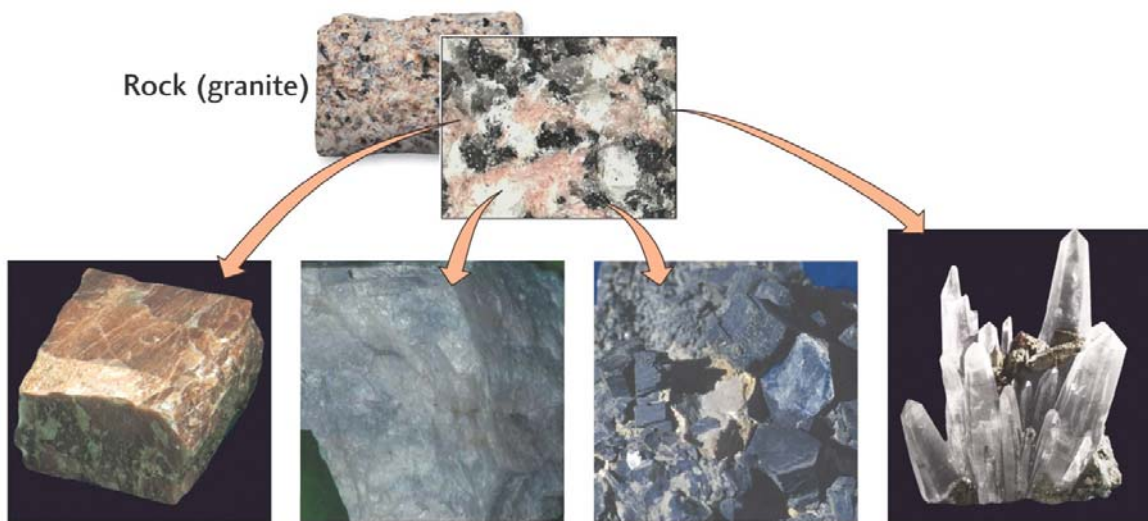
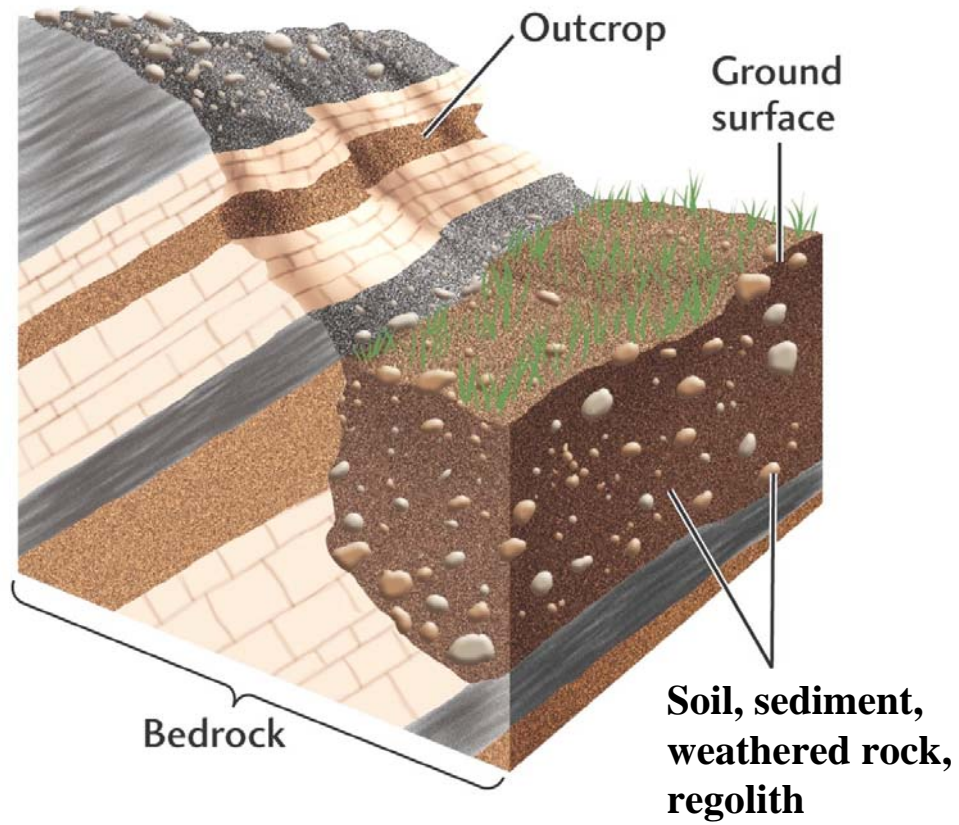
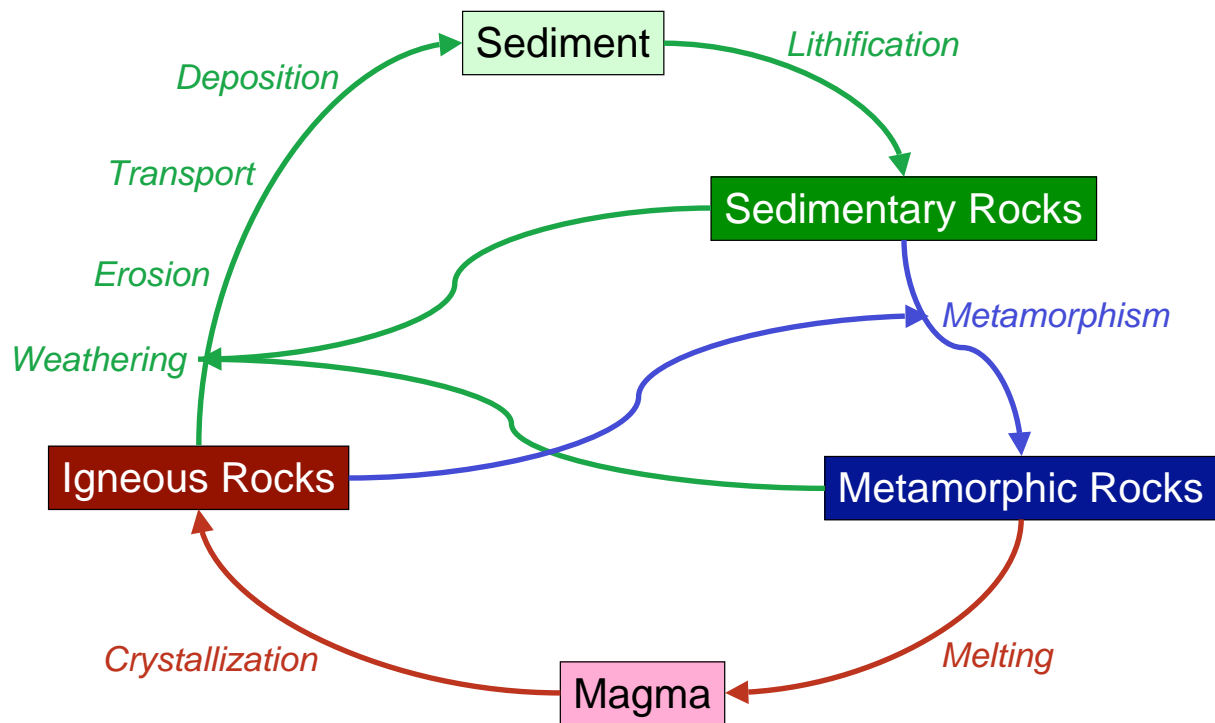


Rocks are made of Minerals
(Minerals in Granite)





Rock Cycle



Rock Identification is based on:

- **Composition**

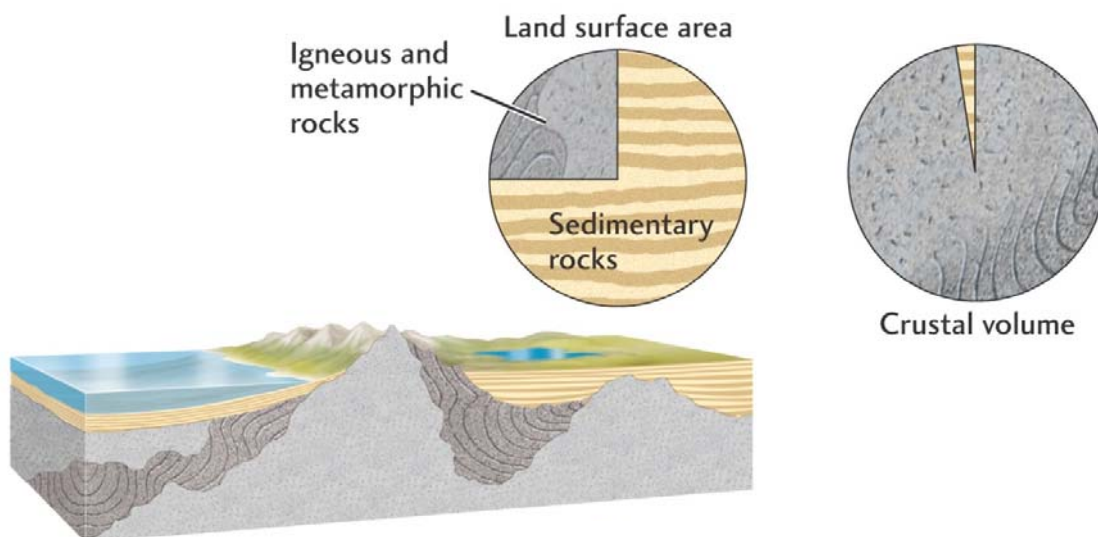
What minerals make up the rock?

- **Texture**

What is the shape, size and orientation of the mineral grains that make up the rock?

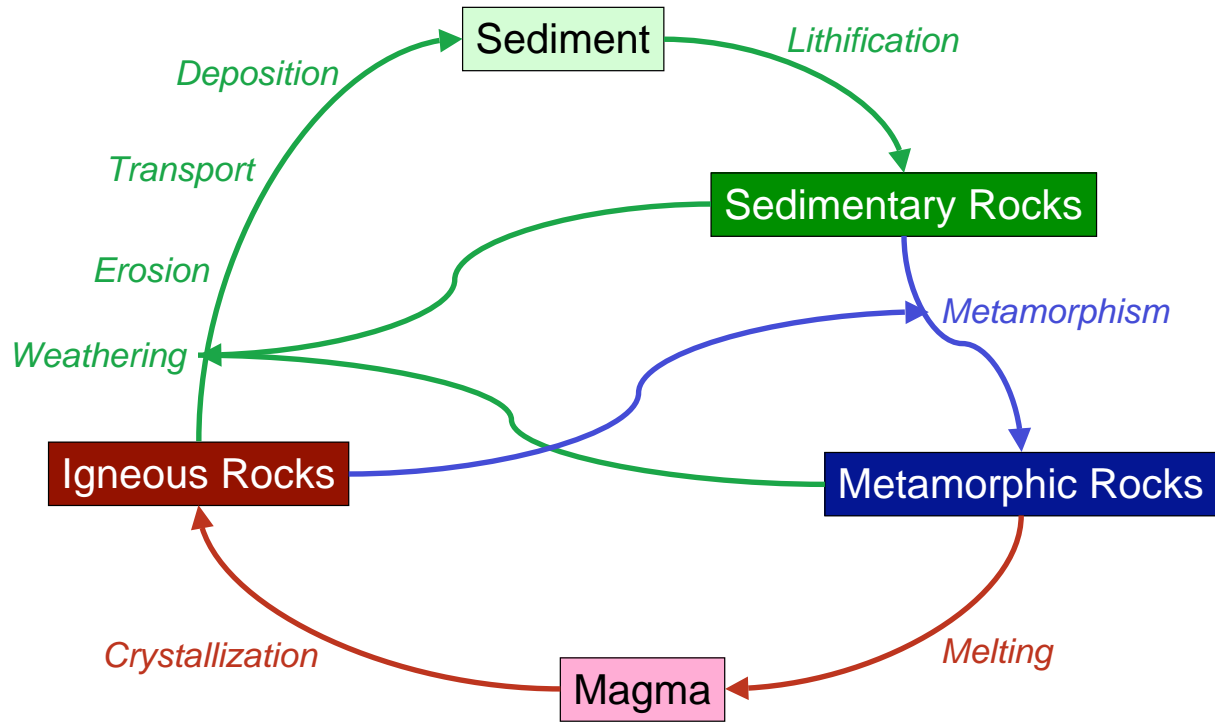
Major Difference:
Crystalline vs. Clastic

Proportions of Rock Types on the Earth



igneous & metamorphic rocks = crystalline rocks

Rock Cycle



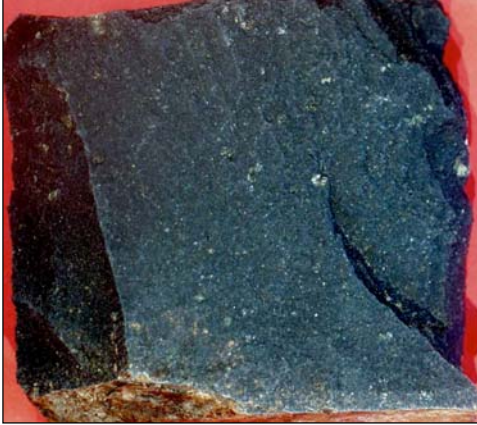
Igneous Rocks

Identification



Igneous Composition

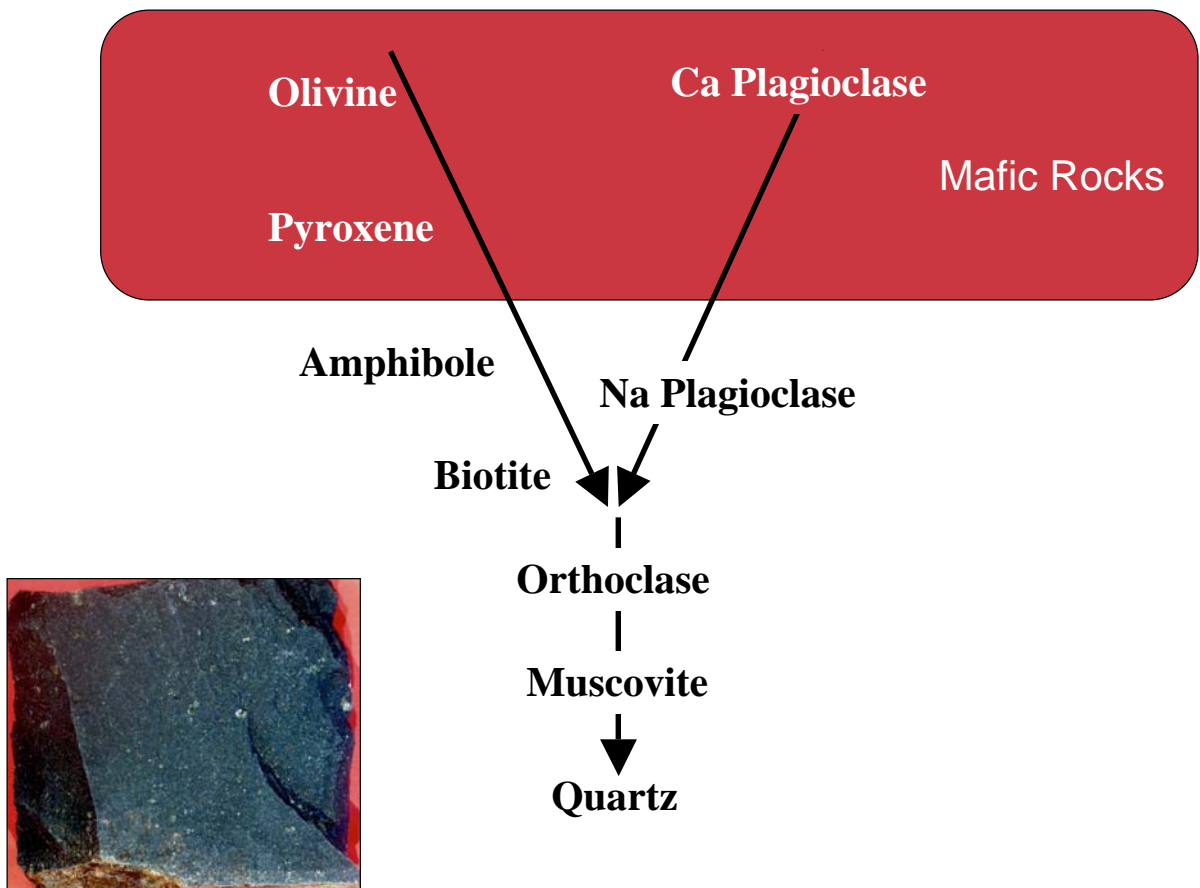
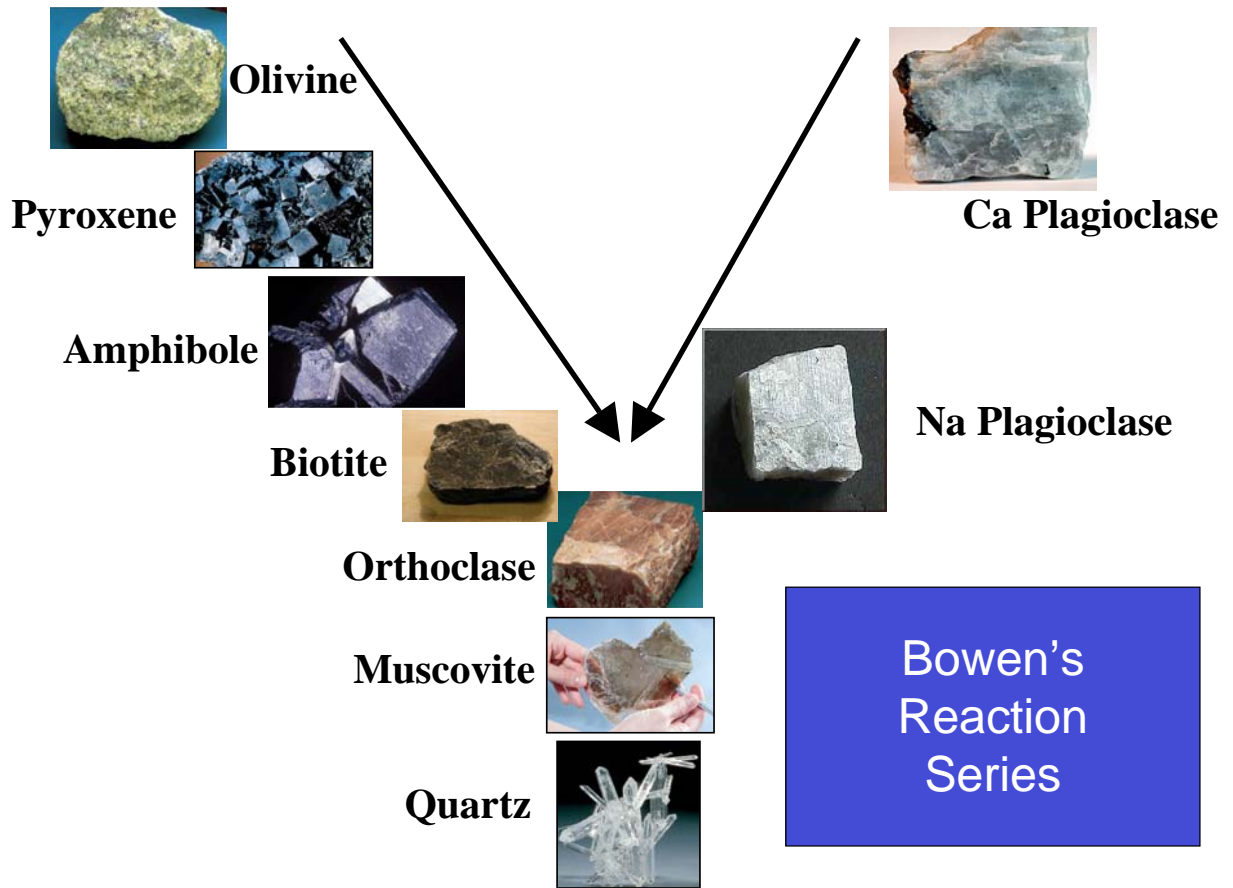
Mafic

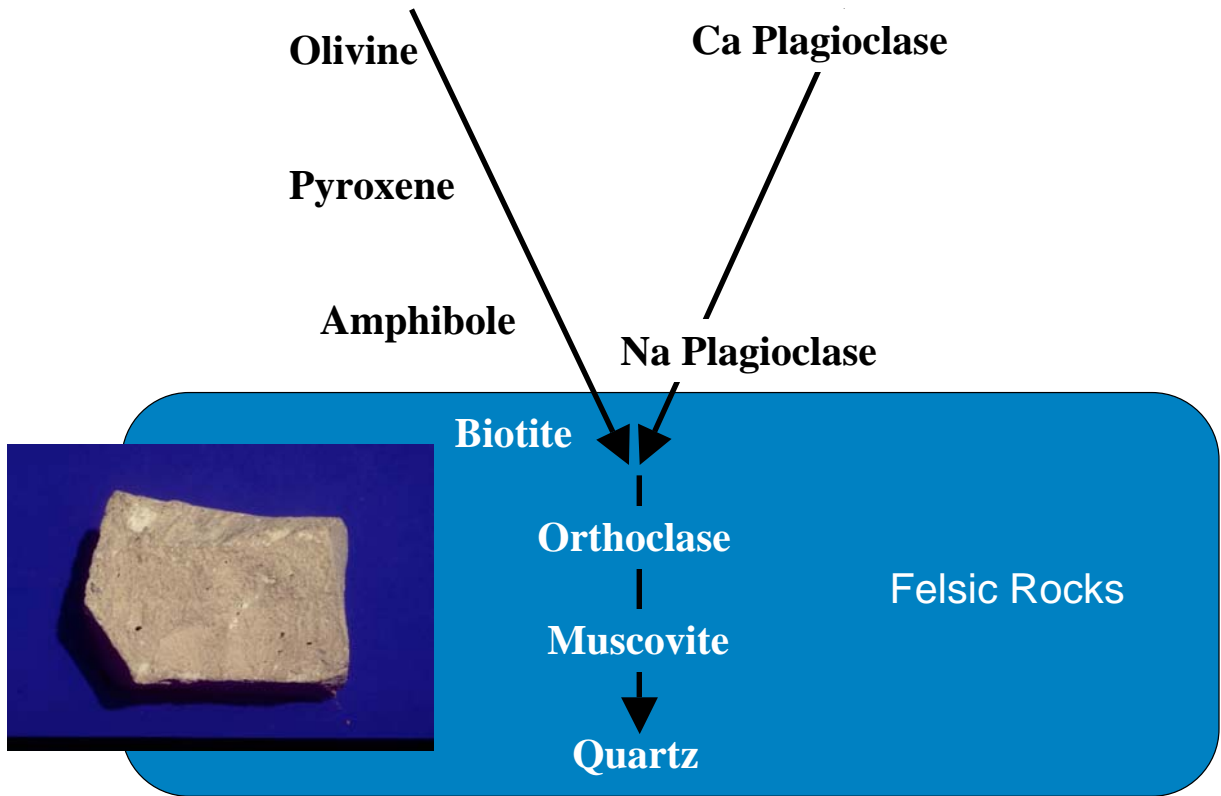
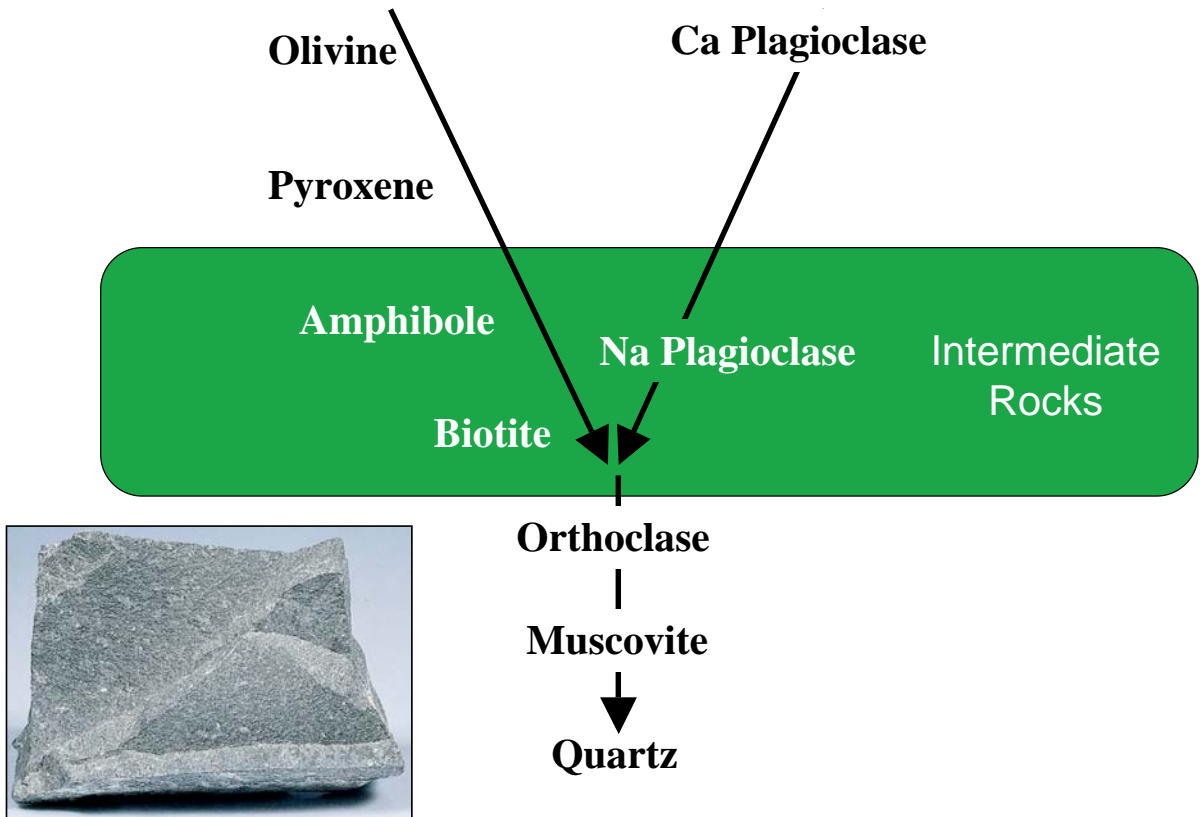


Felsic

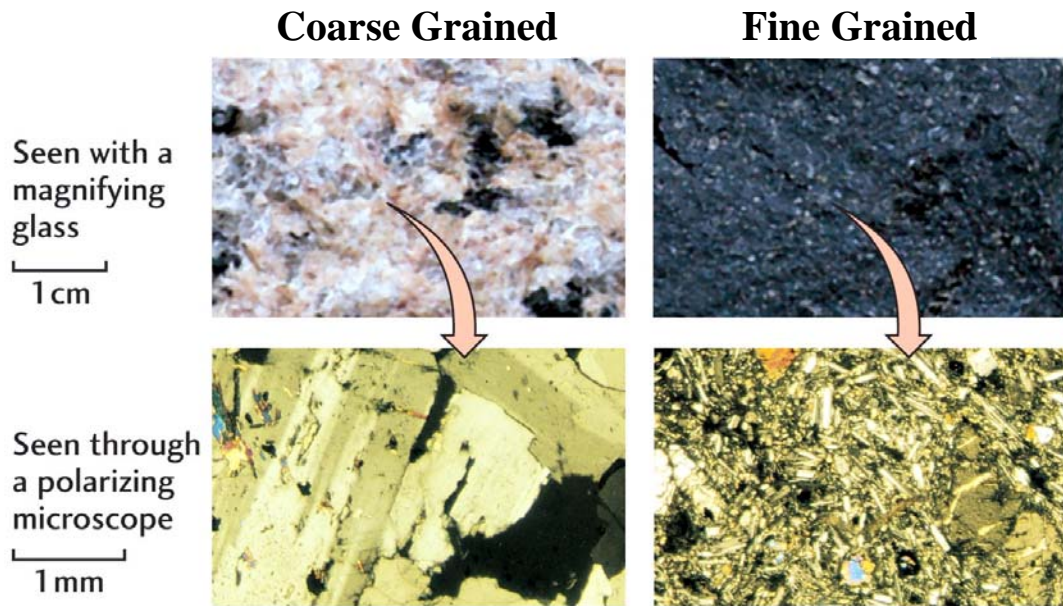
Igneous Minerals (p.21)

Mineral	Properties
Olivine	Green to yellow-green; vitreous; fractures; small, equidimensional grains
Plagioclase	Usually white or gray; 2 cleavages at 90°; elongate grains; striations sometimes visible
Pyroxene	Greenish black or brownish black; rather dull luster; blocky grains
Amphibole	Black with shiny, splintery appearance; two cleavages at 60° and 120°; elongate grains
Biotite	Shiny, black sheets; one perfect cleavage
Orthoclase	Usually white or pink; 2 cleavages at 90°; equidimensional grains
Muscovite	Shiny, silvery sheets; one perfect cleavage
Quartz	Colorless to gray; vitreous with conchoidal fracture; irregular grains in intrusive rocks; equidimensional phenocrysts in extrusive rocks





Igneous Textures - Crystalline



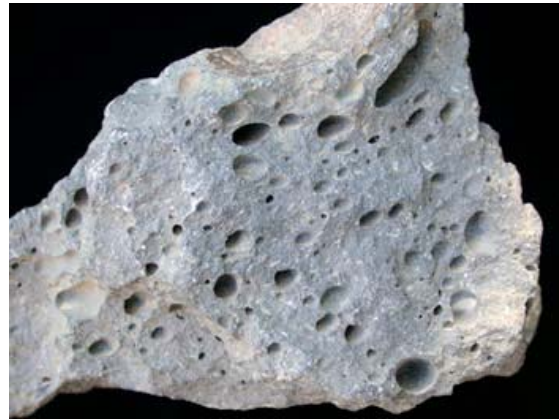
Igneous Textures - Crystalline

Porphyritic



Igneous Textures - Crystalline

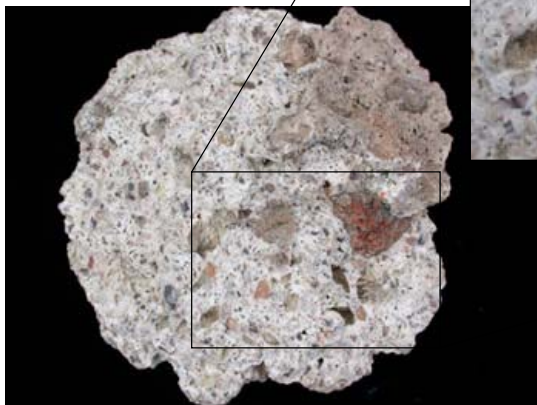
Glassy







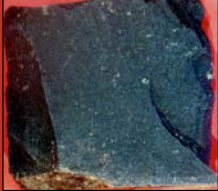



Vesicular

Igneous Textures - Pyroclastic/Fragmental

**Made of rock fragments
rather than crystals**



Igneous Rocks

	Mafic	Intermediate	Felsic	
Coarse	Gabbro 	Diorite 	Granodiorite 	Granite 
Fine	 Basalt	 Andesite	 Dacite	 Rhyolite

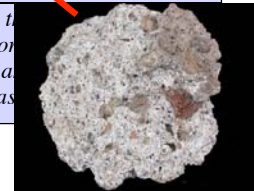
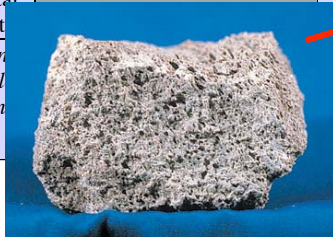
Ultramafic Rock - Dunite



Igneous Rocks (p.20)



		COMPOSITION (Minerals Present)				
		Ultramafic	Mafic	Intermediate	Intermediate	Intermediate
		Olivine (Pyroxene)	Ca-Plagioclase Pyroxene Olivine	Na-Plagioclase Amphibole Pyroxene Biotite	Na-Plagioclase Amphibole Quartz Biotite	Quartz Orthoclase Biotite Na-Plagioclase
TEXTURES	Coarse-grained*	DUNITE	GABBRO	DIORITE	GRANODIORITE	GRANITE
	Fine-grained*		BASALT	ANDESITE	DACITE	RHYOLITE
	Glassy		OBSIDIAN			
	Vesicular		SCORIA	PUMICE		
	Fragmental (Pyroclastic)		TUFF			



Igneous Rocks

Interpretation



Sir James Hall
Scottish Geologist



Silicate Magmas



Felsic (Rhyolitic) Magma



Mafic (Basaltic) Magma

Igneous Rock “Translations”

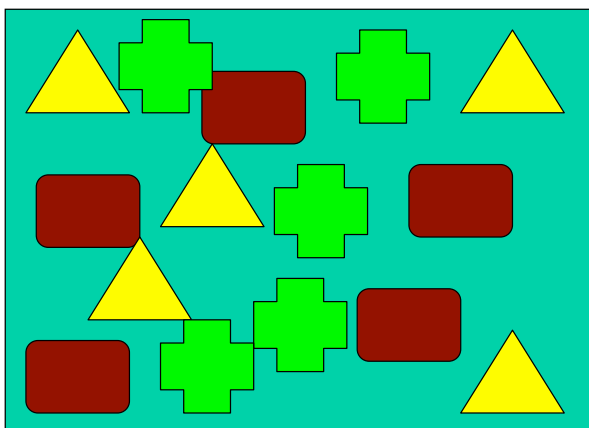
- Composition (Mafic v. Felsic)
- Texture Grain Size, etc.
- Magma source
- How quickly and where magma cooled






Figure 2-13
Earth System History, Second Edition
© 2005 W. H. Freeman and Company

Magma Source: Partial Melting

Hypothetical Solid Rock:
Intermediate Composition

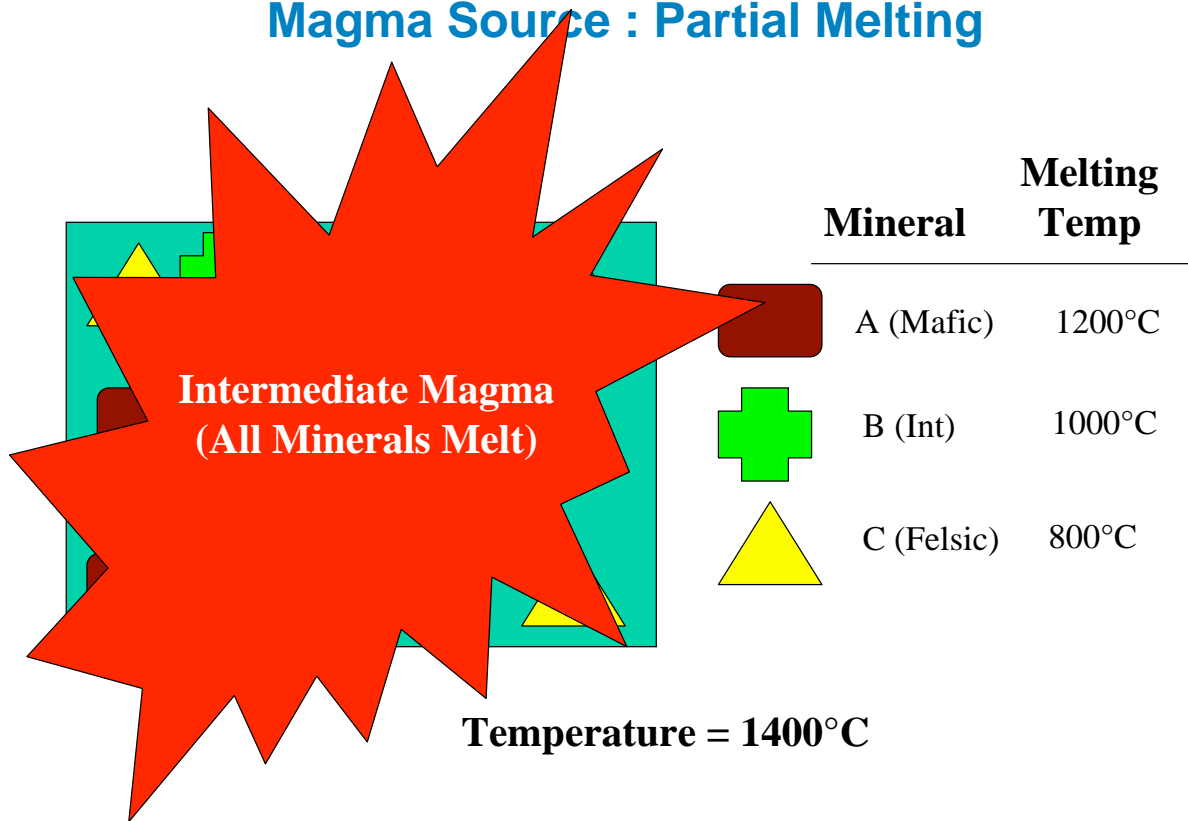


Mineral	Melting Temp
---------	--------------

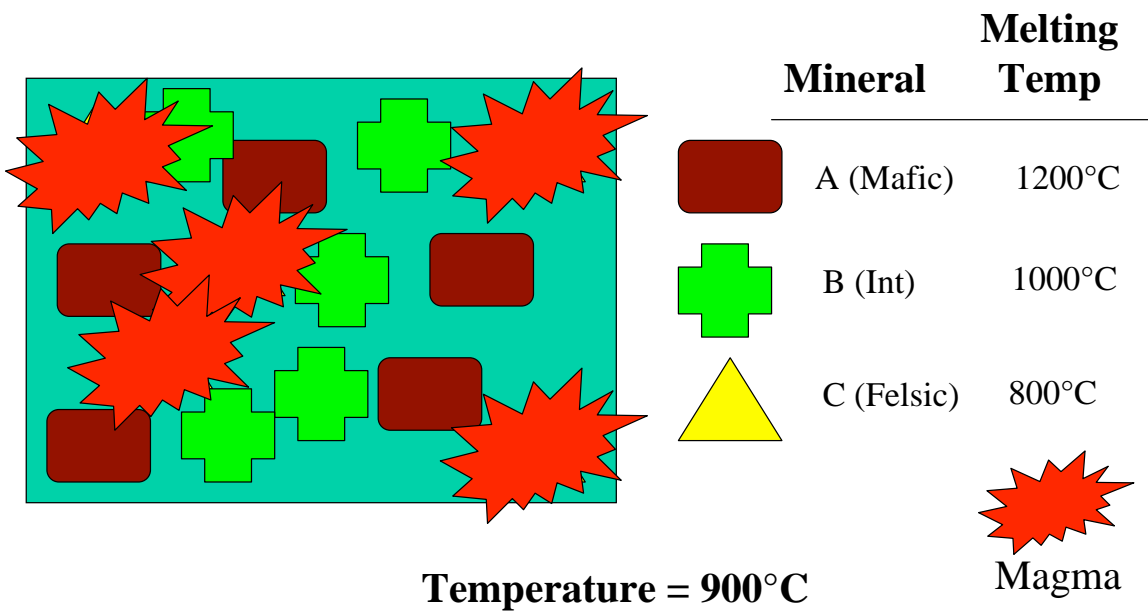
	A (Mafic)	1200°C
	B (Int)	1000°C
	C (Felsic)	800°C

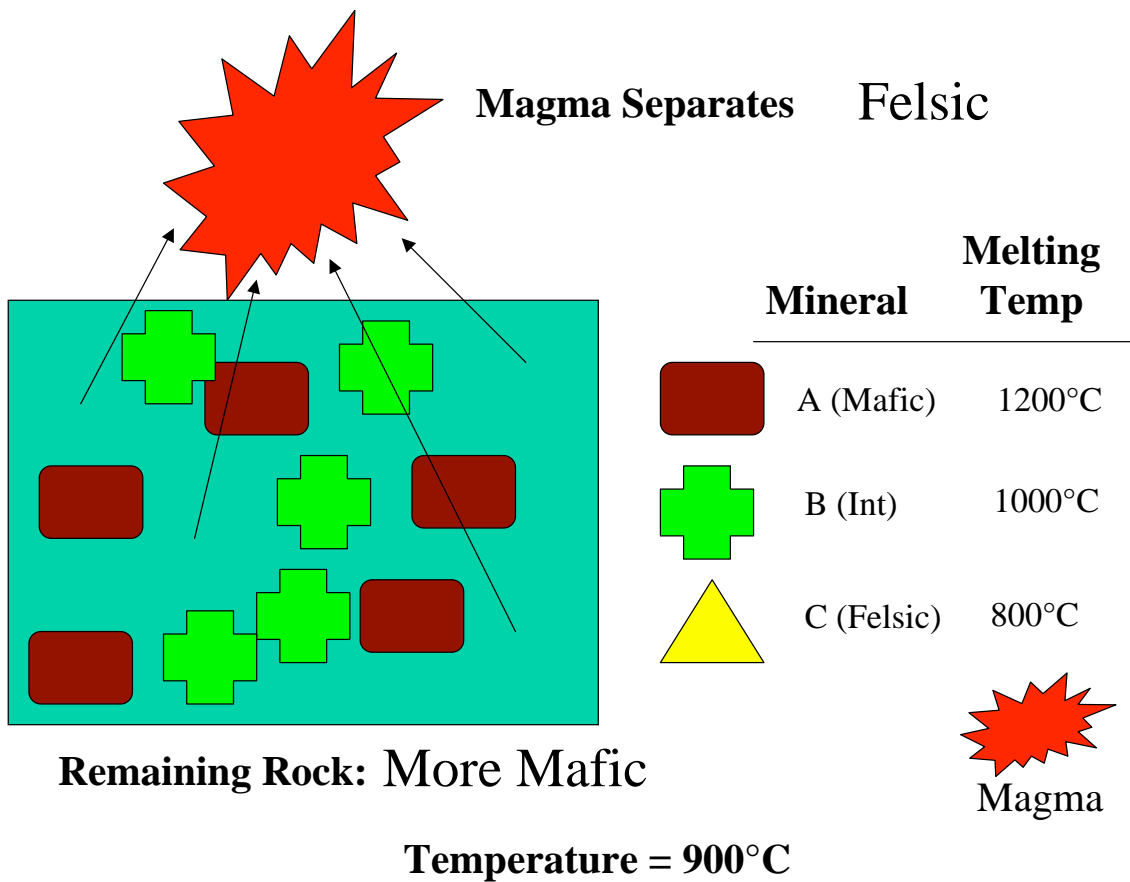
Temperature = 500°C

Magma Source : Partial Melting



Magma Source : Partial Melting

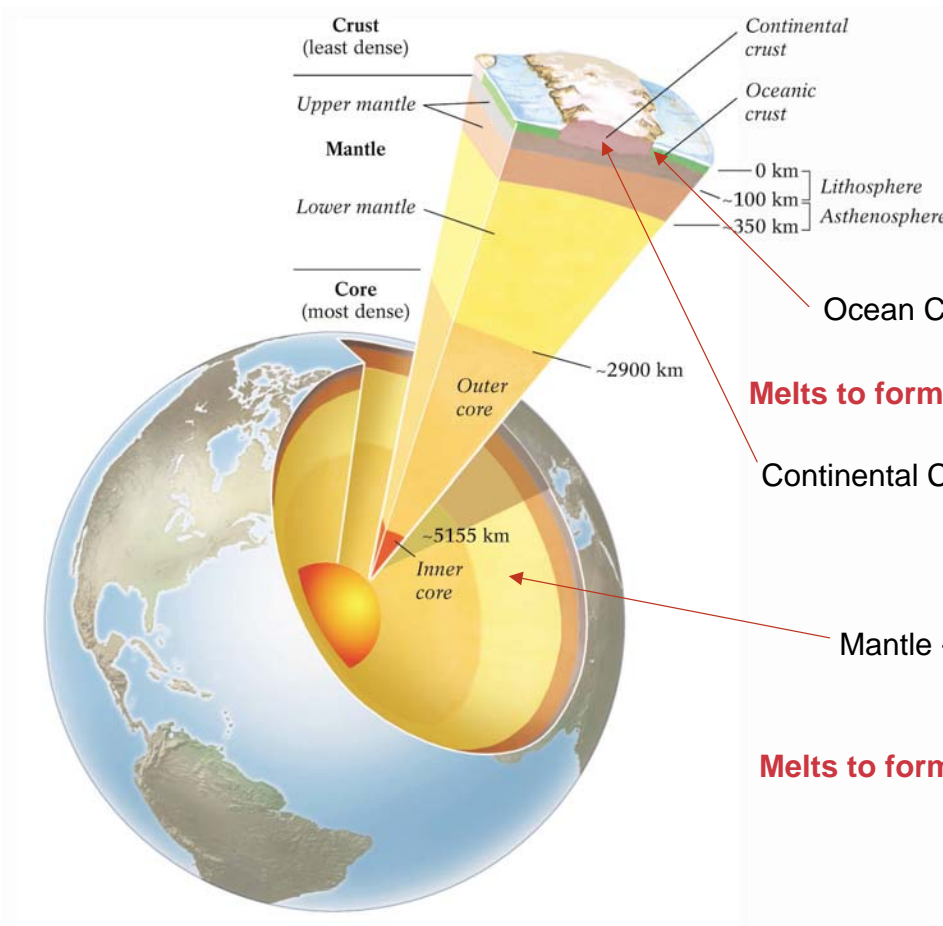




Bottom Line on Partial Melting

Partial Melting produces a **magma that is **more felsic** than the parent rock**

<u>Rock</u>	<u>Magma from Partial Melting</u>
Ultramafic	Mafic
Mafic	Intermediate
Intermediate	Felsic
Felsic	(more) Felsic

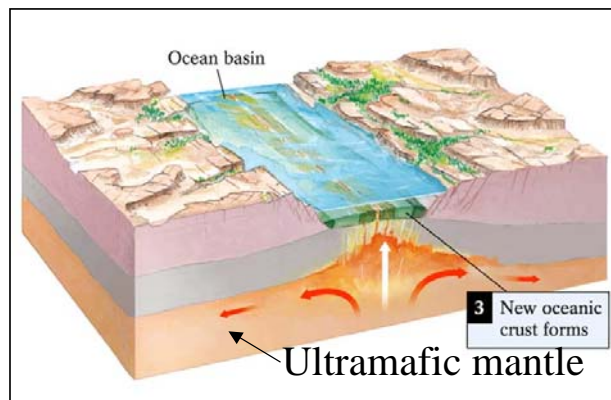


Composition: Magma Source

Mafic

Intermediate

Felsic



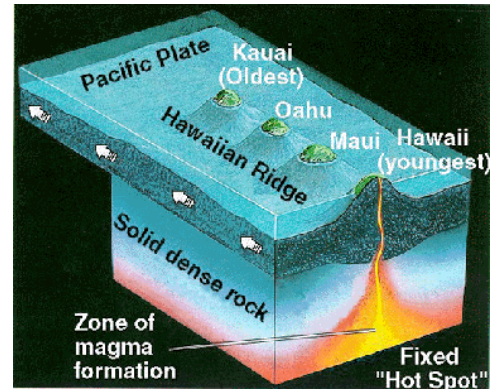
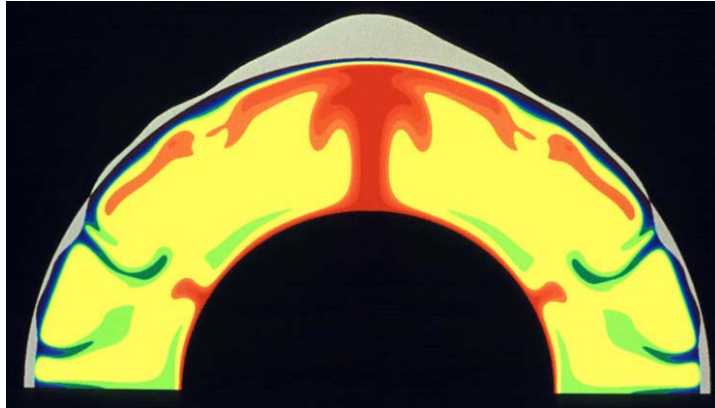
Source: Partial Melting of ultramafic mantle at Divergent Zones and...

Composition: Magma Source

Mafic

Intermediate

Felsic



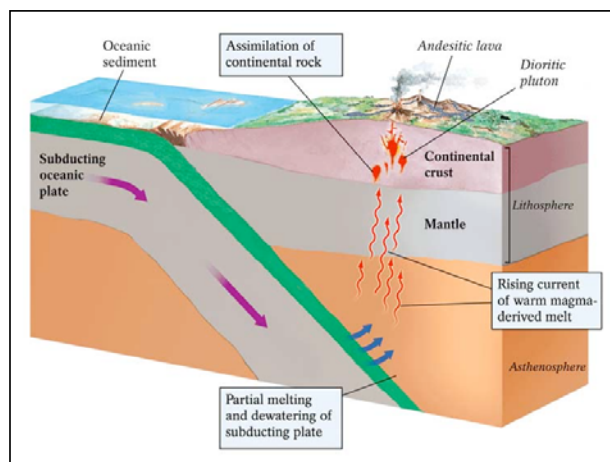
Source: Partial Melting of ultramafic mantle at Divergent Zones and ... Hot Spots

Composition: Magma Source

Mafic

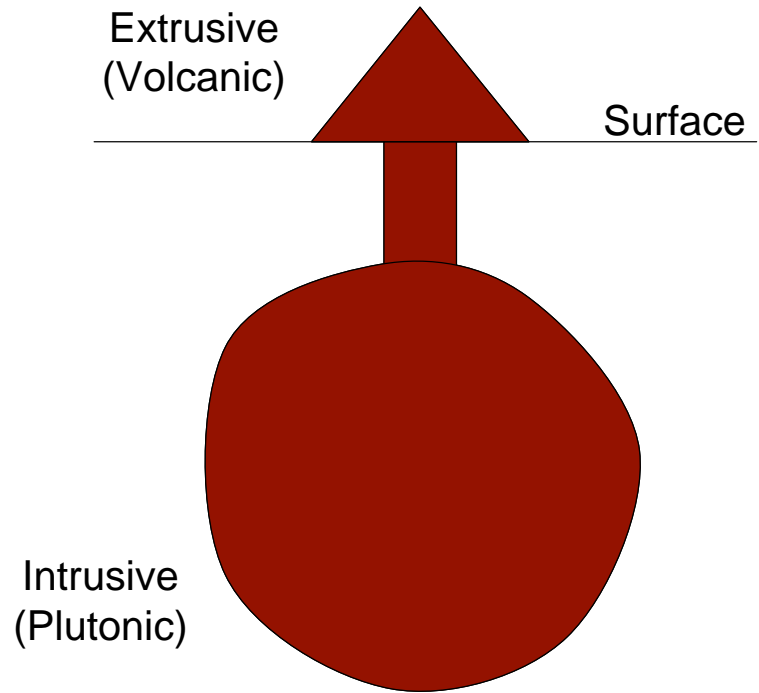
Intermediate

Felsic

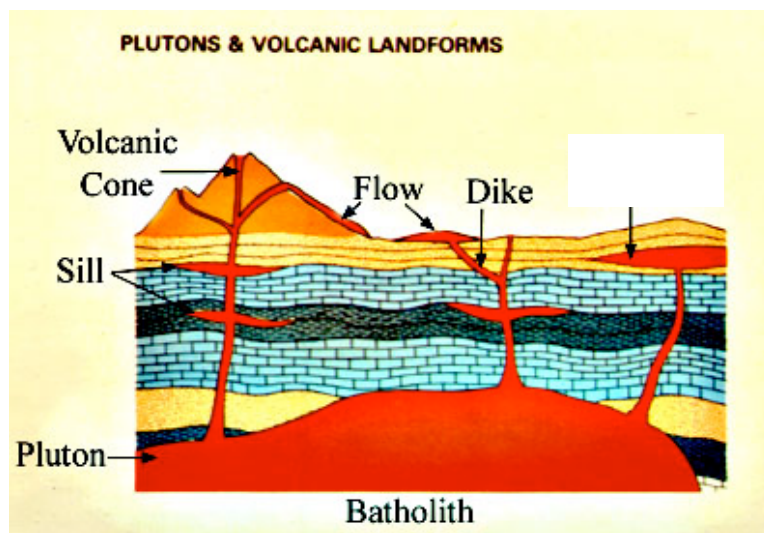


Source: Partial Melting of mantle, ocean crust and continent at Subduction Zones

Magma
Rises
and Cools



Texture - Grain Size: Plutons and Volcanoes



Fine
Grained

↕

Coarse
Grained

The text indicates the relationship between grain size and rock type. 'Fine Grained' is at the top, and 'Coarse Grained' is at the bottom, with a double-headed vertical arrow between them, suggesting a spectrum of grain sizes.

Name this Igneous Feature...



Igneous Dike

Plutonic Structures

Xenoliths






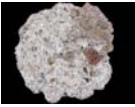
Source: William E. Ferguson

Why do we find Plutons at the Surface?



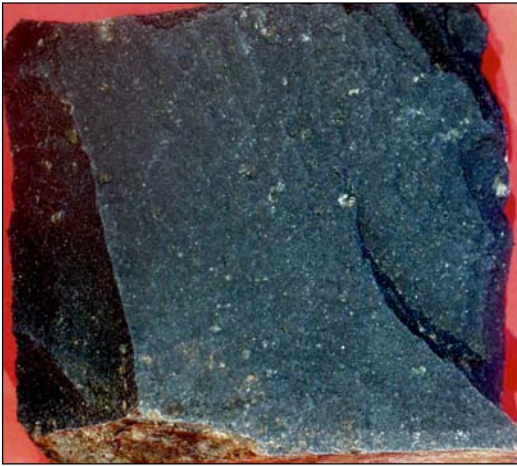
Sierra Nevada Mountains Batholith, California

Other Textures

Porphyritic		Cools Very Fast
Glassy		Cools Very Fast
Vesicular		Volcanic (On land/shallow water)
Pyroclastic		Volcanic (On land)

Intermission: Quiz

What Can you say about the history of this rock?



Basalt

Magma produced by partial melting of the mantle that erupted from a volcano at a divergent zone or hot spot.

Intermission: Quiz

What Can you say about the history of this rock?



Gabbro

Magma produced by partial melting of the mantle that cooled underground (plutonic) at a divergent zone or hot spot.

Intermission: Quiz

What Can you say about the history of this rock?



Granite

Magma produced by partial melting of the continental crust that cooled underground (plutonic) at a subduction zone or continental hot spot.

Intermission: Quiz

What Can you say about the history of this rock?



Andesite

Magma produced by partial melting of the mantle, ocean crust & continental crust, that erupted from a volcano at a subduction zone.