# Rocks and rock cycle

- Minerals are the building blocks of rocks.
- Generally more than one mineral constitutes a rock.

-There are three ways you can make rocks:

1. Bring molten magma to the surface and solidify it.
2. Metamorphose the existing rock and make a new one.
3. Break down existing rocks and solidify after re-deposition.

-Types:

A. Igneous rock.

B. Metamorphic rock

C. Sedimentary rocks

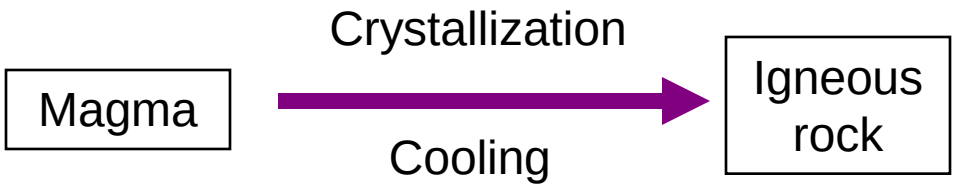
Rock cycles:

- Generation of different rock types are interlinked.
- Generation of new rocks and destruction of old rocks is a continuous cycle.

# Igneous rock

- Rock forms when molten rock (magma) cools and solidifies. [Ignis = Fire]
- A variety of different minerals could be found.
- Magma composition is generally uniform-------- still we see a variety of different igneous rocks differing in their composition.

http://activities.macmillanmh.com/science/ca/scienceinmotion/Common/SIM.html?Module=../Grade4/Chapter3-IgneousRockFormation/

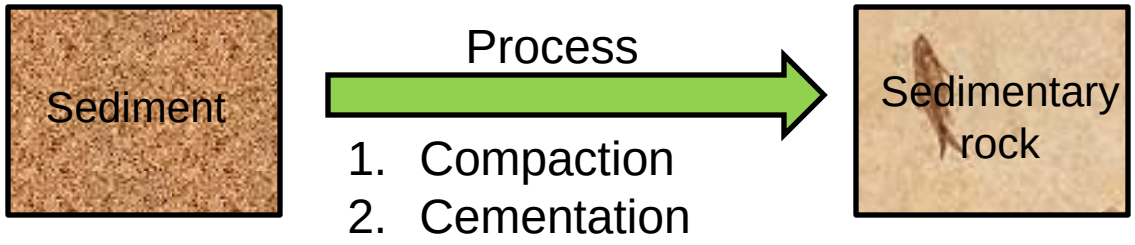



Some common igneous rocks:

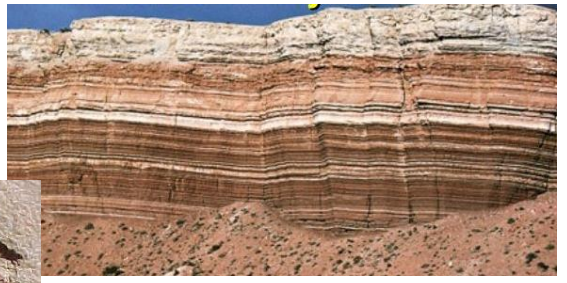
1. Granite
2. Basalt

# Sedimentary rock

• Sediments are the materials from pre-existing rocks generated by the processes of weathering.
• How do you transform sediments into rocks???




-These are generally layered rocks.



- Fossils or remains of ancient life could only be found from this kind of rock.

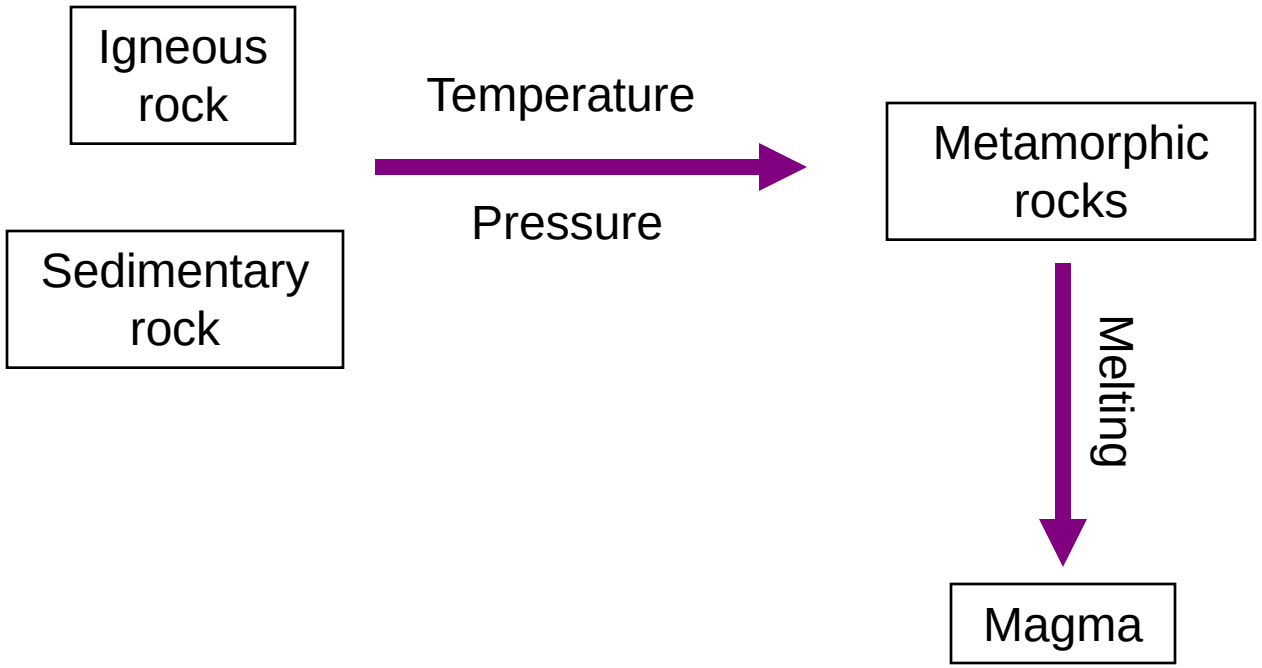
Important sedimentary rocks:
1. Coal
2. Limestone

# Metamorphic rock

Metamorphosis: Transformation

Metamorphic rocks: produced by changes in pre-existing rocks.

Parent rocks: Igneous, metamorphic, sedimentary rocks

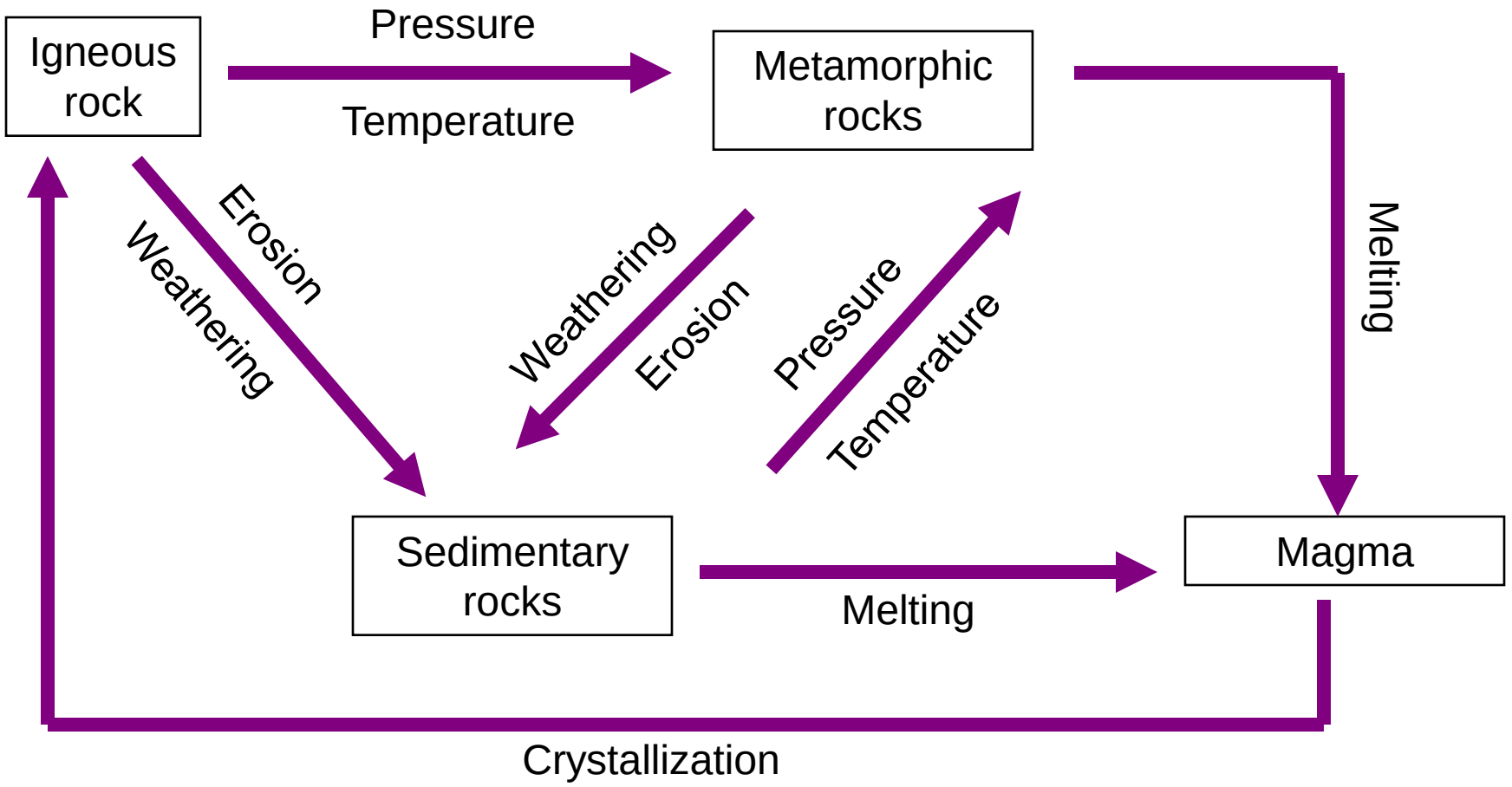



Some common metamorphic rocks:

1. Marble
2. Slate

# What is rock cycle?

- Three different types of rocks are closely related in their formation.




1. Form igneous rocks
2. Rocks that you get from igneous rocks (formation of metamorphic and igneous rocks)
3. Relationship between metamorphic and sedimentary rocks

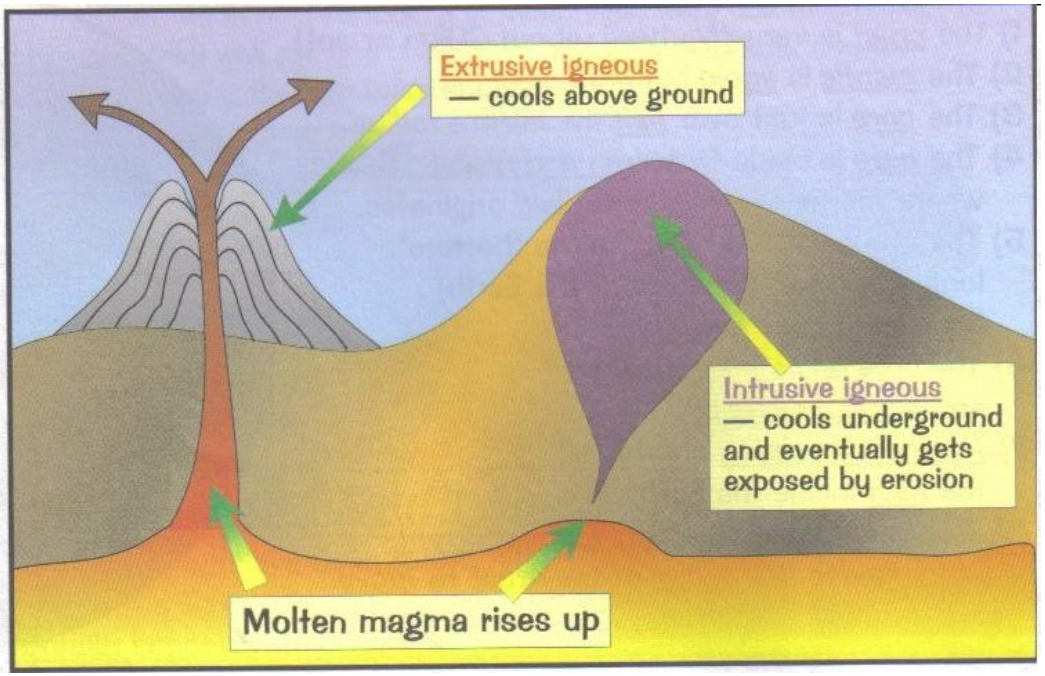
# Magma: The parent material

Magma = Molten rock that comes from the Earth's interior.

Lava = Magma that reaches the surface.

1. Extrusive/Volcanic igneous rocks:
When molten rocks solidify above the ground.

2. Intrusive/Plutonic igneous rocks:
When molten rocks solidify below the ground.




Extrusive rocks: Basalts
Deccan Traps
Intrusive rocks: Granite

# Intrusive structures

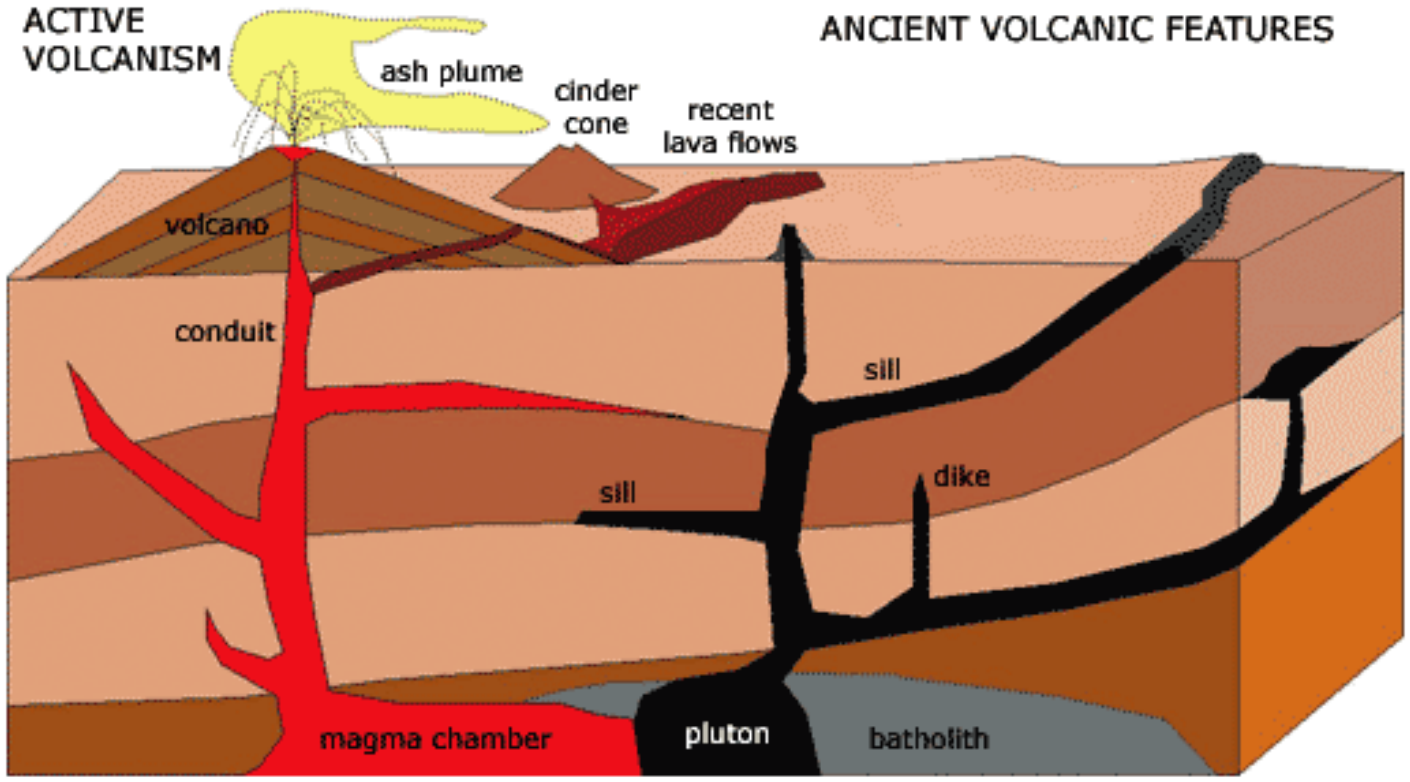
Plutons: The igneous structures that form under the surface.

-They can only be studied if they are uplifted and exposed above the surface.

- They could cut through the existing rocks (discordant) or form parallel layers (concordant).

-Three main types:

- Dikes
- Sills
- Batholiths

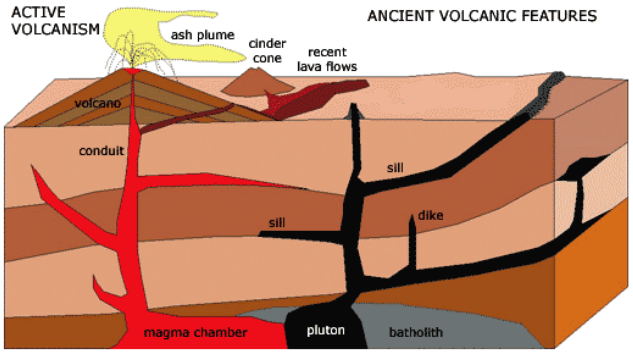


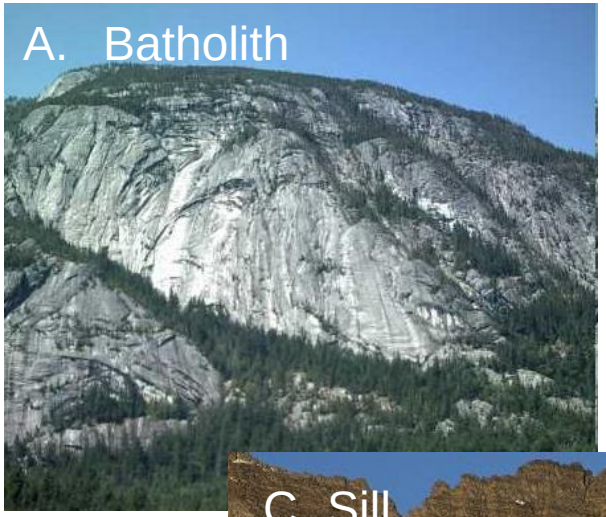
# Intrusive structure

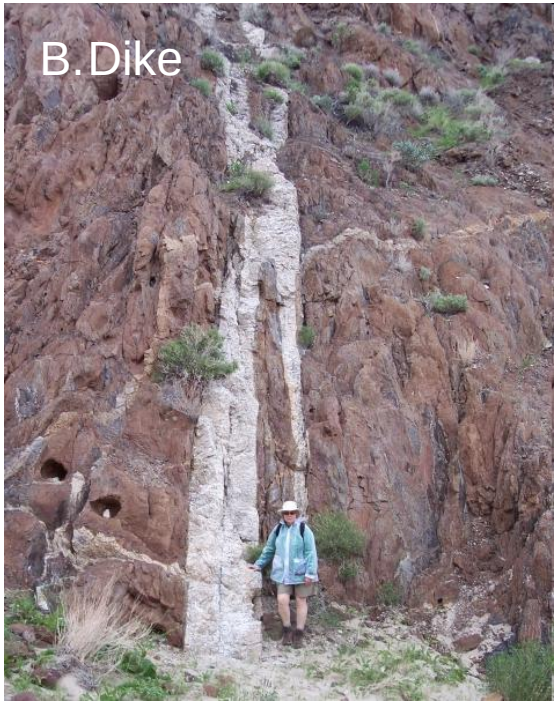
Dike: Discordant bodies produced when magma is injected into fractures.

Sills: Concordant bodies produced when magma is injected along sedimentary bedding surface.

Batholiths: Largest intrusive igneous bodies



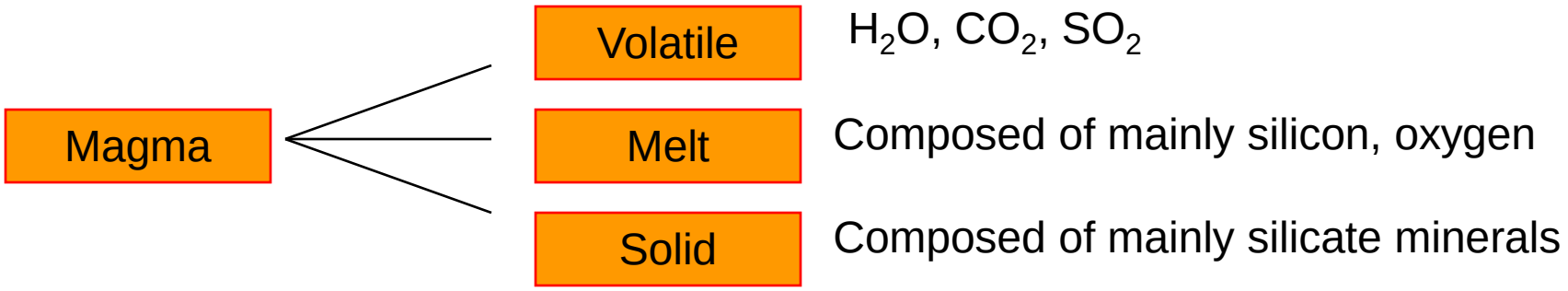





http://reynolds.asu.edu/blocks/intpdst.htm

# Magma to Rock




- As magma cools down, solids crystallizes.

- It settles down from the magma.

-This is known as **Fractional Crystallization**

-The remaining magma changes the composition.

**That is the reason behind the generation of different rocks from the same magma.**

Texture of igneous rocks:

Three factors decide how an igneous rock going to look like (texture):

1. The rate at which magma cools
2. The amount of silica
3. Amount of dissolved gas

# Rate of cooling & crystallization

**If it cools rapidly, the crystals could not grow for very long time --- small crystals.**

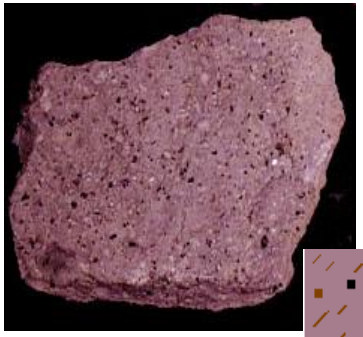
**If it cools very slowly, the crystals grow over a long period --- large crystals.**

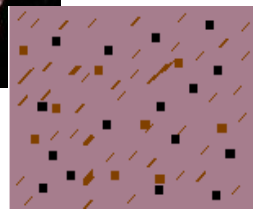
- **What would be the crystal size of an extrusive igneous rock?**
- **What about intrusive ones?**

**When rocks only have unordered ions, it is referred to as glass.**

# Types of igneous texture

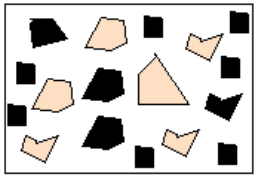
1. Aphanitic (fine-grained) texture: Crystals too small to see.
2. Phaneritic (Coarse-grained) texture: Crystals large enough to see.
3. Porphyritic (mixed) texture: Both large and small crystals.
4. Glassy texture: No crystal structure.
5. Pyroclastic (fragmented) texture: Consolidation of rocks fragments.
6. Pegmatitic texture: Unusually large crystals because of the volatile content.



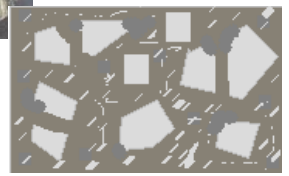


1. Aphanitic

2. Phaneritic

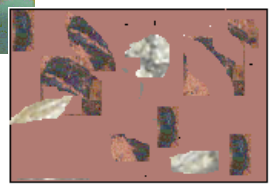


3. Porphyritic



4. Glassy

5. Pyroclastic



6. Pegmatititic

# Igneous composition

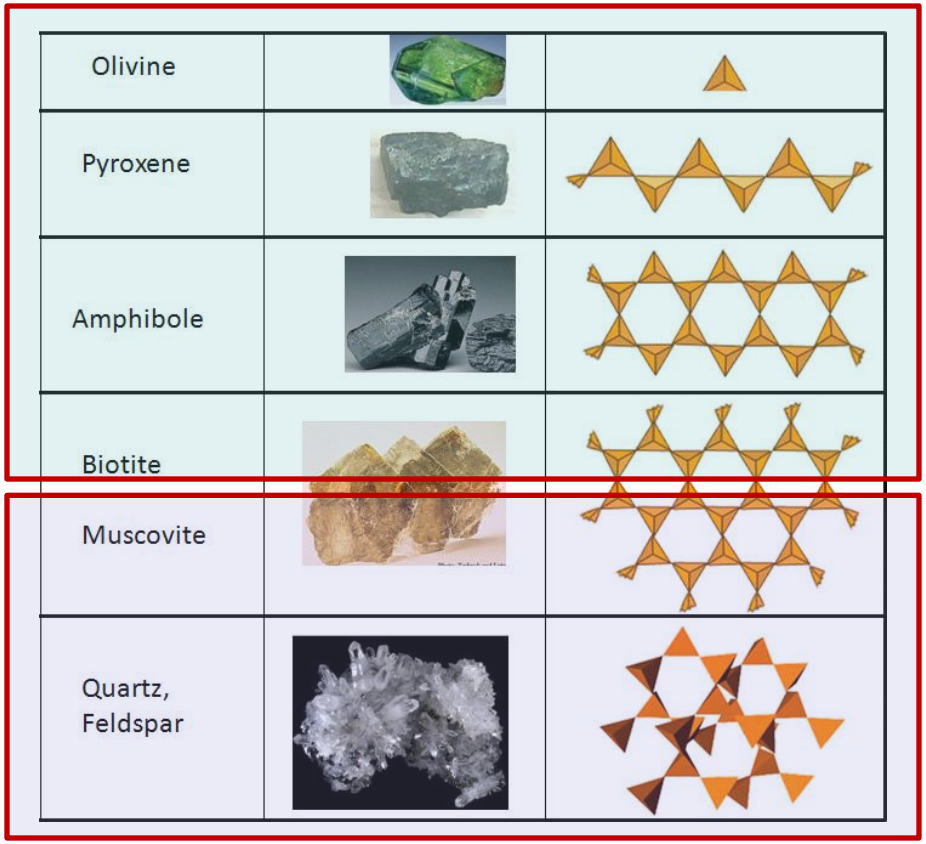
- Mainly composed of silicate minerals.
- Other ions include Al, Ca, Na, K, Mg, Fe

- As magma cools elements combine to form two major groups of silicates --

1. Dark silicates – high in Mg, Fe; low in silica
2. Light silicates – high in silica; also has Na, K, Ca

**Mafic igneous rocks:**
- Composed of dark colored minerals
- High in Mg, Fe (hence the name)
- Basaltic composition

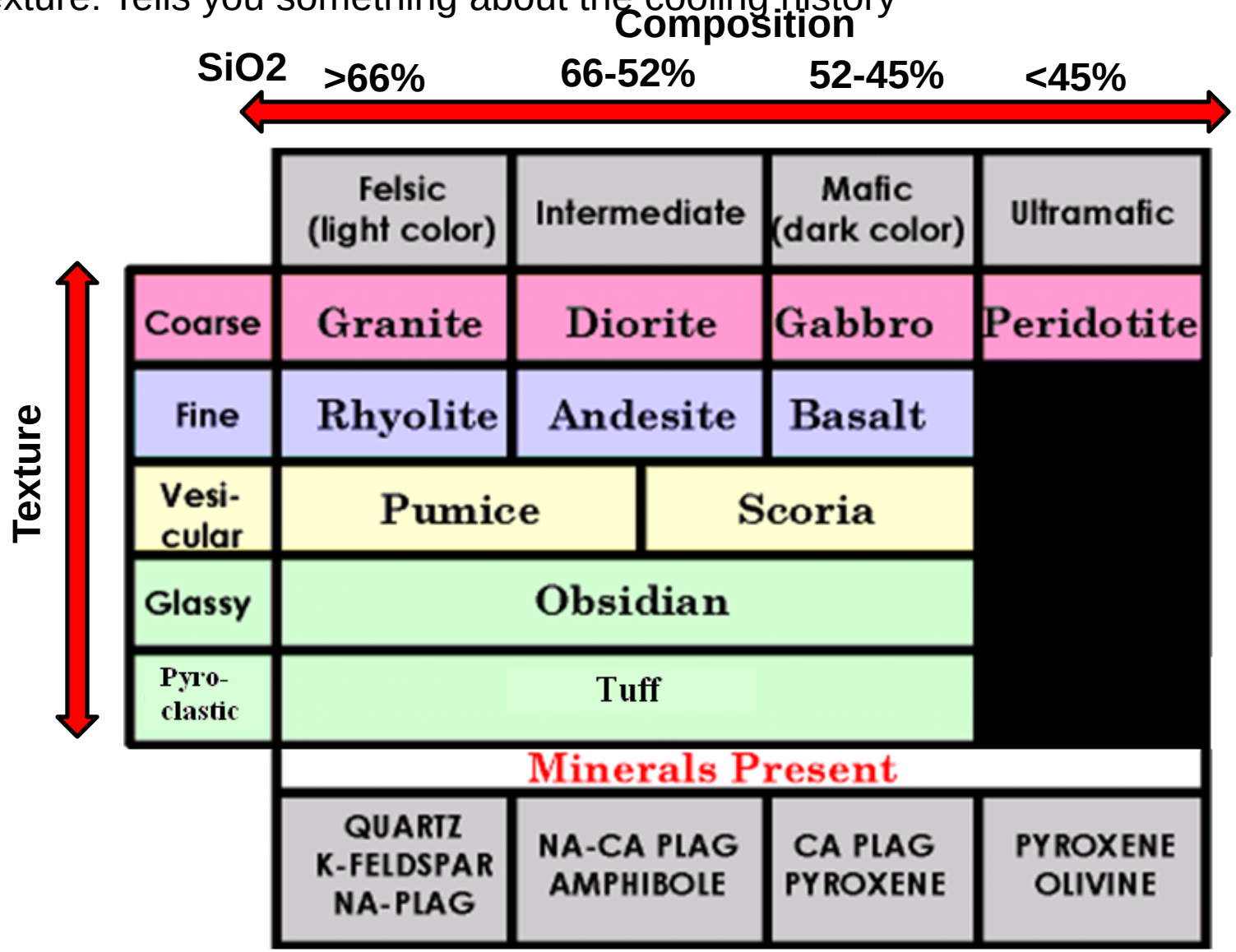
**Felsic igneous rocks:**
- Composed of light colored minerals
- High in feldspar, silica (hence the name)
- Granitic composition



# Classification of igneous rocks

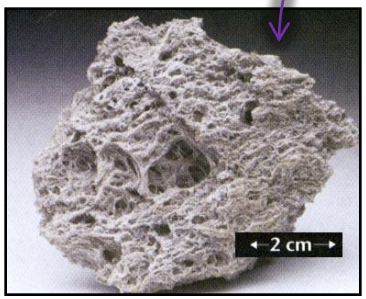
Two main components:

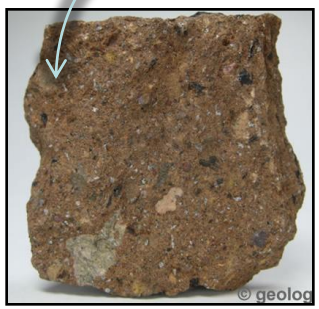
1. Composition: Tells you something about the parent magma
2. Texture: Tells you something about the cooling history



# Classification of igneous rocks

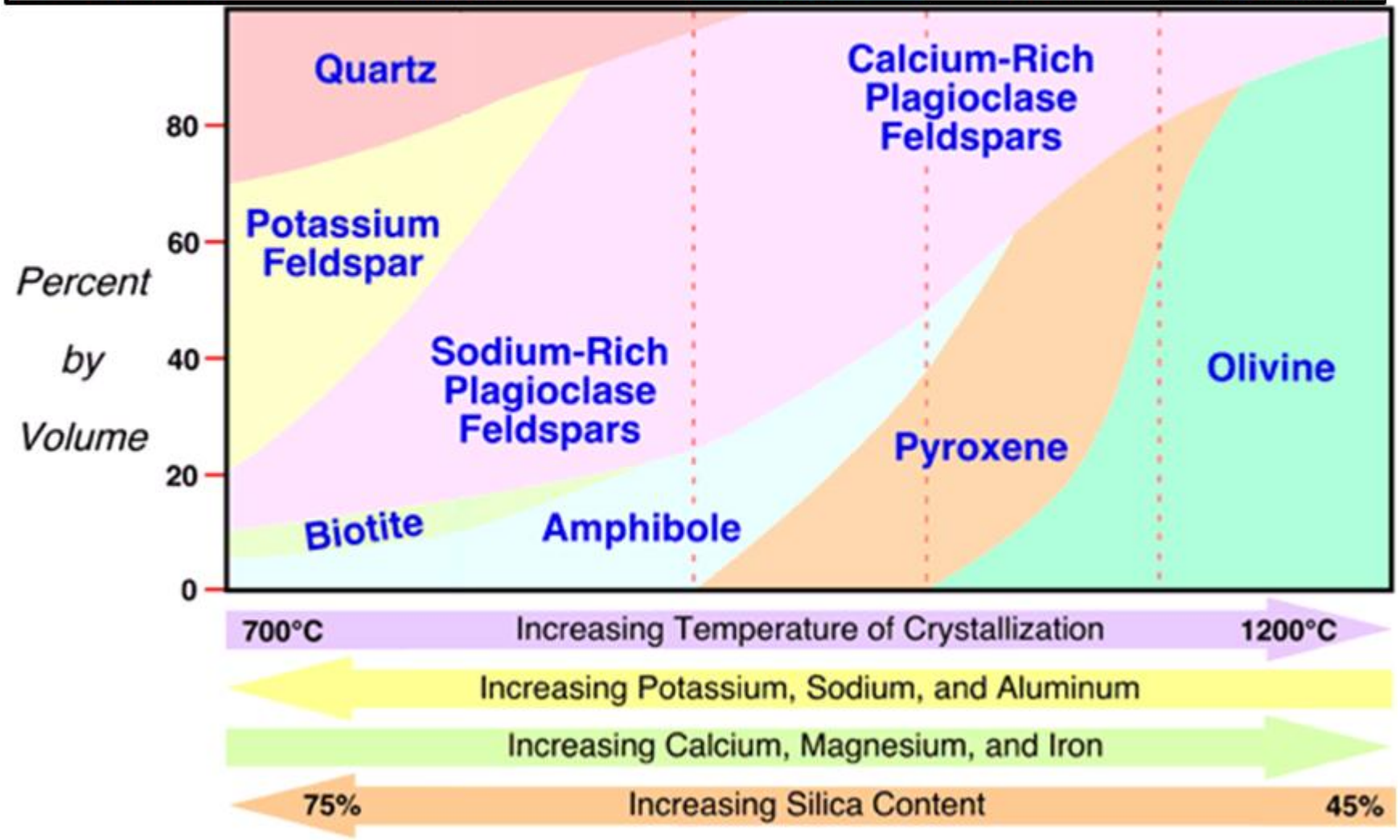
| | Felsic (light color) | Intermediate | Mafic (dark color) | Ultramafic |
|---|---|---|---|---|
| Coarse | Granite | Diorite | Gabbro | Peridotite |
| Fine | Rhyolite | Andesite | Basalt | |
| Vesi-cular | Pumice | | Scoria | |
| Glassy | Obsidian | | | |
| Pyro-clastic | Tuff | | | |



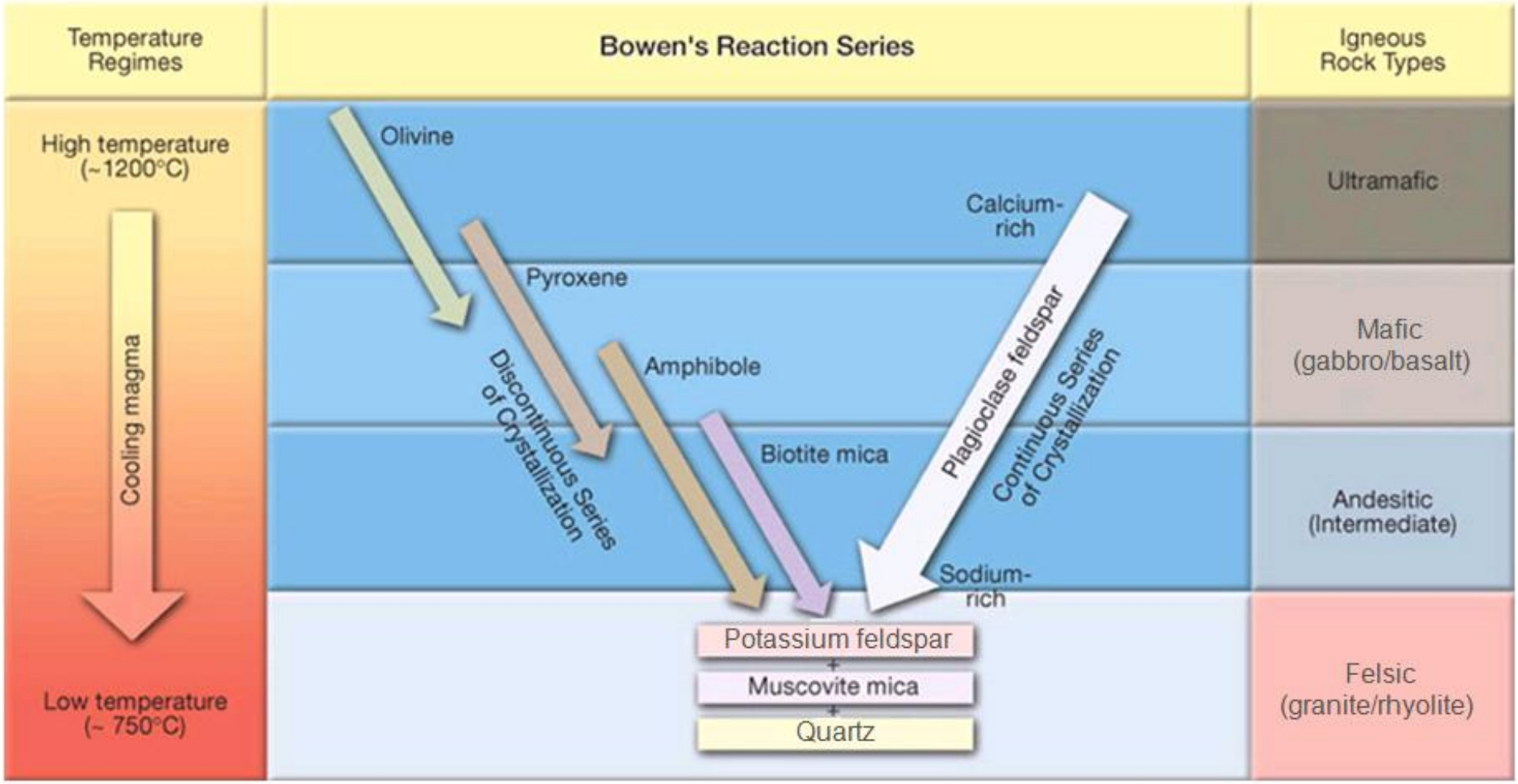
**Viscosity of the magma**

| Composition | Felsic | Intermediate | Mafic | Ultramafic |
|---|---|---|---|---|
| Fine Grained | Rhyolite | Andesite | Basalt | |
| Coarse Grained | Granite | Diorite | Gabbro | Peridotite |



# What determines the composition?

- Magma does not freeze at one particular temperature, rather over a range.
-With progressive cooling different minerals form at different temperatures.
- As a result the composition of the melt is continually changing.
- Bowen's reaction series explains the formation sequence of different minerals.



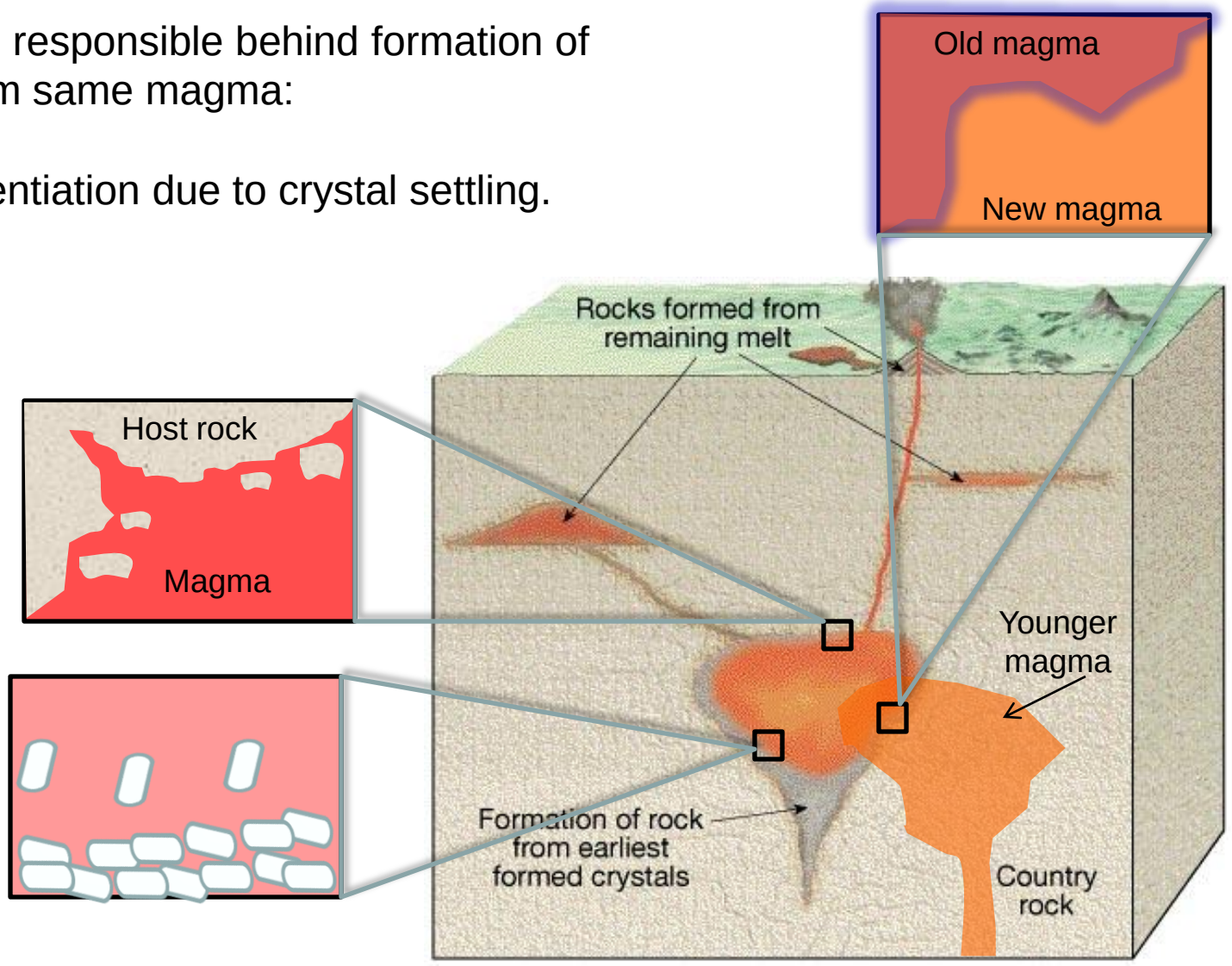
# How do you get various composition?

-Igneous rocks greatly vary in their composition.
- A particular parent magma has a fairly homogeneous composition.

Main mechanisms responsible behind formation of different rocks from same magma:

1.Magmatic differentiation due to crystal settling.
2. Assimilation
3.Magma mixing

Magma mixing (Younger magma body intrudes older one)




Assimilation (Host rocks incorporated into magma)

Crystallization & settling

# Things that come out of a volcano: Lava

- Most of the lava are basaltic in composition
- Flow rate 10-300meters / hour

Types:

1. Aa lava: The outer crust has sharp edges.
2. Pahoehoe (ropy) lava: “on which one can walk”.

- Pahoehoe is extremely slow in its progression
- Pahoehoe could transform into aa lava once it starts cooling.

http://www.youtube.com/watch?v=xExdEXOaA9A&feature=related

http://dsc.discovery.com/videos/understanding-volcanoes-lava-flow.html

3. Pillow lava: When lava forms underwater

http://video.yahoo.com/watch/185214

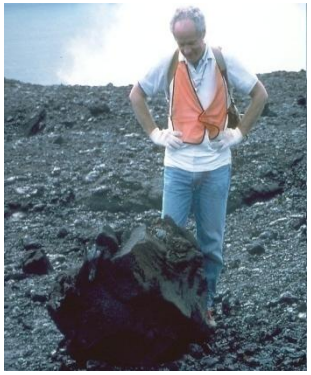
# Things that come out of a volcano: Pyroclastic material

- Pyro = fire, Clast = fragment
- Ejected particles from a volcano
- Size range dust to boulders
- Explosive eruptions often generates *volcanic ash* and *tuff*
- Depending on the size of the particle, it could be called:

***Lapilli* (little rock)**

***Cinders***

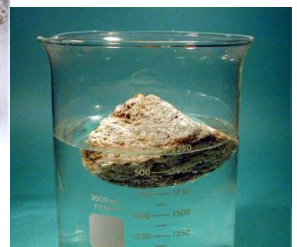
***Bombs***



***Blocks***

- Depending on the texture and composition, it could be called

1. Pumice (Felsic): very light
2. Scoria (Mafic)

* Volcanic ash
  - Fine ash - <0.06mm
  - Coarse ash – 0.06mm to 2mm

* Cinders
  - 2 mm and 64 mm

Bombs
  - Larger than 64mm
  - Molten rock solidifies in the air
  - Shapes vary

# Anatomy of a volcano

## Conduit
The pipe magma comes through.

## Vent
surface opening of the conduit.

## Crater
Funnel shaped depression at the summit.

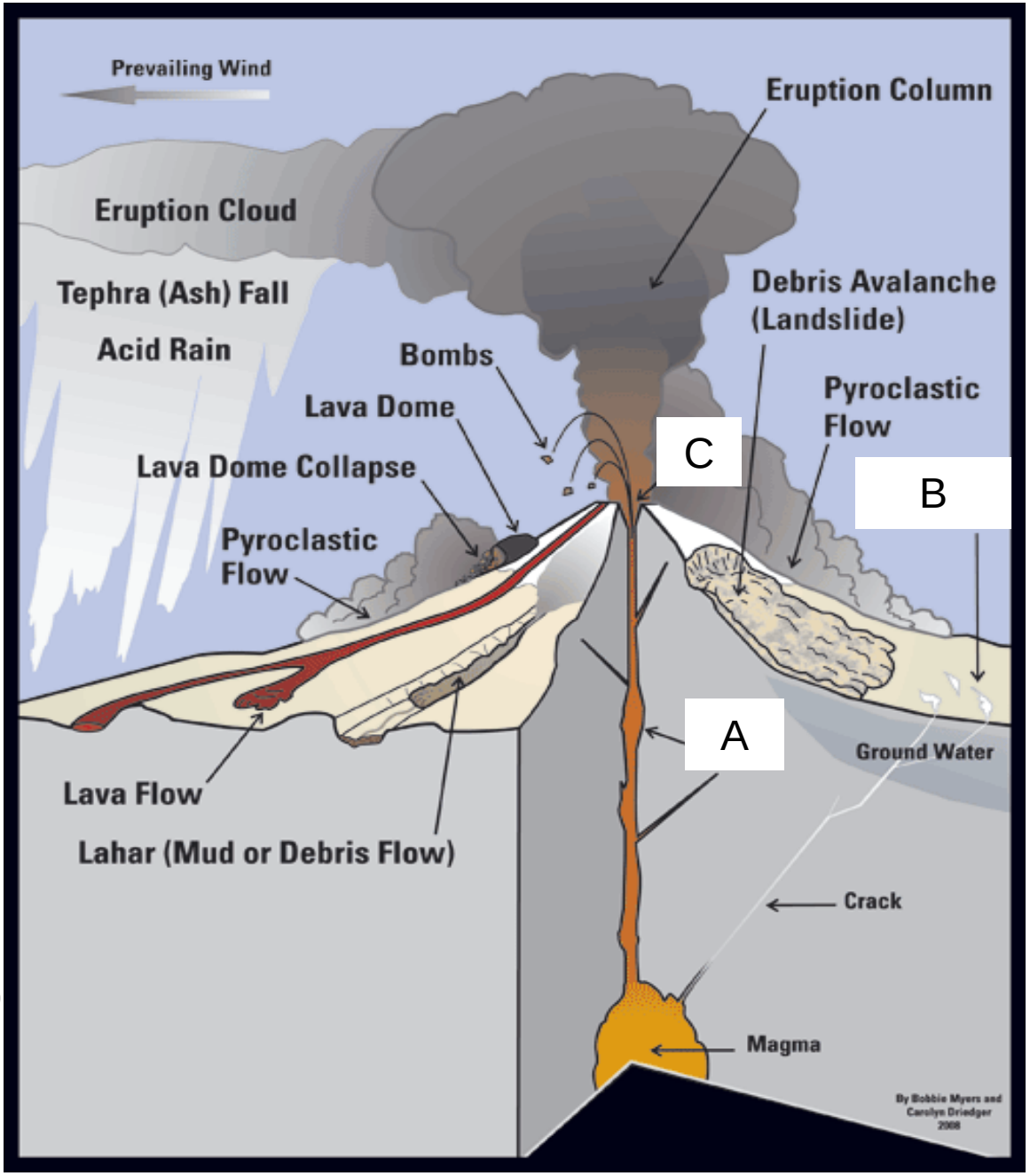
## Caldera
Very large crater.

## Fumaroles
Vents only emitting gases.

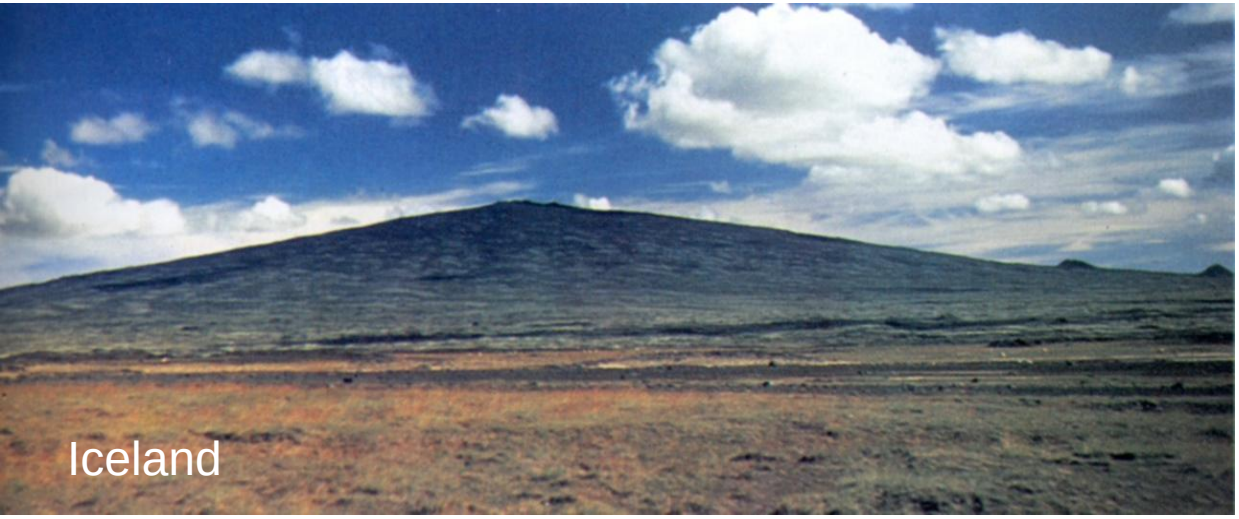
## Lahar
mudflow

(http://www.youtube.com/watch?v=5x5tZAHEoRU)

http://www.pbs.org/wgbh/nova/volcanocity/anat-flash.html



# Shield volcanoes

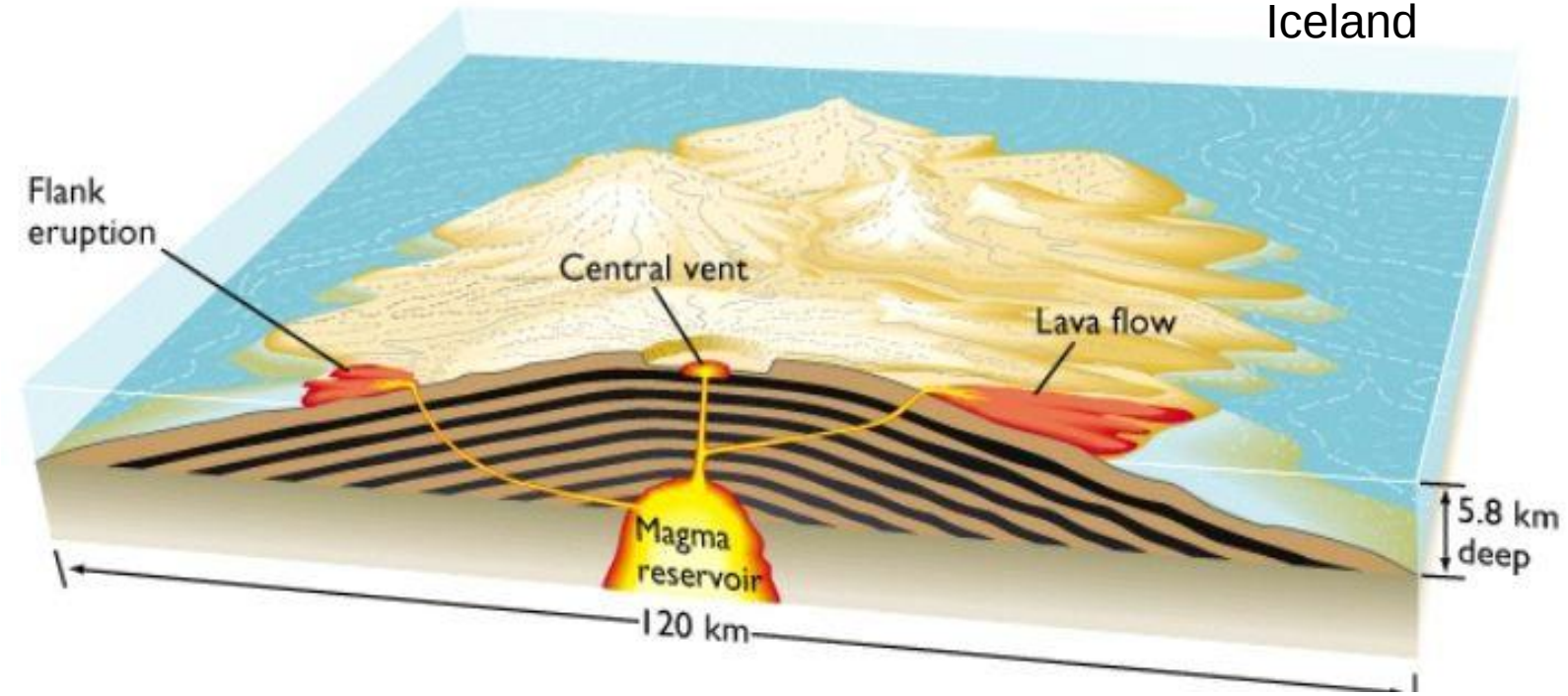



-Looks like warrior's shield

- Produced by accumulation of basaltic lavas.

- Most have grown up from ocean floor to form islands or seamounts.

- Example: Hawaiian chain, Iceland

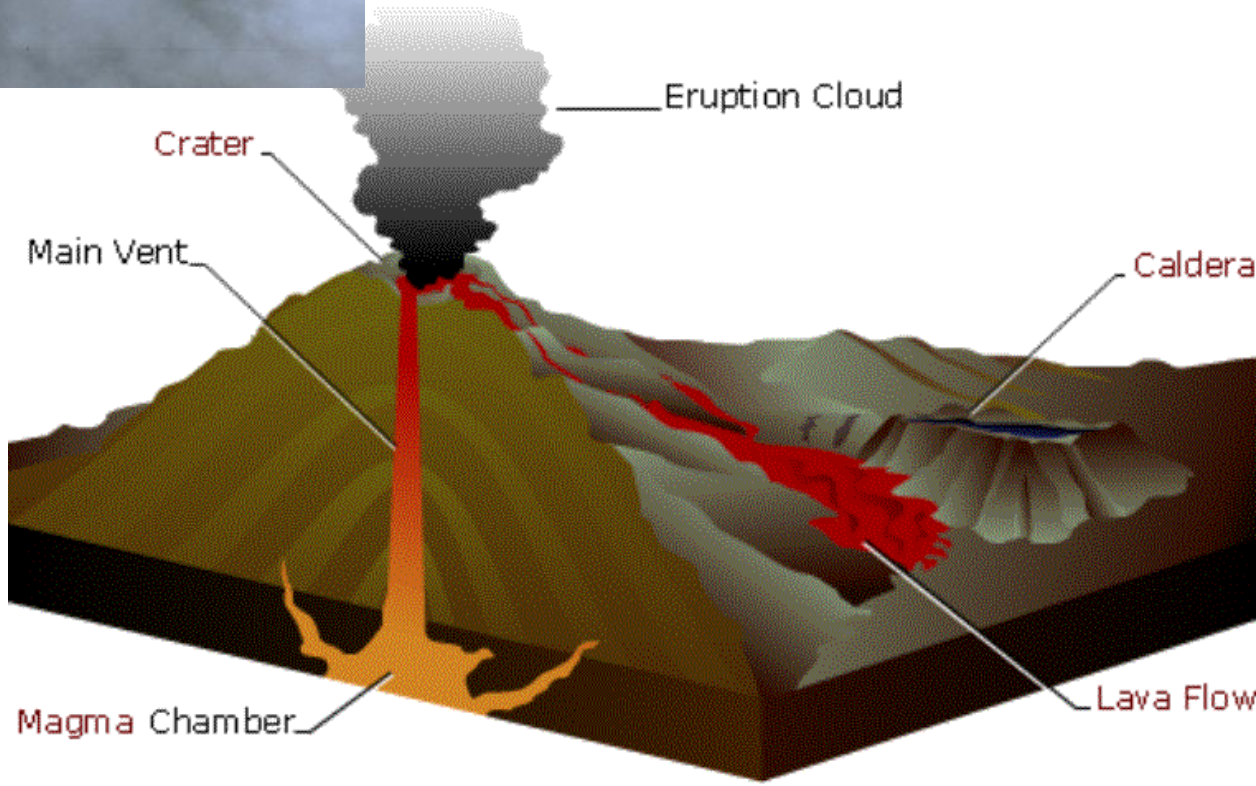


# Cinder cone


- Built from the ejected particles from the volcano

- Most abundant type of volcano

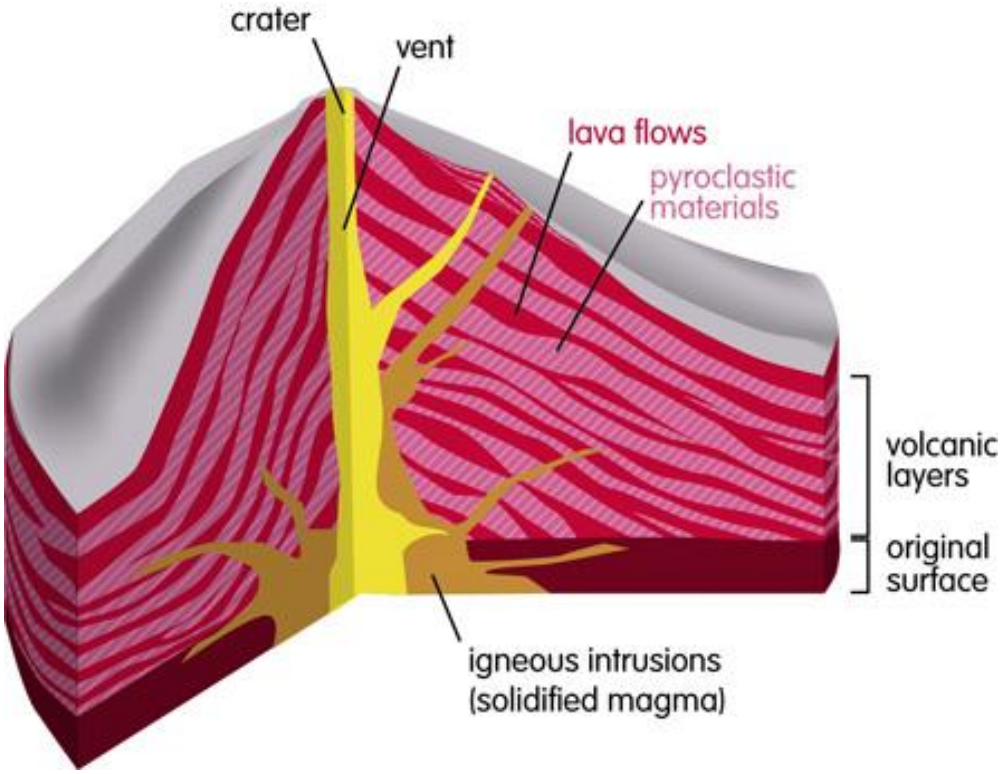
- Example: Mount Etna, Italy



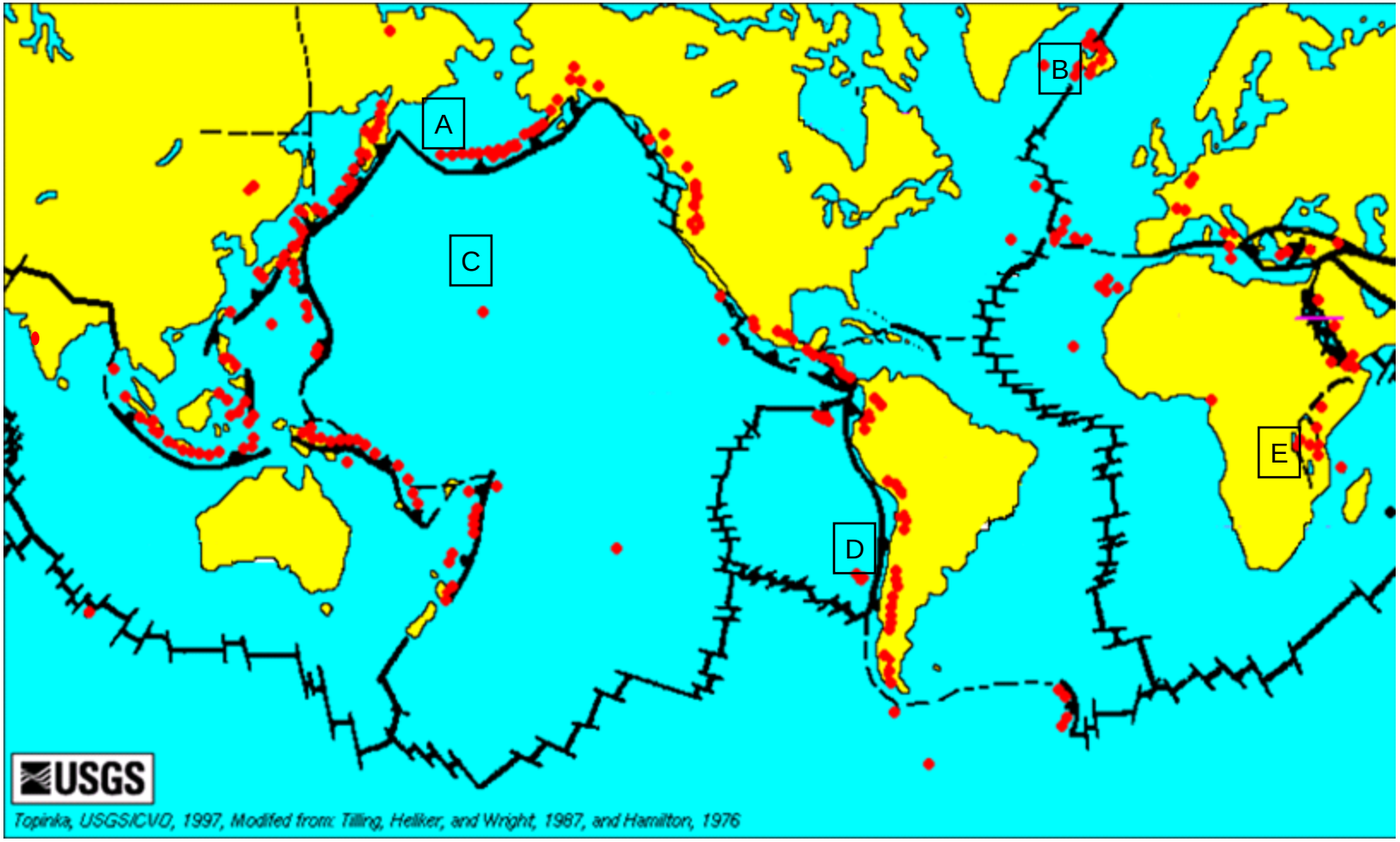
# Composite cone

- Mostly located in “Ring of fire”.
- Most destructive type.
- Large, nearly symmetrical structure
- Composed of both lava & pyroclastic deposits.
-Product of gas-rich andesitic magma.
-Example: Vesuvius, Mount St. Helens.

This type of volcano is also called a stratovolcano --- it has stratified layers of lava and pyroclastic deposits.

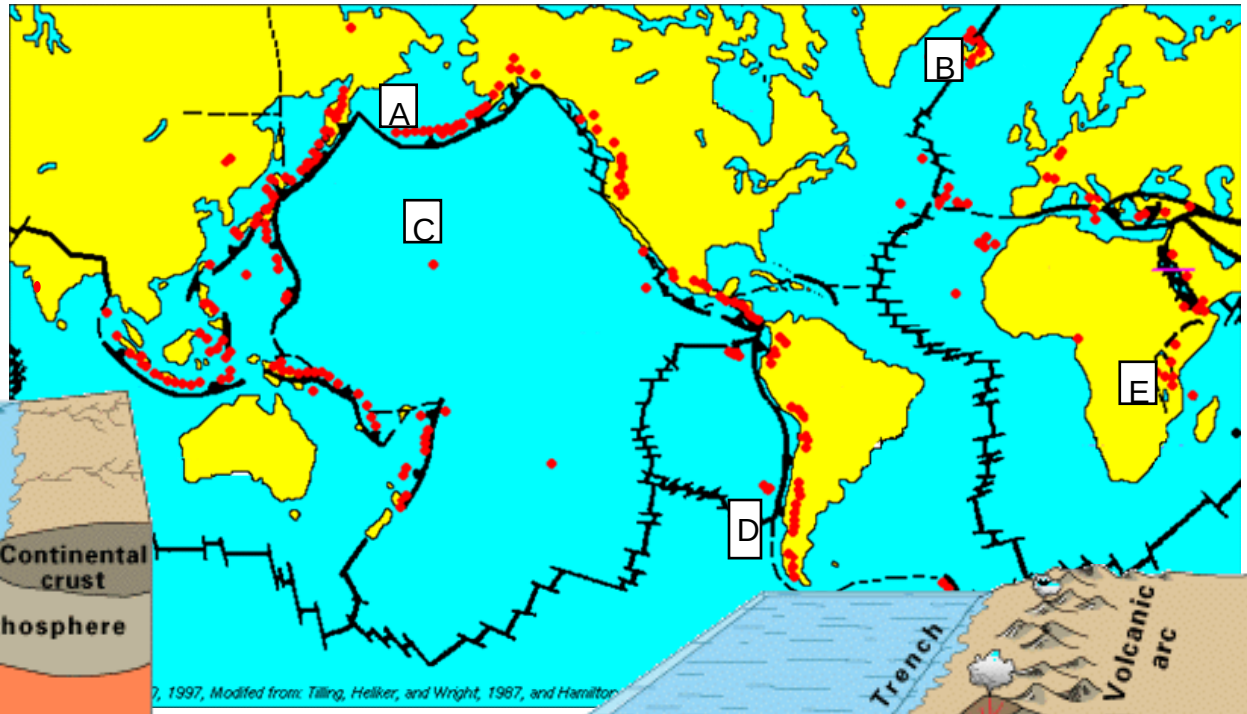


# Distribution of volcanoes

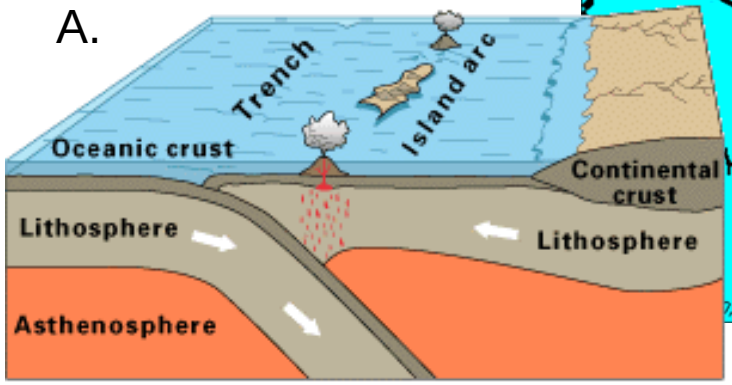



A. Convergent plate volcanism (oceanic-ocenic)
B. Divergent plate volcanism (oceanic ridge)
C. Intraplate volcanism
D. Convergent plate volcanism (oceanic-continental)
E. Divergent plate volcanism (continental rifting)

# Convergent plate volcanism

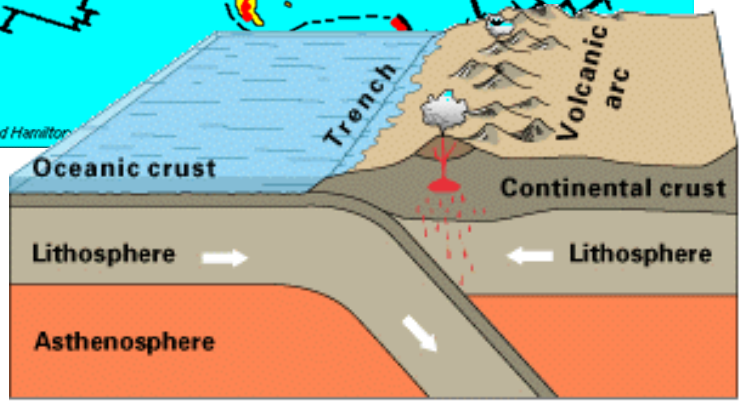



A.




Oceanic-oceanic convergence

Mt. Augustine, Alaska

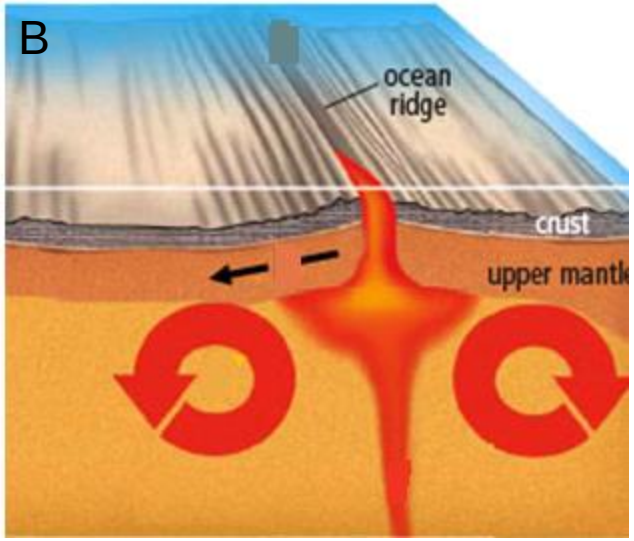



Oceanic-continental convergence

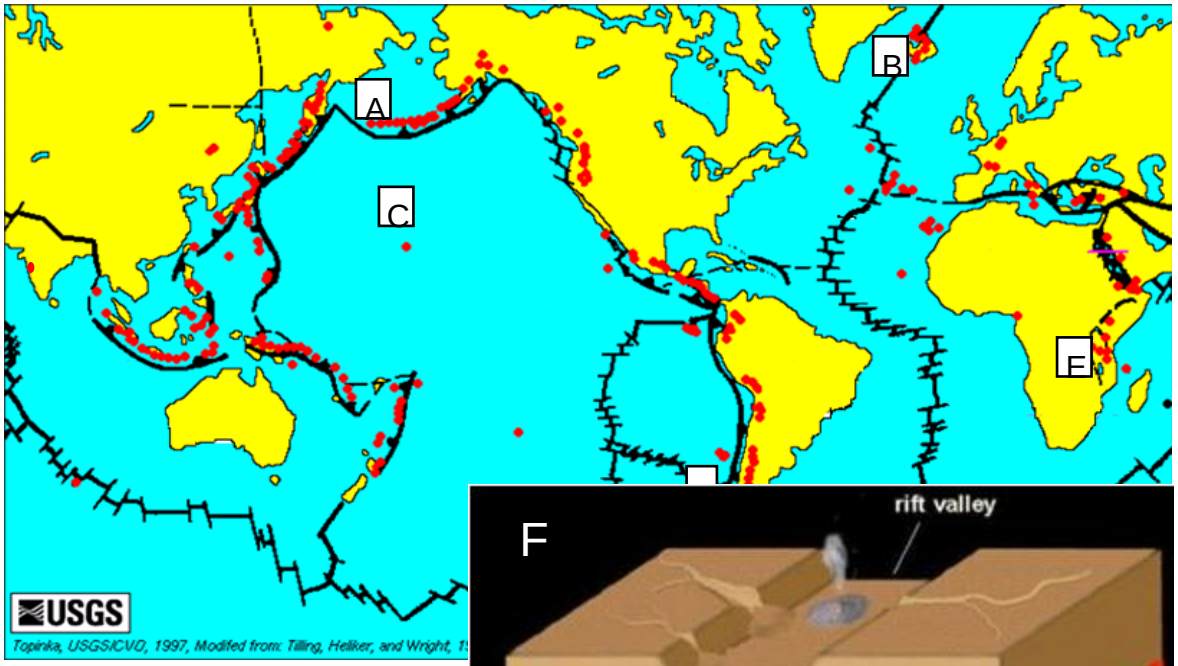
D.

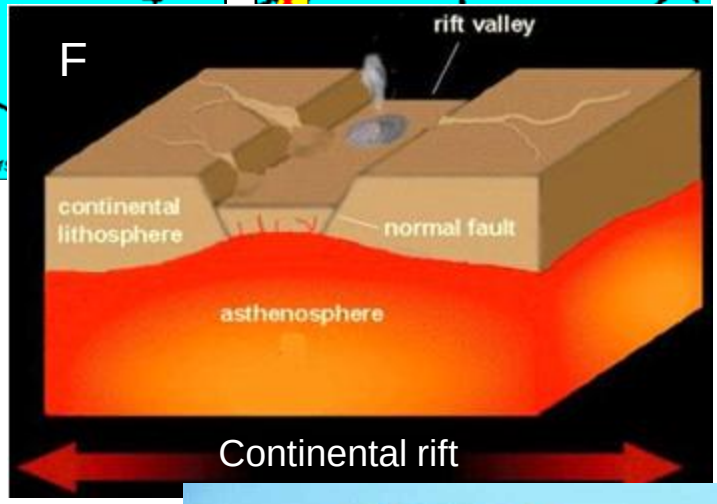

Chaitén Volcano, Chile

# Divergent plate volcanism




Oceanic ridge



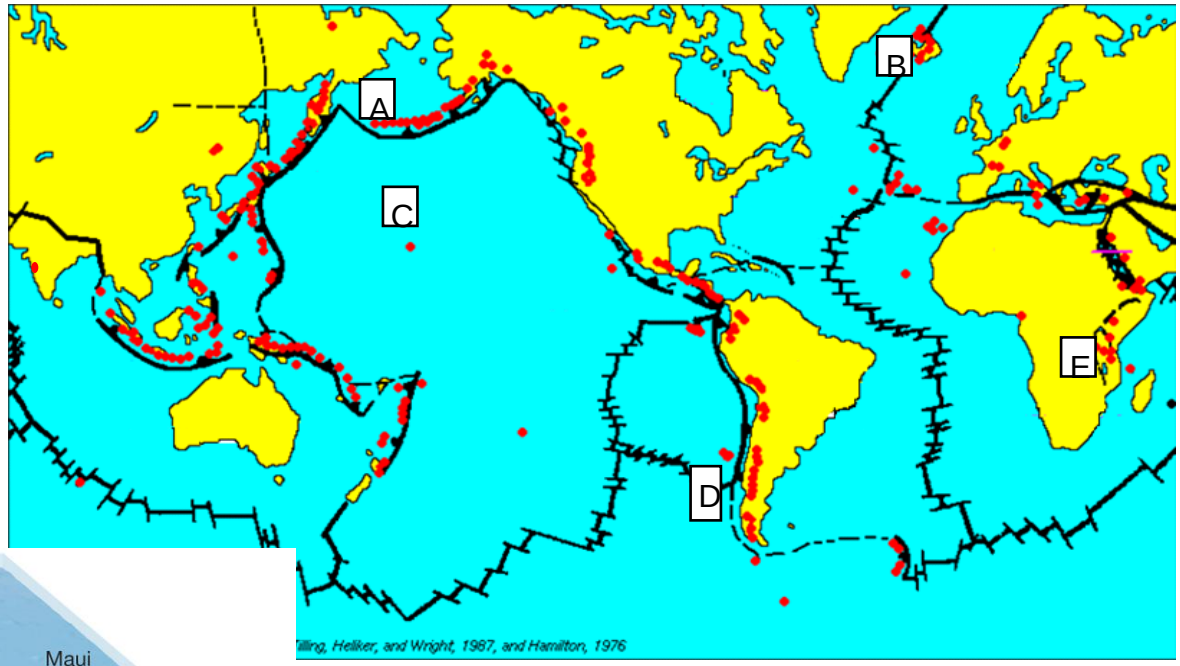




Continental rift

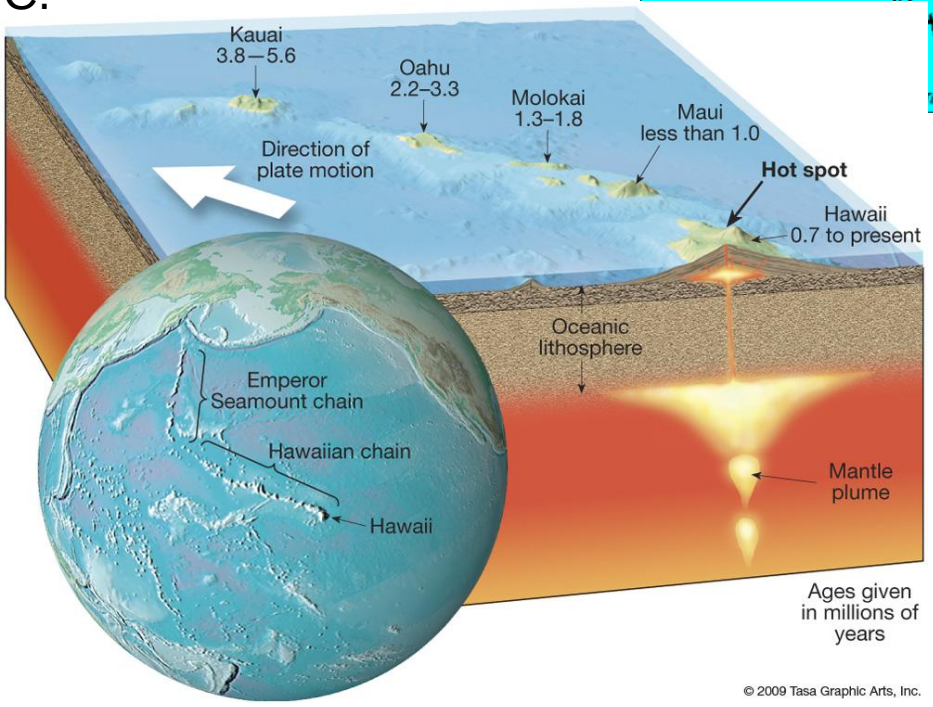
Iceland volcanoes

Mt. Kilimanjaro, Africa

# Intraplate volcanism




C.




Hawaiian volcanoes

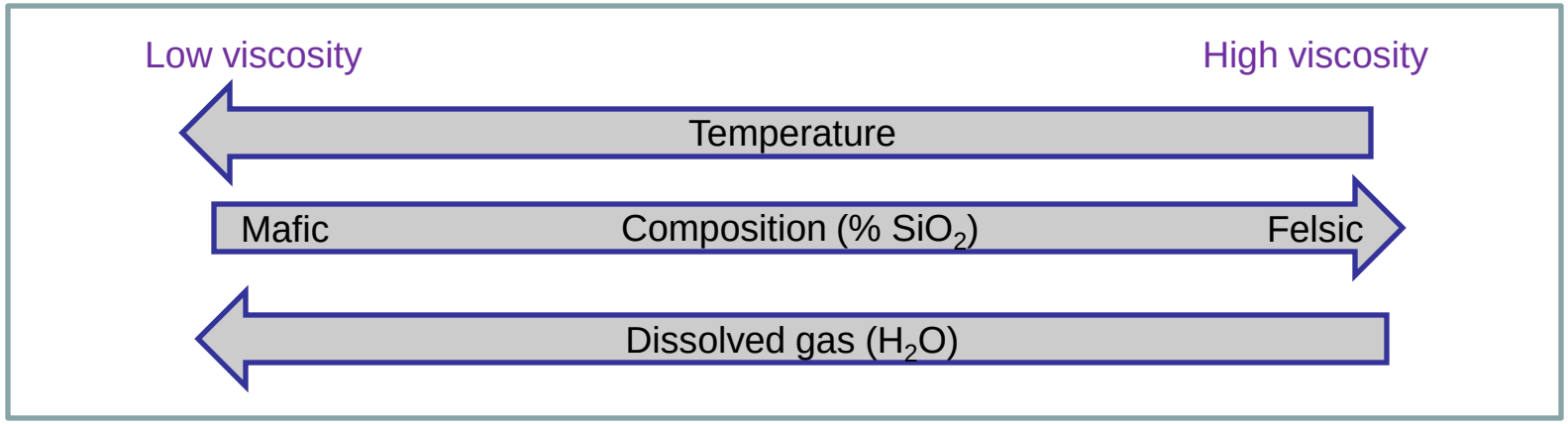
# What determines the “explosiveness” of a volcano?

Primary factors:

1. Temperature
2. Composition
3. Dissolved gas

Mobility / Viscosity

More viscous the material, the greater resistance it has against the flow.




1. With increasing temperature, magma flows more easily.
2. Silica content determines the viscosity. Felsic magma is more viscous than their mafic counterpart.
3. Dissolved water makes magma less viscous.

# Mantle Plumes