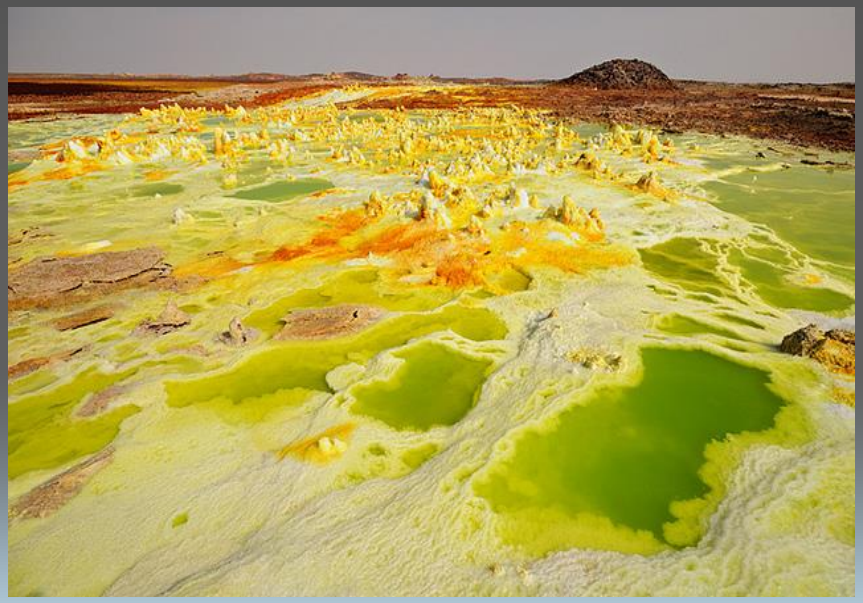
Shield Volcano

- Shield volcanoes can span across hundreds of miles and they can be huge vertically that they can reach the clouds of earth very easy.
- Shield volcanoes have a slow slope and consist of solid lava after it is hardened.
- Shield volcanoes almost always have large craters at their summit.
- Examples are Kilauea and Mauna Loa in Hawaii



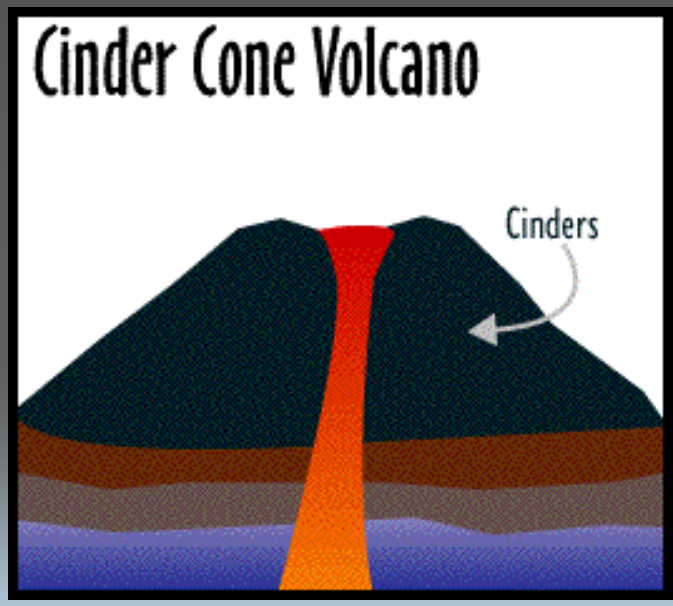
Dallol is a shield volcano

- The yellow color caused by the increase acid in the ground water contacting the magma and volcanic gases.



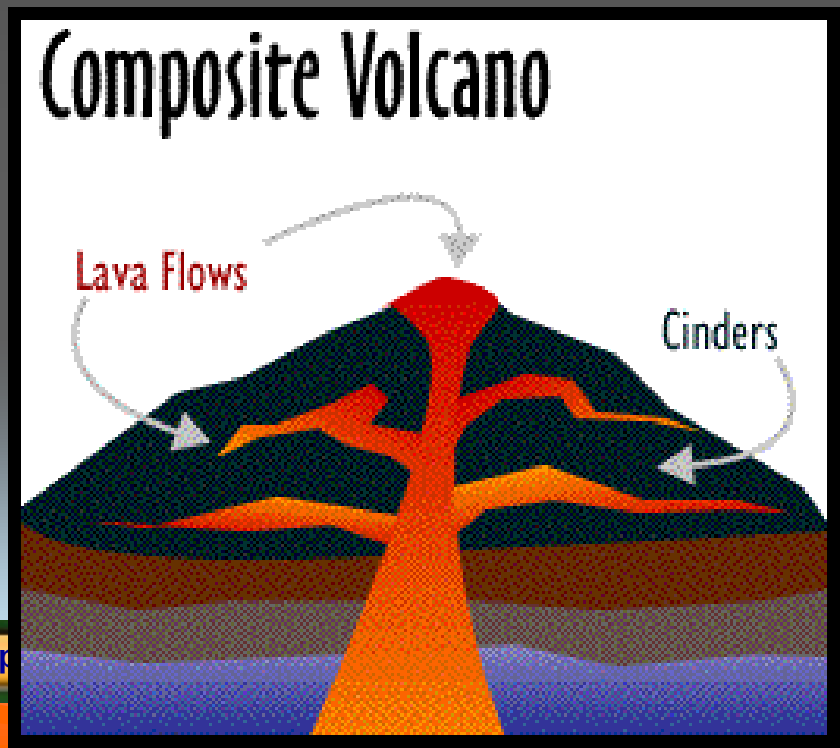
Cinder Cone Volcanoes

- Cinder cone volcanoes consist of mostly loose, grainy cinders and have very little to no lava.
- Cinder cone volcanoes are normally small about a miles span and about one thousand feet vertically.
- Cinder cone volcanoes have fairly steep slopes and normally have a small crater at the top.



Composite Volcanoes aka Strato Volcanoes

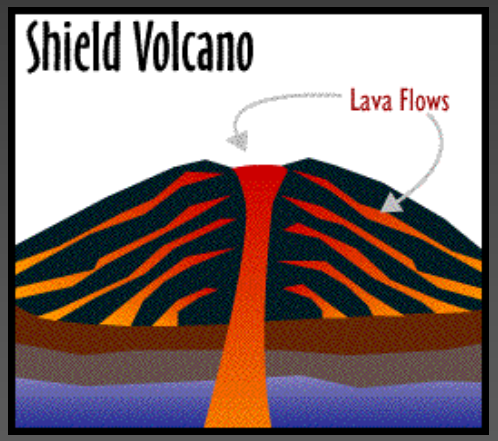
- Composite volcanoes have another name called “Strato Volcanoes.”
- Composite volcanoes consist of lava that is mixed with sand or gravel which in turn creates cinders or volcanic ash.
- Example Mt. St. Helens

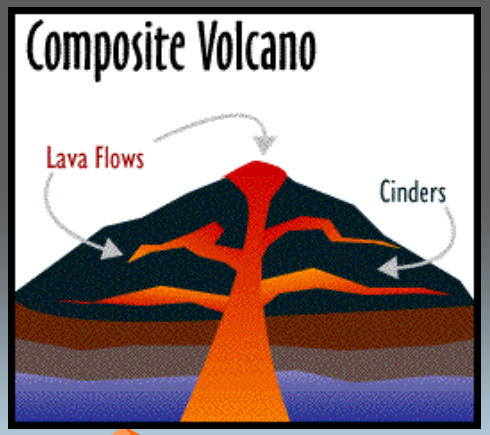


Check for Understanding

1. Describe the type of lava a shield volcano produces?

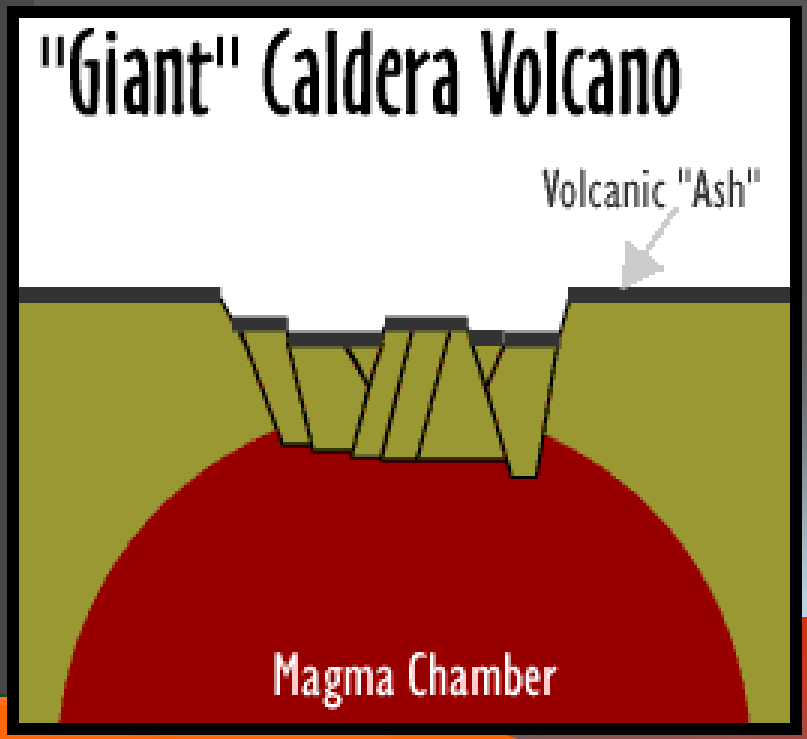
2. Describe the type of lava a composite volcano produces?





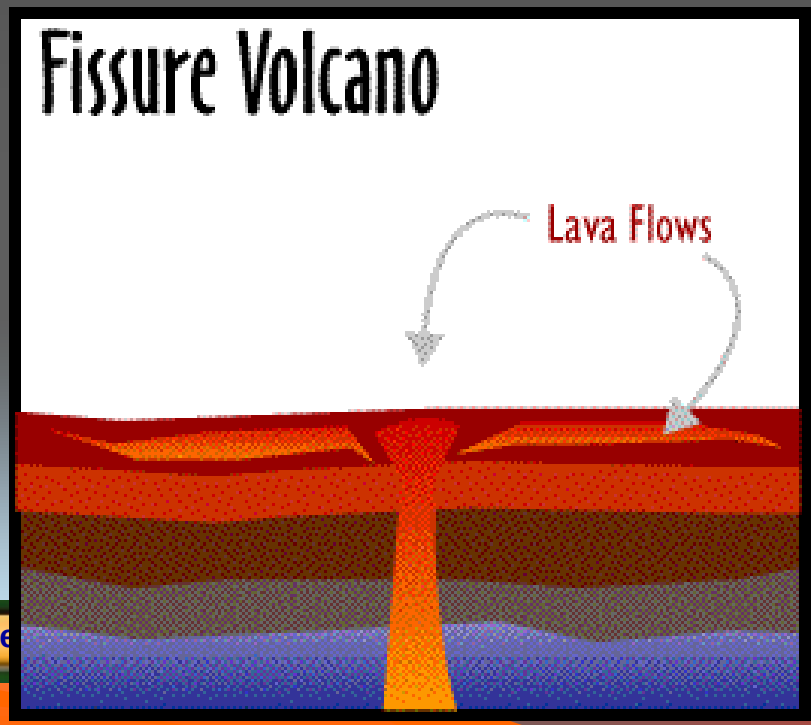
Caldera Volcano

- Caldera volcanoes are circular depressions in the ground over a magma chamber.
- Sometimes the depression in Caldera volcanoes are covered in with lava and volcanic ash making it hard to recognize.
- This type of volcano is easier noticed from space due to the distance and view point. When this volcano erupts it can spew volcanic rocks for miles and miles.
- Example Yellowstone



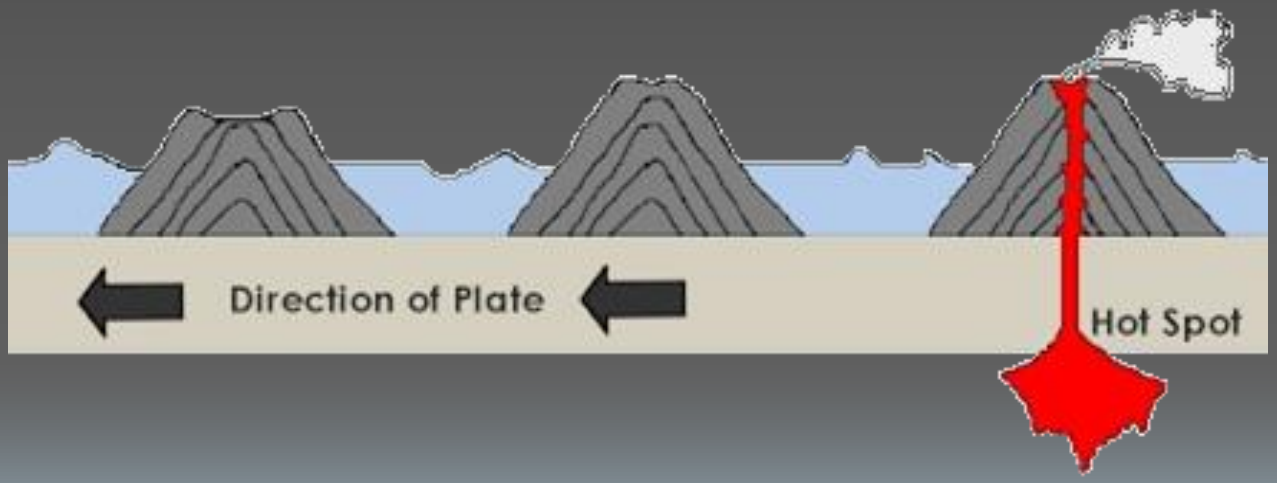
Fissure Volcanoes

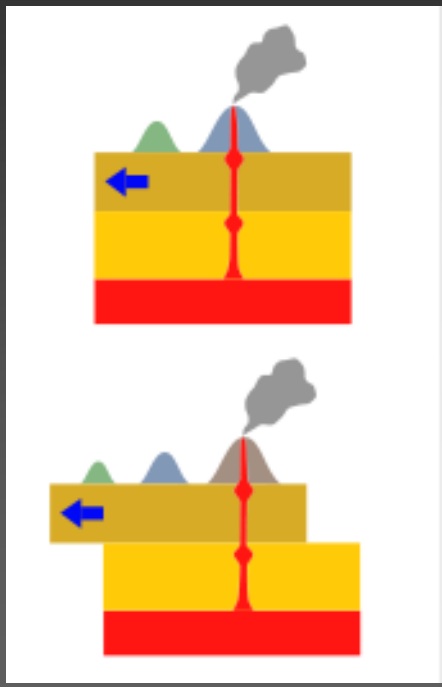
- Fissure volcanoes are also hard to recognize from the ground and sometimes from space.
- Fissure volcanoes have no main crater, the ground just splits and lava pours out through the cracks.
- After a fissure volcano erupts and has cooled because it's a solid it will look mainly like the plains.
- Example Eyjafjallajokull in Iceland



Volcanic Hot Spot

- A fixed source of magma rising beneath a plate forming volcanic islands
- Magma can be basaltic or granitic –so eruptions can be explosive or “quiet”
- Examples are Hawaii and parts of Iceland

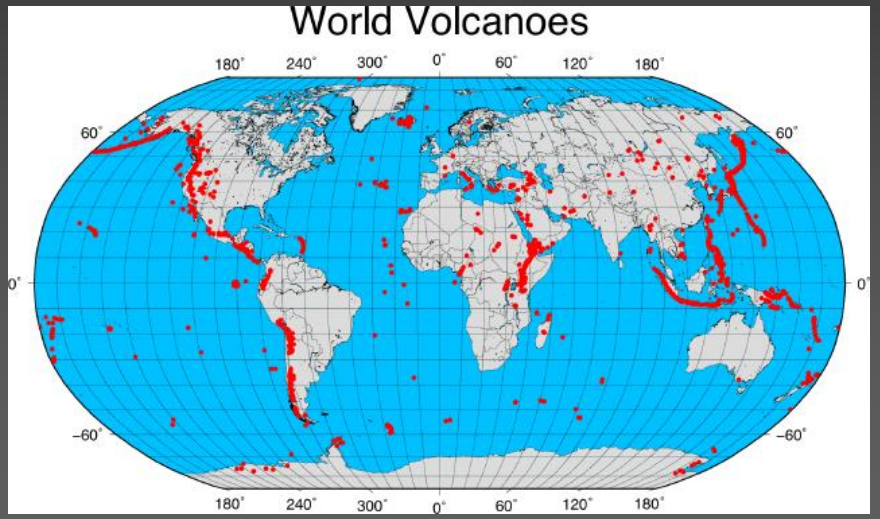




How the Hawaiian Islands Formed.

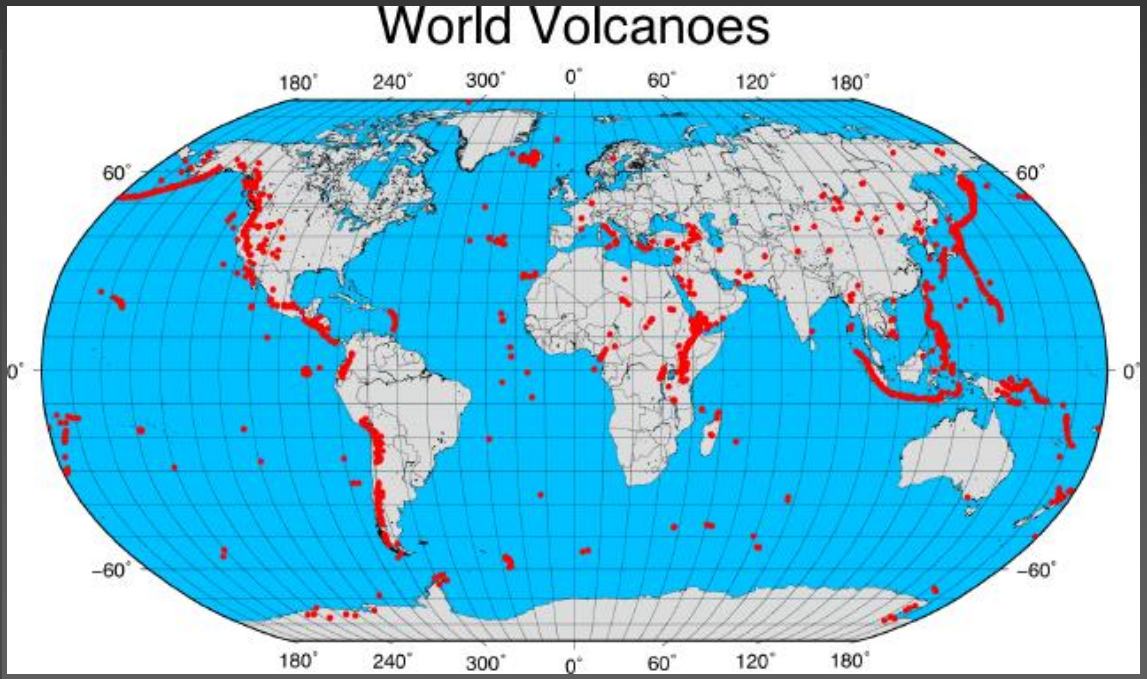
Check for Understanding

1. Draw a picture of a volcanic hot spot. Include the following: magma chamber, tectonic plates, and arrows describing movement.



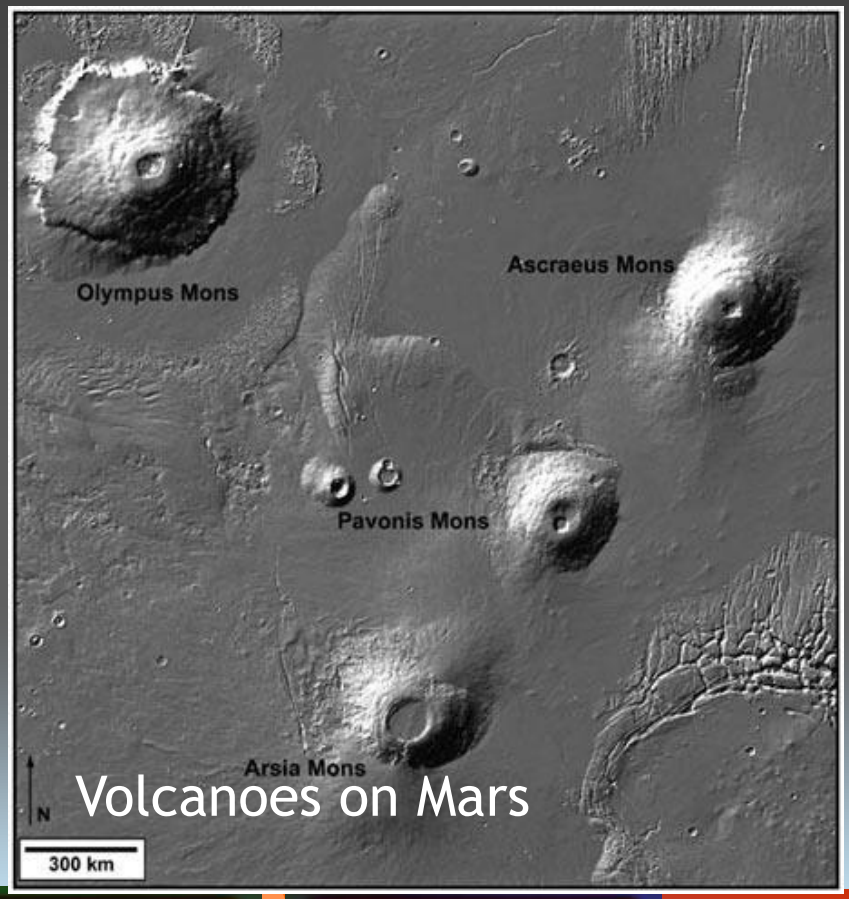
Where are volcanoes likely to occur?

- Volcanoes occur in weak spots in the earth's crust
- There are many volcanoes along the Pacific Ring of Fire.
- Many islands in the Pacific Ocean are actually volcanoes.
- There are approximately five hundred active volcanoes that are known, lying in these belts.



Volcanoes in other places

- Volcanoes aren't just a thing from earth they also happen on other planets as seen in this picture.
- Often scientist look for volcanoes for potential signs of life.



Volcanoes on Mars

How do volcanic eruptions occur?

- Eruptions occur when underground pressure is released when blocks of the earth's crust shift.

- For example, earthquakes or large land slides such as Mt. St. Helens

Pyroclastic Flow

- A **pyroclastic flow** (also known scientifically as a **pyroclastic** density current) is a fast-moving current of hot gas and rock (collectively known as tephra), which reaches speeds moving away from a volcano of up to 700 km/h (450 mph). The gas can reach temperatures of about 1,000 °C (1,830 °F).

Why are some eruptions explosive?

- Steam and gases from magma in the earth create bubbles that expand and burst when the pressure above them is lessened.

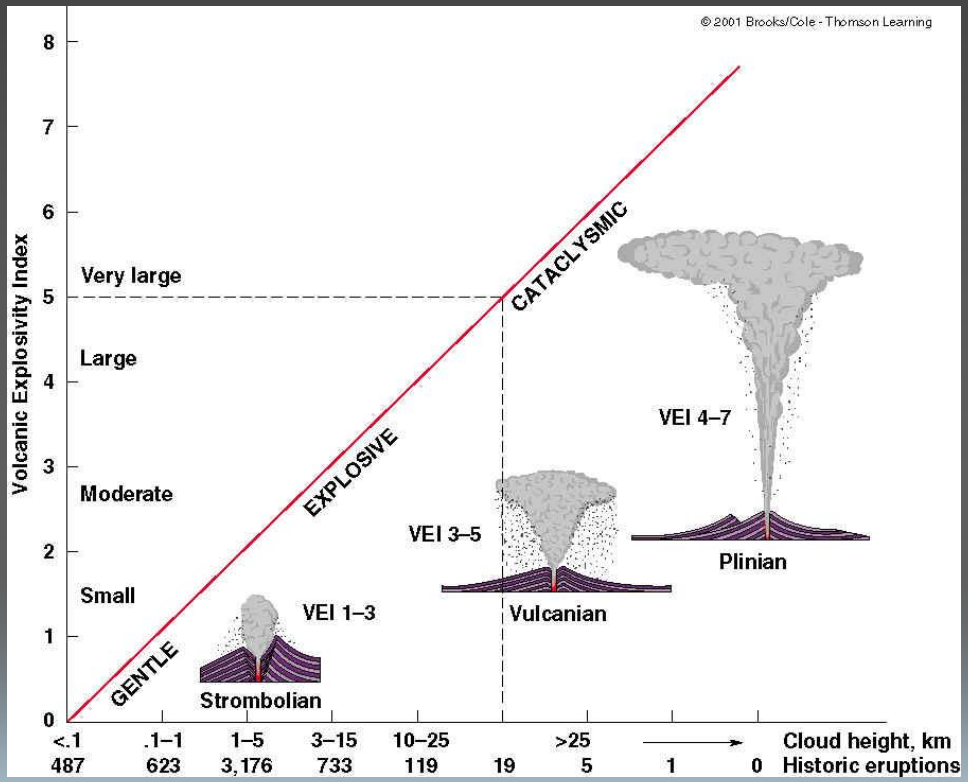
- These bubbles usually burst with a tremendous force that along with escaping gas comes magma too.

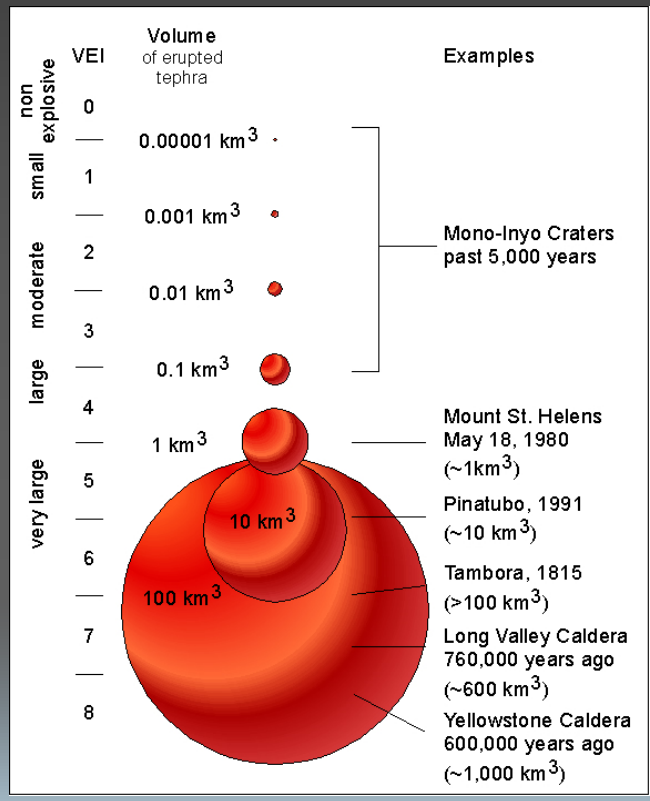
Why are some eruptions explosive continues

- In some cases, it takes years for the magma to break through the surface of the earth.

How are eruptions measured?

- Scientist use the VEI: Volcanic Explosivity Index is used to measure the size of the eruption.





Check for Understanding

1. Describe why some volcanoes are explosive and some are quiet.

Volcano Recap

APPEARANCE → ERUPTIONS

- Steep slopes (Strato volcano) → explosive (violent)
- Gentle slopes (Shield volcano)→ non-explosive (quiet)

MAGMA VISCOSITY → ERUPTIONS

- Viscous (thick) magma → explosive (violent – Strato, Felsic)
- Fluid (thin) magma → non-explosive (quiet – Shield, Mafic)

FORMATION →MAGMA/LAVA →ERUPTIONS

- Subduction zones → explosive (violent - Strato)
- Sea Floor spreading zones → non-explosive (quiet- shield)
- Hot spot → usually non-explosive, but can be explosive

MONITORING→PREDICTION OF ERUPTIONS

- Slope changes, quakes↑, water pH↓ , gases ↑