Chapter IV
Igneous Rocks

Joanna Doummar

WEEK 4

General Terminology: Igneous rocks

What are igneous rocks?

• Igneous rocks form by solidification (or crystallization) of hot molten rock material (magma or lava) under various conditions.

Igneous rocks

- How to identify/ classify them?
- How do igneous rocks form?
  - rock melting
  - formation of a magma,
  - Solidification of a magma.

  } Processes
- What are the types of igneous intrusions?
- Where do igneous processes occur (plate tectonics)?

DIFFERENCES?

Classification of Igneous Rocks

1. Texture – refers to the shape and size of the mineral grains within an igneous rock

2. Chemical Composition – Types of minerals forming the igneous rock (reflected in the color of the specimen)

Classification of Igneous rocks

Texture – refers to the shape and size of the mineral grains within an igneous rock
Grain size

- Coarse-grained rocks : crystals visible to the naked eye

- Fine-grained rocks: crystals cannot be seen even with a magnifying glass

- Mixed texture rocks

Classification of Igneous rocks

Texture – Grain Size

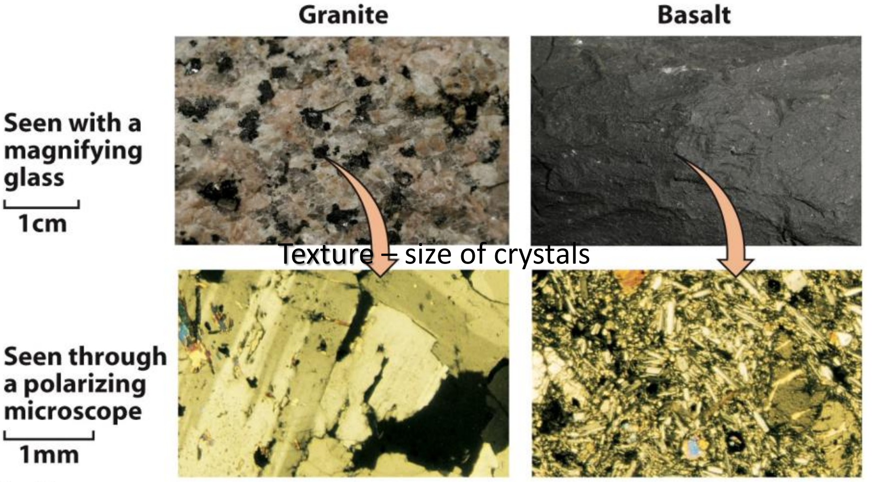


Figure 4-1
Understanding Earth, Fifth Edition

Classification of Igneous rocks

Texture – Nomenclature

4 and 2
Basalt

1
Obsidian

2
Pumice

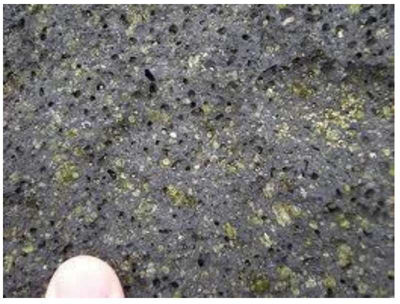
6
Granite

1. Glassy	no minerals present, glassy luster
2. Vesicular	with bubble holes
3. Pyroclastic	fine grained ash material
4. Aphanitic	fine grained crystals
5. Porphyritic	mixture of coarse and fine grained
6. Phaneritic	coarse crystals

Fine → Coarse

Classification of Igneous rocks

Texture – Nomenclature



Porphyritic
Aphanetic
Olivine crystals in fine grained Groundmass (basalt)

Porphyritic
Phaneritic
K-Feldspar crystals in finer grained Groundmass (granite)

Classification of Igneous rocks

Texture – How textural differences were detected?

1. Early studies on volcanic rocks: quick solidification of erupting lava forms fine grained rocks

1. Slow cooling: e.g., granite intrusion. A melt is subject to slow cooling will form coarse grained rocks

Classification of Igneous rocks

3. Crystallization Lab studies: formation of tiny crystals
   --> grow bigger in a definite pattern



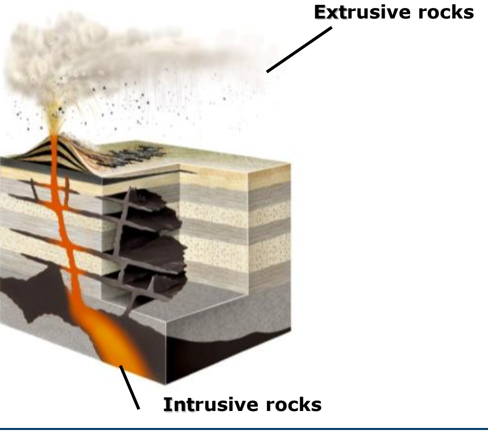
Classification of Igneous rocks

Texture – synthesis: texture is related to the rate of cooling

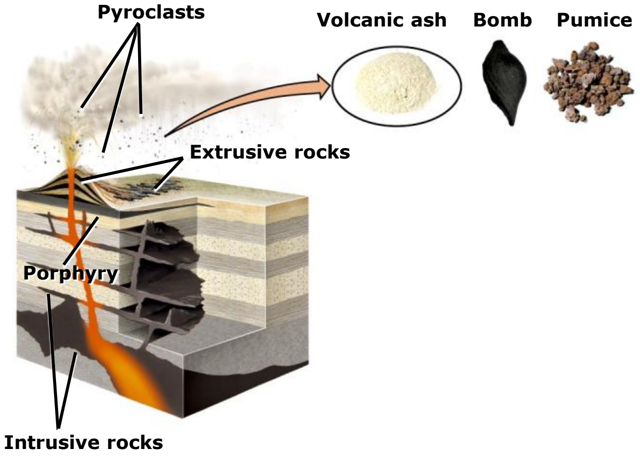
→Intrusive and extrusive textures

•Igneous processes within the Earth produce **intrusive** igneous rocks;

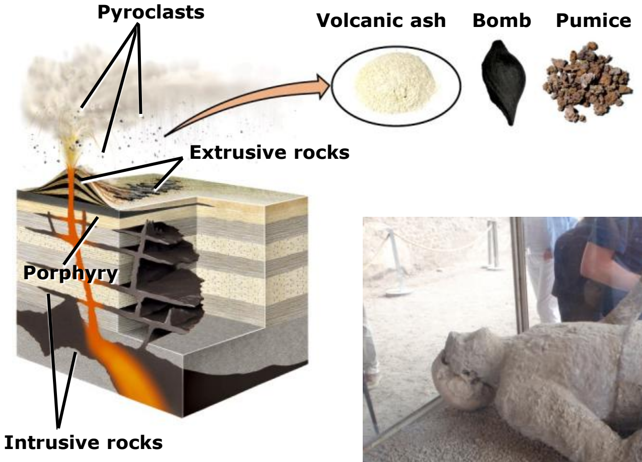
• Igneous processes on or near Earth's surface produce **extrusive** igneous rocks.



Texture – Rate of cooling



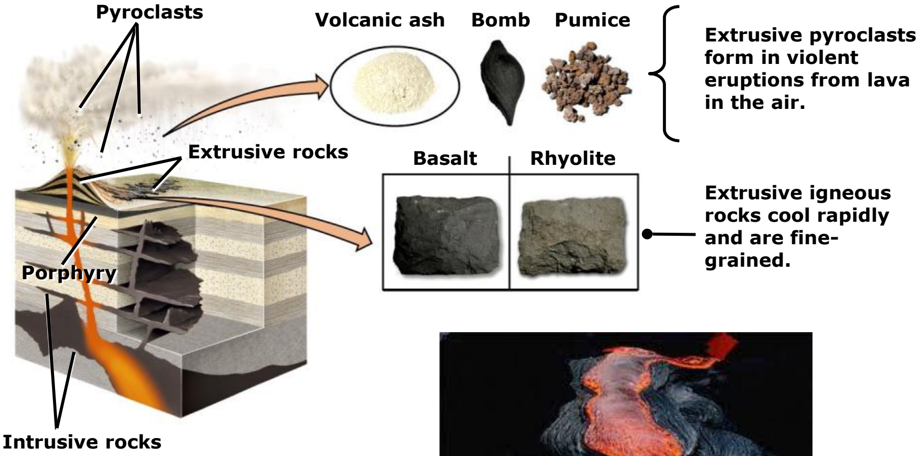
Texture – Rate of cooling



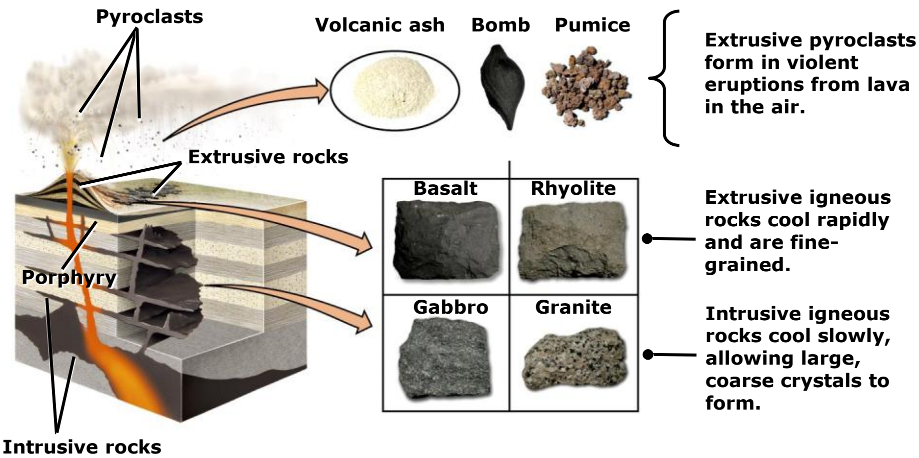
Extrusive pyroclasts form in violent eruptions from lava in the air.

Volcanic ashes: Vesuvio, Pompei

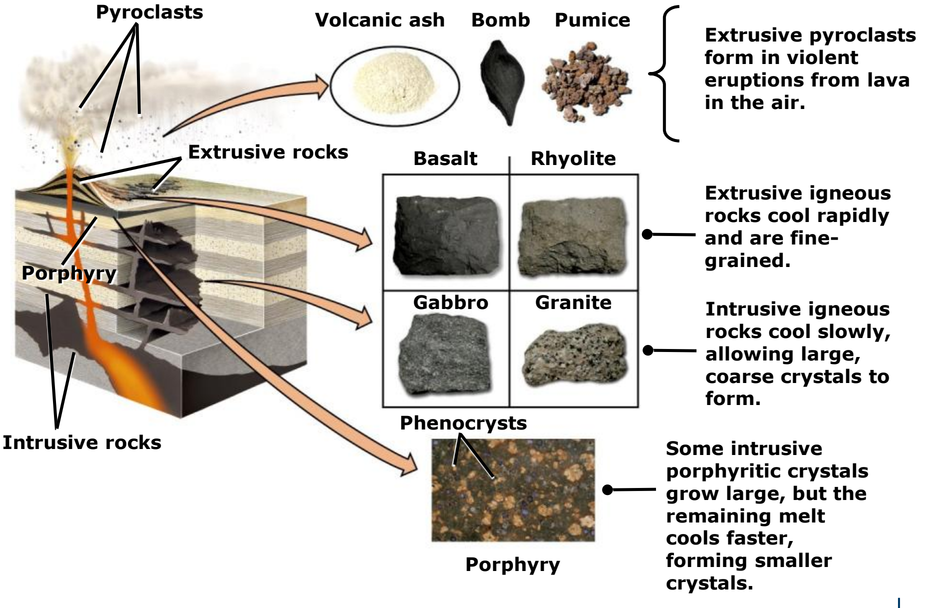
Texture – Rate of cooling



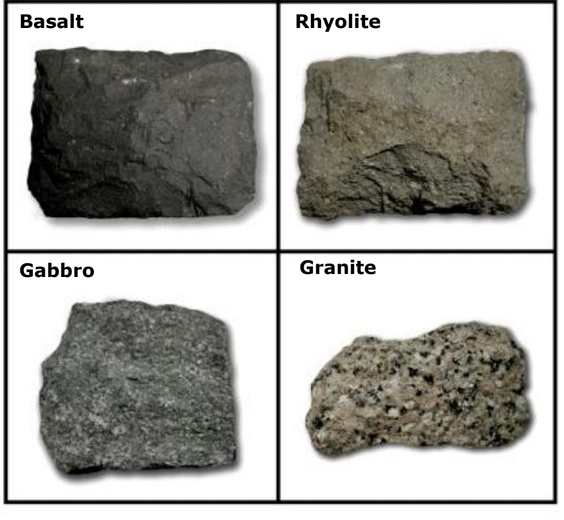
Texture – Rate of cooling



Texture – Rate of cooling



DIFFERENCES beside texture?



Classification of Igneous rocks

Chemical and Mineral Composition

Two basic compositional groups according to forming minerals:

- Felsic igneous rocks (about 70 % silica)
- Mafic igneous rocks
- Intermediate igneous rocks
- Ultramafic igneous rocks

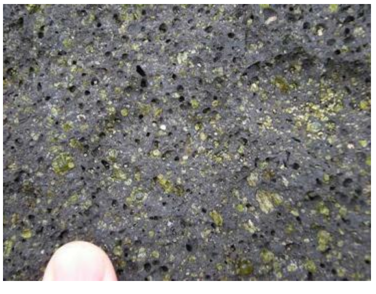
Examples of forming minerals?

Classification of Igneous rocks

Reminder!

Chemical and Mineral Composition

MAFIC SILICATES: Rich in Mg and Fe; denser; dark colored	FELSIC SILICATES: Enriched in the lighter elements such as silicon, oxygen, aluminum, sodium, and potassium, light colored
Olivine Pyroxene	Feldspar Quartz



Reminder!

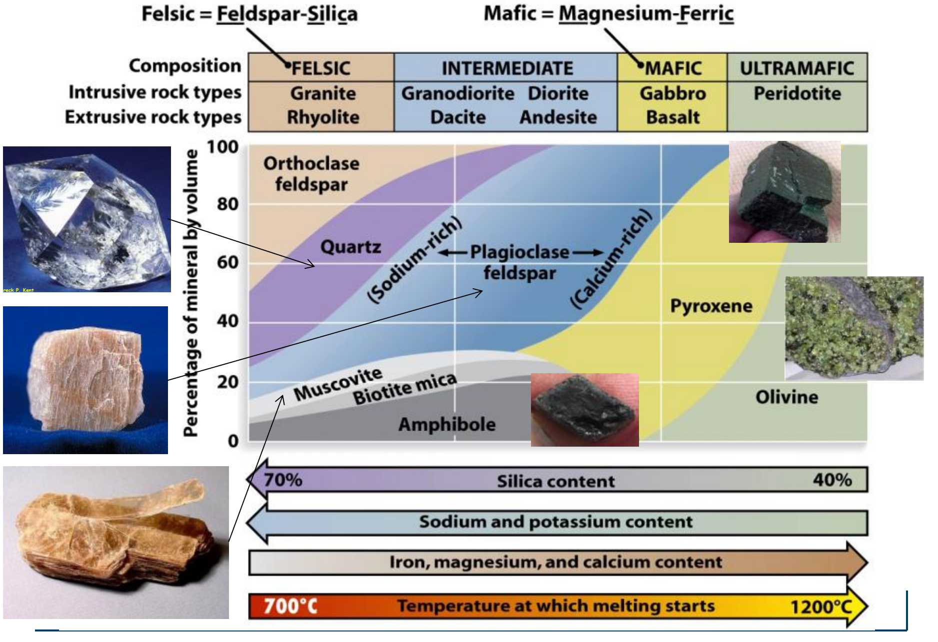
Chemical and Mineral Composition

Common minerals of igneous rocks

Compositional Group	Mineral	Chemical Composition	Silicate Structure
FELSIC	Quartz	SiO_2	Frameworks
	Potassium feldspar	$KAlSi_3O_8$	
	Plagioclase feldspar	$NaAlSi_3O_8$; $CaAl_2Si_2O_8$	
	Muscovite (mica)	$KAl_3Si_3O_{10}(OH)_2$	Sheets
MAFIC	Biotite (mica)	K, Mg, Fe, Al } $Si_3O_{10}(OH)_2$	
	Amphibole group	Mg, Fe, Ca, Na } $Si_8O_{22}(OH)_2$	Double chains
	Pyroxene group	Mg, Fe, Ca, Al } SiO_3	Single chains
	Olivine	$(Mg,Fe)_2SiO_4$	Isolated tetrahedra

Table 4-1
Understanding Earth, Fifth Edition

Chemical and Mineral Composition: Common minerals of igneous rocks



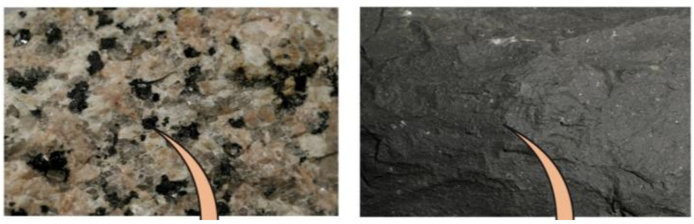
Classification of Igneous rocks

Chemical and Mineral Composition

Common minerals of igneous rocks

	Typical granite	Typical basalt
SiO_2	70%	50%
Al_2O_3	12%	15%
$FeO + MgO$	3%	15%
CaO	2%	8%
K_2O+Na_2O	8%	5%

Granite **Basalt**



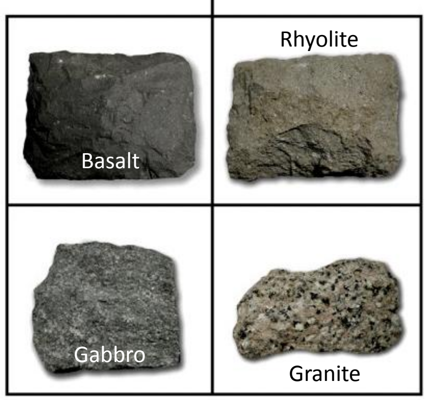
Classification of igneous rocks: Texture and **mineralogical composition**

- Fine-grained versus Coarse-grained
- Felsic versus Mafic

Mafic | Felsic

Fine grained

Coarse grained



Classification of Igneous rocks

Table 4.2 Changes in Some Major Chemical Elements from Felsic to Mafic Rocks

	Felsic	Intermediate		Mafic
Coarse-Grained (intrusive)	Granite	Granodiorite	Diorite	Gabbro
Fine-Grained (extrusive)	Rhyolite	Dacite	Andesite	Basalt

← Silica increasing

← Sodium increasing

← Potassium increasing

Calcium increasing →

Magnesium increasing →

Iron increasing →

← (Viscosity increasing)

(Melting temperature increasing) →

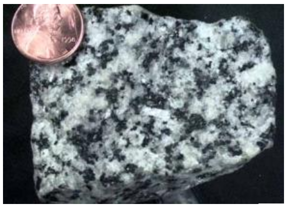
Table 4-2
Understanding Earth, Fifth Edition

Classification of Igneous rocks

Table 4.2 Changes in Some Major Chemical Elements from Felsic to Mafic Rocks

	Felsic	Intermediate		Mafic
Coarse-Grained (intrusive)	Granite	Granodiorite	Diorite	Gabbro
Fine-Grained (extrusive)	Rhyolite	Dacite	Andesite	Basalt

← Silica increasing




Forming an Igneous Rock

- How do igneous rocks form?
-
  - rock melting
  - formation of a magma,
  - Solidification/crystallization of a magma.

Processes

Forming an igneous rock

Solidification of a rock from a melt

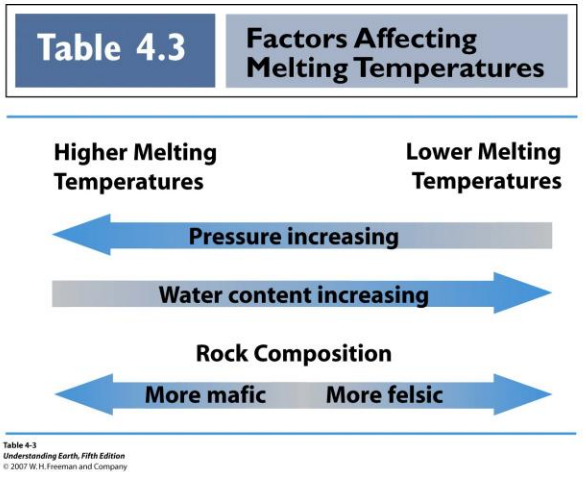
How do Rock melt?

Factor affecting rock melting

- Temperature
- Pressure
- Water Content

Forming an igneous rock

How do Rock melt?



How do Rock melt?

Factor affecting rock melting: Melting temperature
Temperature increases with depth

- Melting of a rock depends on:
  - The proportion of minerals that compose the rock. Minerals will melt at different temperatures
  - Temperature at the locations where melting is occurring

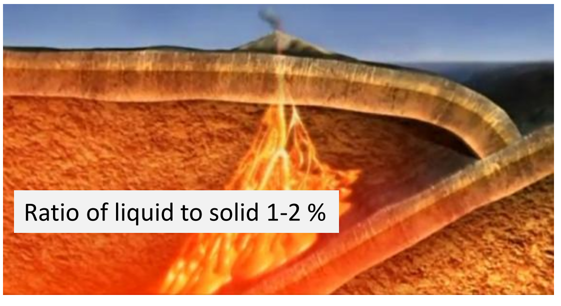
How do Rock melt?

Factor affecting rock melting: Melting temperature
Temperature increases with depth

Partial Melting refers to the incomplete melting of a rock that occurs because the minerals that compose the rock melt at different temperature

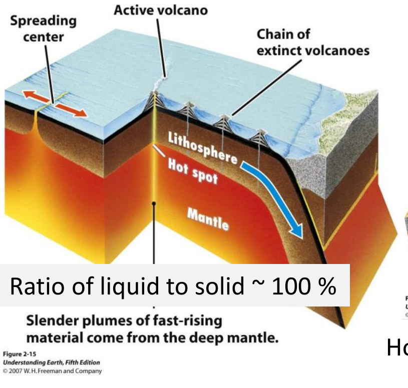
PARTIAL MELTING

Ratio of Solid to Partial melt



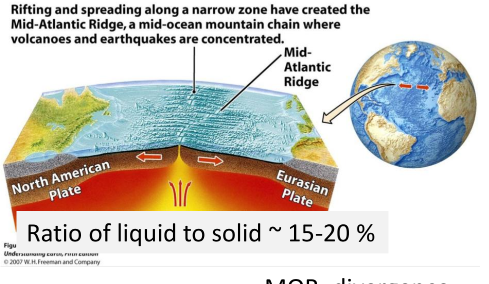
Ratio of liquid to solid 1-2 %

Subduction Zone: convergence



Ratio of liquid to solid ~ 100 %

Hot Spot



Ratio of liquid to solid ~ 15-20 %

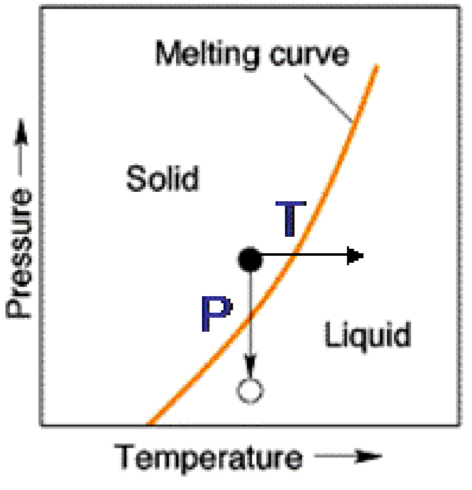
MOR: divergence

How do Rock melt?

Factor affecting rock melting: Pressure

- Pressure and temperature increase with depth
- Higher Pressures lead to higher melting Temperatures
  - E.g., rock that melts at the earth surface at 1000 ^{o}C will melt at 1300 ^{o}C deeper in the earth

E.g., Melting curve: effect of pressure



How do Rock melt?

Factor affecting rock melting: Water Content

- Water content decreases melting temperature
  - E.g., a rock (e.g., Albite) that contains a small amount of water (vapor) melts at 1000 ^{o}C, whereas when it contains large amount of water it will melt at 800 ^{o}C.

How do Rock melt?

Factor affecting rock melting:

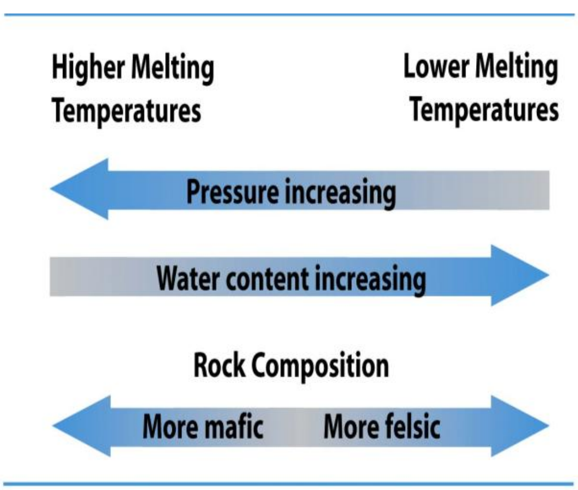
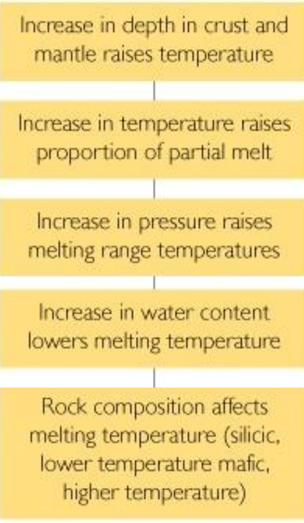


Table 4-3
Understanding Earth, Fifth Edition



Forming an igneous rock

Solidification of a rock from a melt

Magma chambers

Where do magma form?

•A temperature of about 1000°C is required for partial melting of crustal rocks.

•A depth of at least 40 km is required for temperatures of 1000°C to occur. In other places higher depths are required.

Forming an igneous rock

Solidification of a rock from a melt

Magma chambers

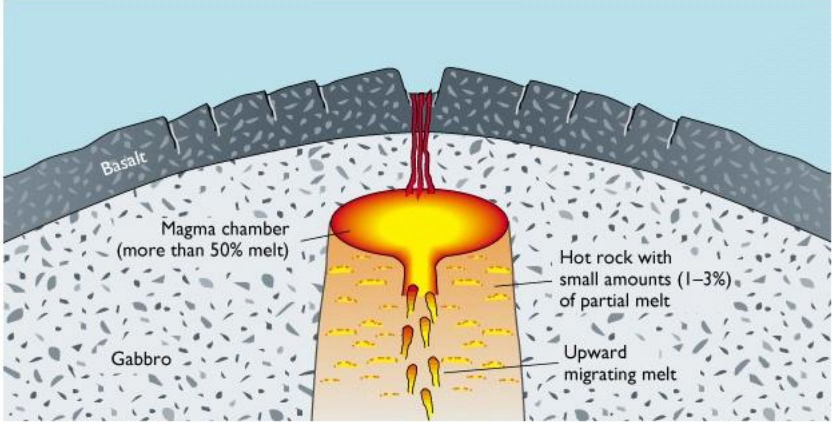
Formation of magma Chambers

- Molten Material will rise up because of their lower density with respect to solid material at rates varying between 0.3 to 50 m/year
- Molten magma will melt host rocks or get mixed with other types of melts
- Formation of a magma Chamber: large liquid filled cavities in solid rocks (several m^3)

Forming an igneous rock

Solidification of a rock from a melt

- Formation of a magma Chamber: large liquid filled cavities in solid rocks (several m^3)



http://web.mst.edu

Forming an igneous rock

Solidification of a rock from a melt

Crystallization of a magma

Crystallization

Is the cooling, solidification of hot magma or lava, in which unordered, randomly distributed ions begin to be arranged in an orderly pattern.

When melt is consumed, it solidifies into interlocking crystals.

Slow cooling gives large crystals, quenching gives fine-grains or glass.

Ideally, crystallization is the opposite of melting.

The crystallization process is influenced by:

- Rate of cooling,
- Composition of magma and
- Volatile content

When melt reaches the crystallization temperature of a mineral, the mineral forms and undergoes no further changes with subsequent cooling.

Forming an igneous rock

Solidification of a rock from a melt

Crystallization of a magma

Magmatic differentiation: a process by which rocks of varying composition can arise from a uniform parent magma

←Different minerals crystallize at different temperature (same as melting)

Rule : the first mineral to melt are the last to crystallize from a cooling magma, similarly the last minerals to melt are the first to crystallize.

Forming an igneous rock

Solidification of a rock from a melt

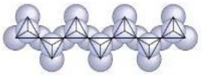
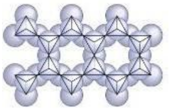
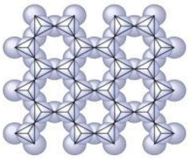
Magmatic Differentiation

Fractional crystallization: a process by which the crystals formed in a cooling magma will be segregated from the remaining liquid rock.

- As magma cools, the most abundant (Si^{4+} and O^{2-}) join to form the $(SiO_4)^{4-}$ tetrahedra.

- With progressive cooling, the tetrahedron polymerizes to form more complex structures of various silicate minerals that crystallize at various T&P conditions.

Silicates

Class	Chemical Formula	Structure
Olivine	$(Mg,Fe)_2SiO_4$	
Pyroxene	$(Mg,Fe)SiO_3$	
Amphibole	$Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$	
Mica	$KAl_2(AlSi_3O_{10})(OH)_2$ Muscovite	

Forming an igneous rock

Solidification of a rock from a melt

Magmatic Differentiation

Fractional crystallization: a process by which the crystals formed in a Cooling magma will be segregated from the remaining liquid rock.

- As magma cools, the most abundant (Si^{4+} and O^{2-}) join to form the $(SiO_4)^{4-}$ tetrahedra.

- With progressive cooling, the tetrahedron polymerizes to form more complex structures of various silicate minerals that crystallize at various T& P conditions.

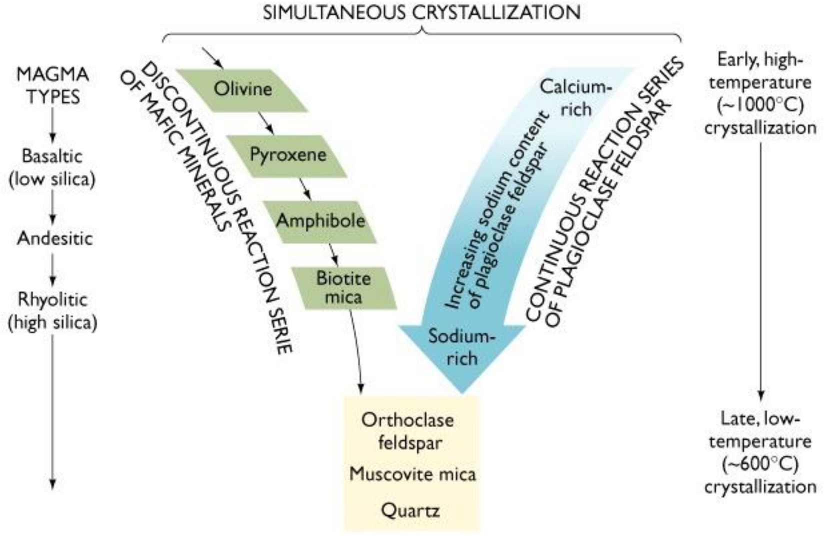
BOWEN 'S REACTION SERIES

Forming an igneous rock

Solidification of a rock from a melt

Magmatic Differentiation

BOWEN 'S REACTION SERIES



Certain minerals crystallize first, therefore the composition of the melt is changed

At successively lower temperature others begin to crystallize as the composition of melt changes (at ~ 50% crystallization:

- Mg, Fe, Ca depleted,
- Si, Na, K enriched

Forming an igneous rock

Solidification of a rock from a melt

Magmatic Differentiation

Continuous Crystallization

The same type of mineral (Plagioclase) begins to crystallize it takes on a given composition but the composition of the Mineral (and the entire crystal) changes due to changes in the composition of the magma.

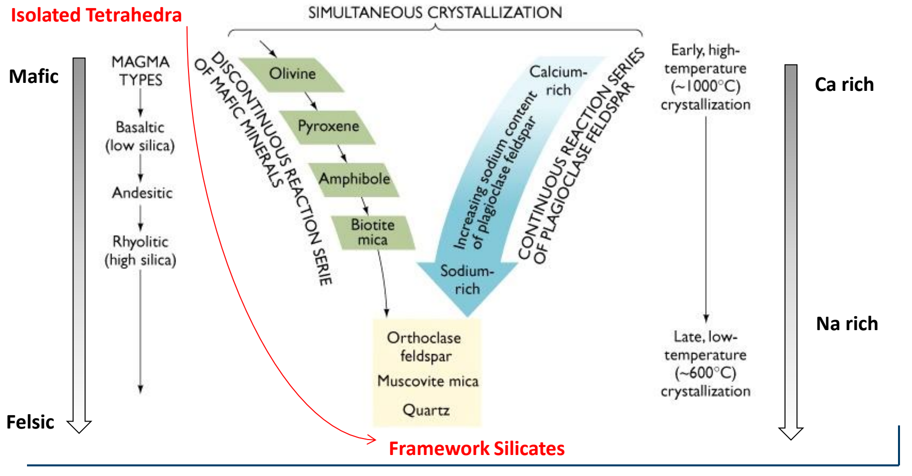
Example: Plagioclase feldspar (calcium rich at the beginning of crystallization becomes sodium rich as the temperature decreases)

Discontinuous Crystallization

Crystals previously formed react with the melt to produce new minerals. e.g., olivine, pyroxene, etc…

BOWEN 'S REACTION SERIES

BOWEN's Reaction Series: As magma cools with the gradual decrease of temperature from 1200°C to 600°C, minerals crystallize in an ordered series

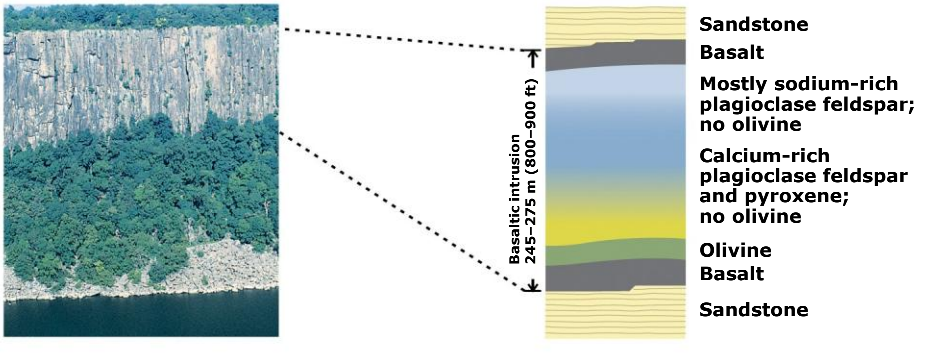


Forming an igneous rock

Solidification of a rock from a melt

Magmatic Differentiation

e.g., The Palisades Intrusion

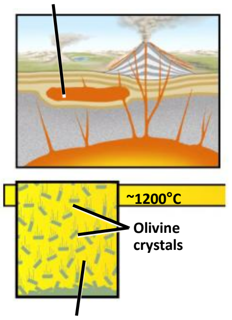


Forming an igneous rock

Solidification of a rock from a melt

Magmatic Differentiation

The Palisades Intrusion



Olivine crystallizes first.

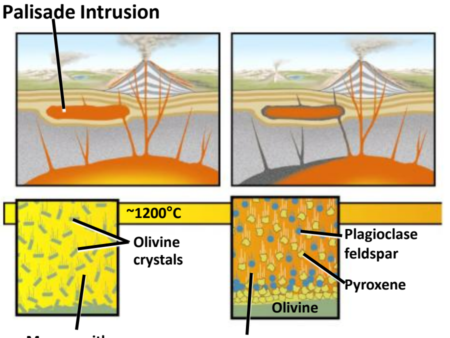
Forming an igneous rock

Solidification of a rock from a melt

Magmatic Differentiation

The Palisades Intrusion

Palisade Intrusion



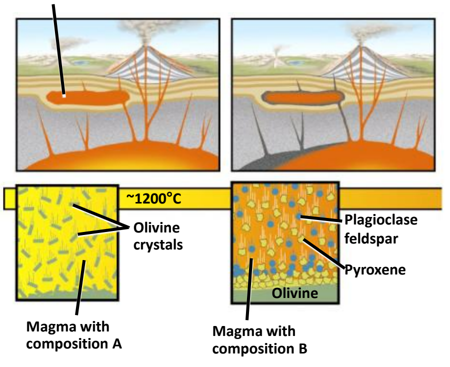
Olivine crystallizes first.

Forming an igneous rock

Solidification of a rock from a melt

Magmatic Differentiation

The Palisades Intrusion



Olivine crystallizes first.

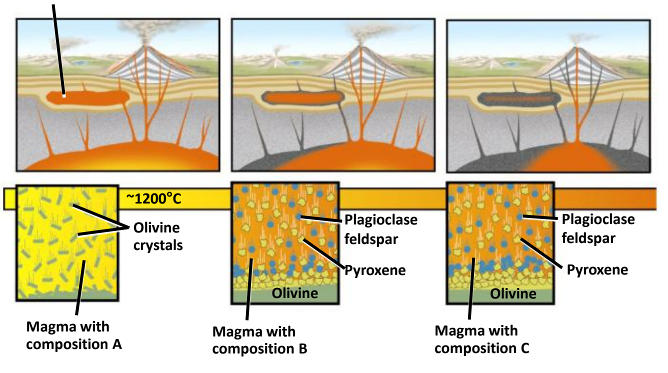
Pyroxene and plagioclase feldspar crystallize.

Forming an igneous rock

Solidification of a rock from a melt

Magmatic Differentiation

The Palisades Intrusion



Olivine crystallizes first.

Pyroxene and Plagioclase feldspar crystallize.

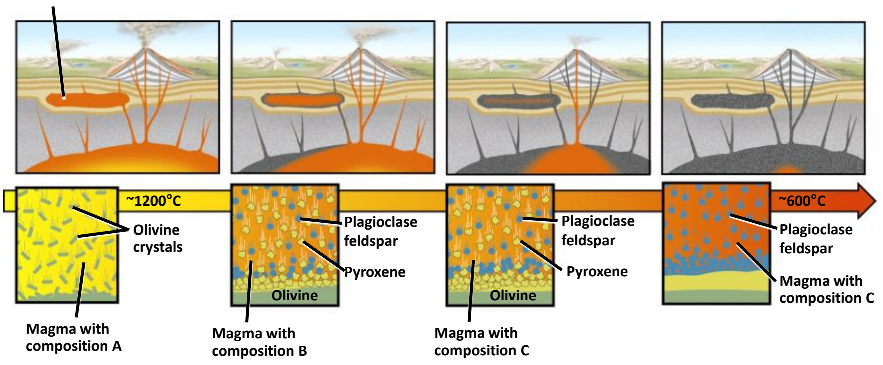
A gradient of pyroxene and feldspar is established.

Forming an igneous rock

Solidification of a rock from a melt

Magmatic Differentiation

The Palisades Intrusion



Olivine crystallizes first.

Pyroxene and Plagioclase feldspar crystallize.

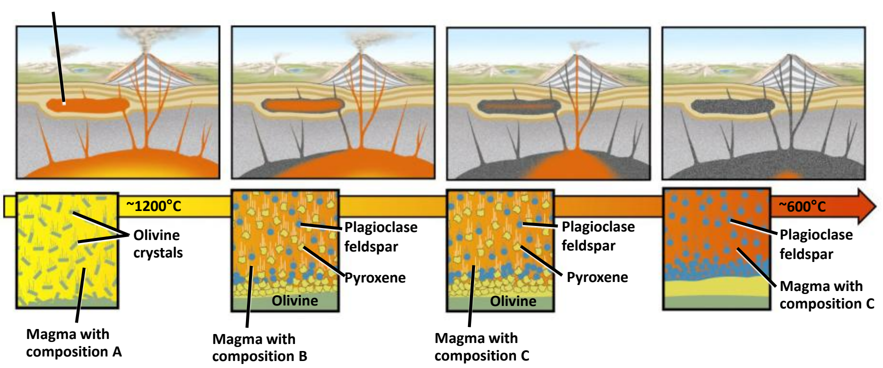
A gradient of pyroxene and feldspar is established.

Forming an igneous rock

Solidification of a rock from a melt

Magmatic Differentiation

The Palisades Intrusion



Olivine crystallizes first.

Pyroxene and plagioclase feldspar crystallize.

A gradient of pyroxene and feldspar is established.

Plagioclase feldspar continues to crystallize.

Forming an igneous rock

Solidification of a rock from a melt

Types of Magma → types of igneous rocks

- Magma do not cool uniformly: Temperatures vary within a magma chamber →Chemical composition of magma varies from one region to another

- Magmas can be
  - Miscible: they mix together but the end result of crystallization is different than the one followed by each magma separately
  - Immiscible: they coexist in one chamber but they do not mix, therefore each magma will follow its own fractional crystallization series

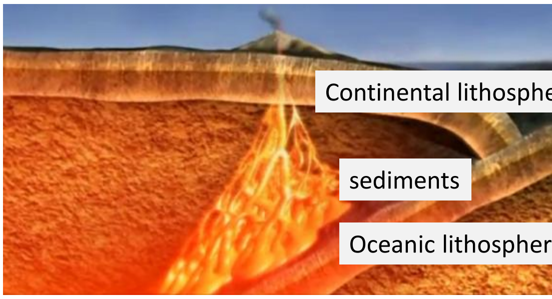
Forming an igneous rock

Solidification of a rock from a melt

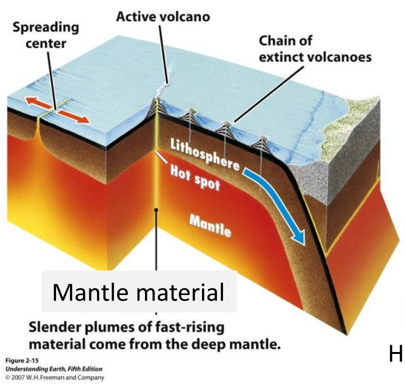
Types of Magma → types of igneous rocks

•What types of rocks are subject to melting?

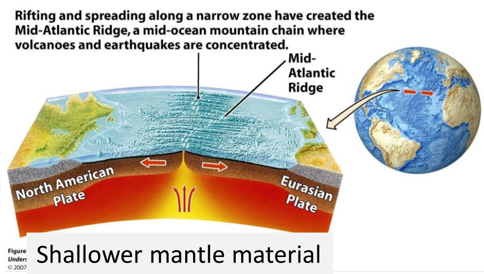
- → types of magma
- → types of igneous rocks



Subduction Zone: convergence



Hot Spot



MOR: divergence

Forming an igneous rock

Solidification of a rock from a melt

Types of Magma → types of igneous rocks

•Different degrees of partial melting of same mantle or crustal source rock or different source rocks will produce different magma compositions which eventually crystallize to give different rocks

Forming an igneous rock

Solidification of a rock from a melt

Types of Magma → types of igneous rocks

•Basaltic magmas
- Produced by partial melting of rocks in the Upper Mantle (Peridotite) → Basalts

•Andesitic magmas (intermediate magmas)
- Produced by melting of a mixture of sedimentary rocks and basaltic oceanic → Intermediate igneous rocks e.g., Andesite

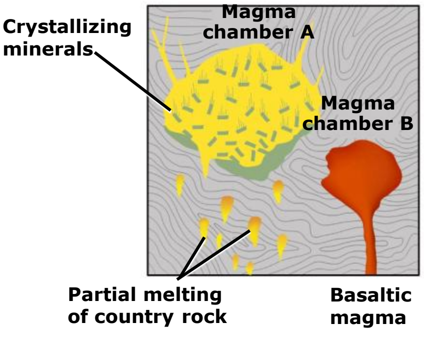
•Granitic magmas
- Generated by melting of sedimentary rocks and continental crust and fractionation → Felsic igneous rocks e.g., Granite

Forming an igneous rock

Solidification of a rock from a melt

Types of Magma → types of igneous rocks

Example: Granite versus basalt

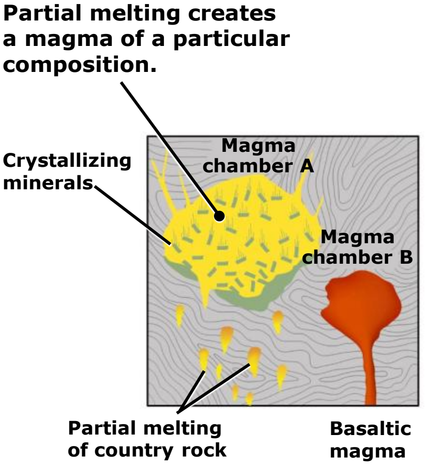


Forming an igneous rock

Solidification of a rock from a melt

Types of Magma → types of igneous rocks

Example: Granite versus basalt

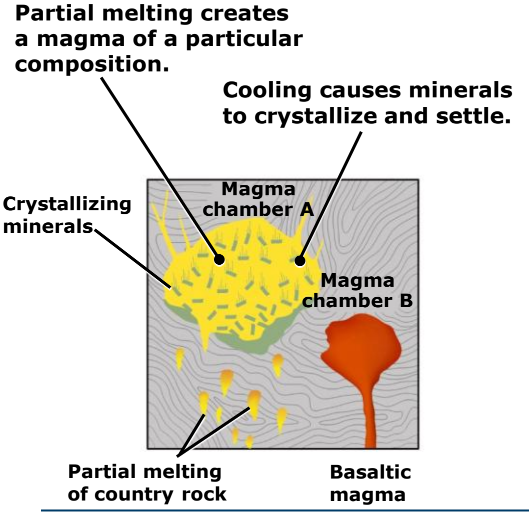


Forming an igneous rock

Solidification of a rock from a melt

Types of Magma → types of igneous rocks

Example: Granite versus basalt

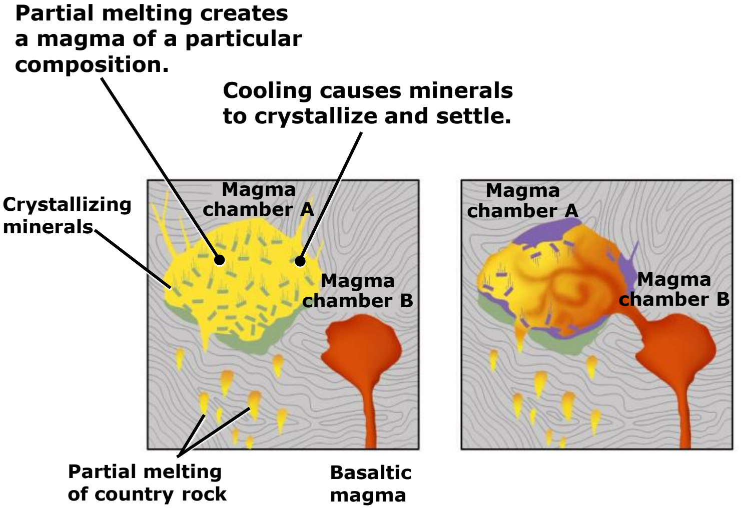


Forming an igneous rock

Solidification of a rock from a melt

Types of Magma → types of igneous rocks

Example: Granite versus basalt

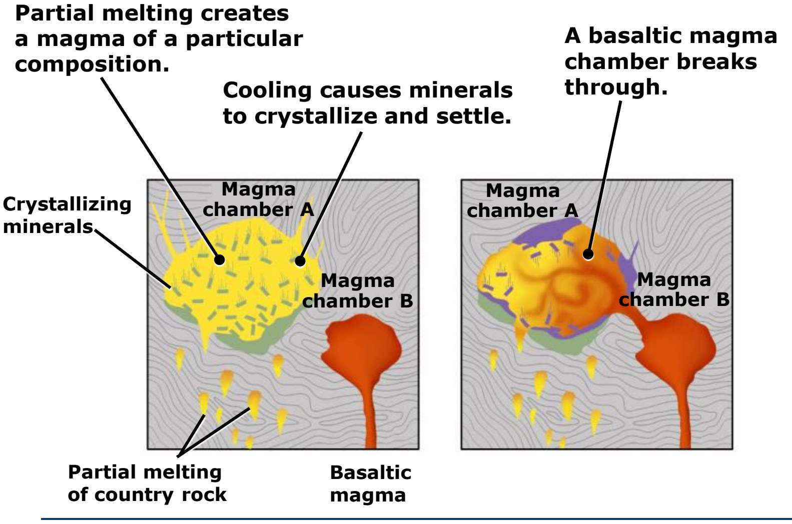


Forming an igneous rock

Solidification of a rock from a melt

Types of Magma → types of igneous rocks

Example: Granite versus basalt

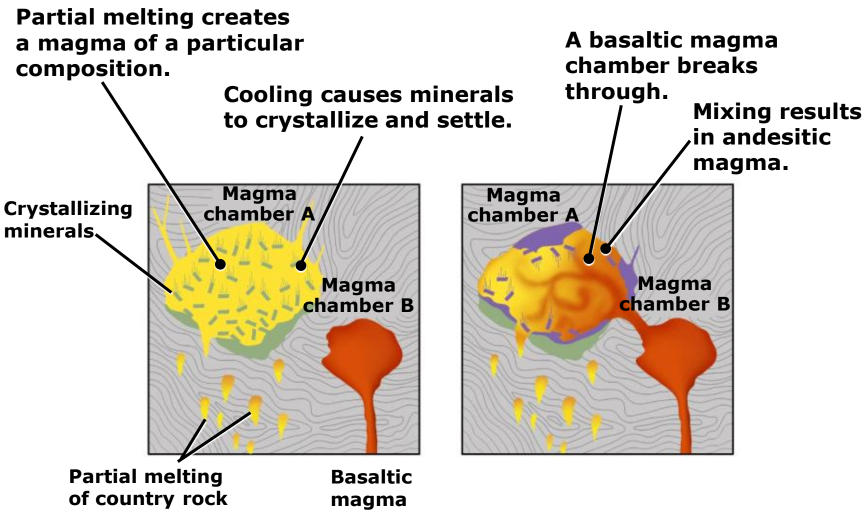


Forming an igneous rock

Solidification of a rock from a melt

Types of Magma → types of igneous rocks

Example: Granite versus basalt

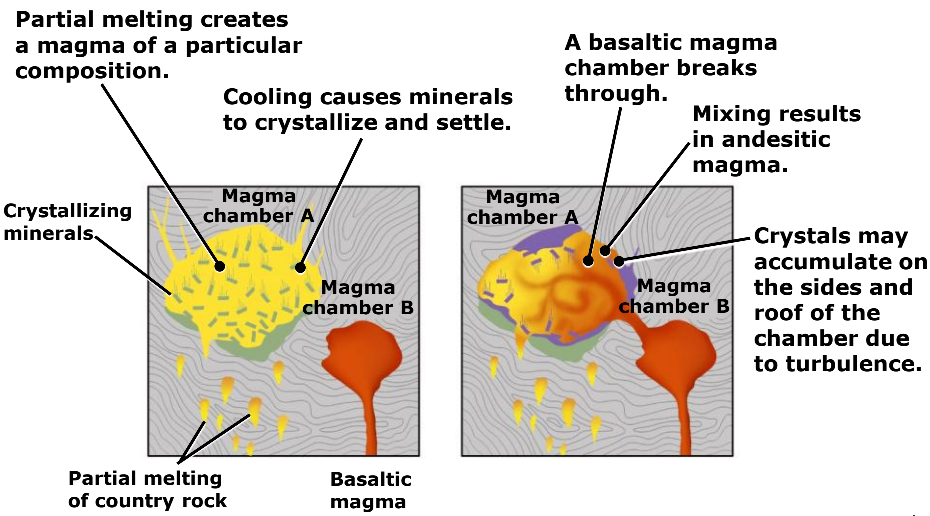


Forming an igneous rock

Solidification of a rock from a melt

Types of Magma → types of igneous rocks

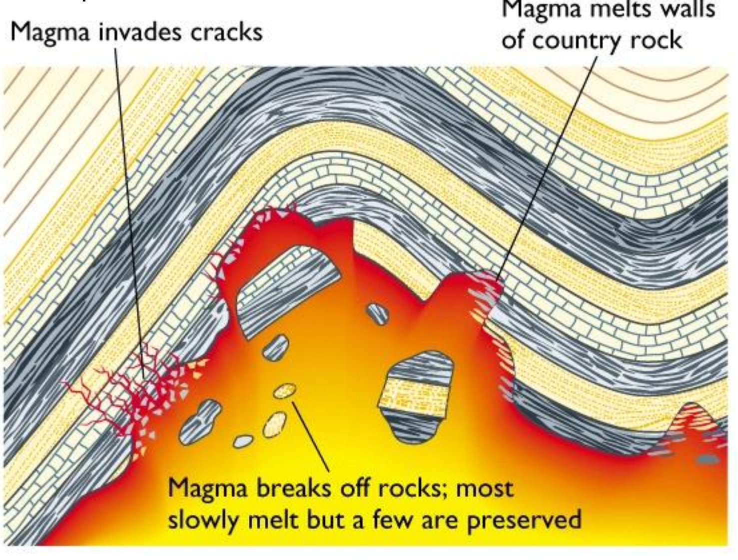
Example: Granite versus basalt



Types of Igneous Intrusions

Forms of Intrusive rock masses

- Molten Material will rise up because of their lower density with respect to solid material

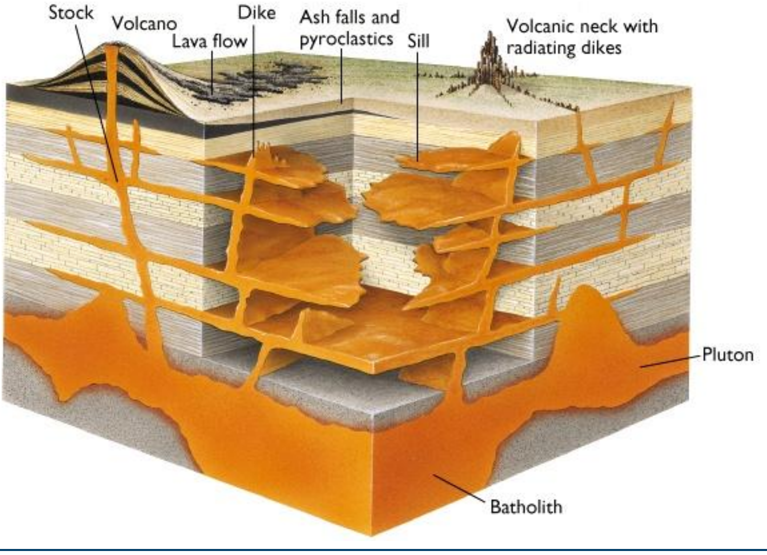


Forms of Intrusive rock masses

Intrusive igneous rock bodies

Emplacement of hot molten magma into intermediate or high levels of the earth crust may be associated with partial melting of the surrounding “host or country rocks”, near contacts (wall rocks), this process is called **assimilation**, and the remnants of these partially melted host rocks called **xenoliths**.

Forms of Intrusive rock masses



Forms of Intrusive rock masses

Types of intrusions

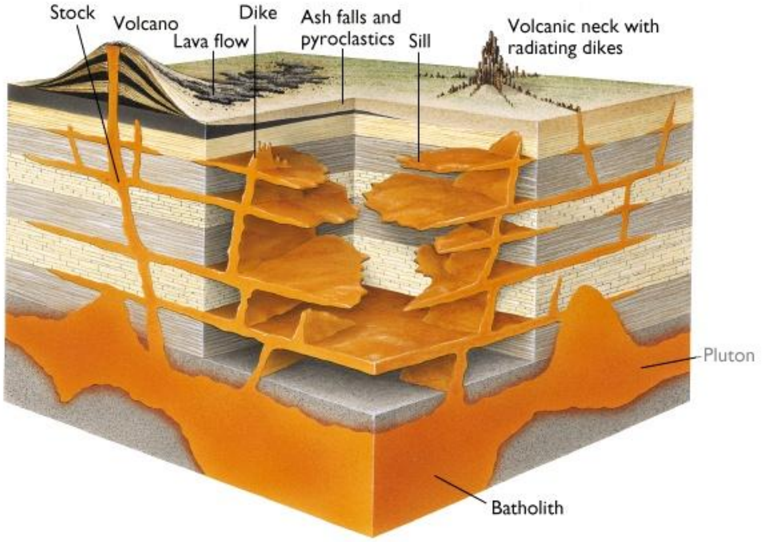
Concordant: their boundaries lie parallel to the country rock layers they intrude, independently if the layers are horizontal or not

Discordant: They cut across the layer or the country rock they intrude

Forms of Intrusive rock masses

Concordant:	Discordant:
Sills	Dikes
Laccoliths	Necks
Layered intrusions	Batholith
Phacolith	Pluton

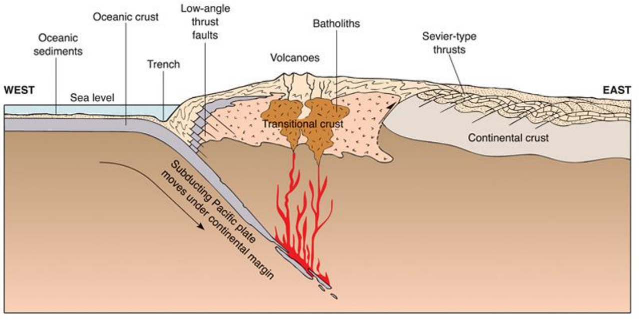
Forms of Intrusive rock masses



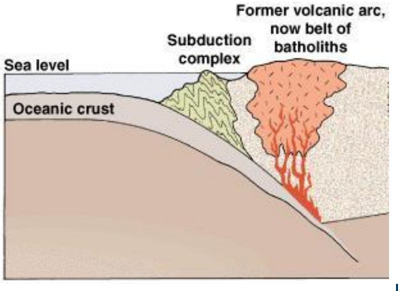
Forms of Intrusive rock masses

- Batholiths: Any deep-seated large intrusion of coarse grained rocks that has a surface exposure of over 100 sq. km that is mostly granitic.

Examples include the Sierra Nevada batholith.



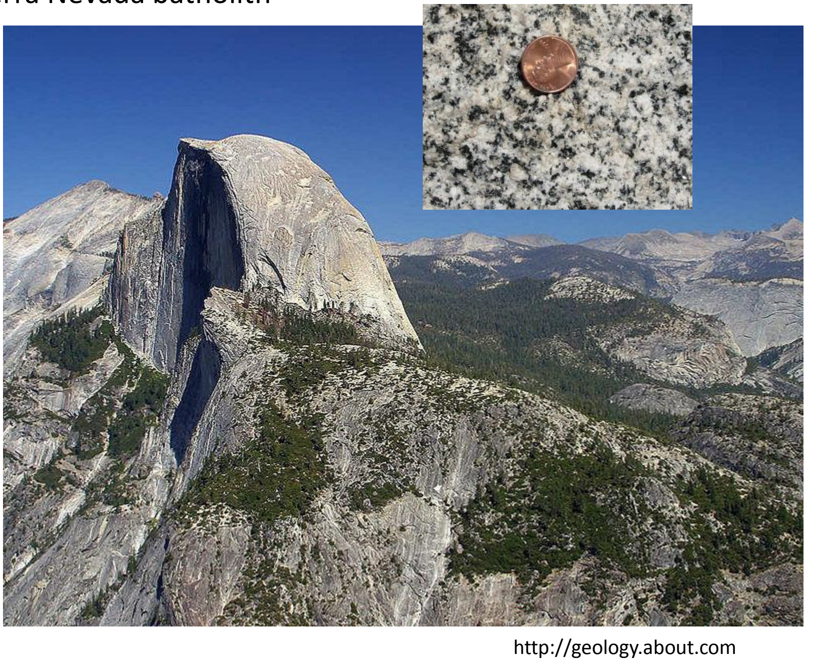
Subduction Zone



Uplift

http://higheredbcs.wiley.com

Sierra Nevada batholith

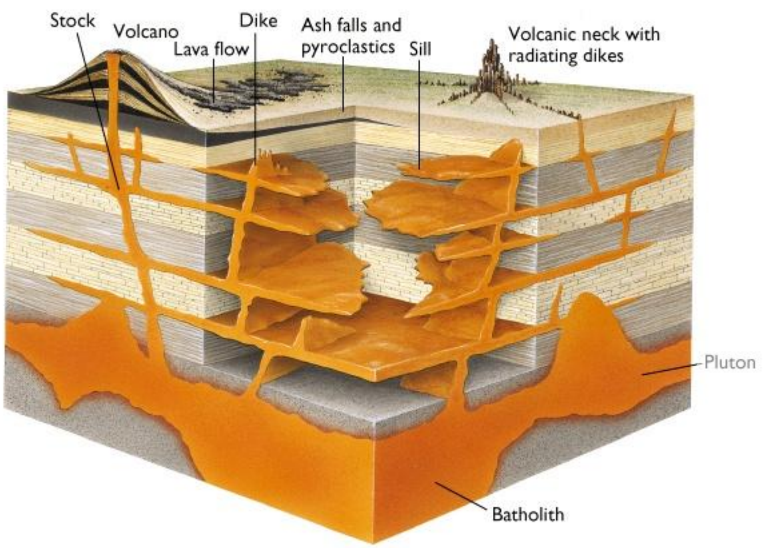


http://geology.about.com

Forms of Intrusive rock masses

- Pluton: A large igneous intrusive body similar to batholith, but smaller size (< 60 km^2 in area) that cuts across the host rocks.

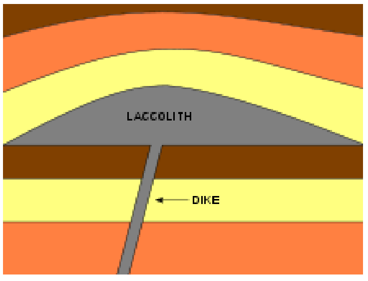
Forms of Intrusive rock masses

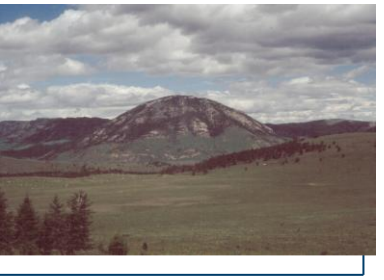


Forms of Intrusive rock masses

- Laccolith: Mushroom-shaped body of relatively small size

  (several km in diameter), formed because of the intrusion of highly pressurized magma. This high pressure results in the arching of the parallel intruded layers

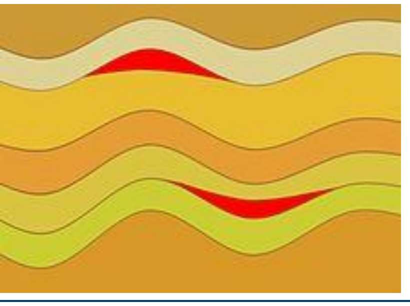




Forms of Intrusive rock masses

- Phacolith: Similar intrusive body to laccolith of small size

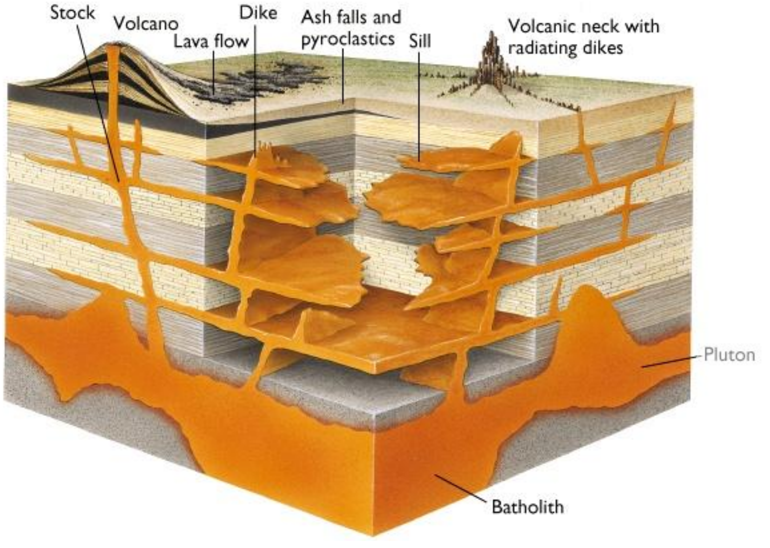
They fill in crests and troughs of folded structures. Therefore they have both curved roof and floor

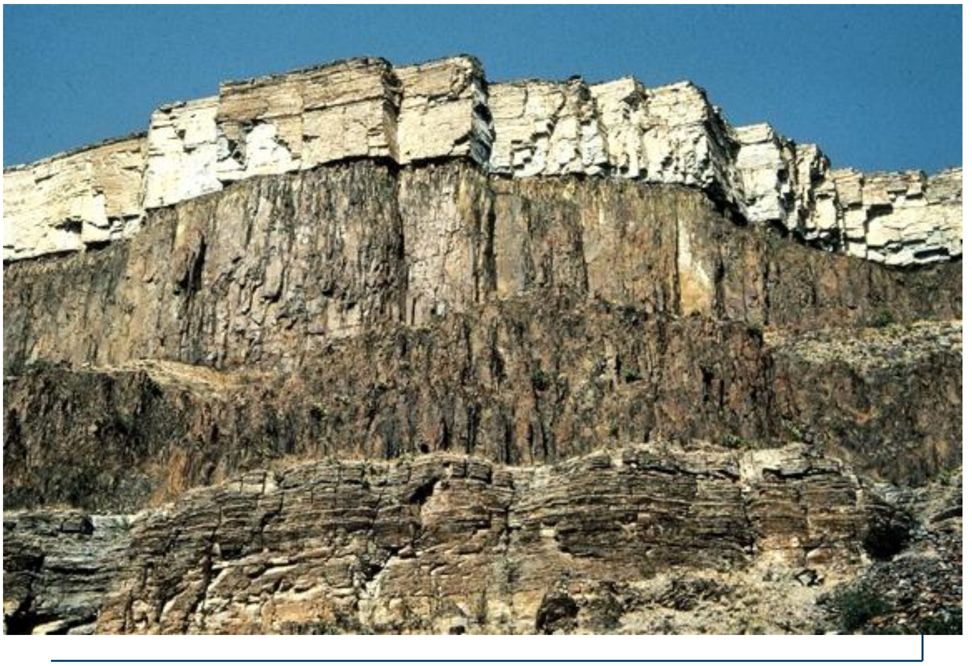


Forms of Intrusive rock masses

- Sill: Concordant horizontal sheets of igneous rocks that lie parallel to the bedding planes of sedimentary (or igneous) host rocks. They frequently show columnar structure.

Forms of Intrusive rock masses



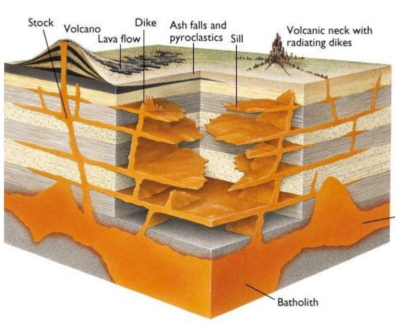


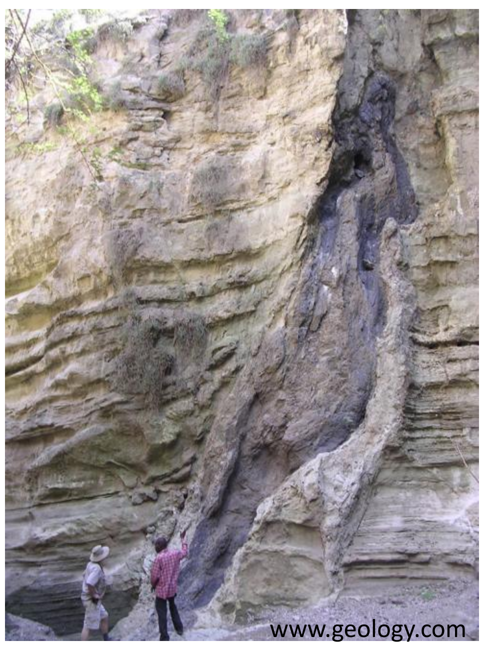
Forms of Intrusive rock masses

- Layered Intrusions : Large sheets of igneous rocks, much thicker than sills. All intrusions are exposed due to uplift and the erosion of the cover.
- Typically they are many kilometers in area covering from around 100 km^2 to over 50,000 km^2 and several hundred meters to over a kilometer in thickness

Forms of Intrusive rock masses

- Dykes are wall-like vertical masses characterized by parallel sides.
  - These vary in width from few centimeters to many meters and may extend for tens of kilometers.
  - They could also occur in groups. They are **discordant**, and cut across surrounding rocks
  - They are emplaced along fissures, cracks and fault planes during extensional or tension-induced tectonics.





www.geology.com

Forms of Intrusive rock masses

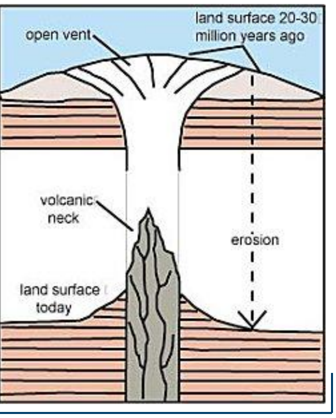
- Veins are deposits of minerals found within a rock fracture that are foreign to the country rock. They can be a few millimeters to several meters across.

Extremely coarse grained Granite cutting through a much finer grained rock = Pegmatite (Crystallizes from a water rich Magma)

www.flickr.com

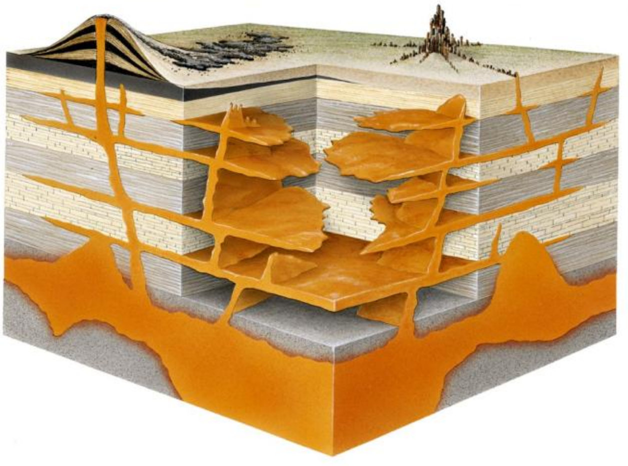
Forms of Intrusive rock masses

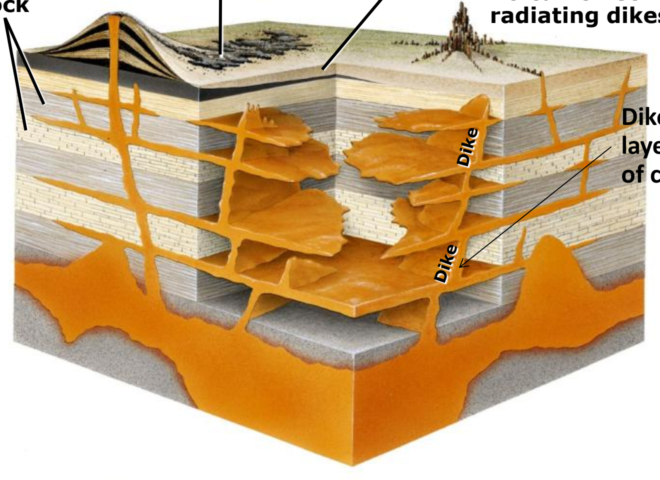
- A neck is a volcanic landform created when magma hardens within a vent on an active volcano.

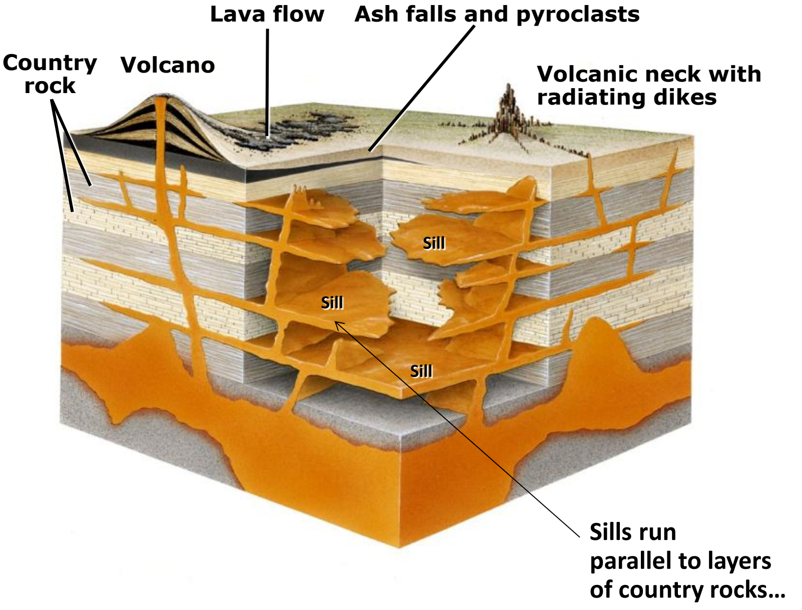


Forms of Intrusive rock masses

Summary







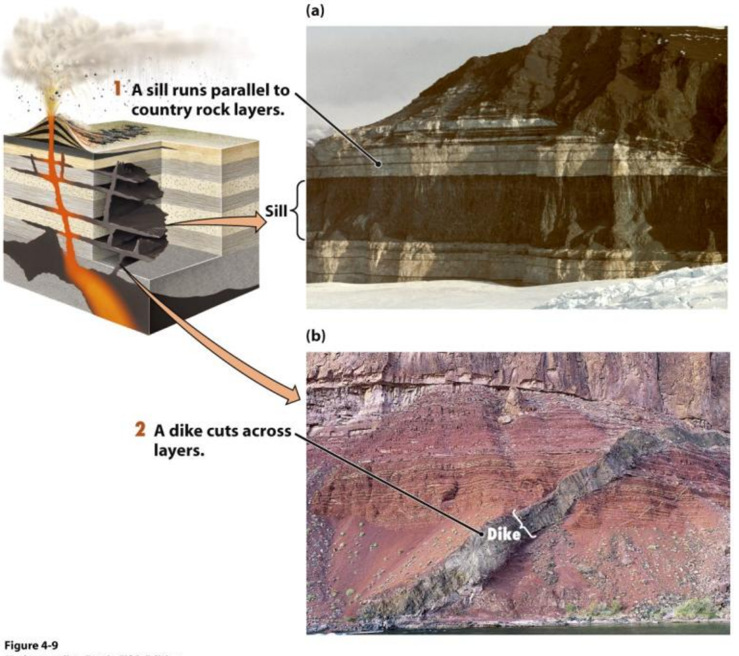
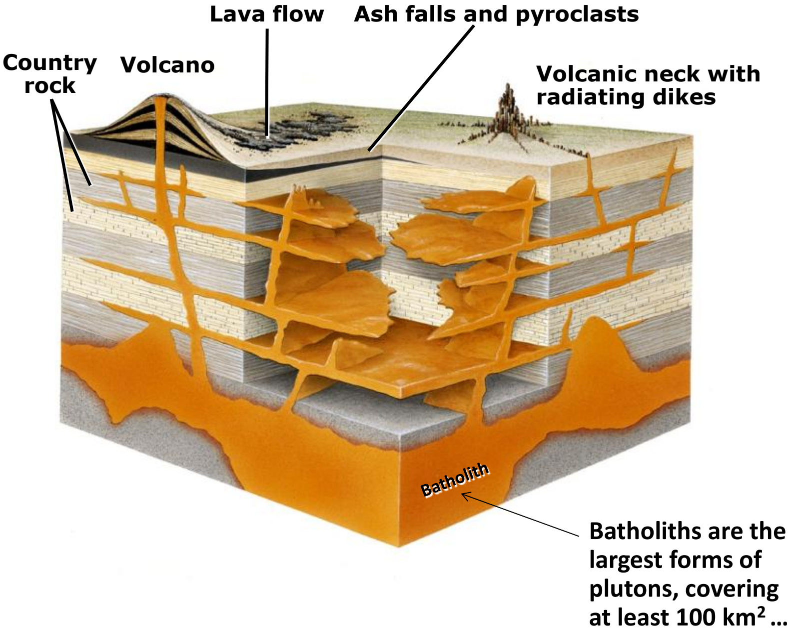
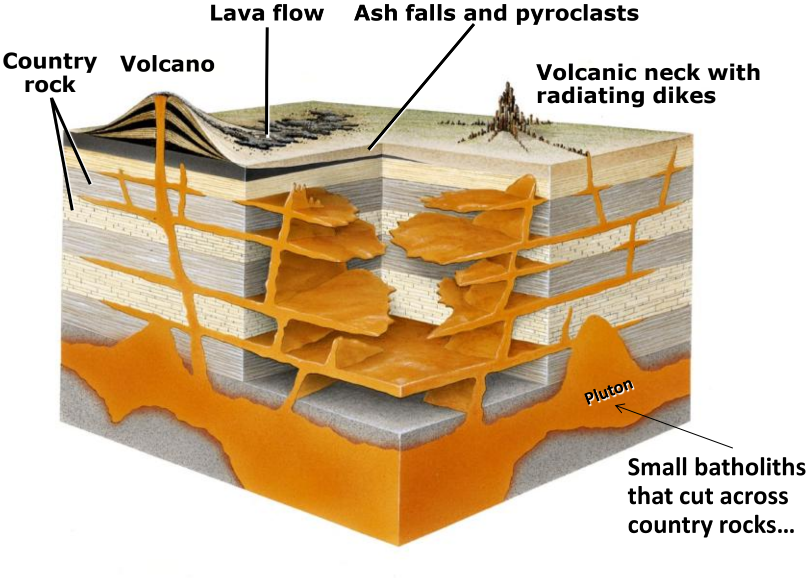
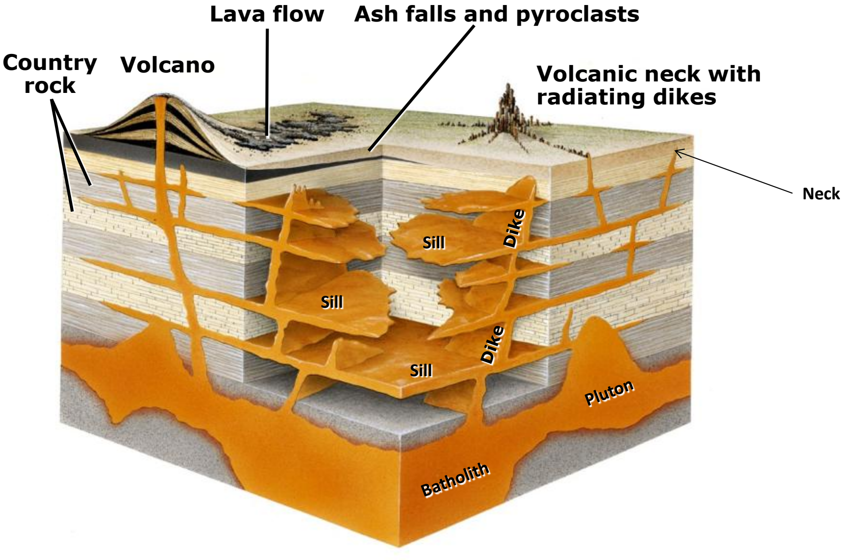


Figure 4-9
Understanding Earth, Fifth Edition

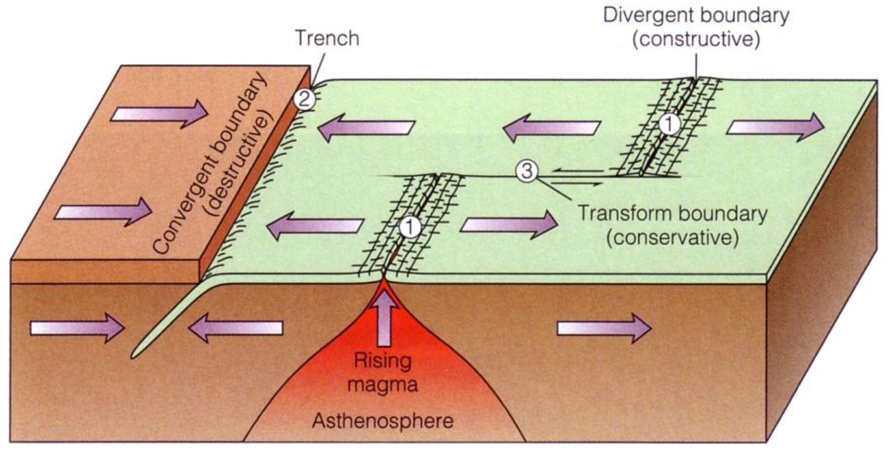

Lava flow
Ash falls and pyroclasts
Country rock
Volcano
Volcanic neck with radiating dikes
Batholith
Batholiths are the largest forms of plutons, covering at least 100 km² …


Lava flow
Ash falls and pyroclasts
Country rock
Volcano
Volcanic neck with radiating dikes
Pluton
Small batholiths that cut across country rocks…



Igneous processes and Plate Tectonics

Back to Plate Tectonics!



What plate tectonics processes affect magma production?

Forming an igneous rock

Igneous rocks and Plate tectonics

- Four main zones of Magma Production

convergence
1. Island arc plate subduction
2. Continental plate subduction

divergence
3. Plate divergence

4. Hot-spot volcanism

Magmatic Geosystems

Forming an igneous rock

Igneous rocks and Plate tectonics

Hot-spot volcanism

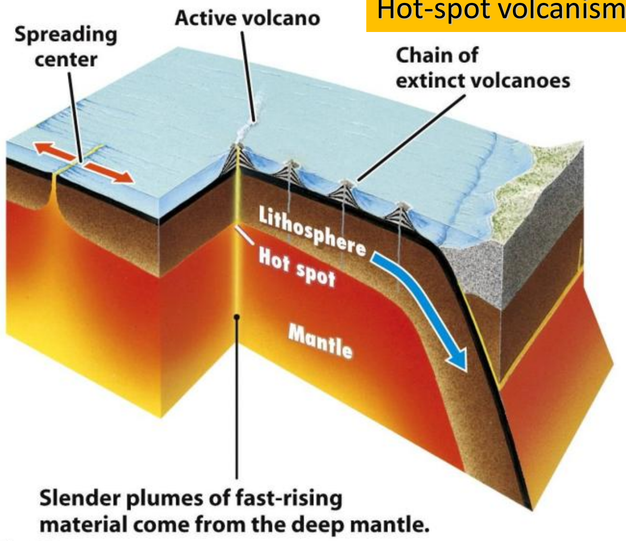


Figure 2-15
Understanding Earth, Fifth Edition

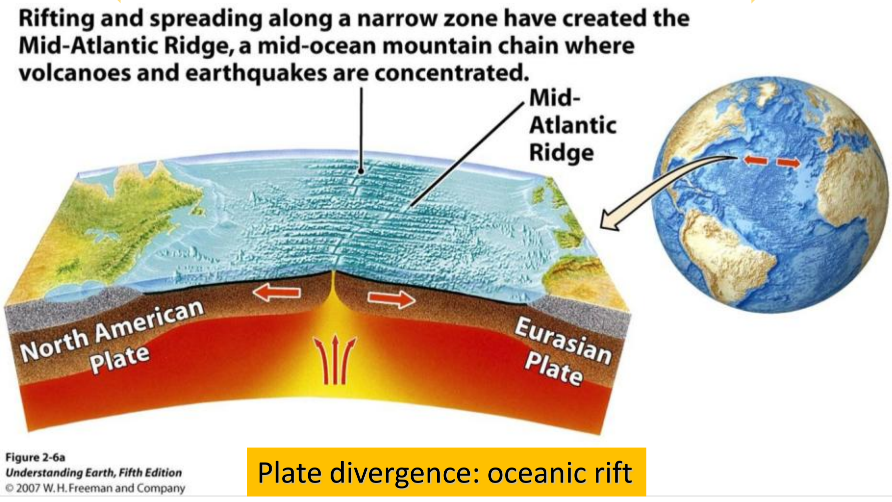
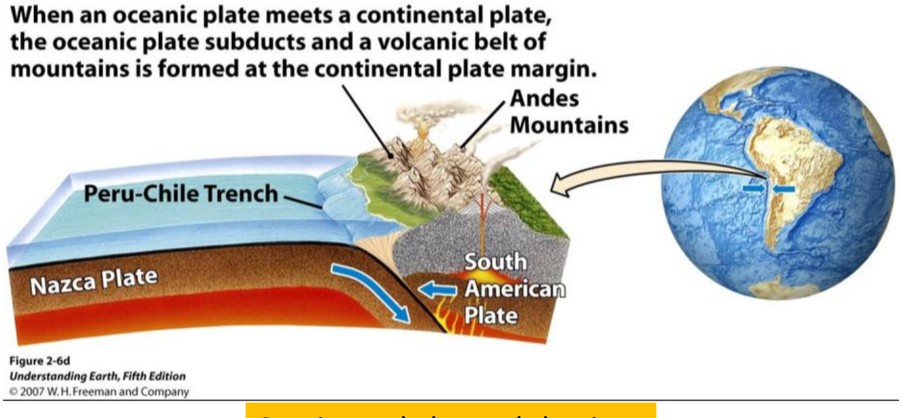


Plate divergence: oceanic rift



Continental plate subduction

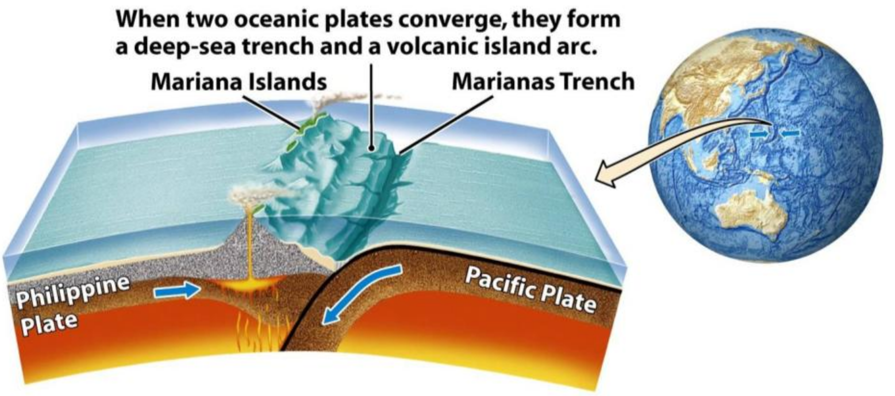


Figure 2-6c
Understanding Earth, Fifth Edition

Island arc plate subduction

Forming an igneous rock

Igneous rocks and Plate tectonics

Magmatic Geosystems

Each type of magmatic Geosystem will generate different types of magma

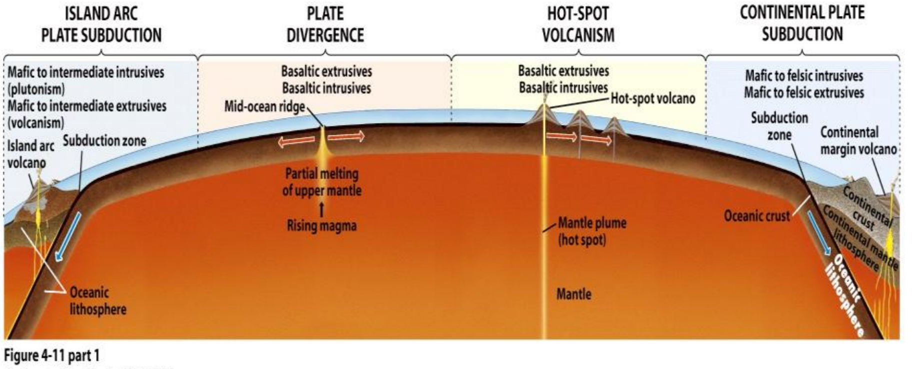


Figure 4-11 part 1
Understanding Earth, Fifth Edition

Forming an igneous rock

Igneous rocks and Plate tectonics

Magmatic Geosystems

Each type of magmatic Geosystem will generate different types of magma → THINK OF INPUT MOLTEN MATERIAL

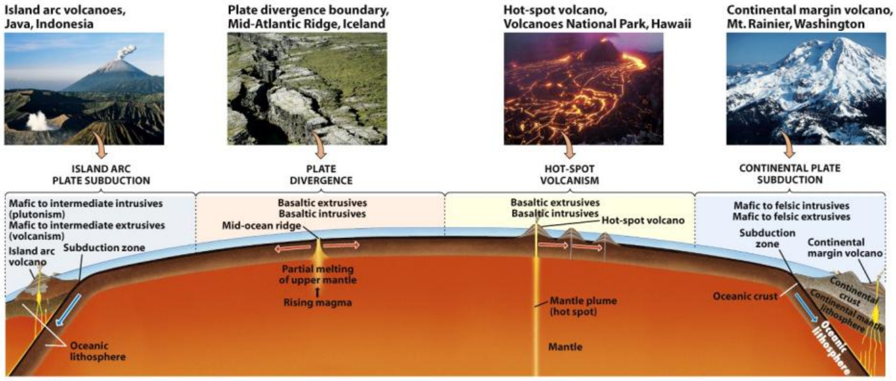


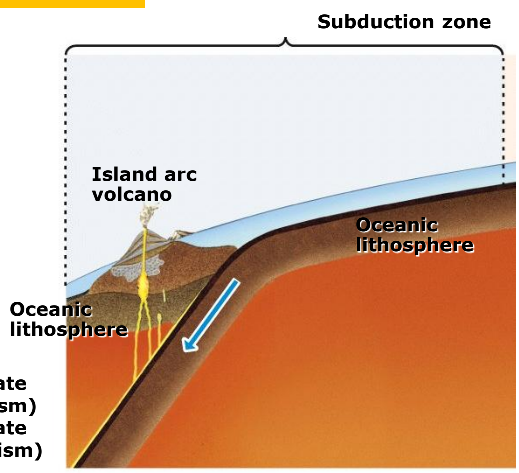
Figure 4-11
Understanding Earth, Fifth Edition

Forming an igneous rock

Igneous rocks and Plate tectonics

Magmatic Geosystems

Island arc plate subduction



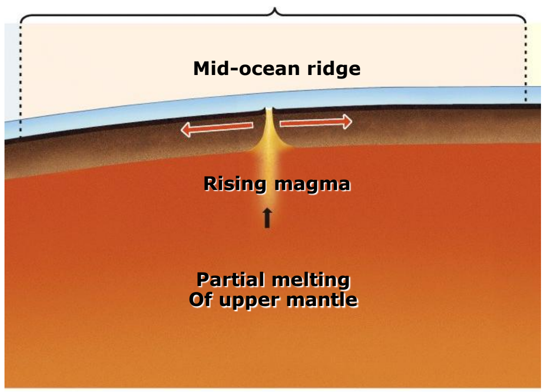
Mafic to intermediate intrusives (plutonism)
Mafic to intermediate extrusives (volcanism)

Forming an igneous rock

Igneous rocks and Plate tectonics

Magmatic Geosystems

Plate divergence: oceanic rift

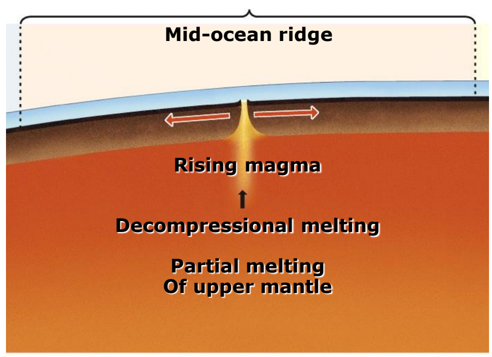


Basaltic extrusives
Basaltic intrusives

Effect of pressure at mid Oceanic Ridge

- Pressure and temperature increase with depth
- Higher Pressures lead to higher melting Temperatures

•Decompression melting:
Decrease of Pressure on
The uprising magma →
Decrease of melting
temperature

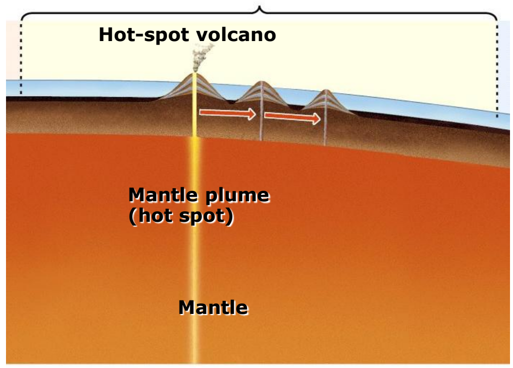


Forming an igneous rock

Igneous rocks and Plate tectonics

Magmatic Geosystems

Hot spots



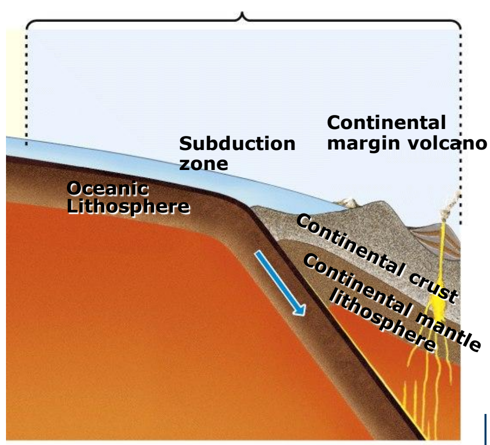
Basaltic extrusives
Basaltic intrusives

Forming an igneous rock

Igneous rocks and Plate tectonics

Magmatic Geosystems

Continental plate subduction



Mafic to felsic intrusives
Mafic to felsic extrusives

Forming an igneous rock

Igneous rocks and Plate tectonics

Magmatic Geosystems

Continental plate subduction: Fluid Induced Melting

- Fluid induced melting:
  Water contained in pore spaces will decrease melting temperature and therefore enhance melting at lower temperature.

Forming an igneous rock

Igneous rocks and Plate tectonics

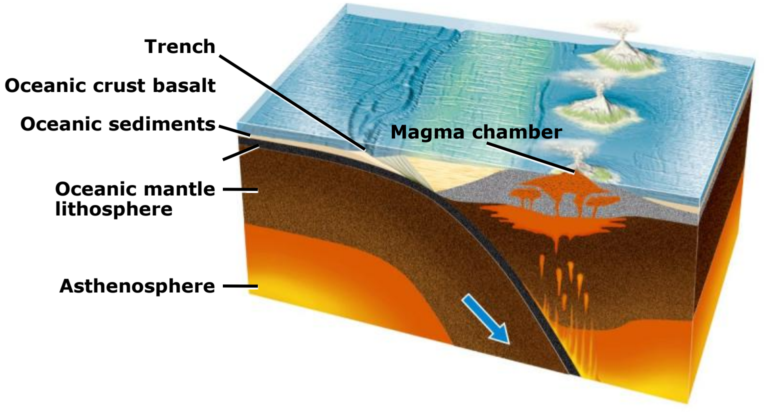
Magmatic Geosystems

Continental plate subduction: Fluid Induced Melting

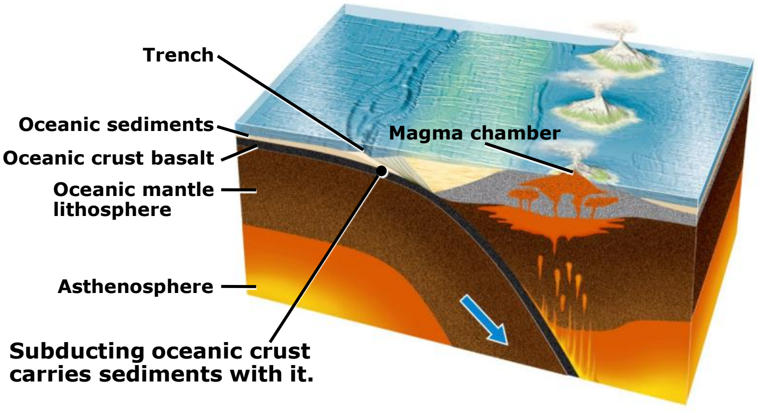
- Fluid induced melting:
  Water contained in pore spaces will decrease melting temperature and therefore enhance melting at lower temperature.

Remember: when the oceanic plate goes beneath the continental plate
→ it **DEHYDRATES !**

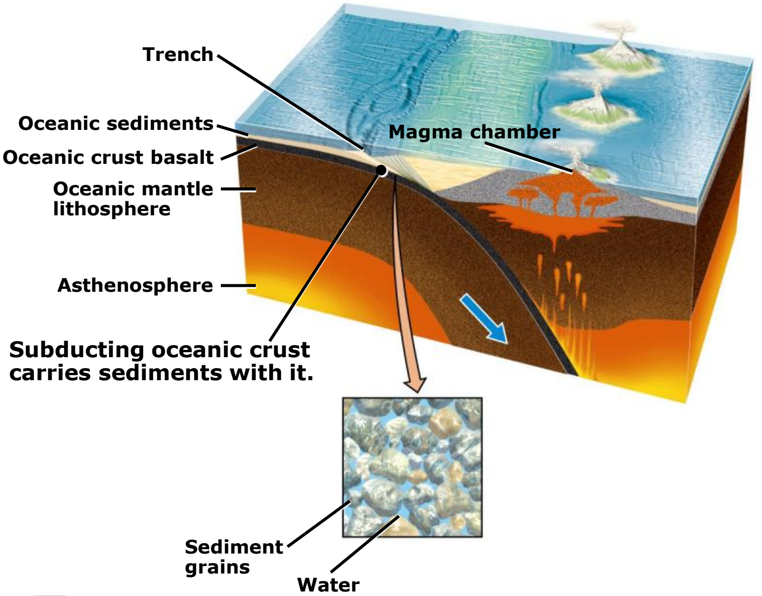
Fluid Induced Melting



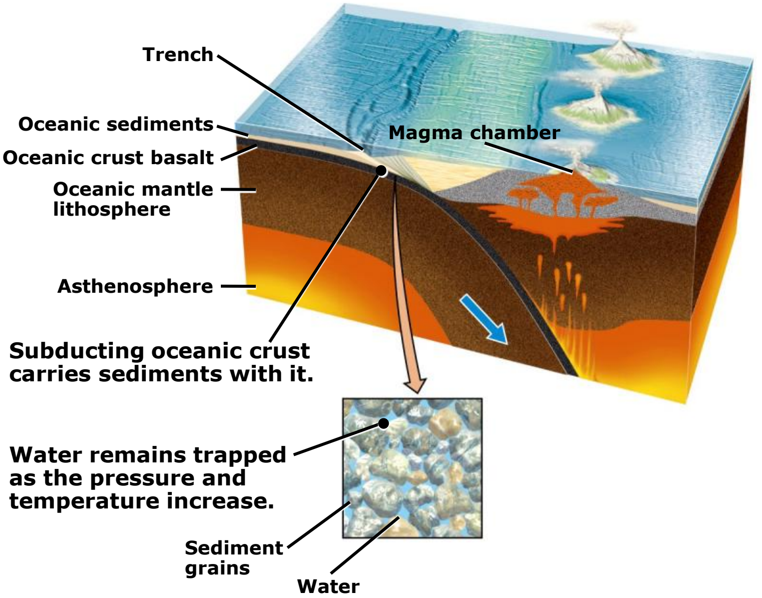
Fluid Induced Melting



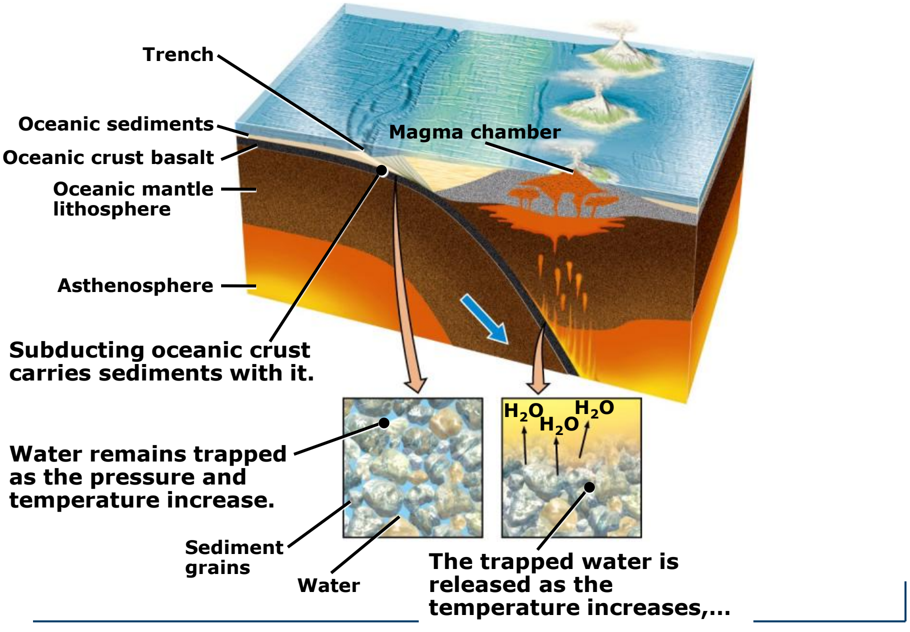
Fluid Induced Melting



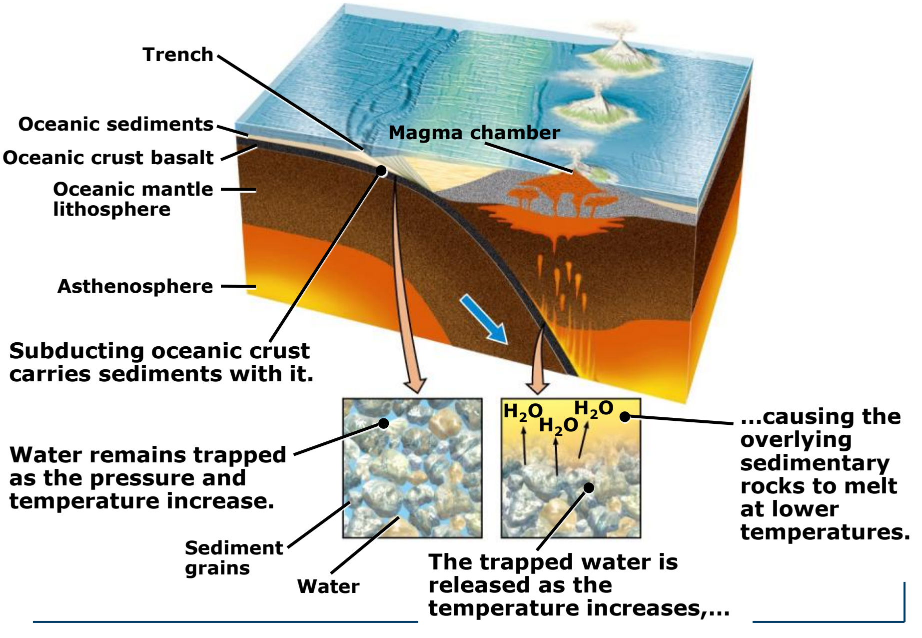
Fluid Induced Melting



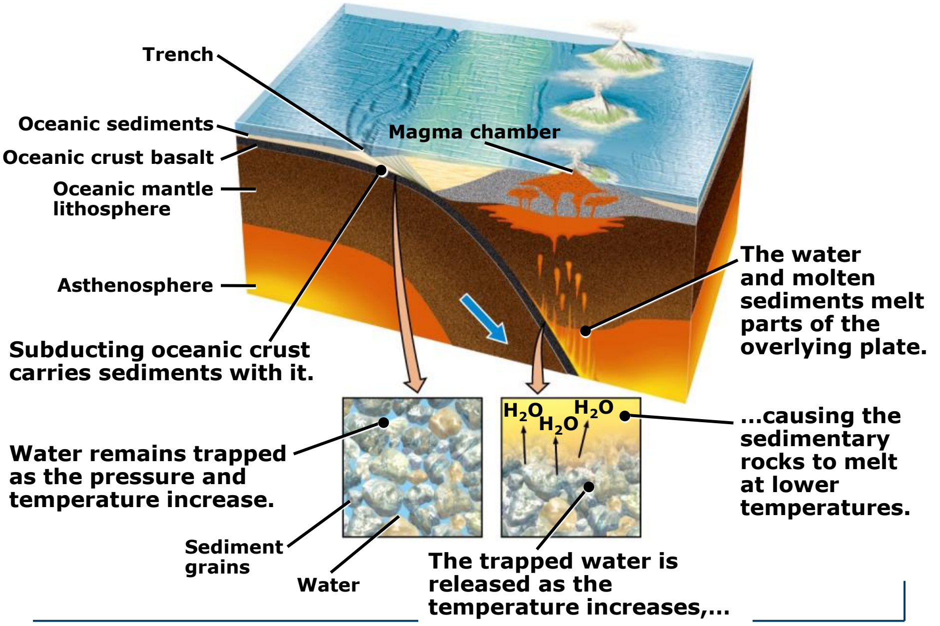
Fluid Induced Melting



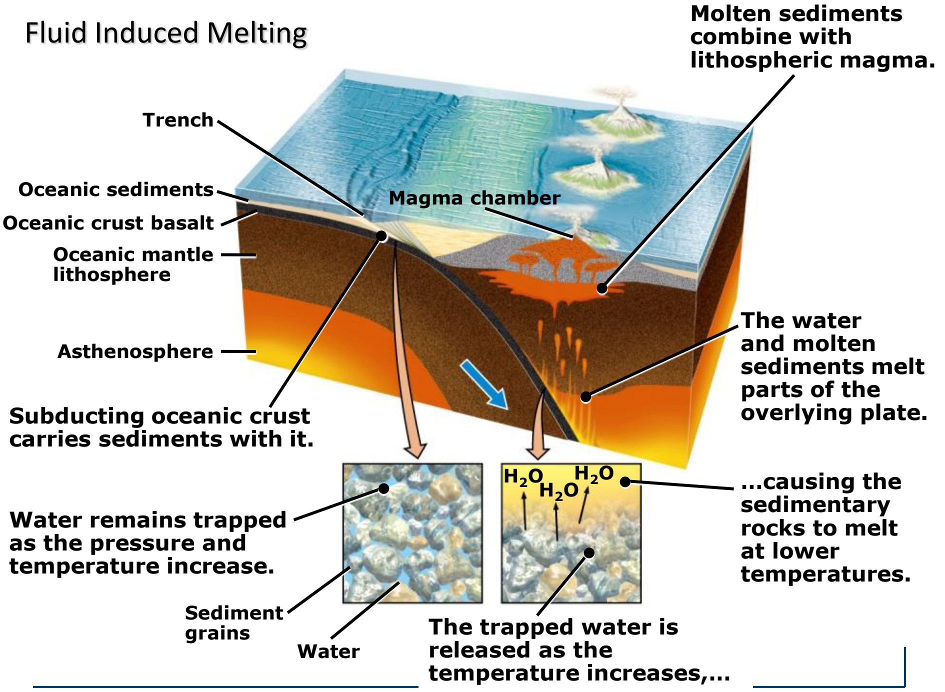
Fluid Induced Melting

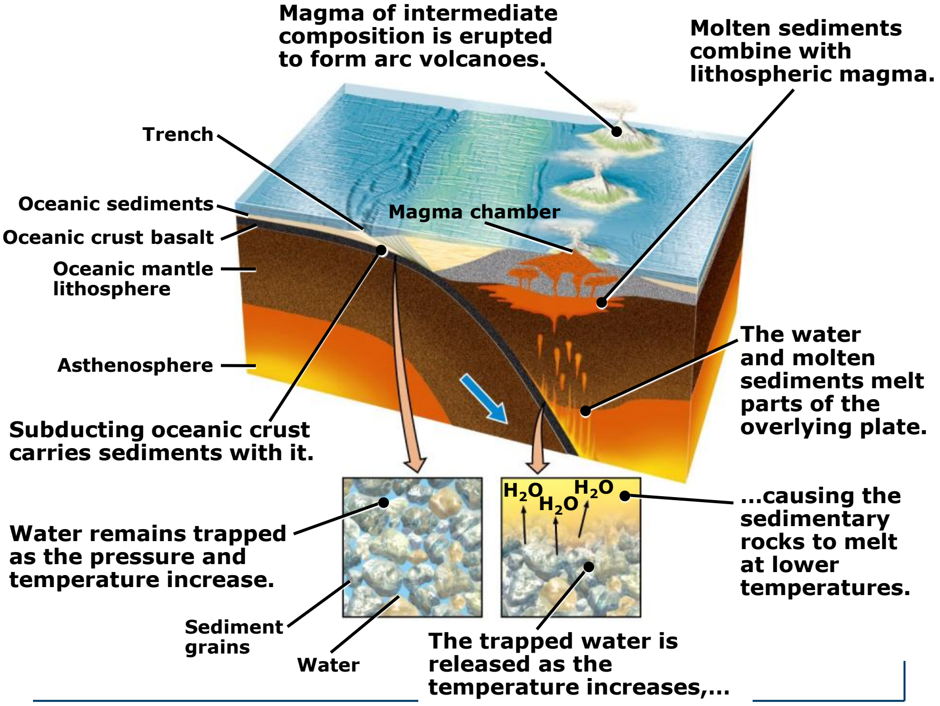


Fluid Induced Melting



Fluid Induced Melting





Igneous rocks

Plate Tectonics

Rock Melt
- Pressure
- Temperature
- Water content

Formation of magma chambers

Magma Crystallization
- Magmatic Differentiation
- Slow versus quenching

BOWEN'S REACTION SERIES!

- Forms of Igneous Intrusions
- Types of magma

Formation of an Igneous rock
- Texture
- Mineralogical composition

Forming an igneous rock

Do you know your Igneous terms?

Andesite
Basalt
Batholith
Concordant intrusion
Country rock
Dacite
Decompression melting
Dyke
Discordant intrusion
Extrusive igneous rock
Felsic rock
Fluid-induced melting
Fractional crystallization
Gabbro
Granodiorite

Forming an igneous rock

Do you know your Igneous terms?

Vein
Intermediate igneous rock
Intrusive igneous rock
Mafic rock
Magma chamber
Magmatic differentiation
Obsidian
Partial melting
Pegmatite
Peridotite
Pluton
Porphyry
Pumice
Pyroclast

Forming an igneous rock

Do you know your Igneous terms?

Rhyolite
Sill
Ultramafic rock
Vein
Viscosity
Volcanic ash

Forming an igneous rock

Do you know your Igneous rocks?

Fast cooling

Fine grained

Slower cooling

Coarser grained

Darker/ Mafic

Extrusive

Picrite
Basalt

Andesite
Syenite
Dacite
Rhyolite

Intrusive

Peridotite
Gabbro

Diorite
Trachyte
Granodiorite
Granite

Lighter/ Felsic