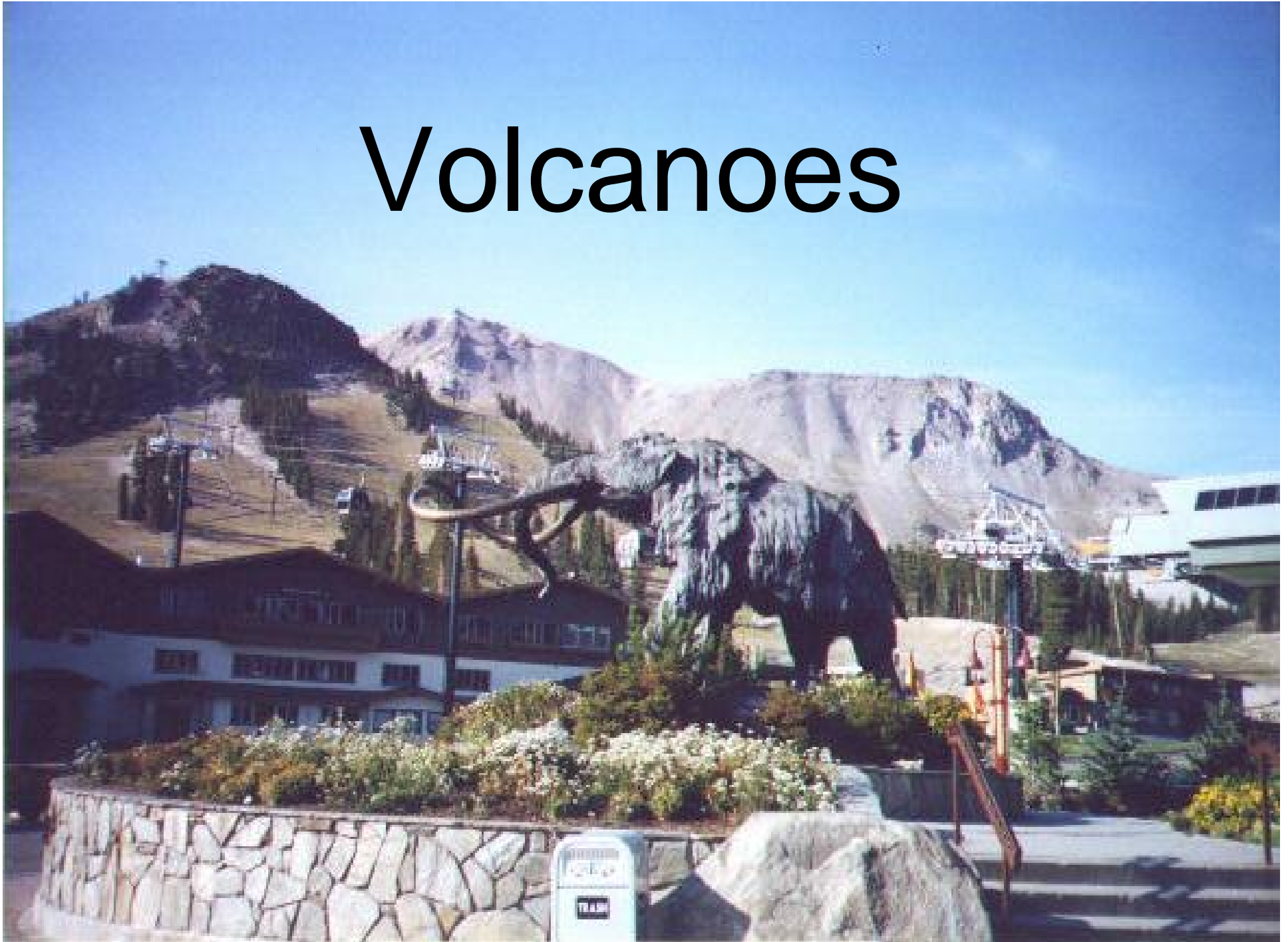


Volcanoes



A *Volcano* is an area in the earth's crust where molten rock, gases, and ash erupt from. Volcano also refers to the landform that develops.

How Volcanoes Form

Magma Formation

The following 3 conditions
will allow magma to form.

1. A decrease in pressure lowers the melting point of rock material. This happens along a rift valley at a mid-ocean ridge.

2. An increase in temperature can cause rock material to melt. This happens near a *hot spot* such as the Hawaiian Islands.

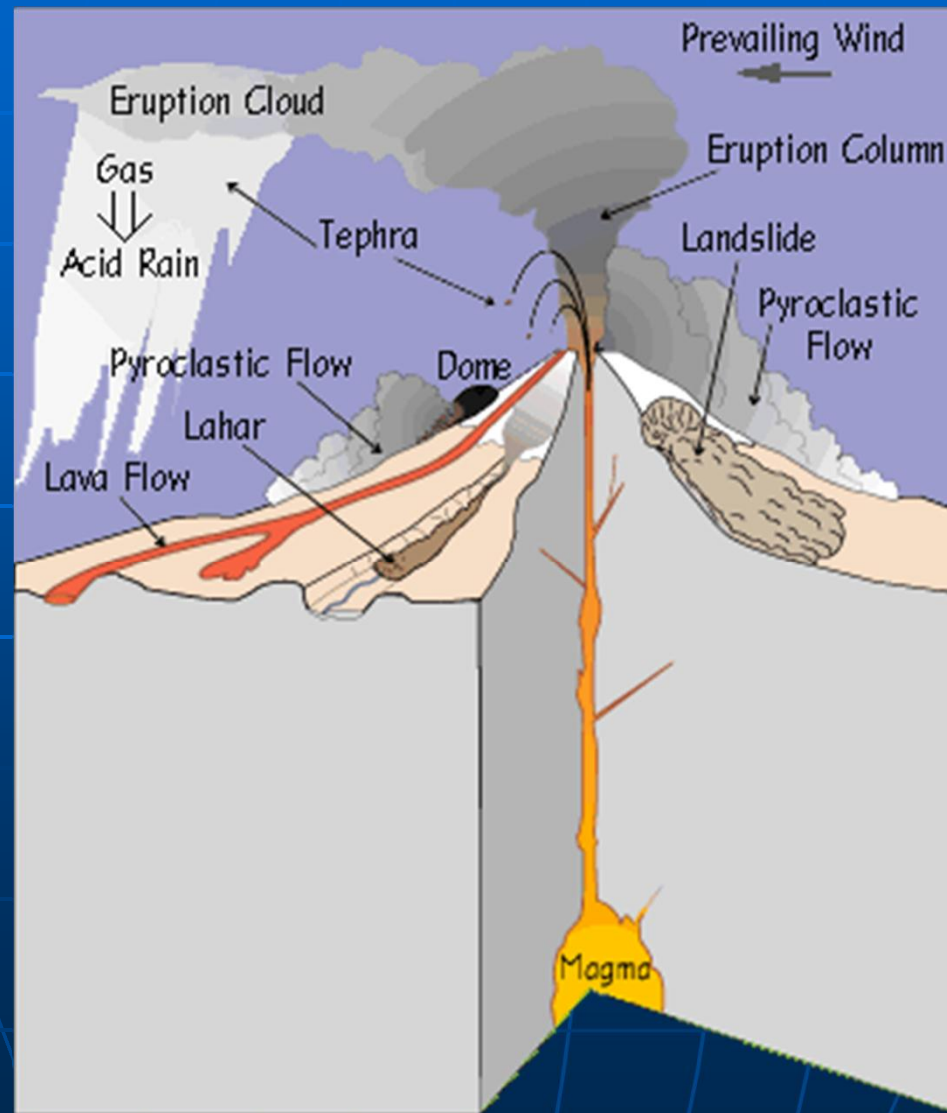
3. An increase in the amount of water in the *asthenosphere* can lower the melting temperature. This happens at subduction boundaries.

Why water lowers the melting point of rock and forms magma in subduction zones, by Brandon Browne, former LCHS student and Ph.D. volcanologist at Cal State Fullerton

When water dissolves into the structure of rock, chemical bonds holding minerals together are shortened (reducing viscosity) and eventually broken (melting) if the rock becomes saturated, which is defined as the point where any additional water added to the rock will form a separate phase like a bubble. Another way to think about it is that water saturation requires the total Pressure to equal dissolved H₂O Pressure.

Decompressing rock has the same effect, which is why anhydrous (dry) mantle can melt through decompression at constant T.+

Parts of a Volcano



Volcano Activity

A volcano is considered:

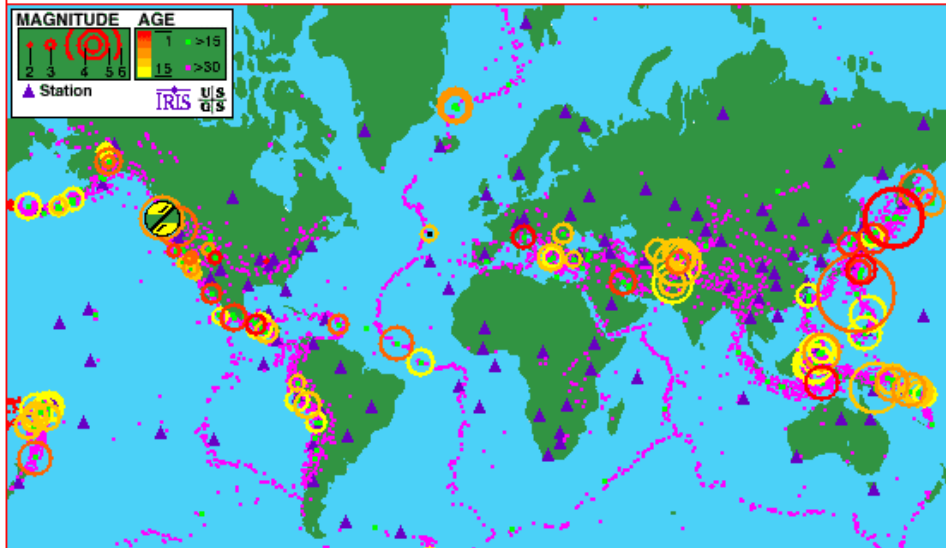
“Active if it has erupted in historic time. This is anywhere from 200 to 3,000 years, depending on the region.

Dormant if it is not currently active, but could become so.

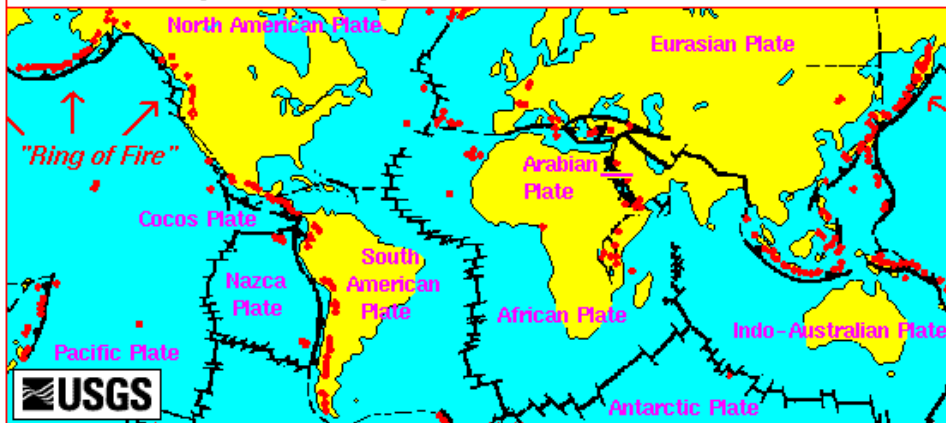
Extinct when scientists consider it unlikely to erupt again.

Where Volcanoes Form

Earthquakes, Active Volcanoes, and Plate Tectonics

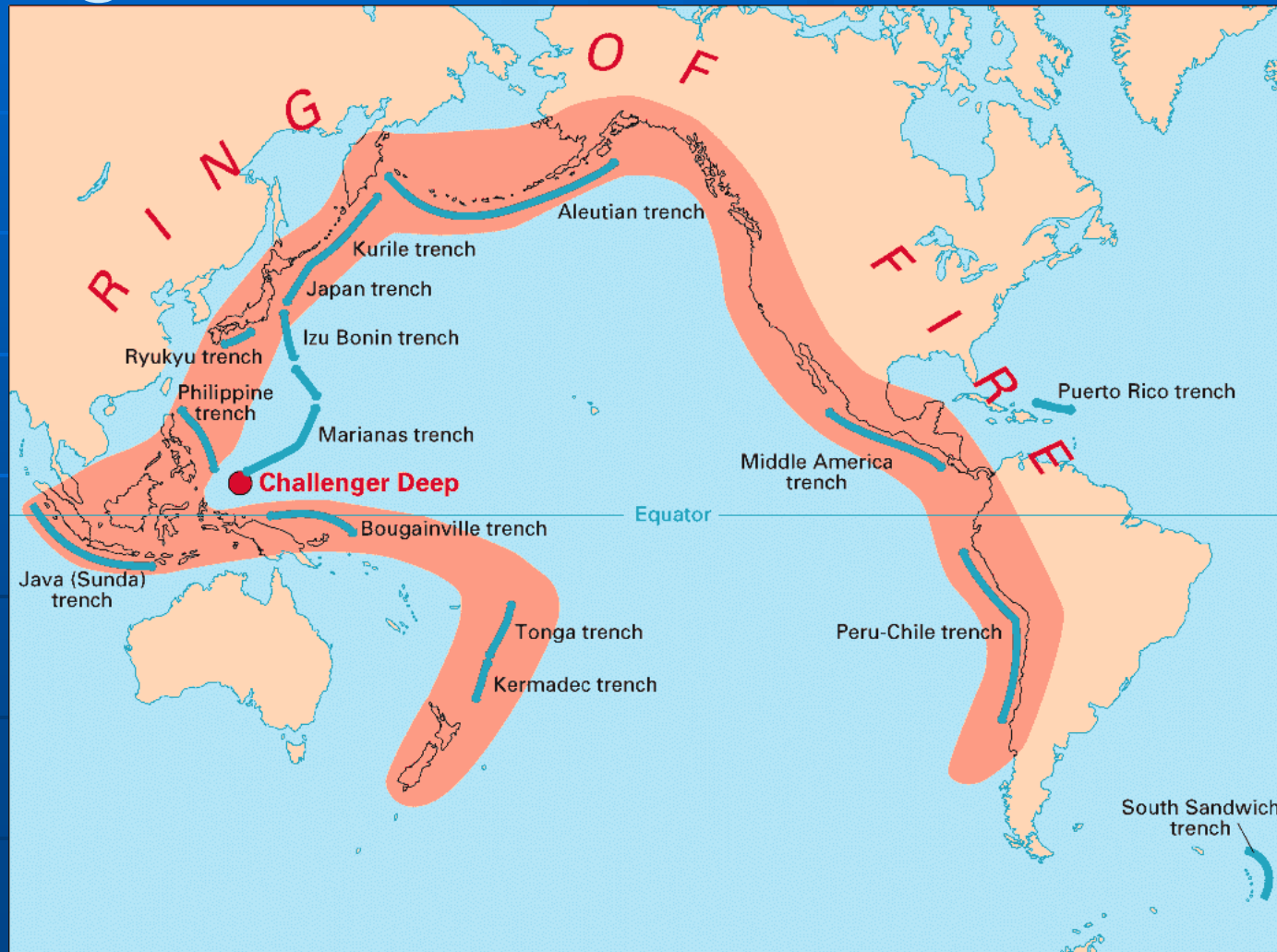


TOP: World-wide earthquakes on July 7, 1999, and past 5 years, demonstrating how earthquakes define boundaries of tectonic plates. Data from NEIC. Chart from IRIS Consortium, USGS, U.Colorado, Reel Illusions, Inc., and U.Washington. Chart modified for web use. Purple triangles are seismic stations, green/yellow "ball" is 5.1 event of July 3, 1999. **BOTTOM:** World-wide active volcanoes (red circles), tectonic plates, and the "Ring of Fire". Chart modified from Tilling, Heliker, and Wright, 1987, and Hamilton, 1976. -- Topinka, USGS/CVO, 1999



World Earthquake and Volcano Distribution

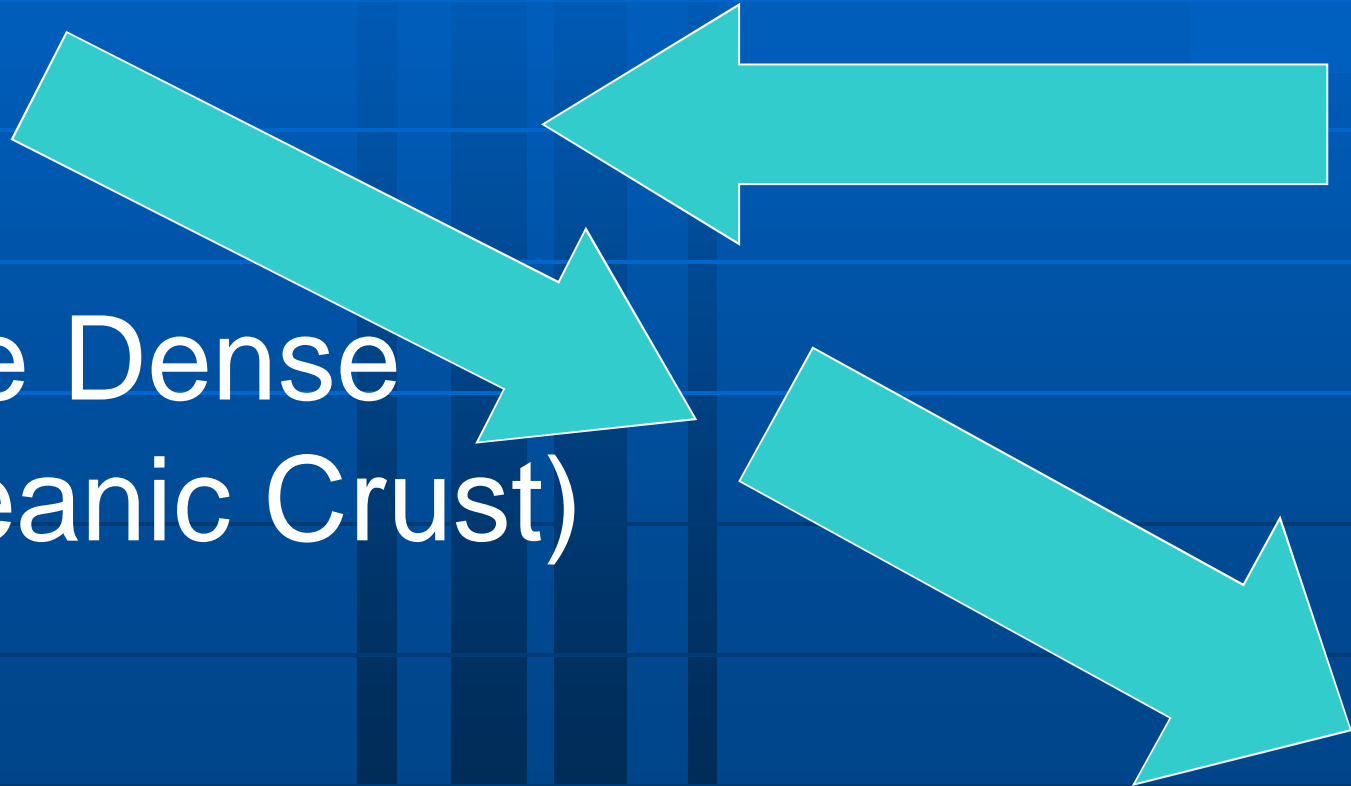
Many powerful volcanoes of the world can be found in the Pacific Ring of Fire.



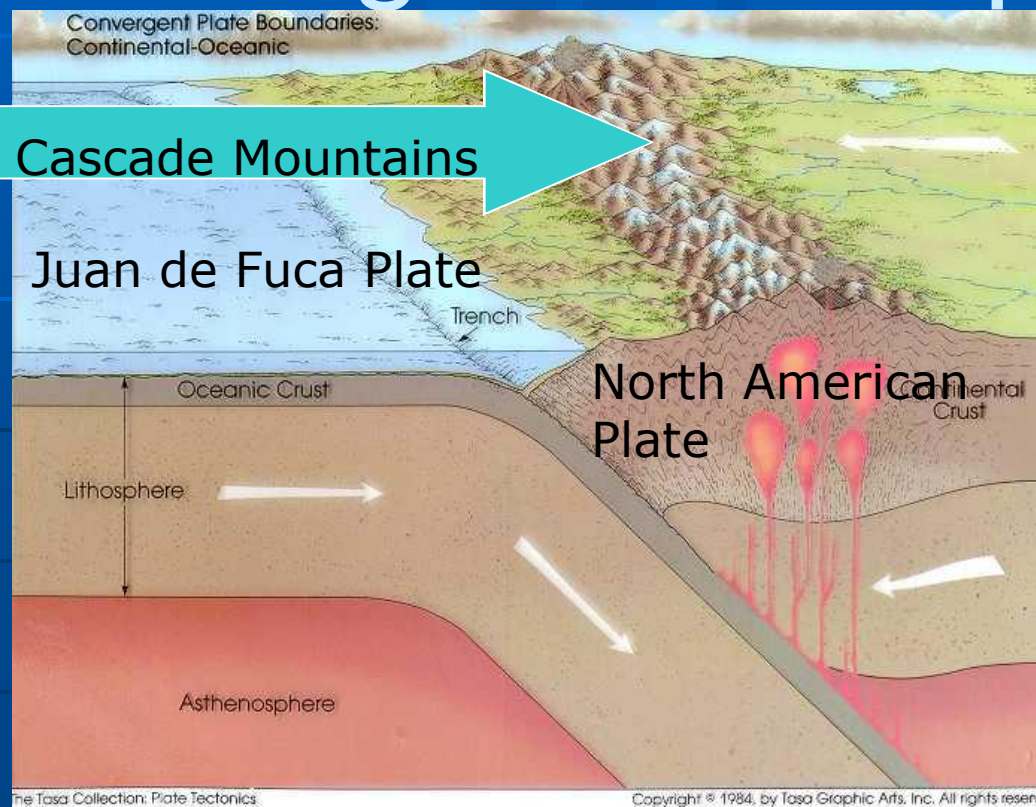
At Subduction Boundaries

Less Dense (Continental or Oceanic Crust)

More Dense
(Oceanic Crust)



Volcanoes form on the overriding plate. The Cascades (Mt. St. Helens, Mt. Shasta, Mt. Rainier) are a good example



Mt. Rainier, Washington: A composite volcano formed at a subduction boundary where the Juan De Fuca Plate is diving under the North American Plate

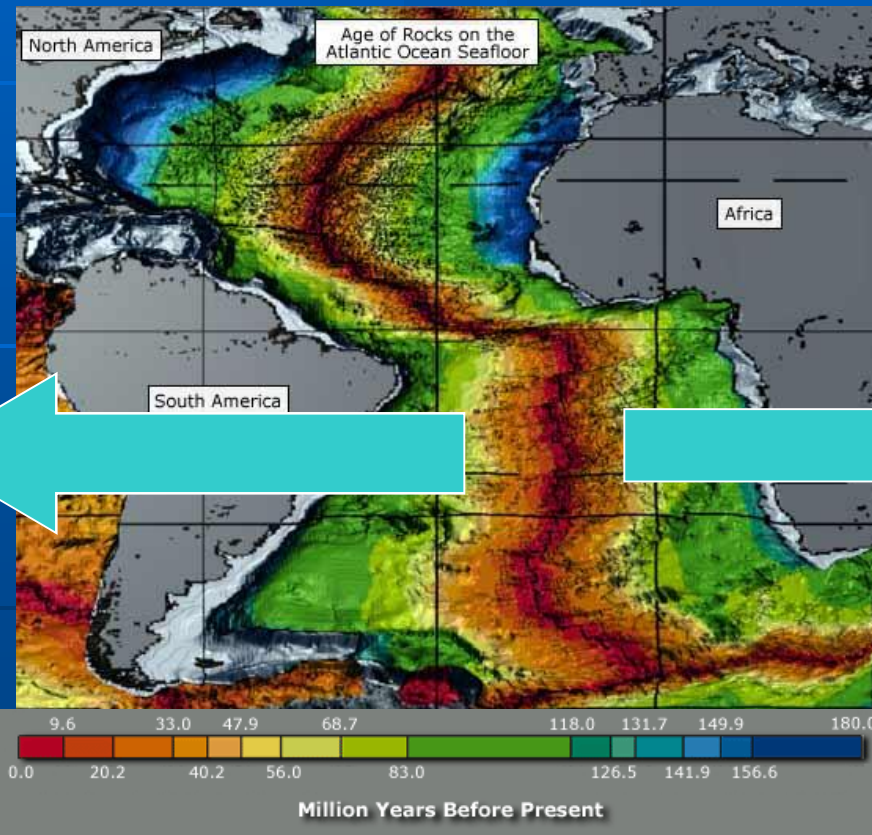


At Divergent Boundary



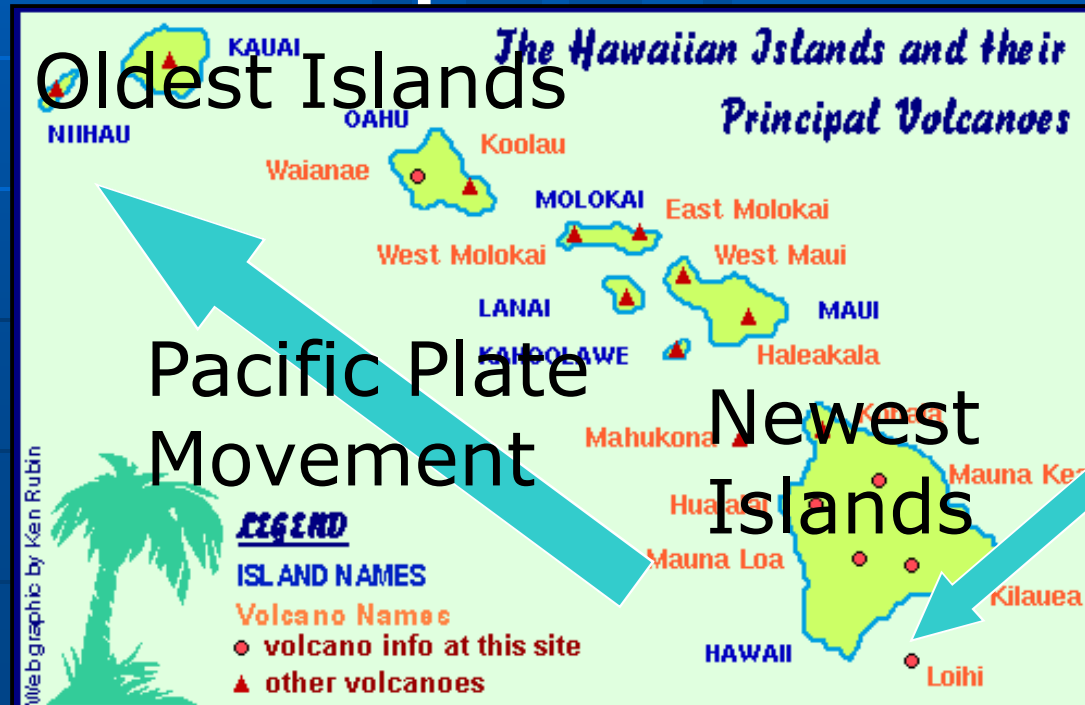
Rift Valleys and Mid-Ocean Ridges

Magma rises to the surface at a mid-ocean ridge in pillow lava formations and/or hydrothermal vents. Most volcanoes occur here.



At Hot Spots

Hawaiian Islands are a good example.



Magma and Material Erupted from a Volcano

What determines whether
a volcano will be
explosive like this?



ō and what determines whether a volcano will be docile like this?



The answer is the type of magma that causes the eruption.

Low Viscosity, gas and silica content

High Viscosity, gas and silica content



õ but what is viscosity?

Viscosity is the resistance
to flow of magma/lava.

Viscosity Ratings of Known Liquids

Water



Vegetable Oil



Syrup



Viscosity Ratings of Known Liquids

Water



Low Viscosity

Vegetable Oil



Syrup



Viscosity Ratings of Known Liquids

Water



Low Viscosity

Vegetable Oil



Medium Viscosity

Syrup



Viscosity Ratings of Known Liquids

Water



Low Viscosity

Vegetable Oil



Medium Viscosity

Syrup



High Viscosity

Viscosity Ratings of Known Liquids

Water



Low Viscosity

Like basaltic
magma

Vegetable Oil



Medium Viscosity

Syrup



High Viscosity

Viscosity Ratings of Known Liquids

Water



Low Viscosity

Like basaltic
magma

Vegetable Oil



Medium Viscosity

Like andesitic magma

Syrup



High Viscosity

Viscosity Ratings of Known Liquids

Water



Low Viscosity

Like basaltic
magma

Vegetable Oil



Medium Viscosity

Like andesitic magma

Syrup



High Viscosity

Like rhyolitic
magma

Magmas high in silica
(quartz) concentration
resist flow and have
high viscosity.

Magmas low in silica
(quartz) concentration
flow more easily and
have low viscosity.

Higher concentrations of gas (mostly water vapor and carbon dioxide) in the magma result in explosive volcanoes.

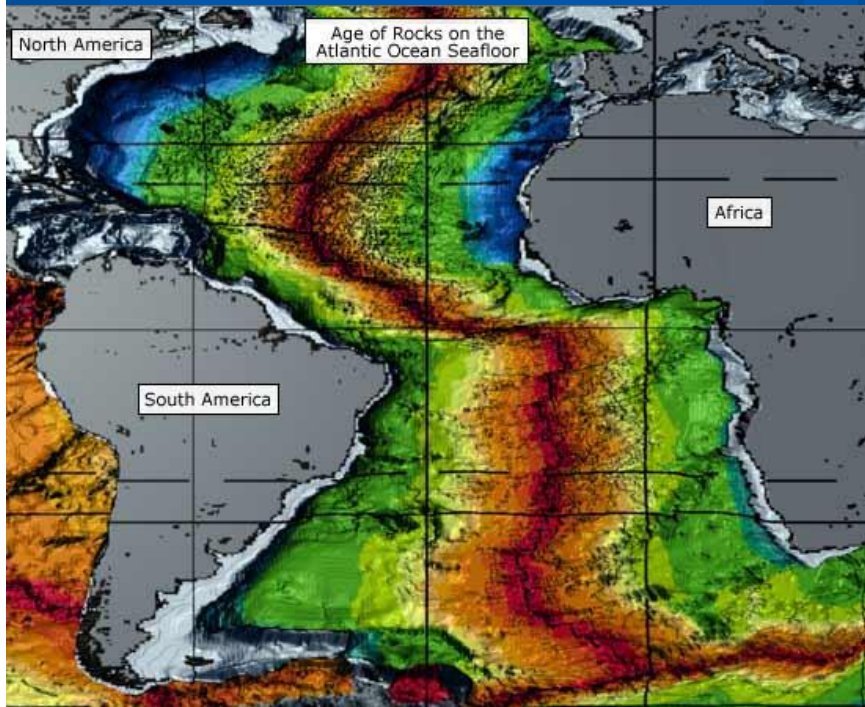
Lower concentrations of gas (mostly water vapor and carbon dioxide) in the magma result in docile volcanoes.

Characteristics of Magma (see page 199 in your book)

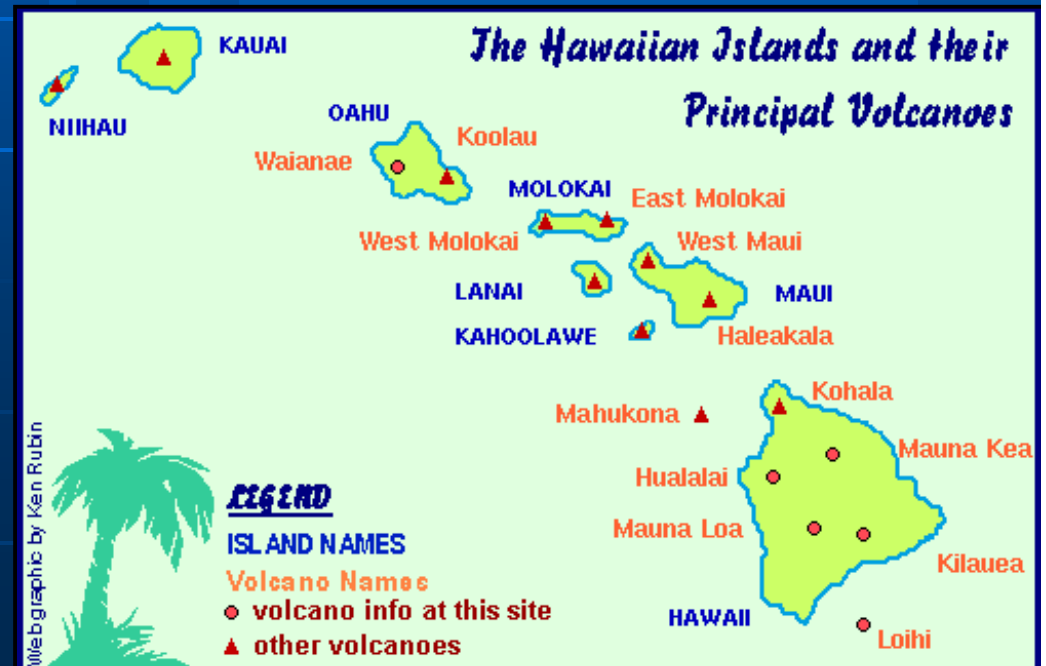
	Basaltic Magma	Andesitic Magma	Rhyolitic Magma
Silica Content	Least (~50%)	Intermediate (~60%)	Most (~70%)
Gas Content	Least	Intermediate	Most
Viscosity	Least viscous	Intermediate	Most viscous
Type of Eruption	Rarely explosive	Sometimes explosive	Usually explosive
Melting Temperature	Highest	Intermediate	Lowest
Location	Rifts, Oceanic Hot Spots	Subduction boundaries	Continental Hot Spots

Basaltic magma forms at mid-ocean ridges and hot spots.

Mid-Ocean Ridges



Hot Spots



Hawaii: A low viscosity lava.



Hawaii: A low viscosity lava.



Hawaiian Basalt



Kilauea Crater

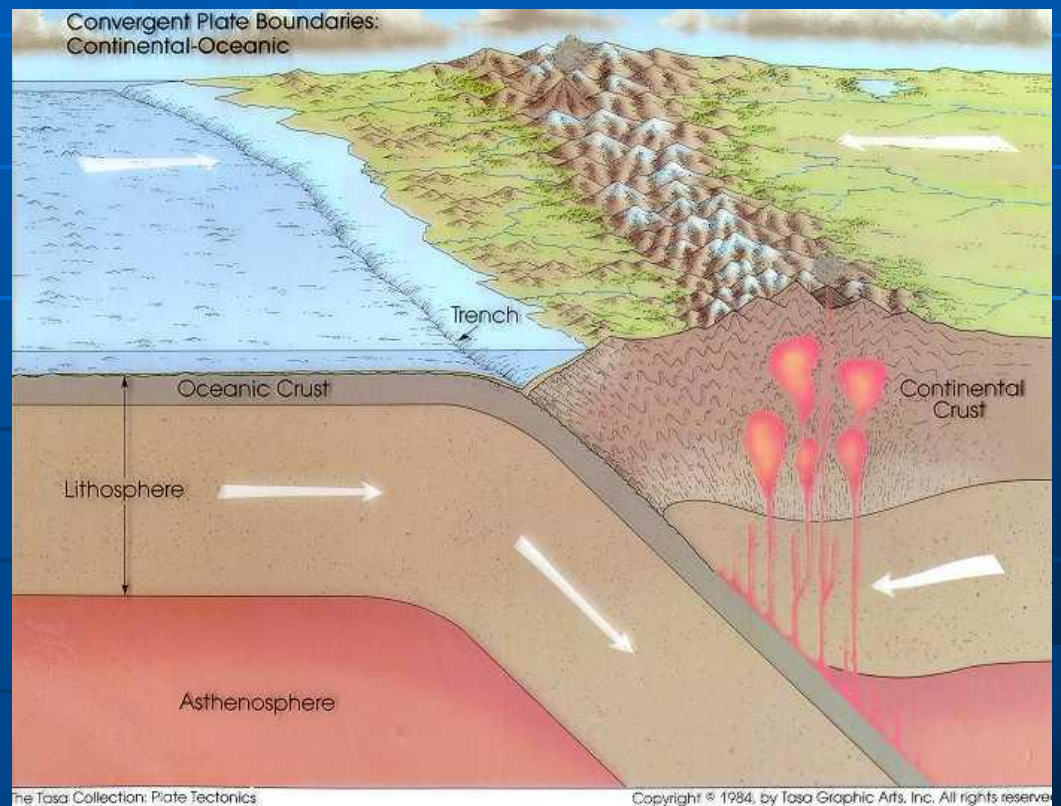


Basalt eats roads!



Andesitic magma forms at subduction zones.

Subduction Zone



Andesitic Magma found at Mt. St. Helens, WA



Devastation from explosive eruption of Mt. St. Helens, WA



Rhyolitic magma forms at continental hot spots such as Yellowstone Park.

Continental Hot Spot



Yellowstone National Park is a good example of an extremely explosive volcano with rhyolitic magma!



Yellowstone National Park is a good example of an extremely explosive volcano with rhyolitic magma!



Yellowstone National Park is a good example of an extremely explosive volcano with rhyolitic magma!

ELEVATION ABOVE SEA LEVEL - 7367'

Old Faithful Geyser

ERUPTION HEIGHT		ERUPTION INTERVAL		
AVG.	MAX.	MIN.	AVG.	MAX.
130 FT.	184 FT.	33 min	64.5	91 min

WATER DISCHARGE
10,000 - 12,000 GAL.
PER ERUPTION

DURATION 2-5 min
WATER TEMPERATURE
204° F AT VENT

Expected Eruption

NATIONAL PARK SERVICE INTERPRETATIVE PROGRAM
AMPHITHEATER LODGE REC HALL NATURE WALK GEYSER WALK

BOATS
BOATS FOR TOURING OR FISHING ARE AVAILABLE.
GO ON YOUR OWN OR WITH AN EXPERIENCED GUIDE. PLEASE INQUIRE AT THE REGISTRATION DESK.

SADDLE HORSES
ONE AND TWO HOUR GUIDED TRAIL RIDES AVAILABLE AT THREE YELLOWSTONE LOCATIONS. PLEASE INQUIRE AT THE REGISTRATION DESK.

ENTERTAINMENT
THE OLD WEST DINNER COOKOUT IS A MEMORABLE EXPERIENCE GO BY HORSEBACK OR WAGON.
OLD WEST STAGECOACH RIDES ARE AVAILABLE THROUGHOUT THE DAY AT ROOSEVELT LODGE. PLEASE INQUIRE AT THE REGISTRATION DESK.

SERVICES
CHOOSE A GUIDED BUS TOUR TO APPRECIATE YELLOWSTONE.
CIRCLE OF FIRE TOUR
WASHBURN ERUPTION TOUR
YELLOWSTONE IN A DAY TOUR
LAMAR VALLEY WILDLIFE EXCURSION
HARDY VALLEY TRAILER TOUR
PHOTO SAFARI
YELLOWSTONE LARK SUNSET TOUR
PLEASE INQUIRE AT THE REGISTRATION DESK.



Yellowstone National Park is a good example of an extremely explosive volcano with rhyolitic magma!



Yellowstone National Park is a good example of an extremely explosive volcano with rhyolitic magma!



Numerous hot springs in Yellowstone, indicating that it is VERY active! Magma below the surface heats the water in the hot springs. This water is over 200 degrees Fahrenheit!

Lava Flows

Lava is magma that reaches the surface of the Earth.

There are 2 types of basaltic lava flows on land, *pahoehoe* and *aa*. These are Hawaiian terms and these types of lava are usually found in Hawaii.

Pahoehoe: smooth and rope-like



aa : sharp and jagged

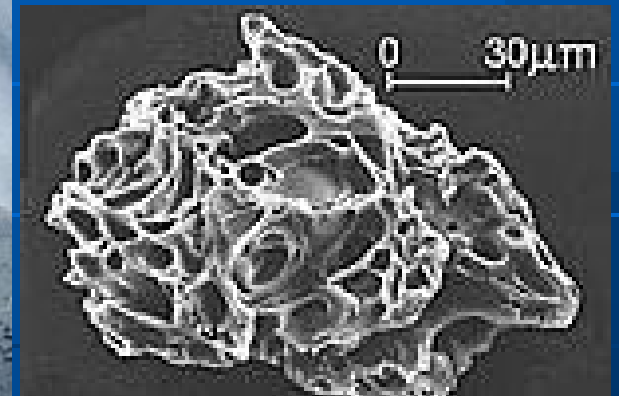


Underwater *Pillow Lava*
found offshore of Hawaii.
These can also be found
at Mid-Ocean Ridges.



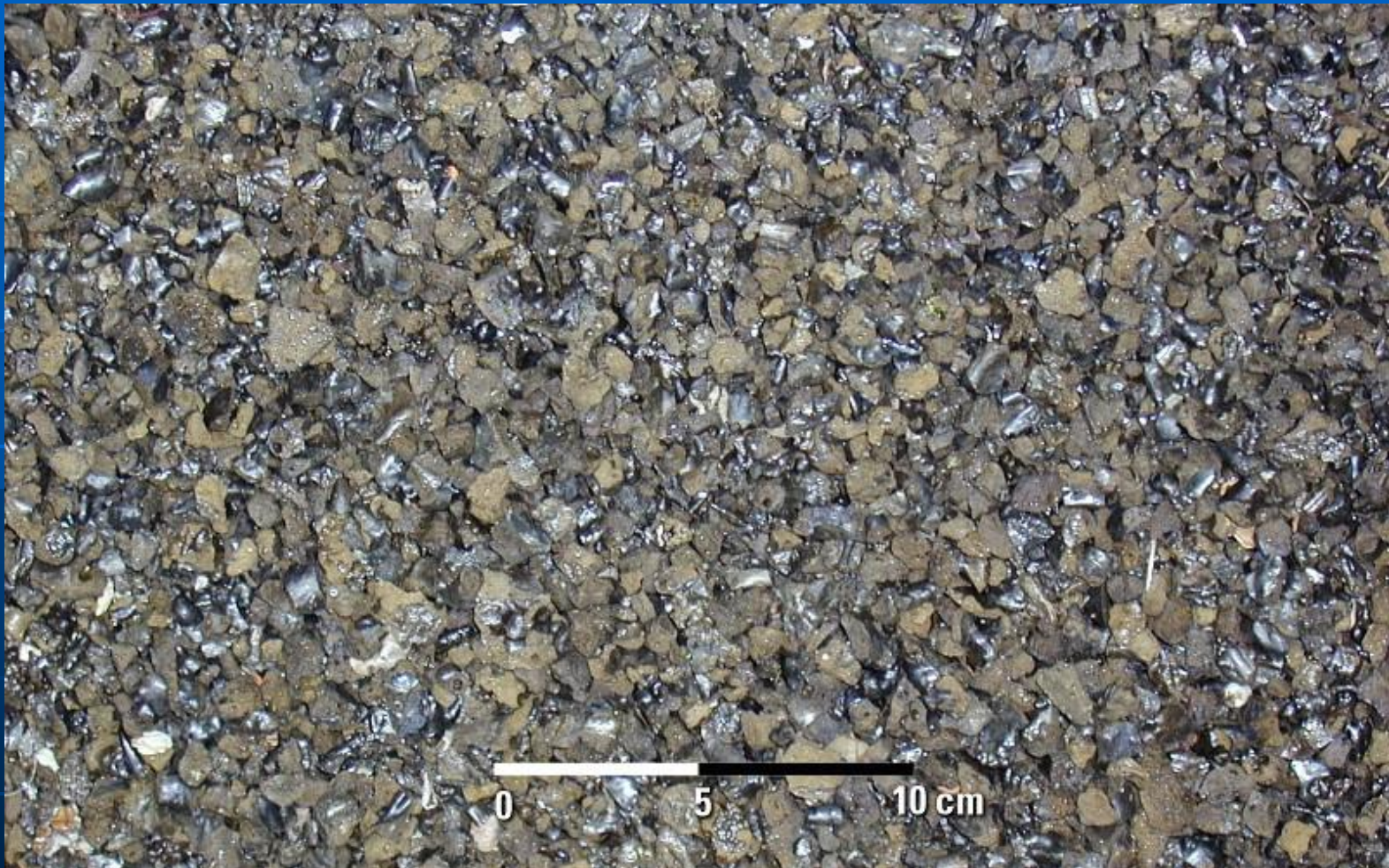
Solid Ash and Rock
Fragments erupted from
Volcanoes are called
pyroclastic material. They
are classified by size.

Volcanic Ash: Diameter < 2 mm



USGS Photo by Lyn Topinka, August 22, 1980

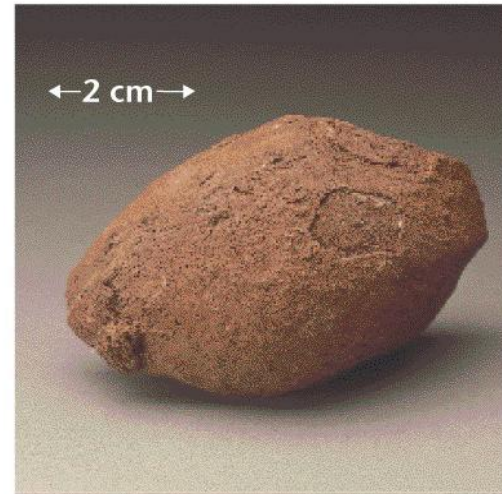
Volcanic Lapilli: Diameter from 2 to 64 mm



Volcanic Blocks or Bombs: Diameter > 64 mm



Volcanic Bomb





*Pyroclastic
Flow:*
pyroclastic
material
combines with
hot gases. Can
travel at speeds
> 100 km/hr.

Volcanic Landforms

“Shield Volcanoes

Cinder Cones

Composite Volcanoes

Calderas

Lava Domes

See graphic on pages 202
to 203!

Shield Volcanoes: Broad bases and gently sloping sides. Because they discharge basaltic flows, they are usually the least explosive.



Shield Volcanoes: Broad bases and gently sloping sides. Because they discharge basaltic flows, they are usually the least explosive.



Shield Volcanoes are usually found above hot spots such as in Hawaii. Kilauea is an example.



Hot Spot

Cinder Cones: Cone-shaped mound that are smaller than other volcanoes. They can be quite explosive.



Cinder Cones: Cone-shaped mound that are smaller than other volcanoes. They can be quite explosive.



Panum Crater near Mammoth and Mono Craters

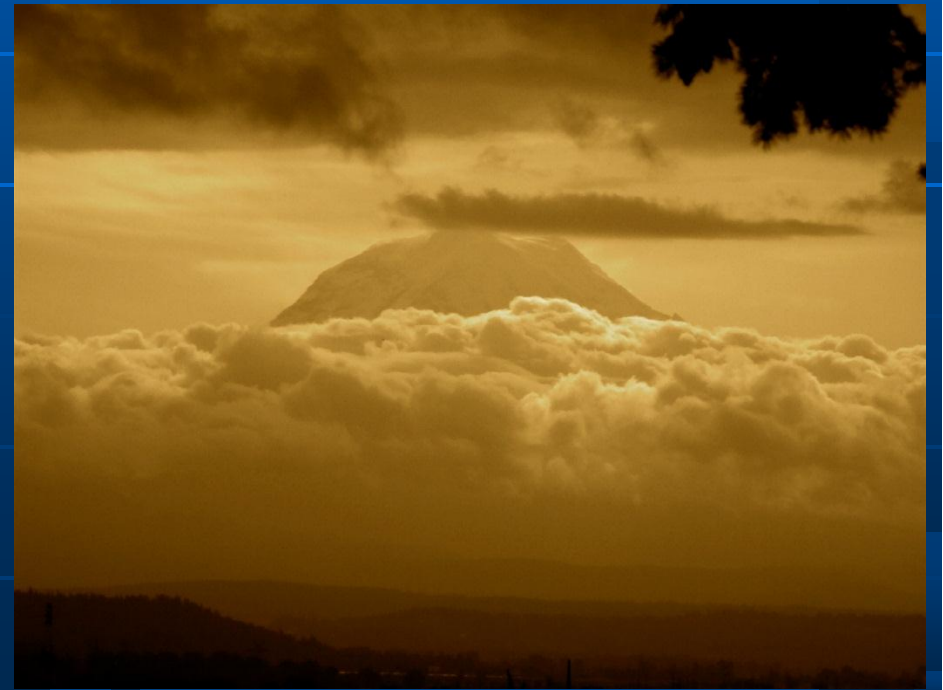


Fossil Falls and Red Hill at the Southern part of the Owens Valley

Cinder Cones can usually be found over subduction zones on continents. Paricutin and El Chichon in Mexico are examples.



Composite Volcanoes
(*stratovolcano*): The largest of all!
They are usually quite explosive
and are made of alternating layers
of lava and pyroclastic material.



Lahars: Fast moving rivers of mud and debris flow.



Composite Volcanoes are usually found above subduction zones. Mount Fuji and Mt. St. Helens are examples.



Calderas: a large crater-shaped basin caused by the collapse of the top of a volcano cone. Crater Lake, Oregon is an example.



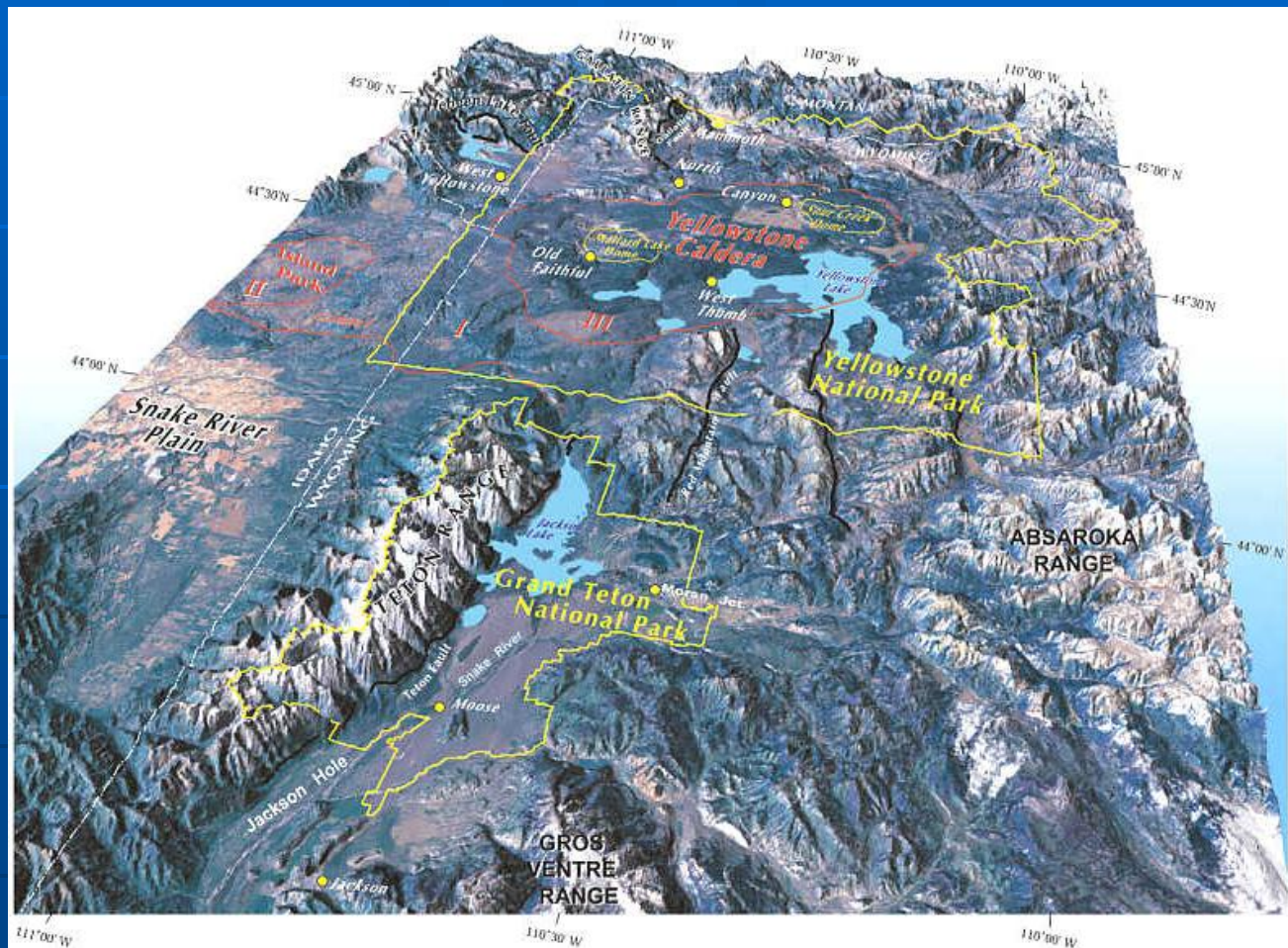
Crater Lake National Park, Oregon was formed when the 12,000 foot ancient Mt. Mazama erupted 7,700 years ago.



Wizard island formed from eruptions that came after the major eruption of Mt. Mazama.



Another example of a caldera is Yellowstone National Park.



Lava Dome: a mound of lava formed by viscous lava solidifying near the vent.

