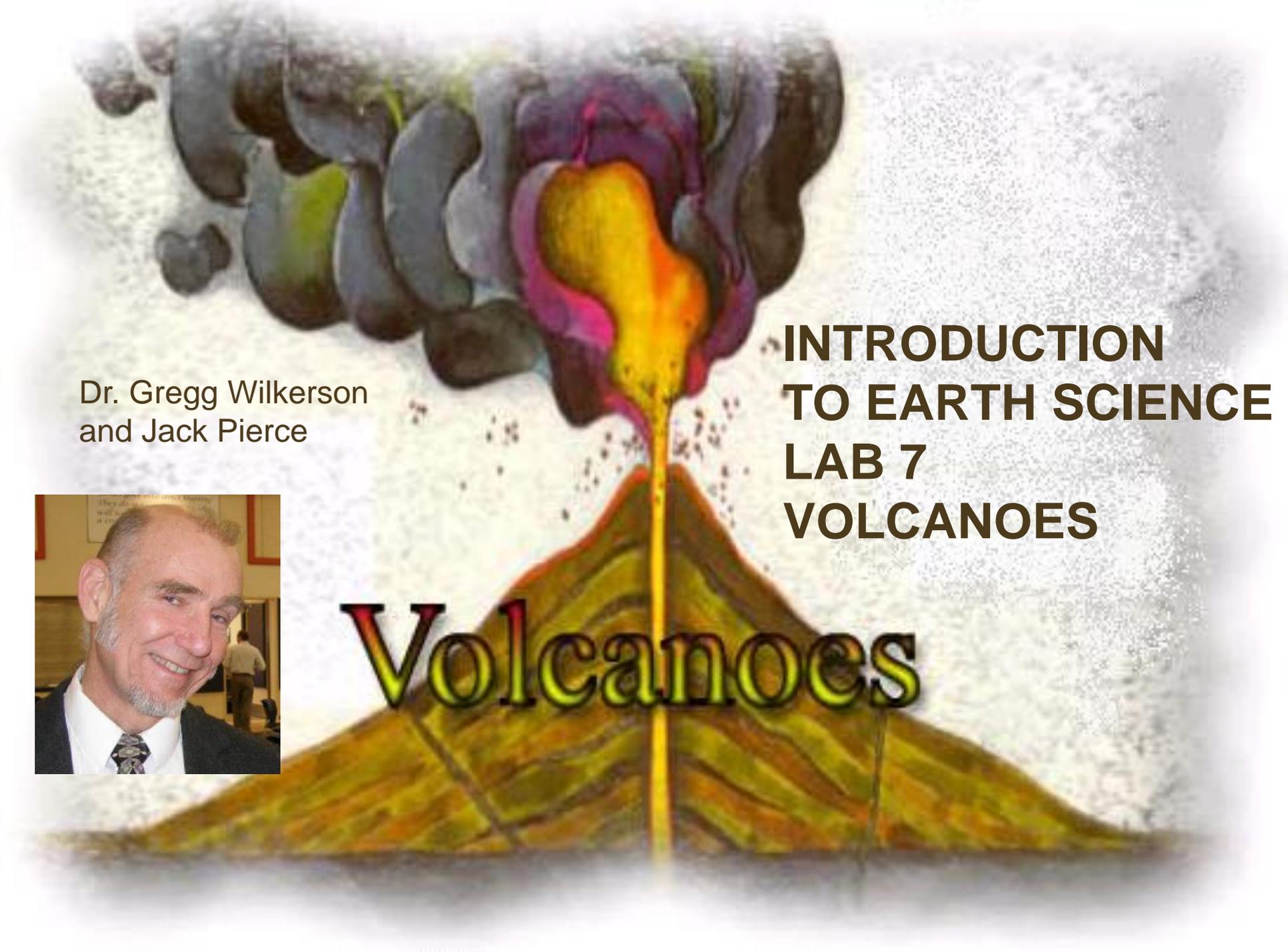


Dr. Gregg Wilkerson
and Jack Pierce



**INTRODUCTION
TO EARTH SCIENCE
LAB 7
VOLCANOES**

Volcanoes

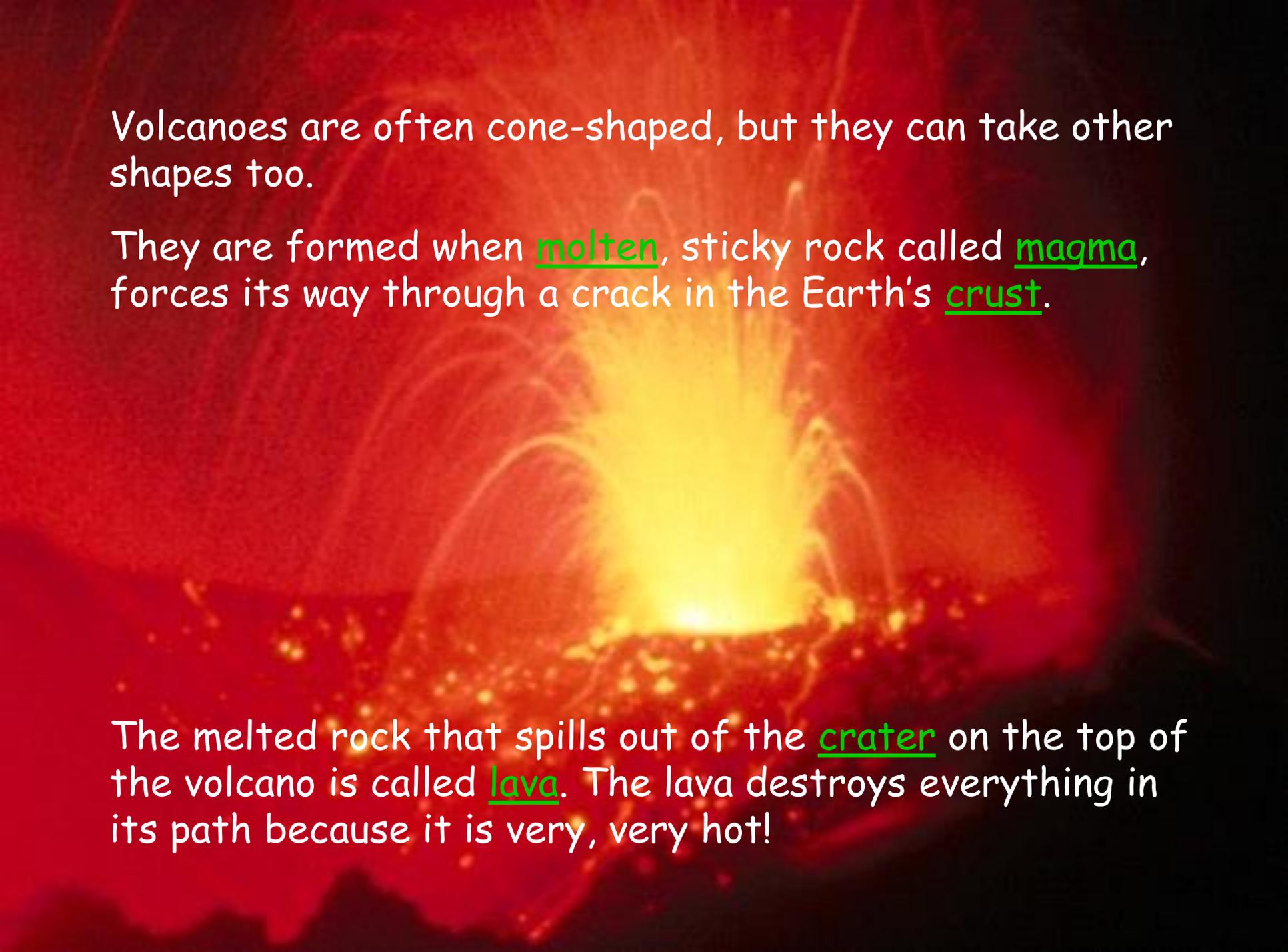




Volcanoes

Volcano Videos

- ANAK KRAKATAU
- https://video.search.yahoo.com/yhs/search;_ylt=AwrCwOU.VXtc5l8AKq4PxQt.;_ylu=X3oDMTByMjB0aG5zBGNvbG8DYmYxBHBvcwMxBHZ0aWQDBHNIYwNzYw--?p=explosive+volcanic+eruptions&fr=yhs-sz-001&hspart=sz&hsimp=yhs-001#id=1&vid=fccd8a38d05aa9241eae628f7b190683&action=view



Volcanoes are often cone-shaped, but they can take other shapes too.

They are formed when molten, sticky rock called magma, forces its way through a crack in the Earth's crust.

The melted rock that spills out of the crater on the top of the volcano is called lava. The lava destroys everything in its path because it is very, very hot!

Where do volcanoes happen?

Most volcanoes are formed on land, but there are some volcanoes that are on the ocean floor. Some of these volcanoes emerge from the water because they are very high.



Why does a volcano erupt?

A volcano erupts when magma and gases find a way to escape, so they burst to the surface through a vent. An eruption can be quite gentle or very violent.

Types of volcano

Volcanoes can be active, dormant or extinct.

- A volcano is active, or alive, when it erupts often.
- When a volcano is dormant, or sleeping, it has not erupted for a long time - but it might in the future.
- A volcano is extinct, or dead, when it hasn't erupted for at least 100,000 years.

But: Yellowstone Volcano erupted 2.1 million, 1.3 million, and 630,000 years ago



Eruption patterns

There are three different levels of eruption:

1. If it easy for the gases to escape, then the eruption is very gentle. However, the lava is very runny and can move very fast.



2. Gas builds up and lumps of rock ('bombs') and ash burst out of the volcano. This makes the lava thick and sticky.

3. This is the fiercest eruption of all because the gases and magma become trapped inside the volcano. This causes a huge explosion, which can be big enough to remove the top of the whole mountain!



Did you know?

Mount Kilauea, in Hawaii, is the most active volcano on Earth because it has been erupting since 1983!



Pumice stone, which comes from volcanoes, is very light because it contains a lot of tiny bubbles. If there are enough bubbles, then pumice stone can float on water!

The word, 'volcano' comes from the name Vulcan, who was the Roman god of fire.

GLOSSARY

Bomb - a lump of rock thrown out in an eruption

Crater - a deep hollow at the top of a volcano

Crust - The top layer of the Earth

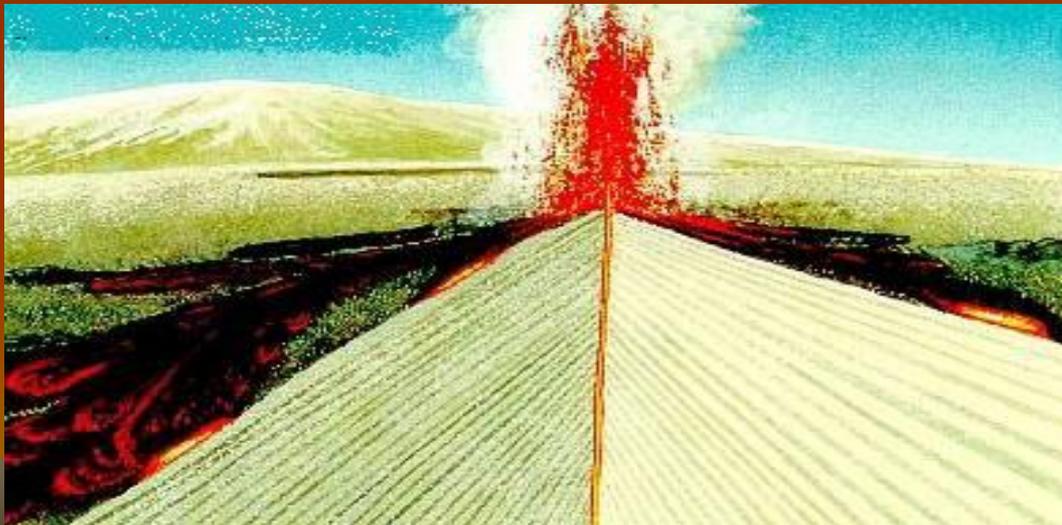
Eruption - the release of gases, magma and rock from a volcano

Lava - melted rock that flows down the volcano

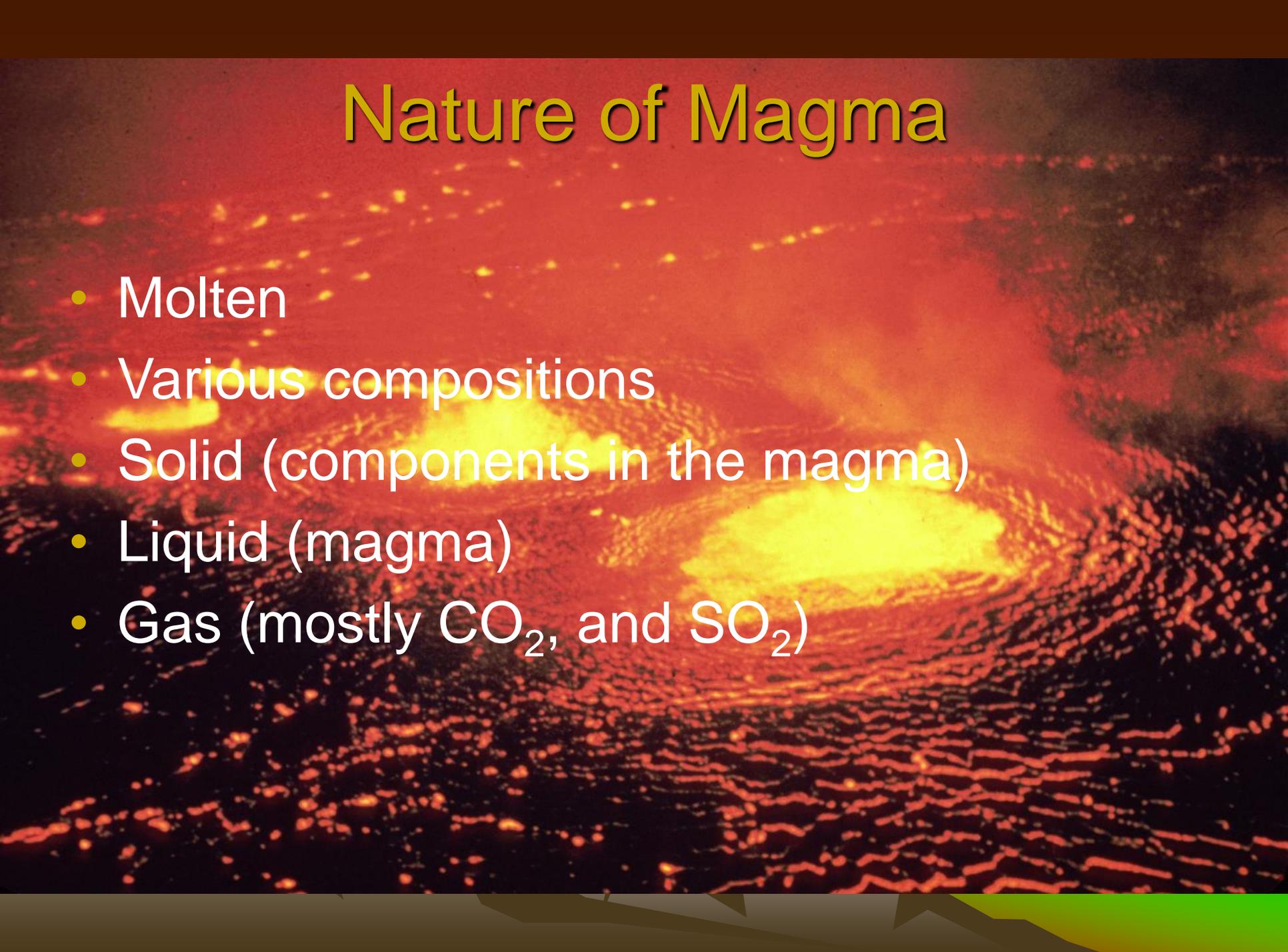
Magma - melted rock inside the Earth

Molten - melted, liquid

Vent - a crack on the side of a volcano where magma can escape



Nature of Magma

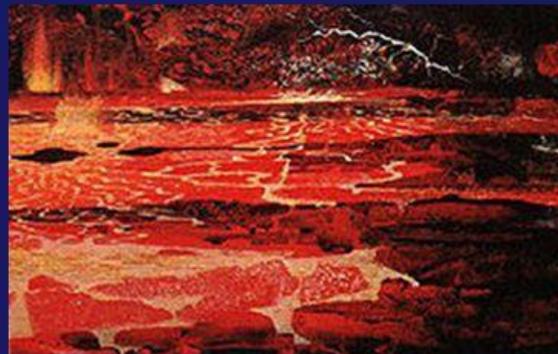


- Molten
- Various compositions
- Solid (components in the magma)
- Liquid (magma)
- Gas (mostly CO_2 , and SO_2)

Where does the Magma come from?: Partial Melting

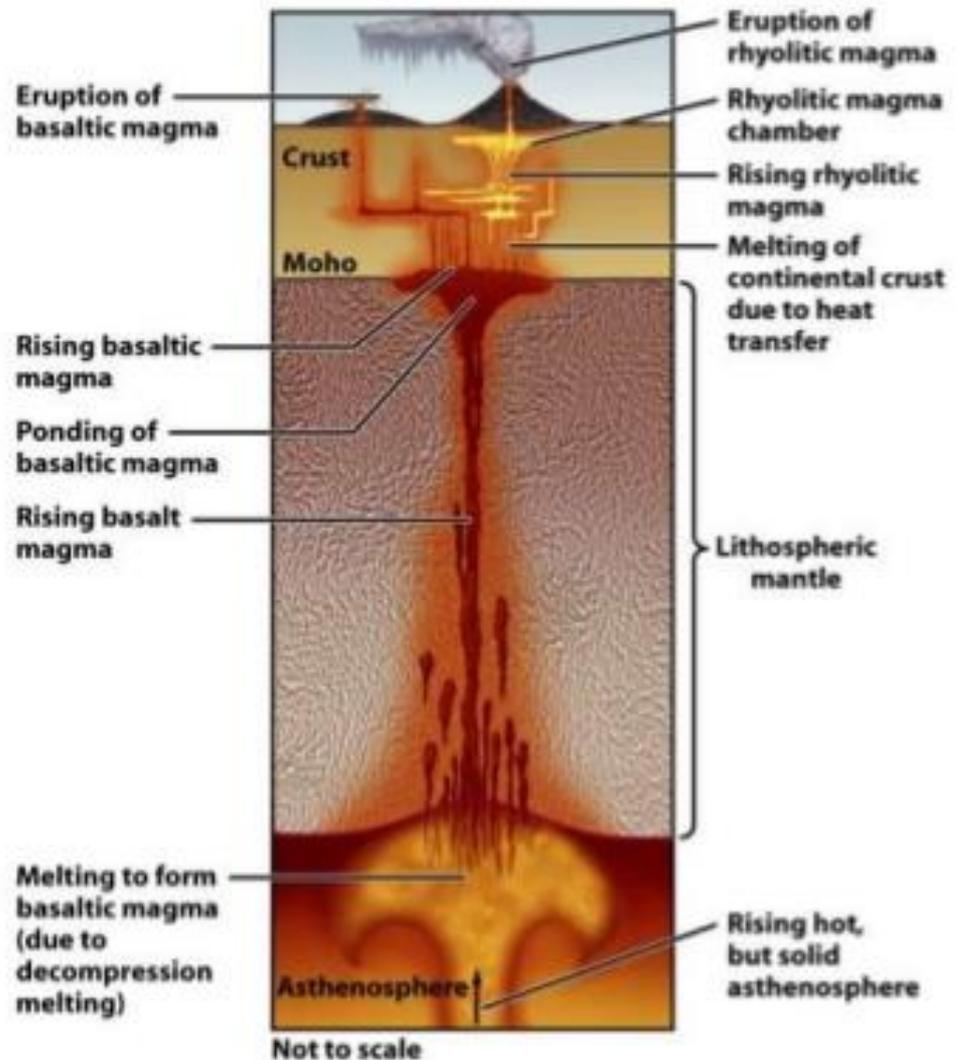
Partial Melting

- Minerals with **lower melting points** are the first minerals to melt.
- As the temperature increases and as other minerals melt, the magma's composition changes.



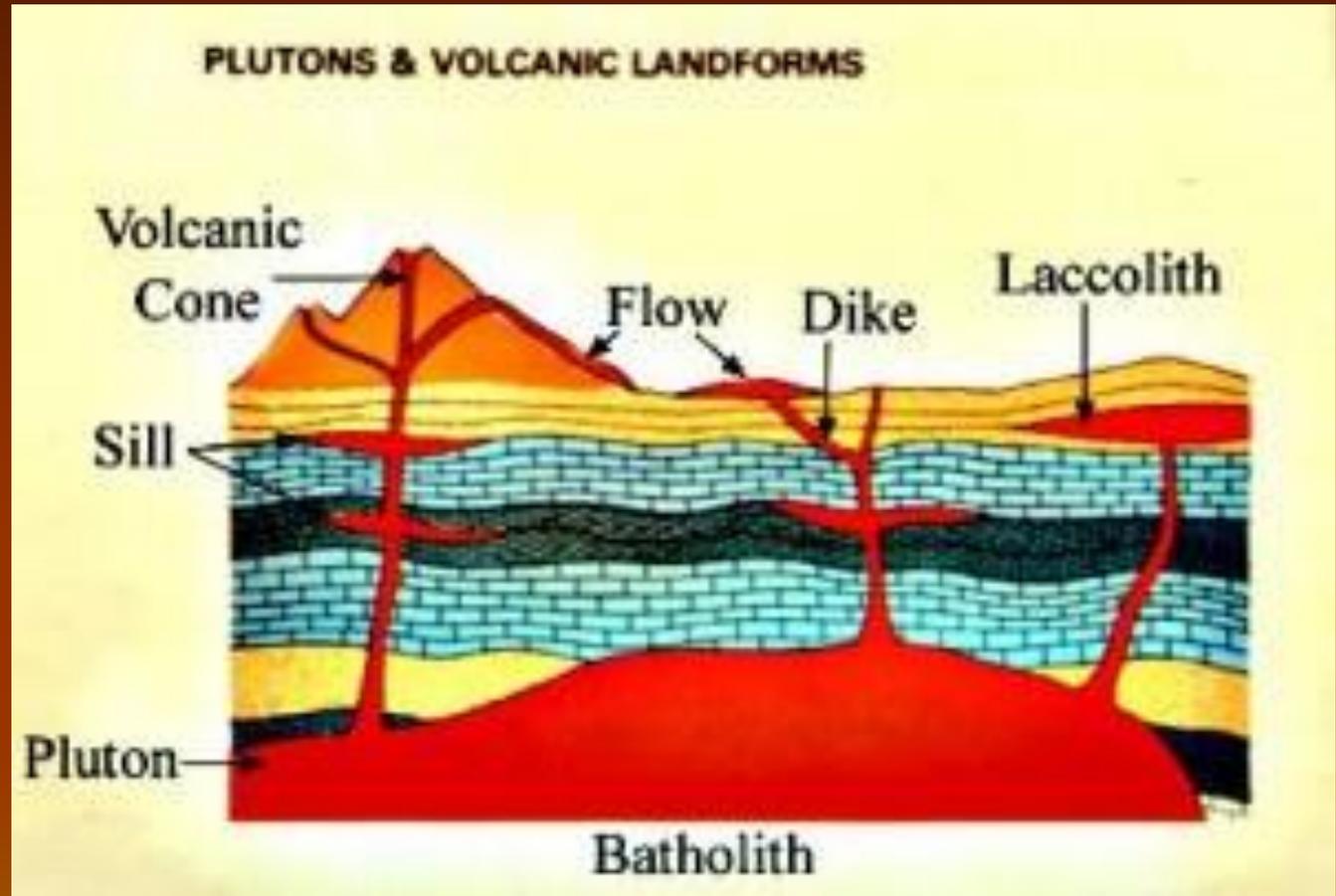
Magma Formation

- Melting (partial) in crust/upper mantle.
- Melting mechanisms:
 - 1 pressure release
 - 2 heat transfer
 - 3 volatile addition



Magma to Volcanic Rock

- Intrusion
- Extrusion



More silica

Less silica

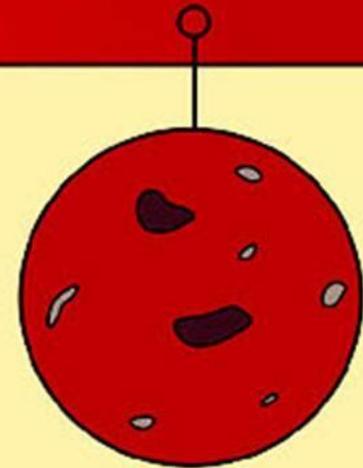
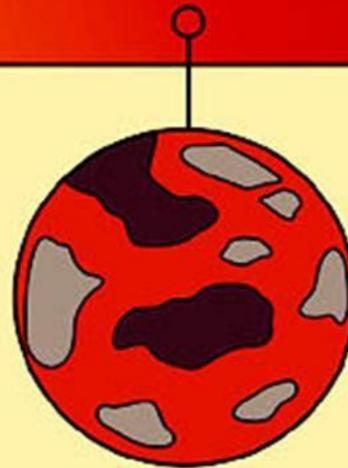
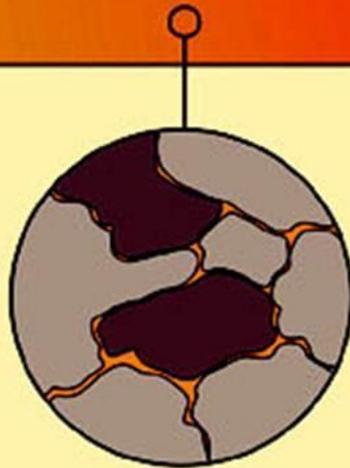
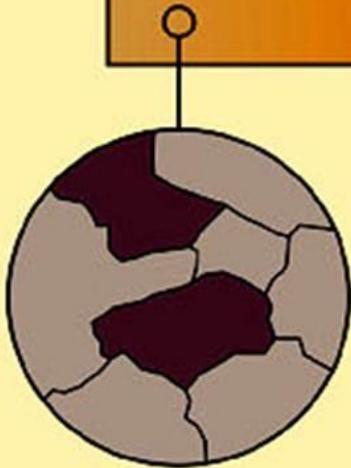
Relative silica content of magma

Temperature

No melt

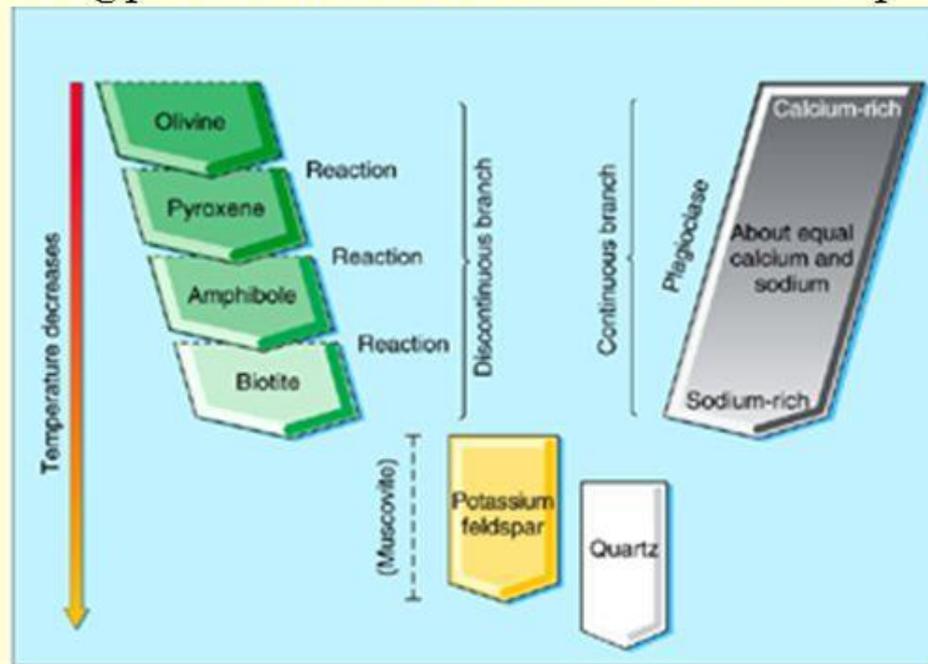
Partial melt

Nearly complete melt



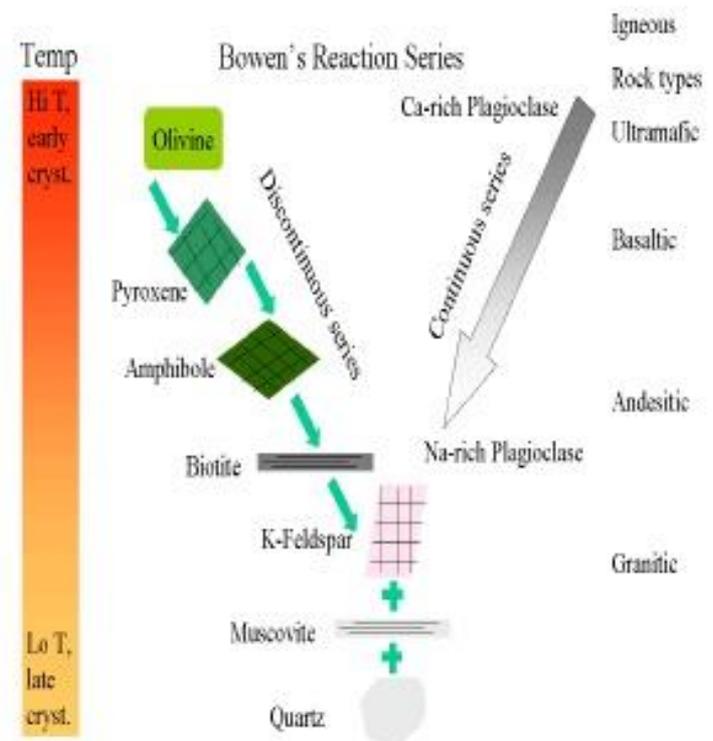
Magma Evolution

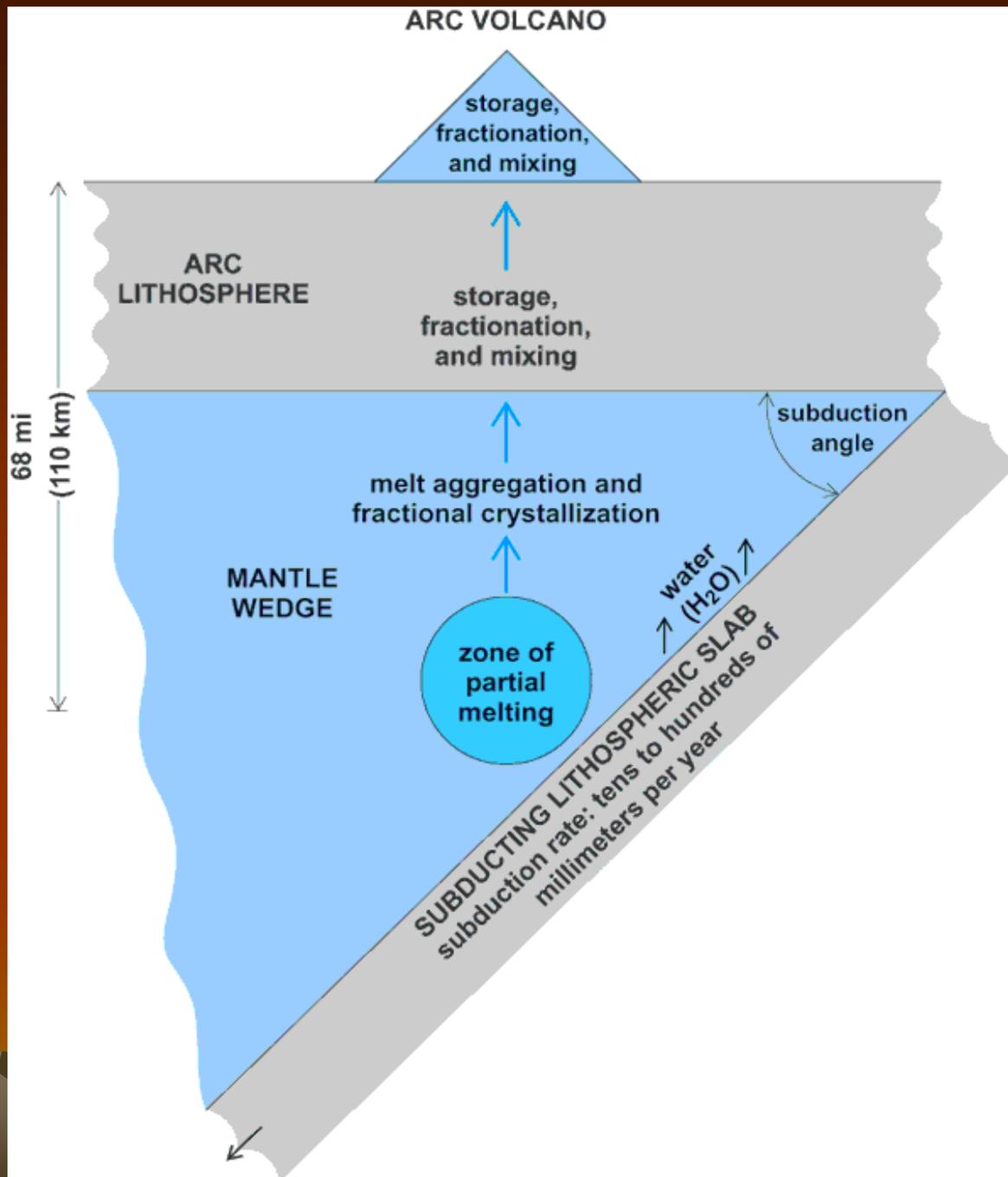
- Incomplete or **partial melting** produces magmas less mafic than their source rocks\
 - Minerals melt in the reverse order of that in which they crystallize from a magma
 - Lower melting point minerals are more felsic in composition



Bowen's Reaction Series

- Predictable pattern of magma cooling
- Feldspars (calcium rich) change composition to sodium rich rocks gradually
- Iron-Rich rocks change stepwise with fractional crystallization
 - Rocks form in order of Bowen's





I  a good volcanic eruption.

Discuss with a friend:

1. How are magmas made?
2. How does Bowen's Reaction Series explain the composition of magmas created from melting of different materials?
3. Where does partial melting occur?
4. What are the types of magmas and corresponding volcanoes?

I will get an A on my exams and quizzes.

Classification of Volcanic Rocks

- Texture (size)
- Composition (chemical)



Fine grained

Coarse grained

Rhyolite



Felsic

Granite



Andesite



Increasing silica content

Diorite



Basalt



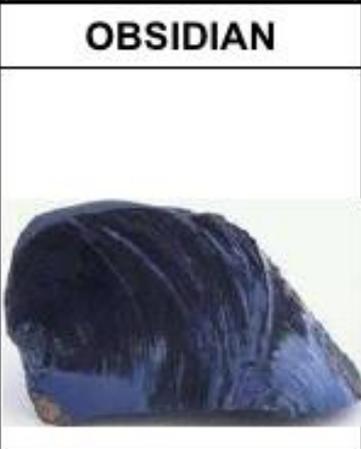
Mafic

Gabbro





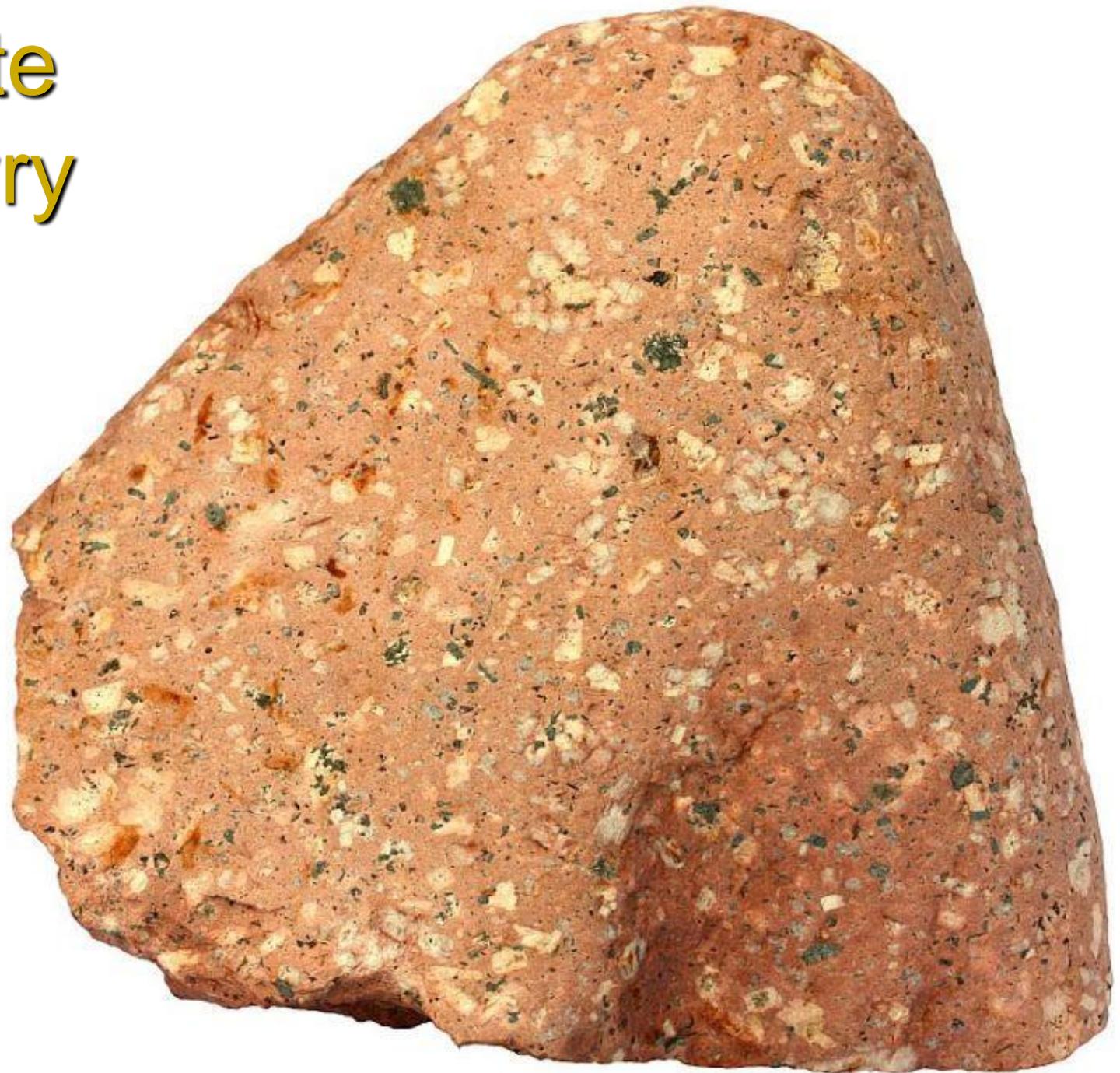
Igneous rocks

Common igneous rocks				
Plutonic or intrusive igneous rocks	GRANITE	PEGAMATITE	SYENITE	GABBRO
				
Volcanic or extrusive igneous rocks	VOLCANIC SCORIA	PUMICE	OBSIDIAN	BASALT
				

Porphyritic Volcanic Rocks



Rhyolite Porphyry



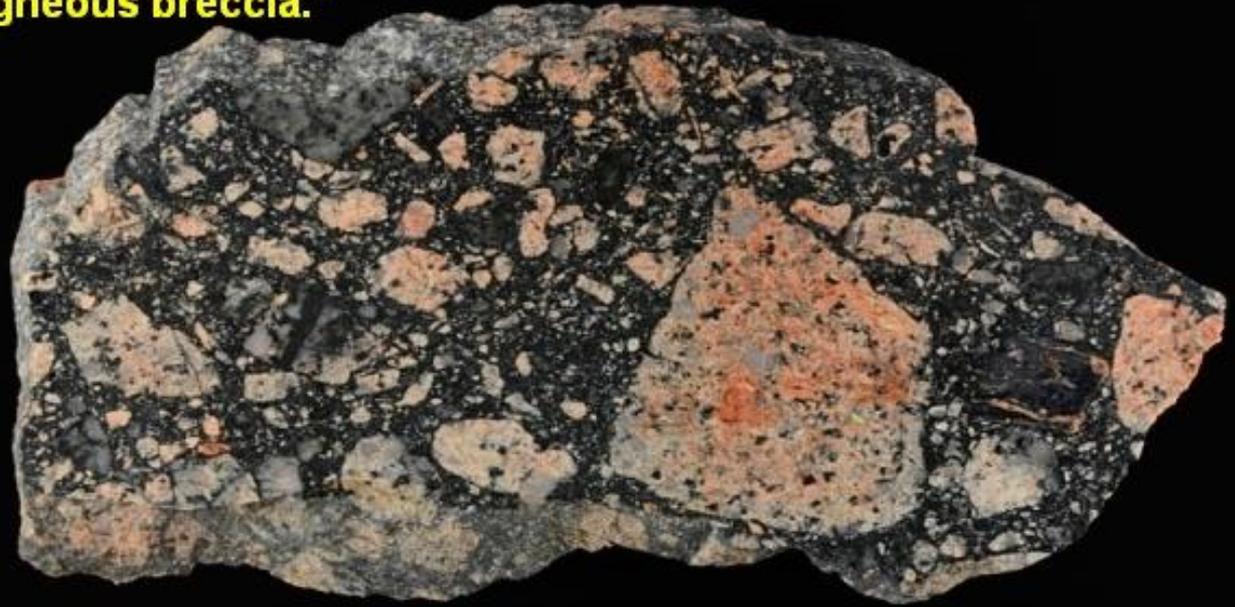
Andesite Porphyry



Special Volcanic Rocks

- Breccias
- Lahars

breccia composed of angular fragments of igneous rocks. "Flow breccia" and "pyroclastic breccia" could be called "igneous breccia."





I  a good volcanic rock

Discuss with a friend:

1. What are porphyritic rocks
2. What are breccias and lahars?
3. How to you tell basalt from andesite and rhyolite?

I will get an A on my exams and quizzes.

Lahar Volcanic Mudflow



Types of Basaltic Lava

- Pahoehoe
- AA



Pahoehoe Lava



AA lava



AA basaltic lava



Obsidian





Columnar Jointing





Morro Rock



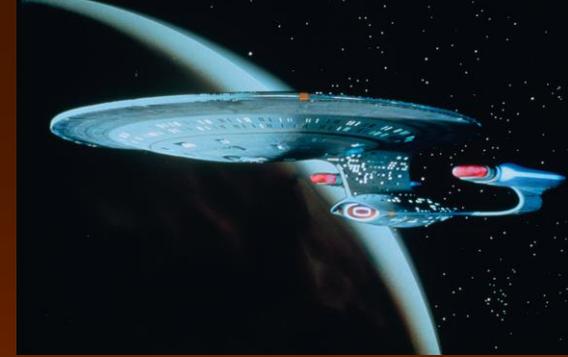
I  a good classification

Discuss with a friend:

1. Explain how volcanic lavas are classified
2. What is columnar jointing?

I will get an A on my exams and quizzes.

Star Trek Moment



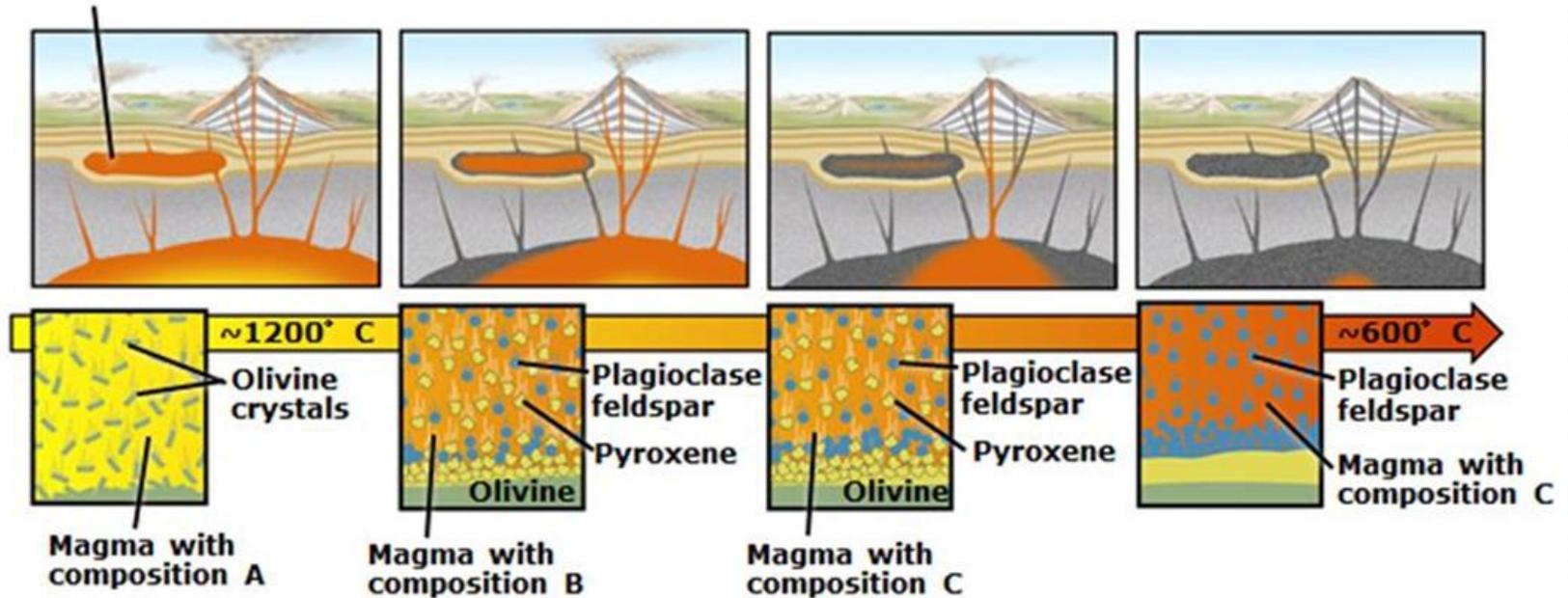
- The starship Voyager is boarded by a fugitive from a super-secret society. The planet is paranoid of being detected by other races. So they have developed the ability to make anyone they meet forget them. Or if anyone tries to leave the planet, they are hunted down, arrested, and their memories erased of their attempt to escape. [WATCH IT!](#)

Magma Cooling Fractional Crystallization and Differentiation



Fractional crystallization:

Palisades intrusion



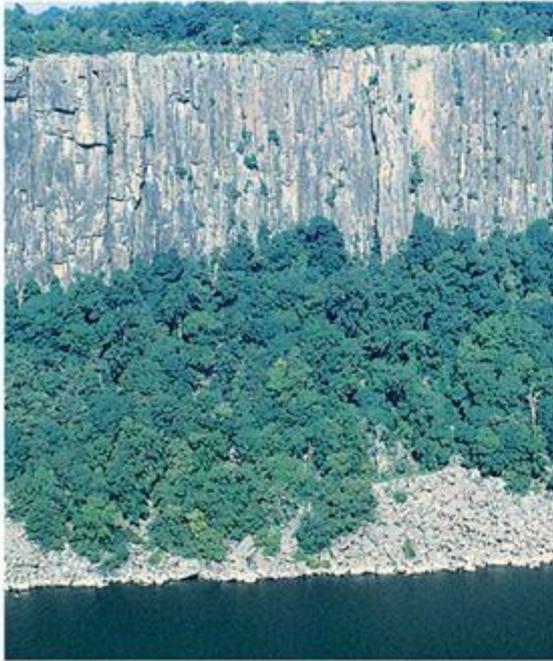
Olivine crystallizes first

Pyroxene and plagioclase feldspar crystallize

A gradient of pyroxene and feldspar is established.

Plagioclase feldspar continues to crystallize.

Fractional crystallization:

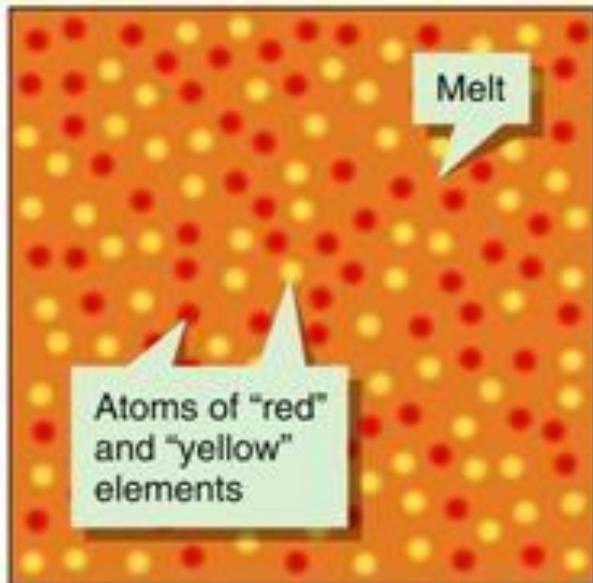


Basaltic intrusion
245-275 m (800-900 ft)

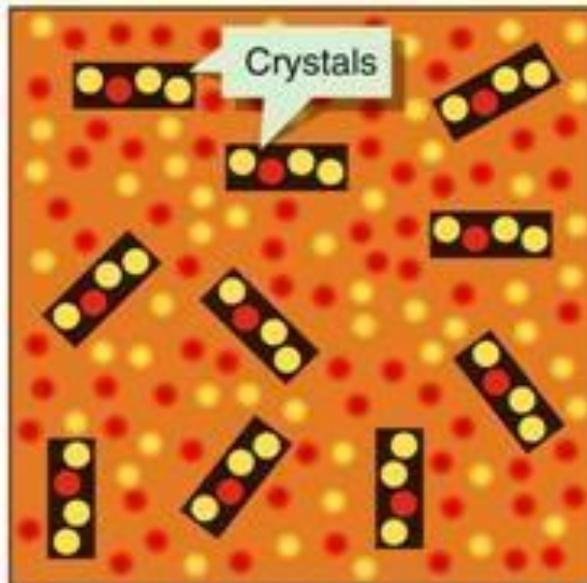


- Sandstone
- Basalt
- Mostly sodium-rich plagioclase feldspar; no olivine
- Calcium-rich plagioclase feldspar and pyroxene; no olivine
- Olivine
- Basalt
- Sandstone

Basalt cooled quickly at the edges of the intrusion.



100% Melt, 0% Crystals



75% Melt, 25% Crystals

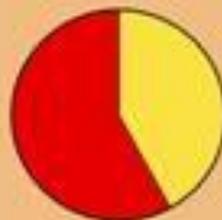


50% Melt, 50% Crystals



Ratio of red element to yellow element: 50:50

No crystals



Ratio of red element to yellow element: 58:42

Melt

Crystals



Ratio of red element to yellow element: 25:75



Ratio of red element to yellow element: 75:25

Melt

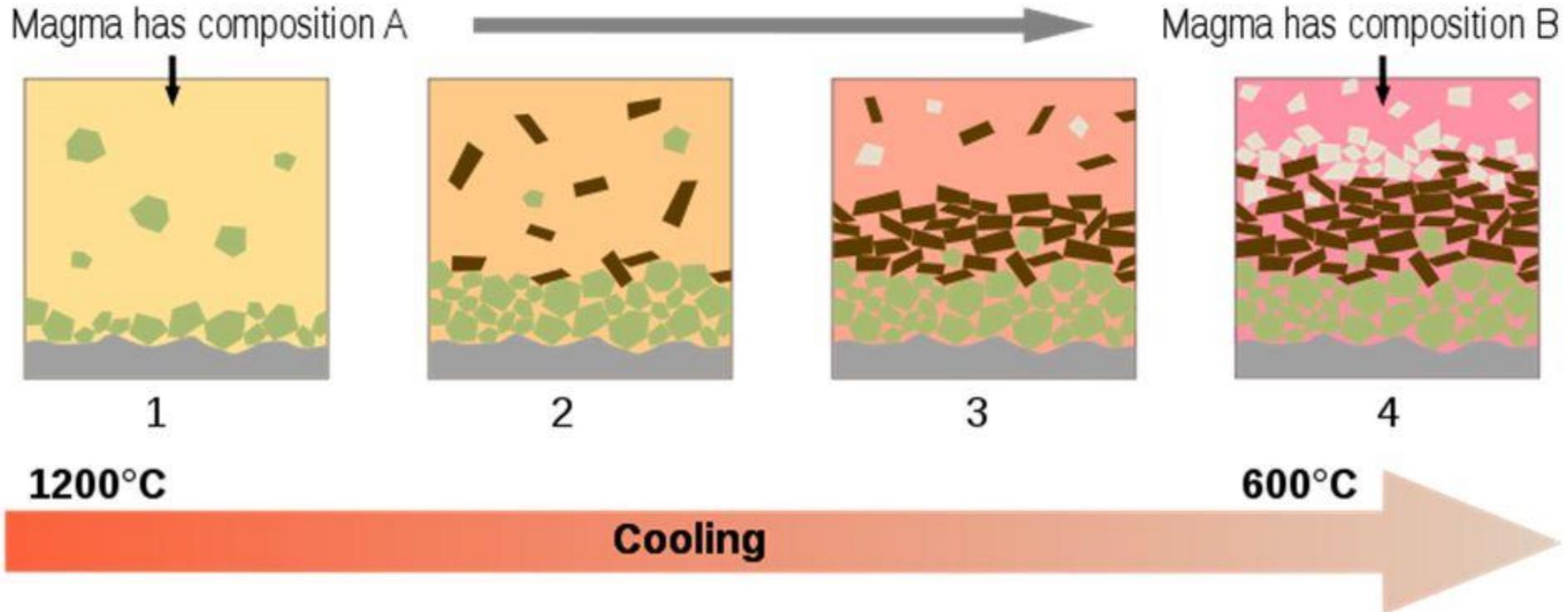
Crystals



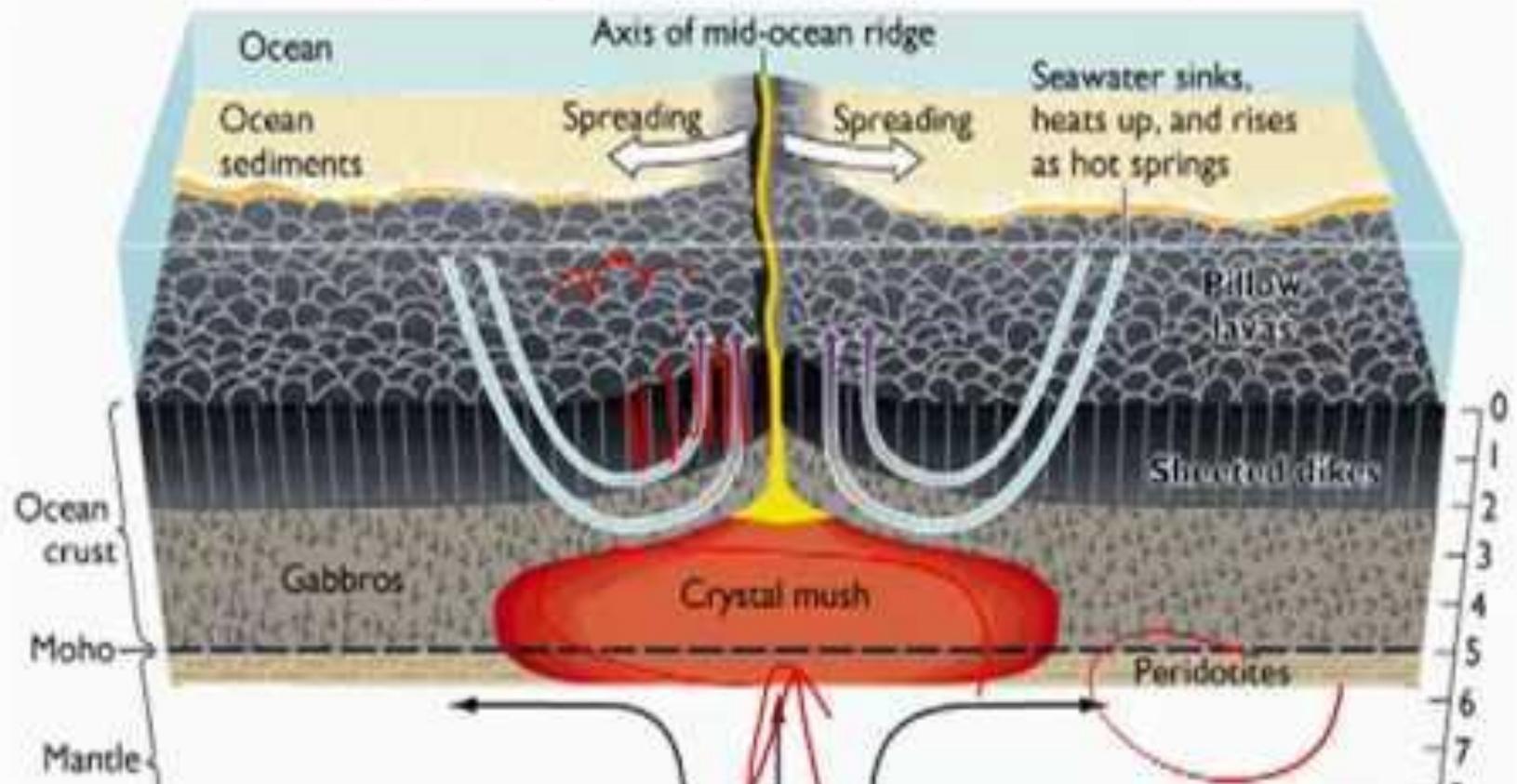
Ratio of red element to yellow element: 25:75

b. Fractional Crystallization:

- i. Magma crystallizes in the reverse order of partial melting when cooling.
- ii. The first minerals to crystallize were the last to melt.
- iii. **Fractional Crystallization:** The process wherein different minerals form at different temperatures.



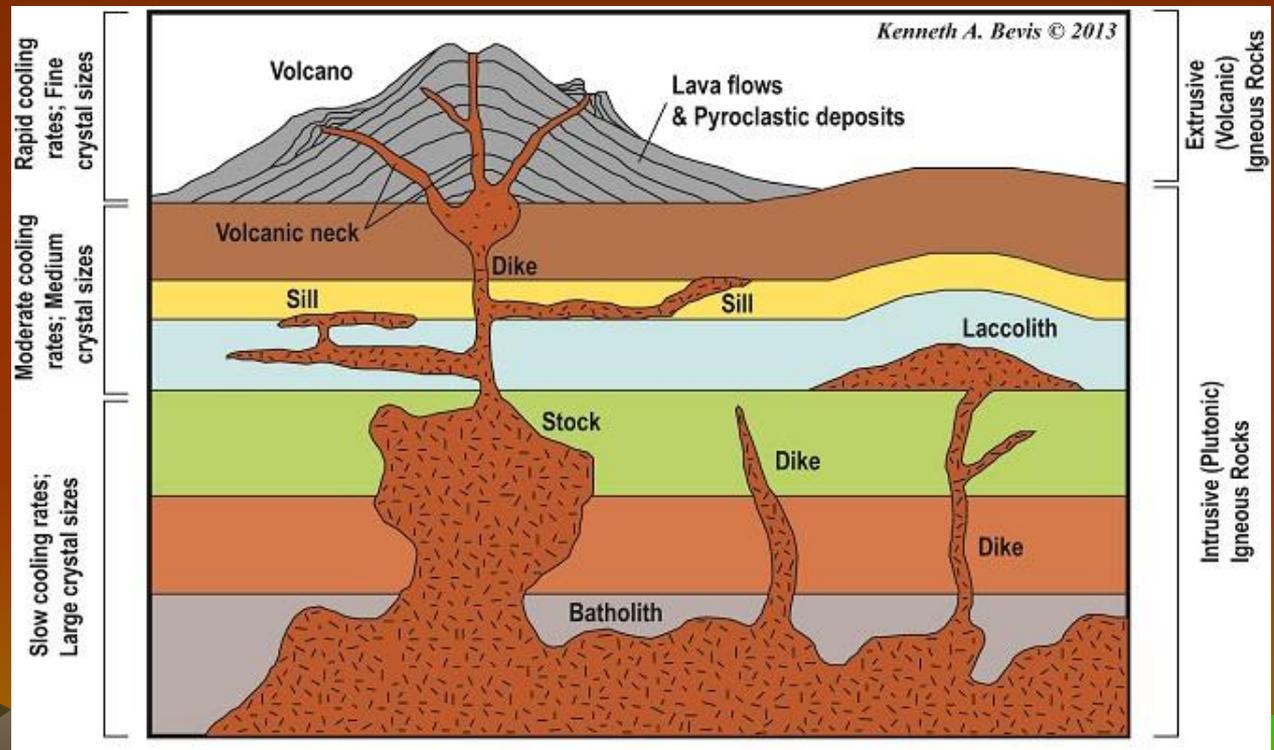
How can basalt be made from mantle-derived magma (mantle is peridotite)



100 kg of mantle peridotite (olivine + pyroxene): 43% SiO₂ → 38 kg of basaltic magma: 48% SiO₂ + 62 kg of olivine crystals: 40% SiO₂, which never melt and remain in the mantle

Volcanic Features

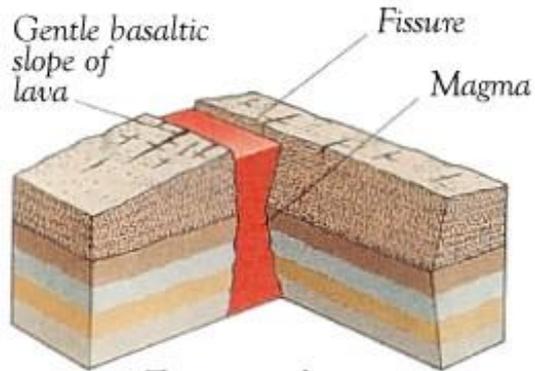
Intrusive
Extrusive



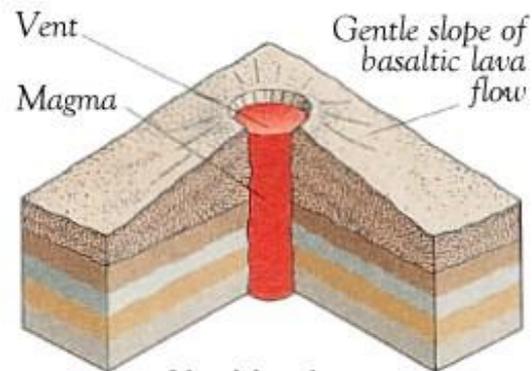
Extrusive



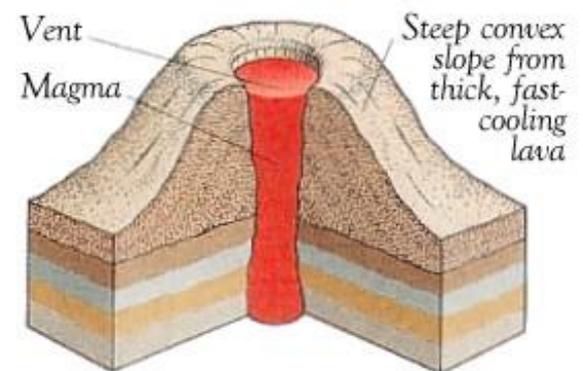
TYPES OF VOLCANO



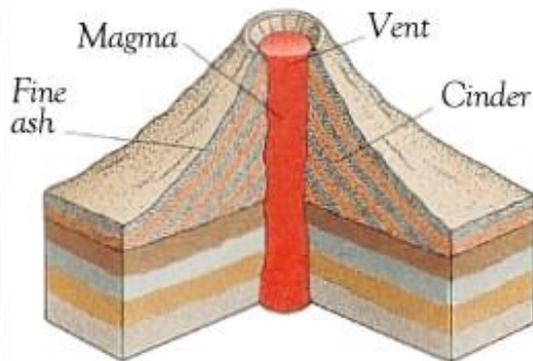
Fissure volcano



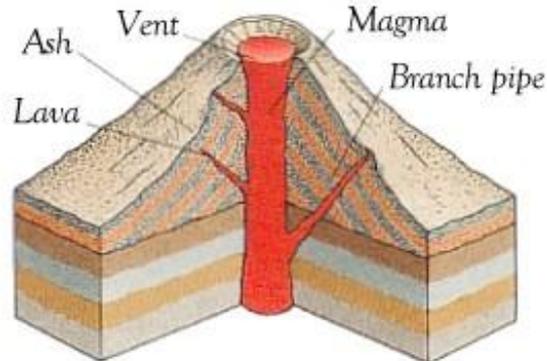
Shield volcano



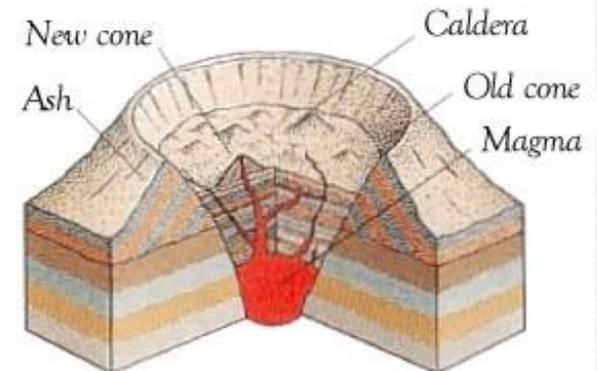
Dome volcano



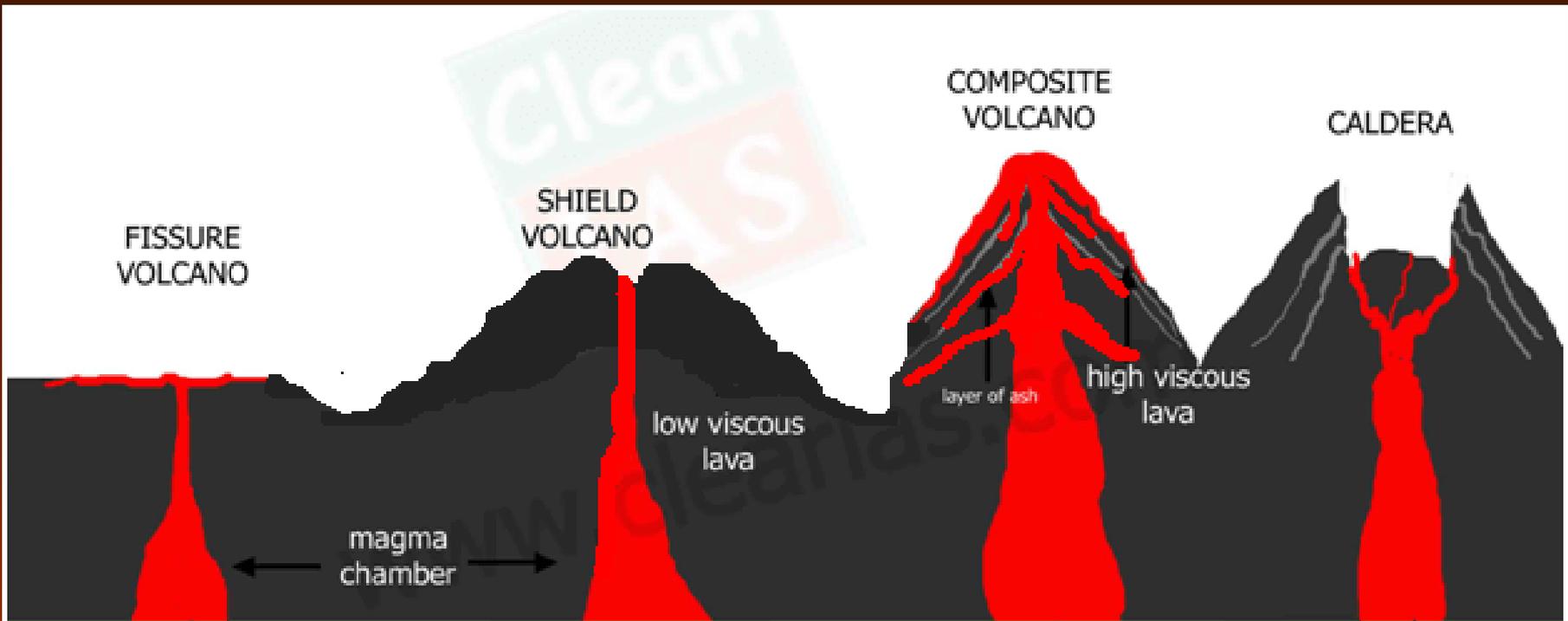
Ash-cinder volcano



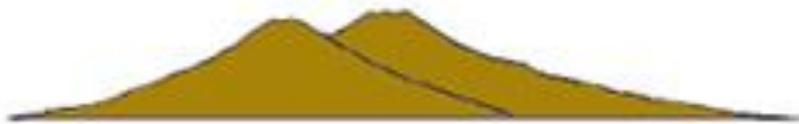
Composite volcano



Caldera volcano



Types of Volcanoes



COMPOUND VOLCANO
COMPLEX VOLCANO



STRATO - VOLCANO
(COMPOSITE VOLCANO)



SOMMA VOLCANO



CALDERA



SHIELD VOLCANO



LAVA DOME



CRATER ROW
FISSURE VENT



CINDER CONE
SCORIA CONE
PUMICE CONE



TUFF CONE



TUFF RING



MAAR

----- PYROCLASTIC CONES -----

Fissure Volcano



Shield Volcano



The Anatomy of a Shield Volcano

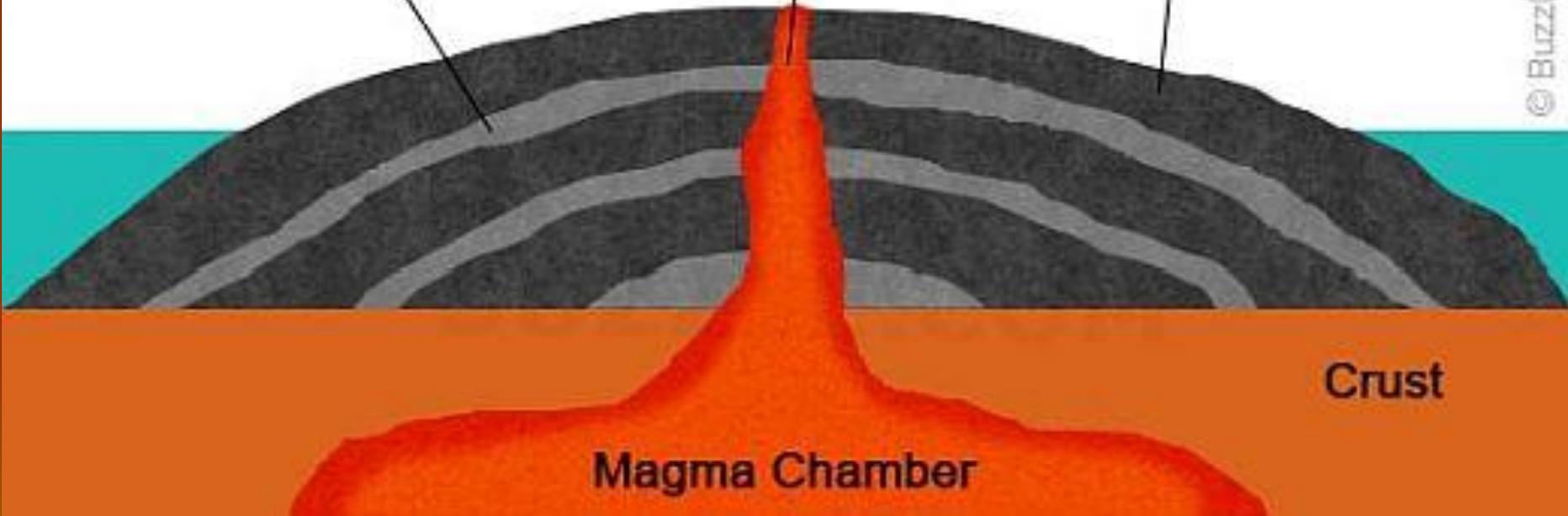
Formed through
gentle lava eruptions

Vent

Solid Lava layers

Crust

Magma Chamber





Dome Volcano

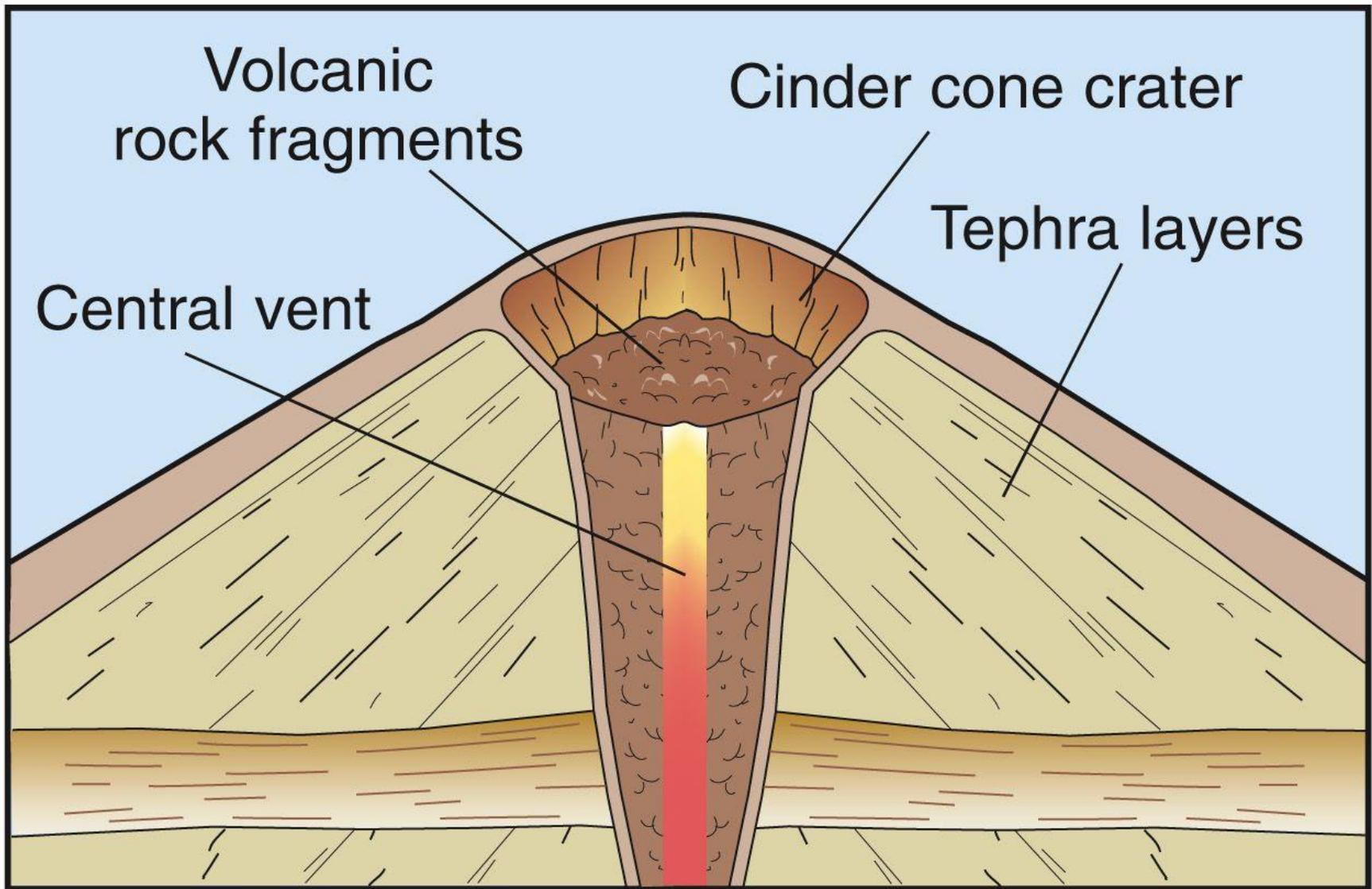






Cinder Cone Volcanos





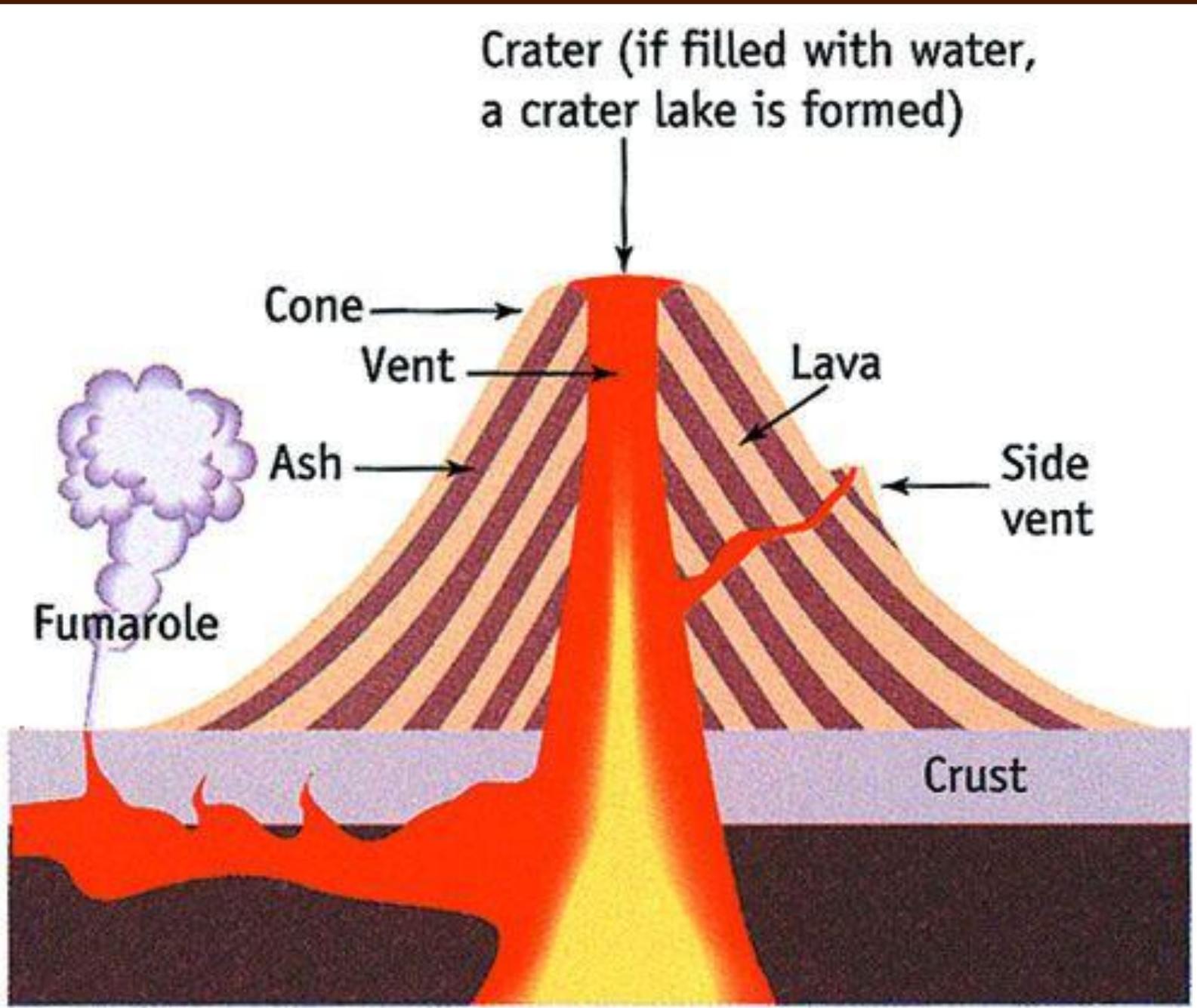
(b)





Composite Volcano











Caldera Volcanoes













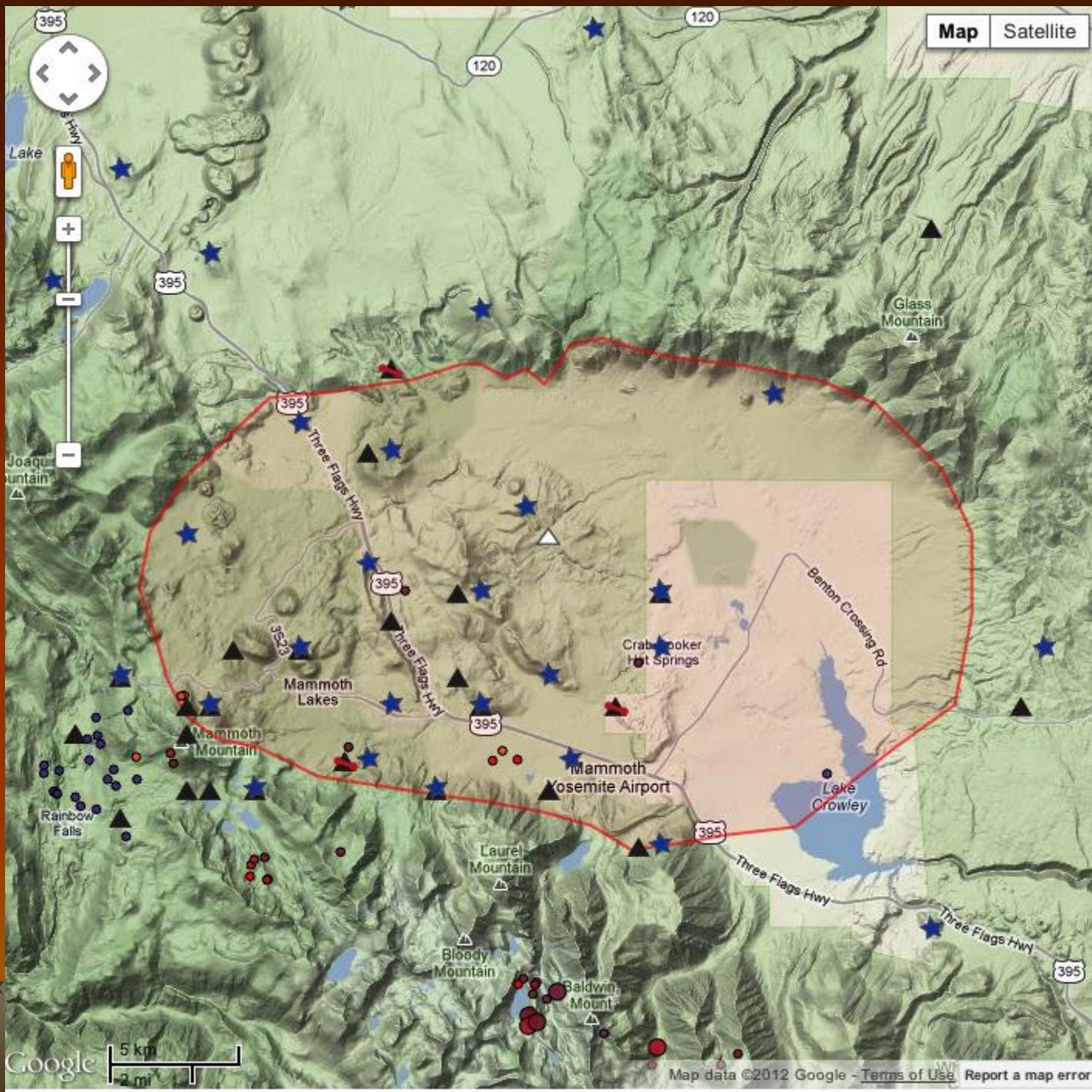
Long Valley Caldera

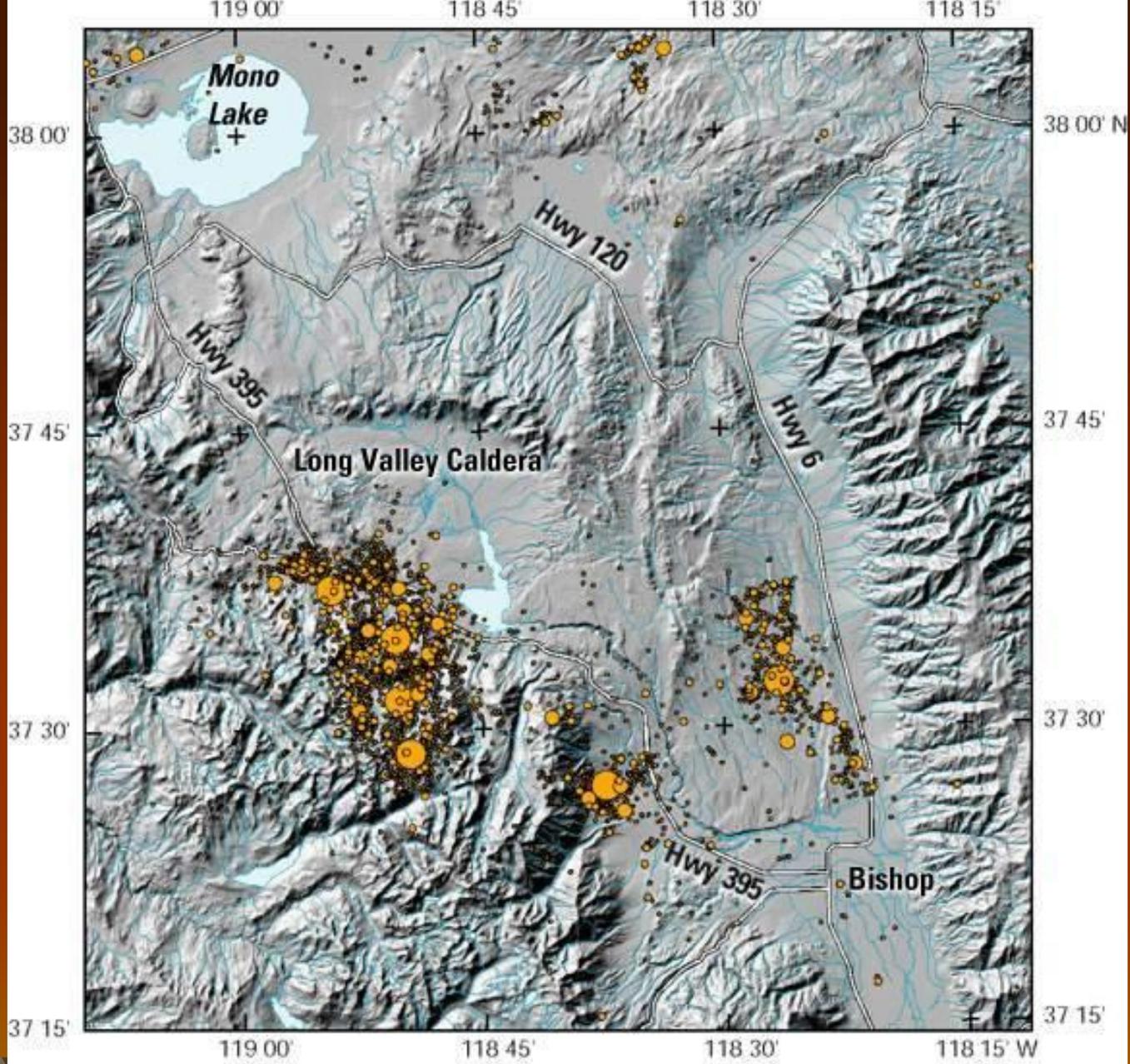


Long Valley Caldera

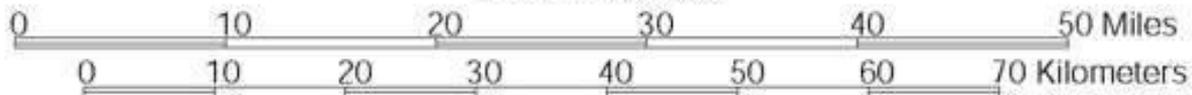
- https://video.search.yahoo.com/yhs/search;_ylt=AwrCwOUwSntcWzYAdm4PxQt.;_ylu=X3oDMTByMjB0aG5zBGNvbG8DYmYxBHBvcwMxBHZ0aWQDBHNIYwNzYw--?p=long+valley+caldera&fr=yhs-sz-001&hspart=sz&hsimp=yhs-001#id=51&vid=6d0fc9bf1edd450d56a130c65108a1d5&action=view

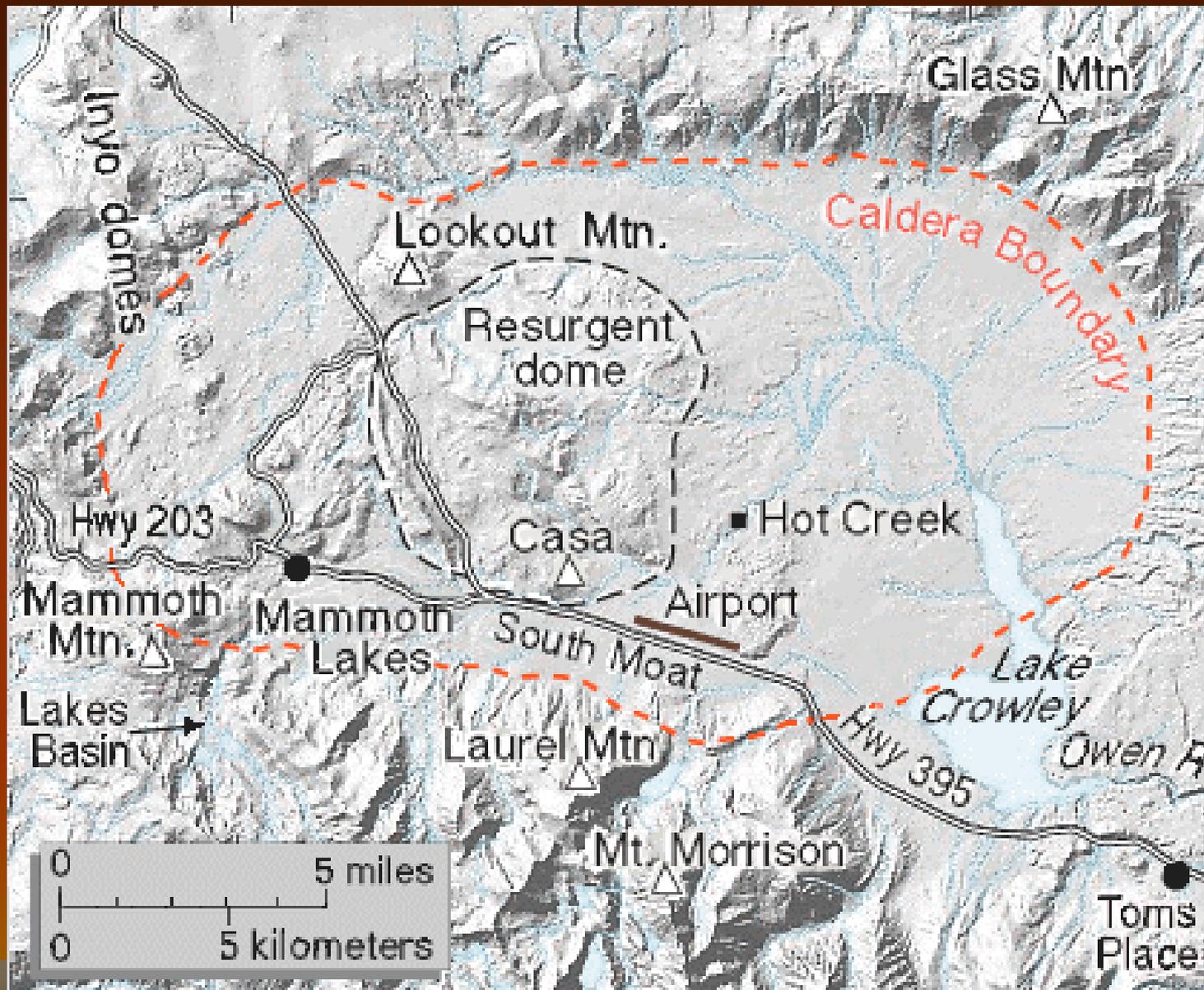






SCALE 1:500000



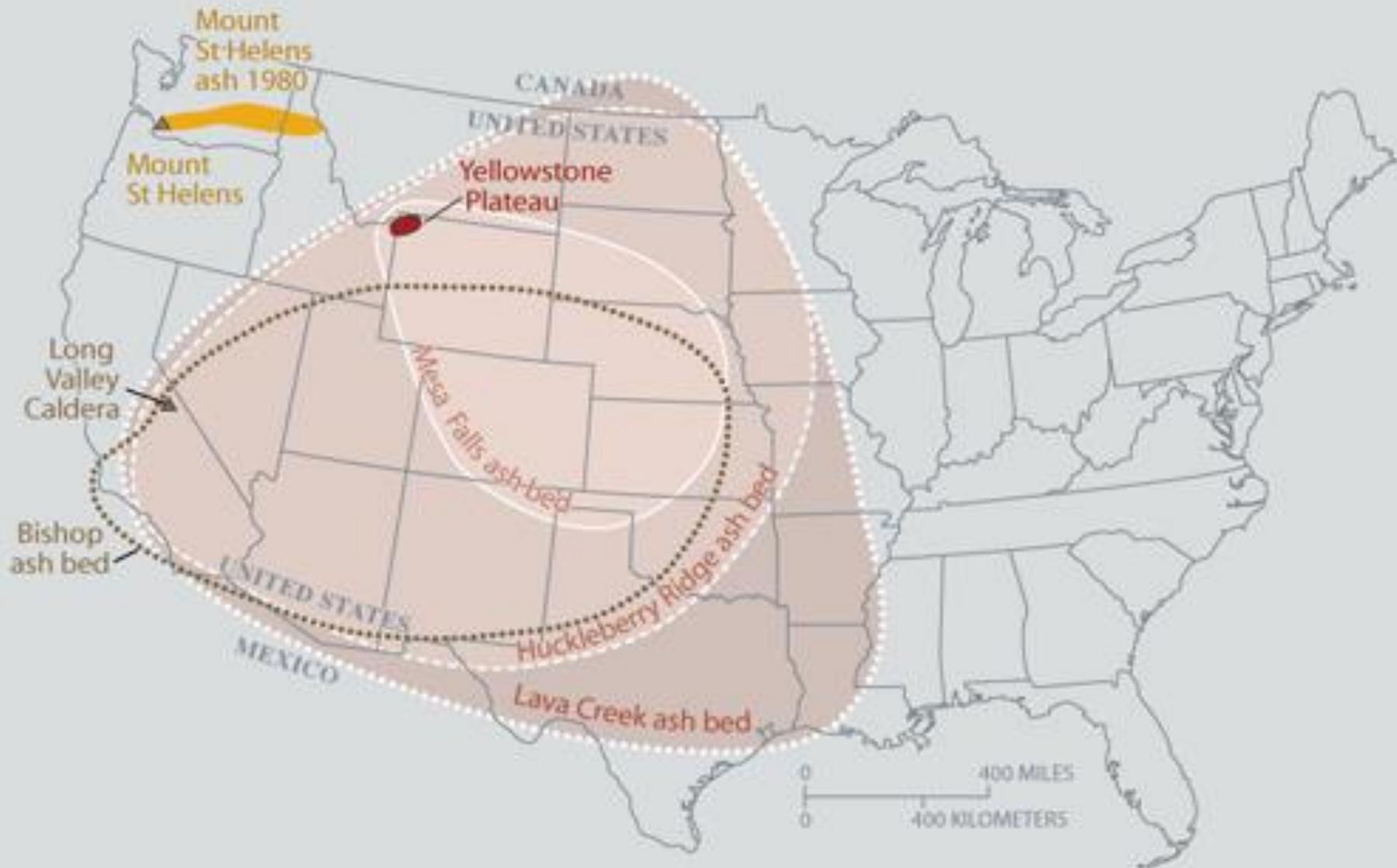


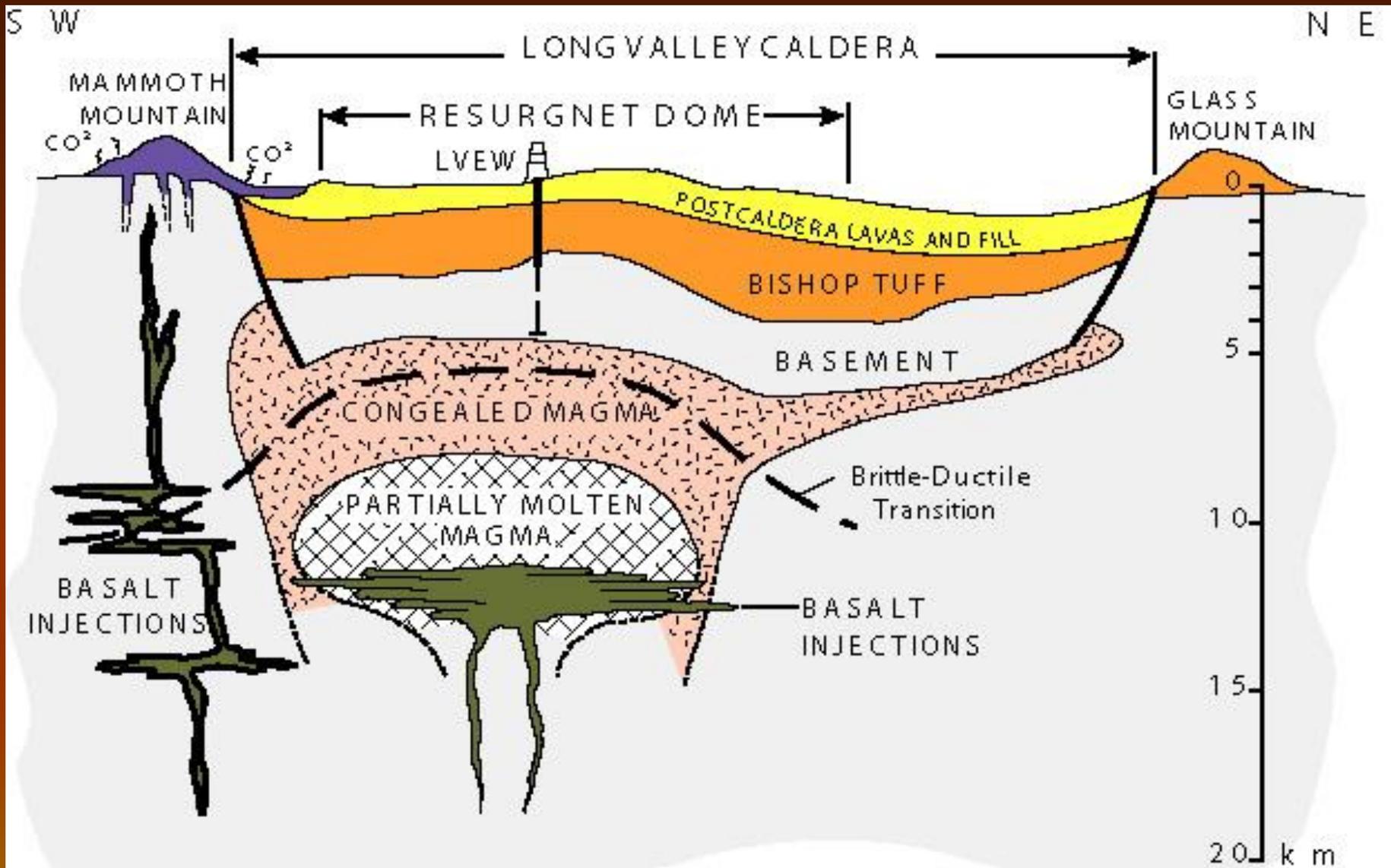
The Long Valley Caldera Erupted the Bishop Ash 760,000 Years Ago



FIGURE 6-22

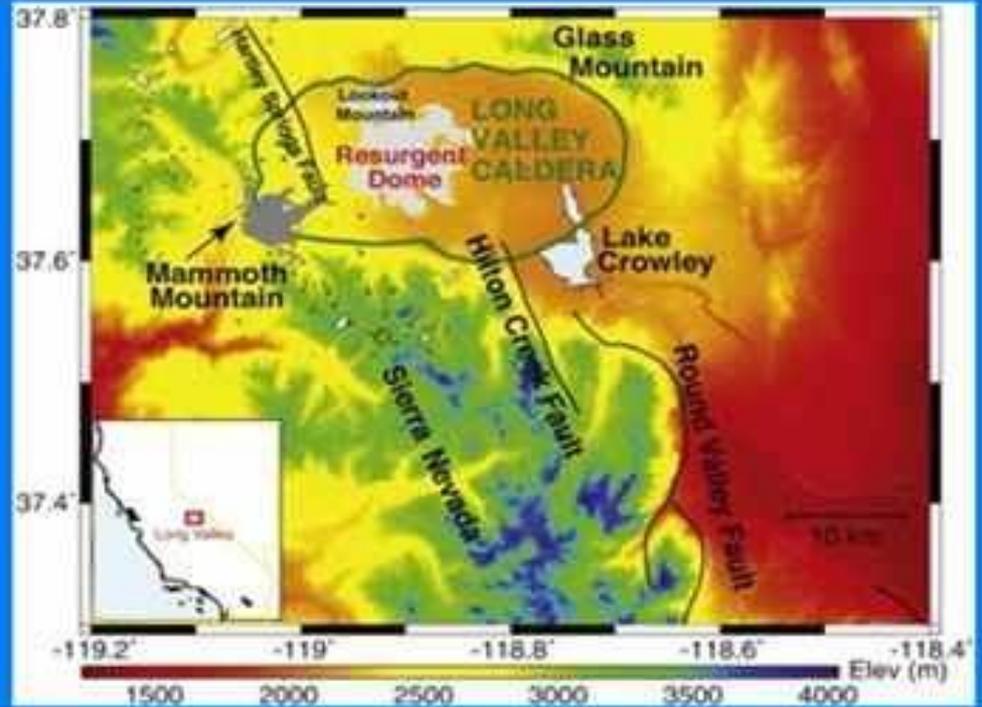
(a) This volcanic eruption covered most of the southwestern United States, including Los Angeles, with ash. The continued volcanic activity, which produced Mammoth Mountain (b) with its popular ski slopes, is still active and is being closely monitored by the U.S. Geological Survey.





Scientists Warning

California
Nevada
Arizona
New Mexico
Colorado
and Utah





I a good classification

Discuss with a friend:

1. Differentiate between intrusive and extrusive volcanic features
2. Explain how volcanoes are classified
3. Be able to draw: shield volcano, dome volcanoes, composite volcano, cinder cone, fissure eruptions.

I will get an A on my exams and quizzes.

Volcanic Features

- Concordant
- Discordant



Intrusive Igneous Structures

- Contacts (boundary between two rock bodies) can be:
 - **Concordant**
 - Does not cross cut country rock (surrounding rock) structure, bedding, or metamorphic fabric
 - Ex: laccolith, sill
 - **Discordant**
 - Cross cuts country rock structure
 - Ex: dike, batholith, stock

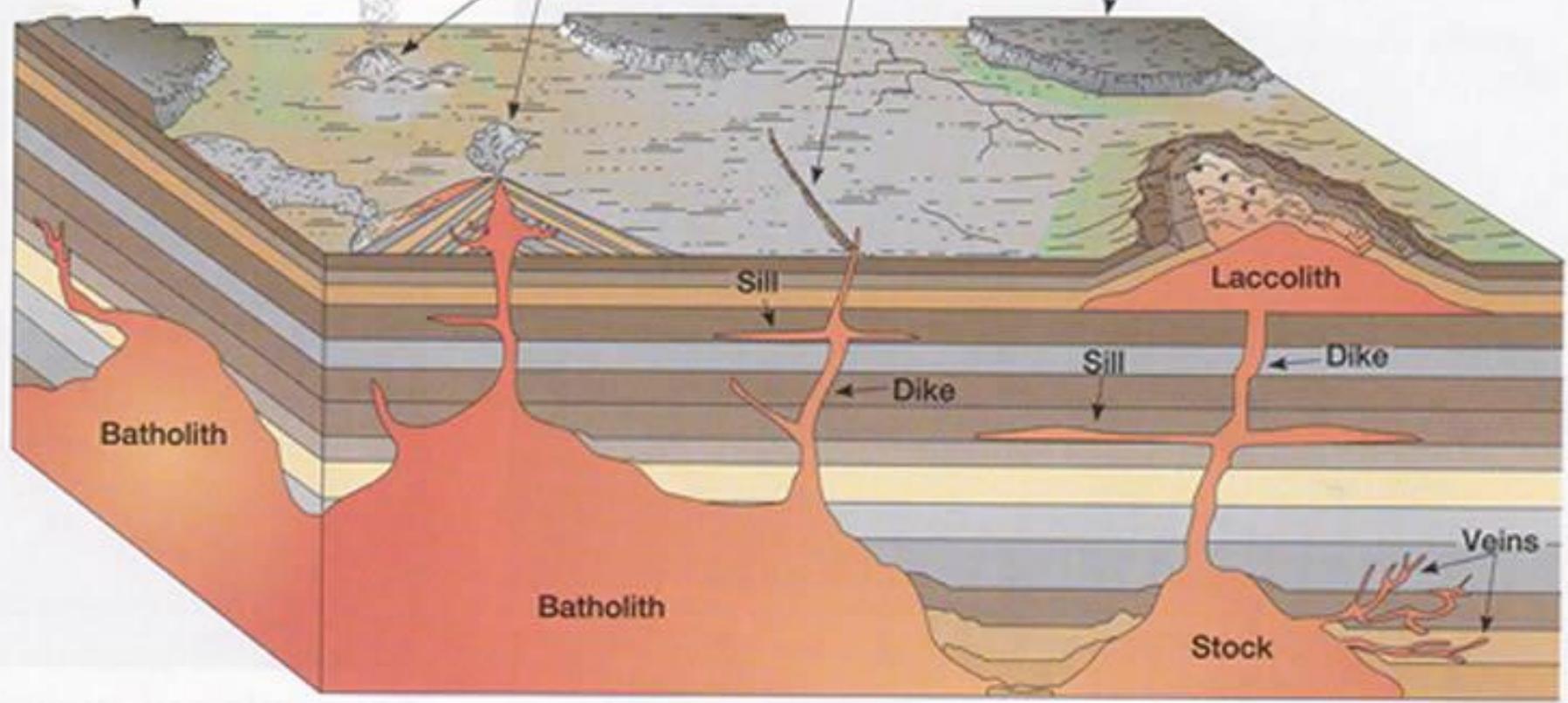


Lava-capped plateau

Volcanoes

Lava-capped plateau

Dike



Laccolith

Batholith

Batholith

Sill

Sill

Dike

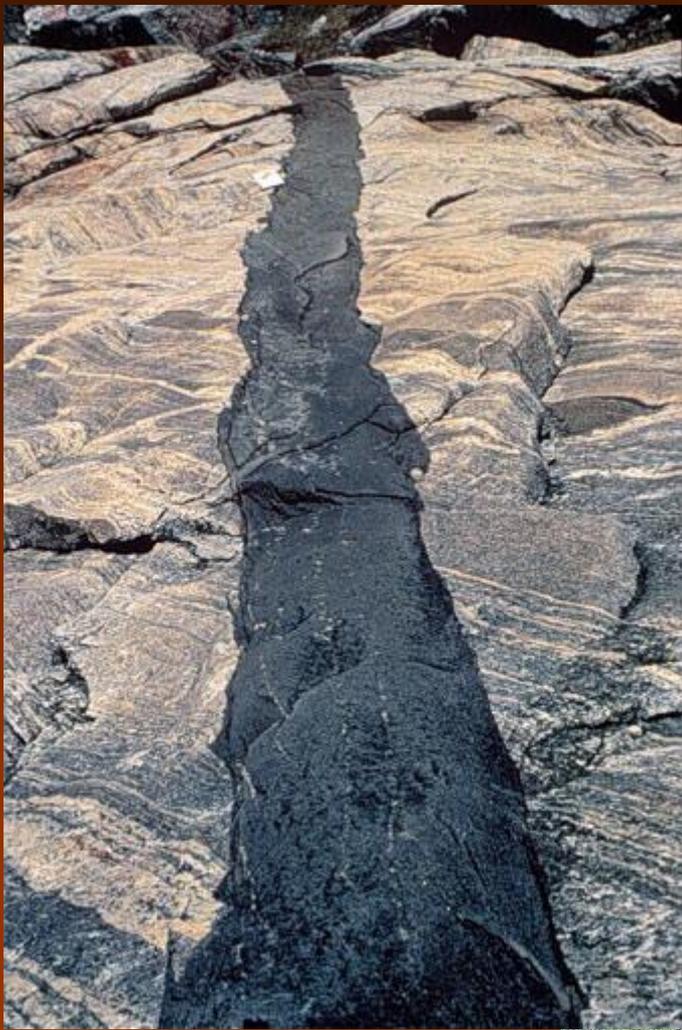
Dike

Stock

Veins

Dikes: Discordant





Sills: Concordant





Volcanic Neck

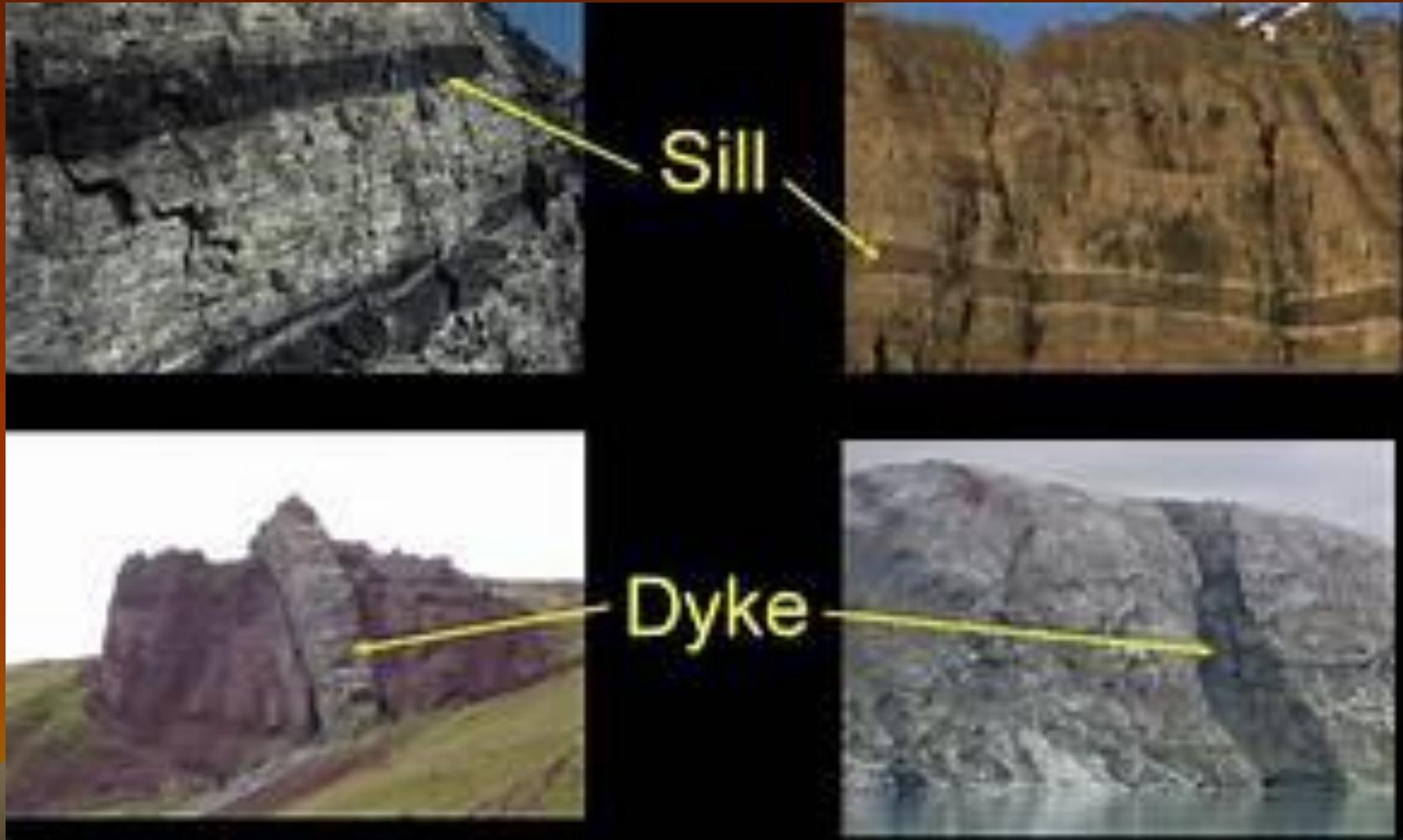


Intrusive Igneous Rocks



The Navajo word for Shiprock is Tse'Bit'Ai, and means "rock with wings." Shiprock was formed by a volcanic vent 27 million years ago. At that time the surrounding land was 2000 feet higher. When the column of lava cooled, the softer earth eroded and left a 1700 foot stone pillar atop a 5500 plain. The wings are three lava walls 150 feet high and three feet wide. Shiprock is the world's finest example of an exposed volcanic throat and can be seen for 100 miles.

Dike vs Sill





I ♥ a good classification

Discuss with a friend:

1. Differentiate between concordant and discordant volcanic features
2. Draw and define: dike, sill, laccolith, batholith, stock

I will get an A on my exams and quizzes.

Volcanic Style

- Gentile
- Explosive



Basaltic Flows: Liquid







Explosive Andesitic Volcanoes





Mount Saint Helens

May 19, 1982









I a good classification

Discuss with a friend:

1. Differentiate between gentle and explosive volcanic eruptions

I will get an A on my exams and quizzes.