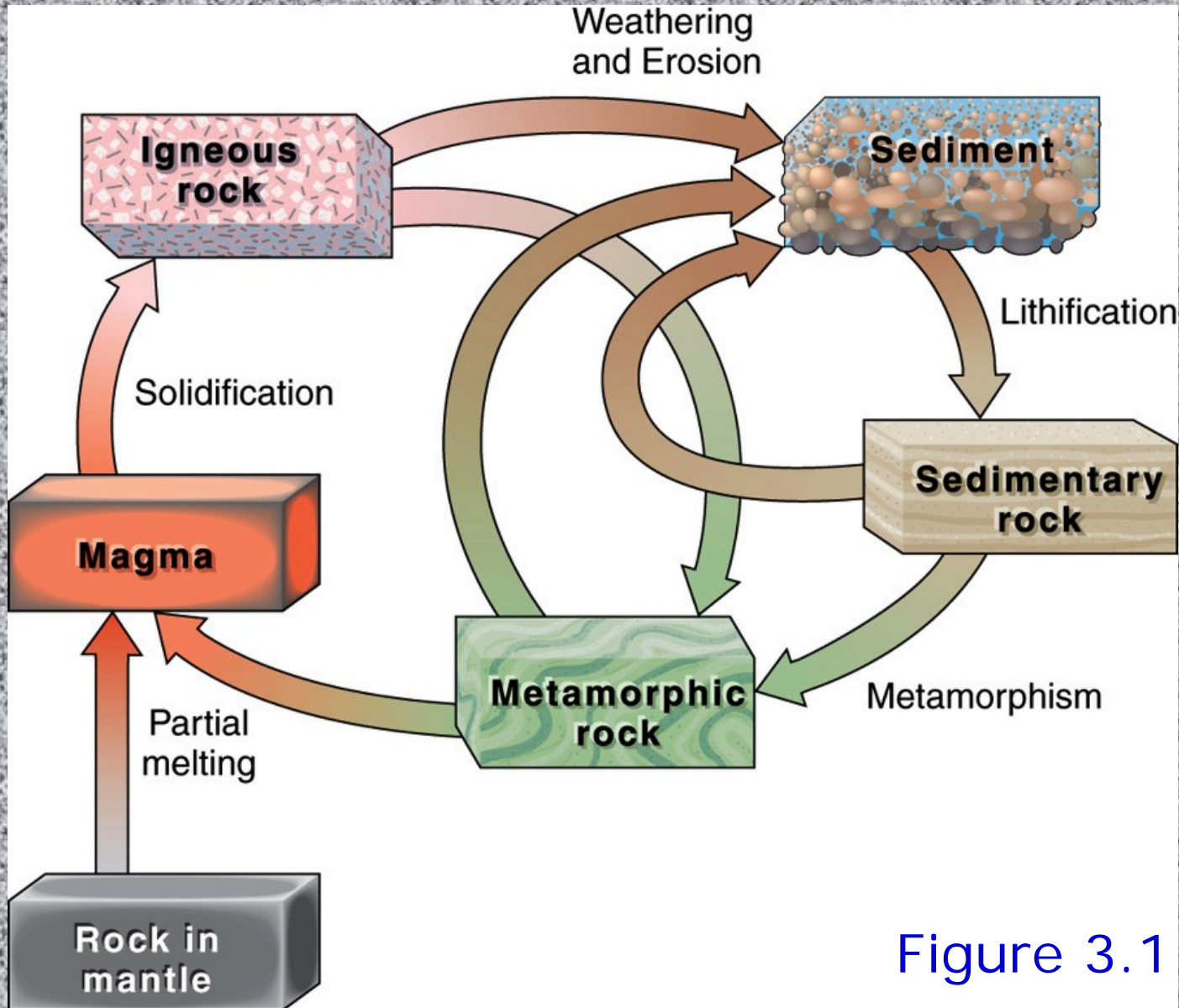


# The Rock Cycle



# Igneous rocks

Formed by cooling and solidifying magma

***Magma*** – molten rock

***Lava*** – magma on the Earth surface

Magma and igneous rocks can be:

***Extrusive*** – on the Earth surface

***Intrusive*** – magma solidifies underground

# Rock cycle – plate tectonic example

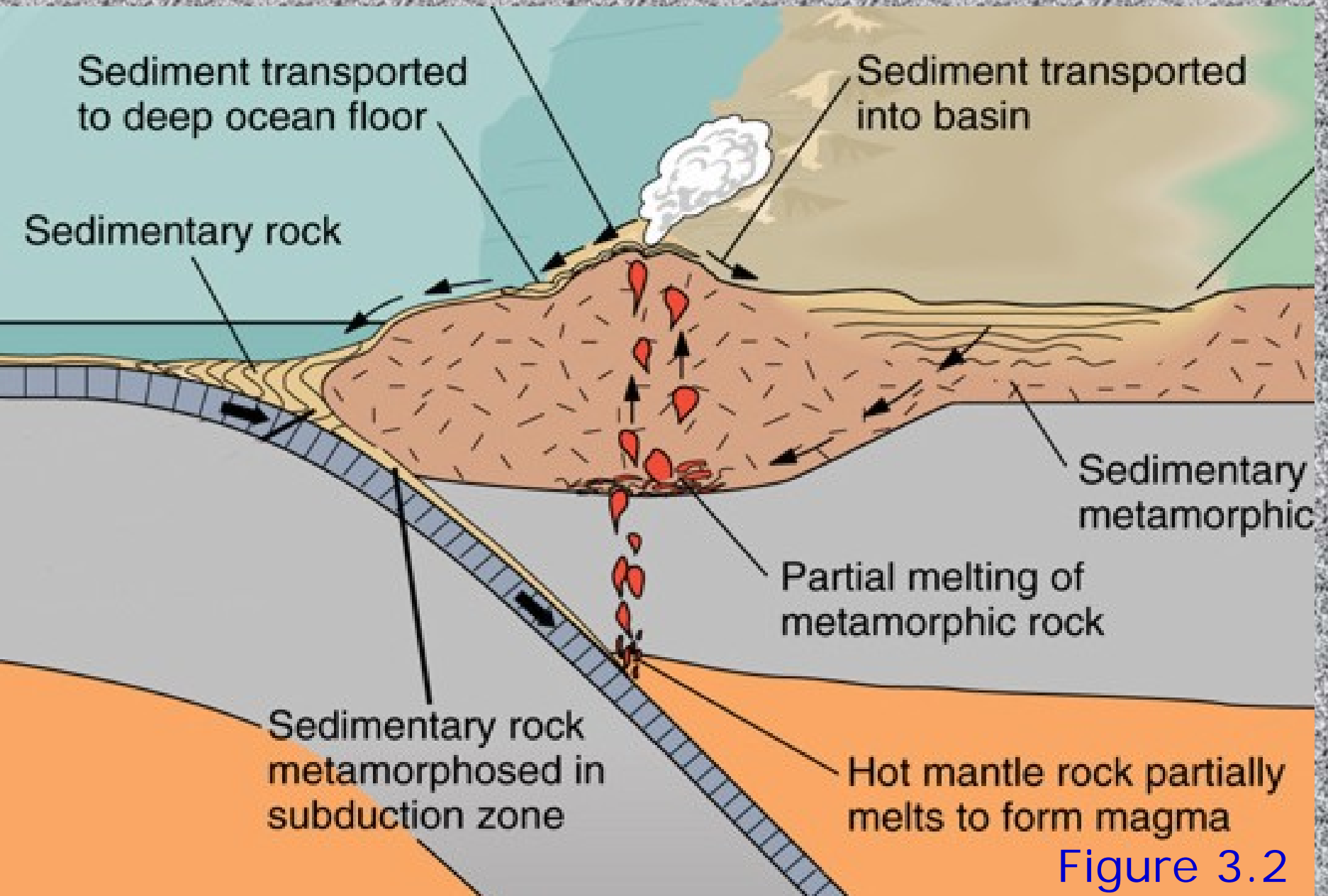


Figure 3.2



# Textures of igneous rocks

Coarse grained – mineral grains greater than 1 mm, can see with the eye

Magma cools slowly, enough time to form large crystals

## **Intrusive**

rocks are very good insulators

# Textures of igneous rocks

Fine grained – mineral grains smaller than 1 mm

Magma cools quickly

Glass forms when quenched quickly, such as lava flowing into water

**Extrusive**

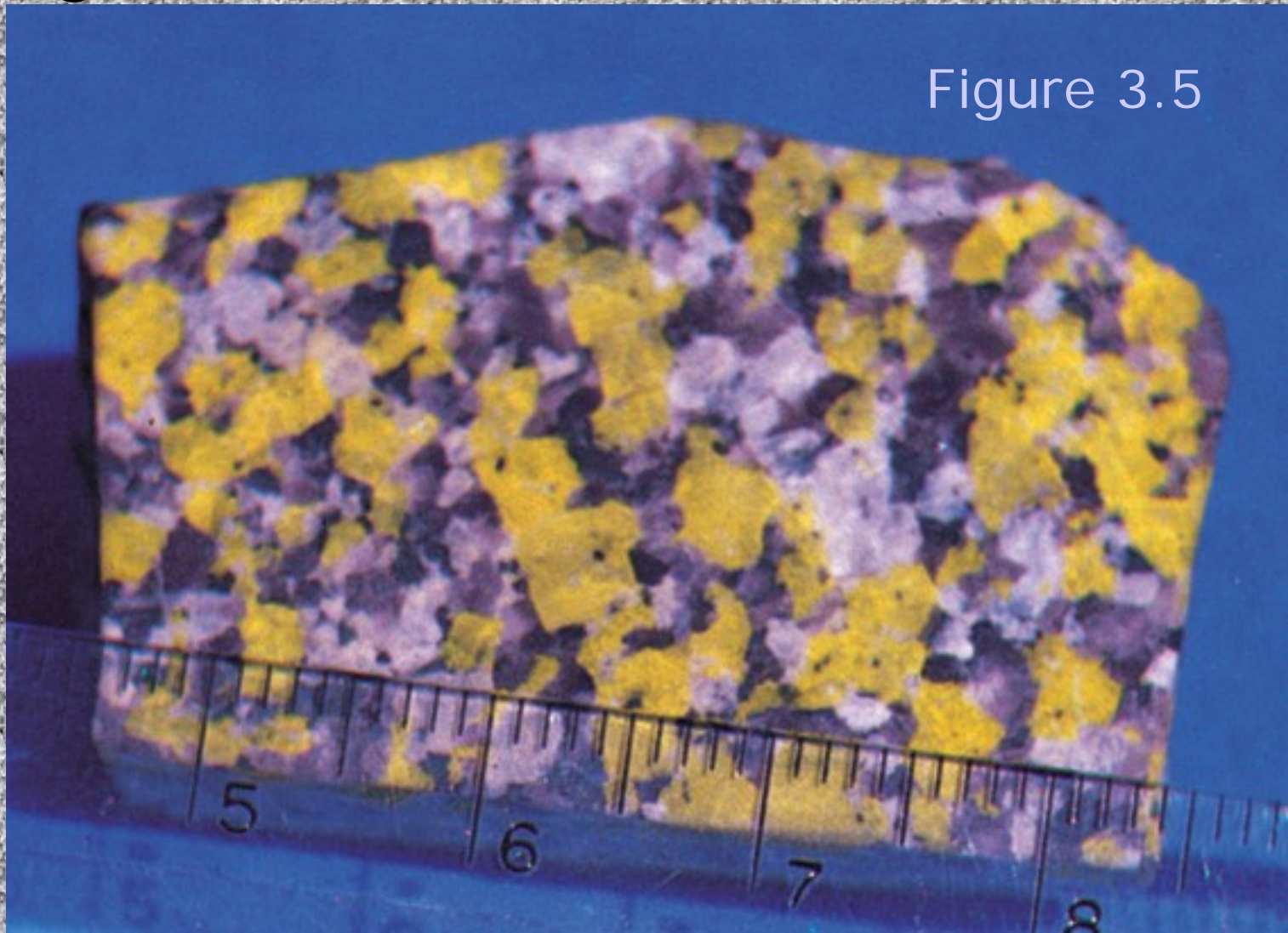


# Intrusive granite – coarse texture

Quartz  
gray

Plagio-  
clase  
white

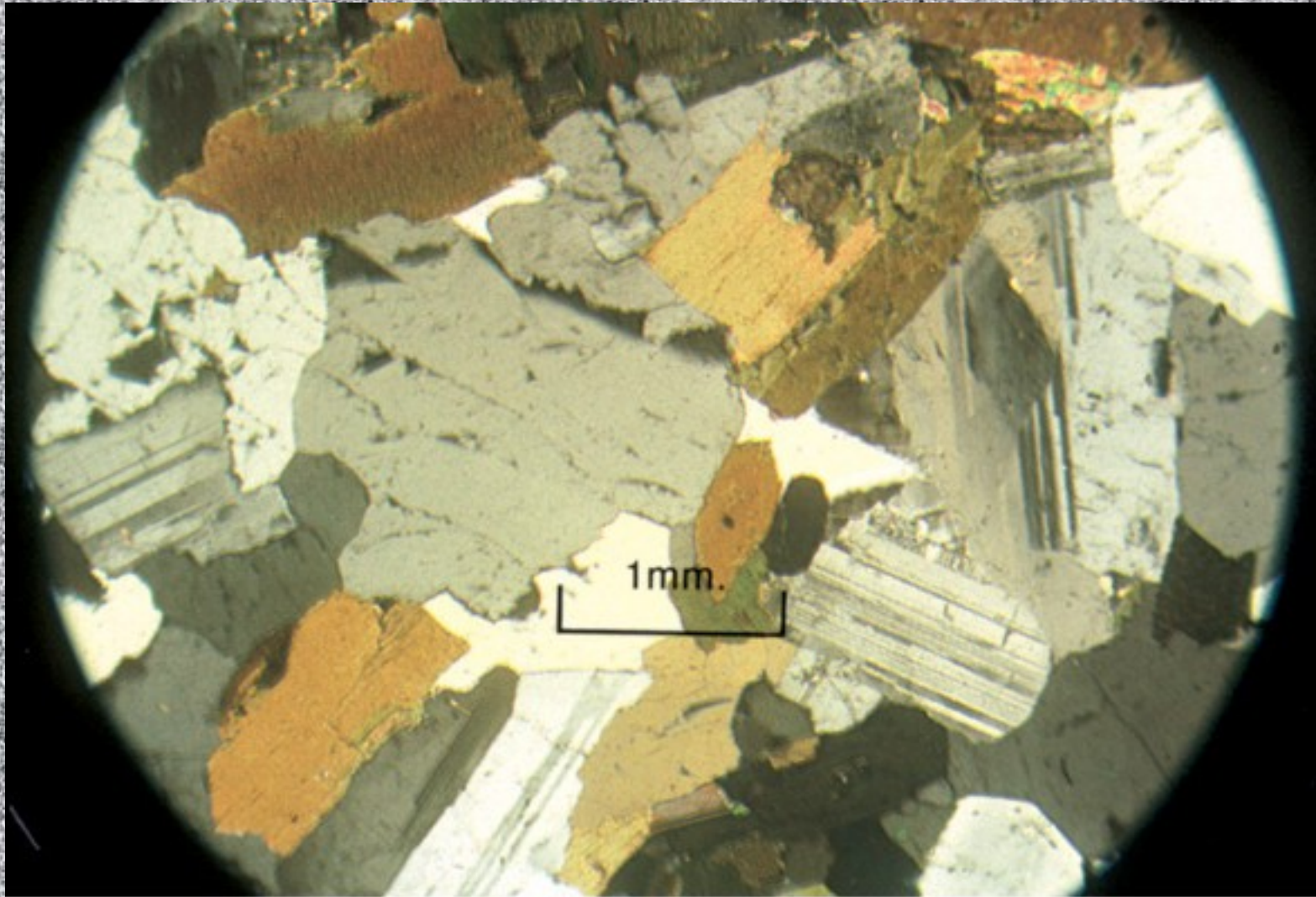
Figure 3.5



K feldspar is stained yellow



# Intrusive granite – thin section



Note interlocking mineral grains [Figure 3.1](#)

# Composition and Texture

Magma  
type

---

Coarse  
grained

Fine  
grained

Mafic

**Gabbro**

**Basalt**

Intermediate

**Diorite**

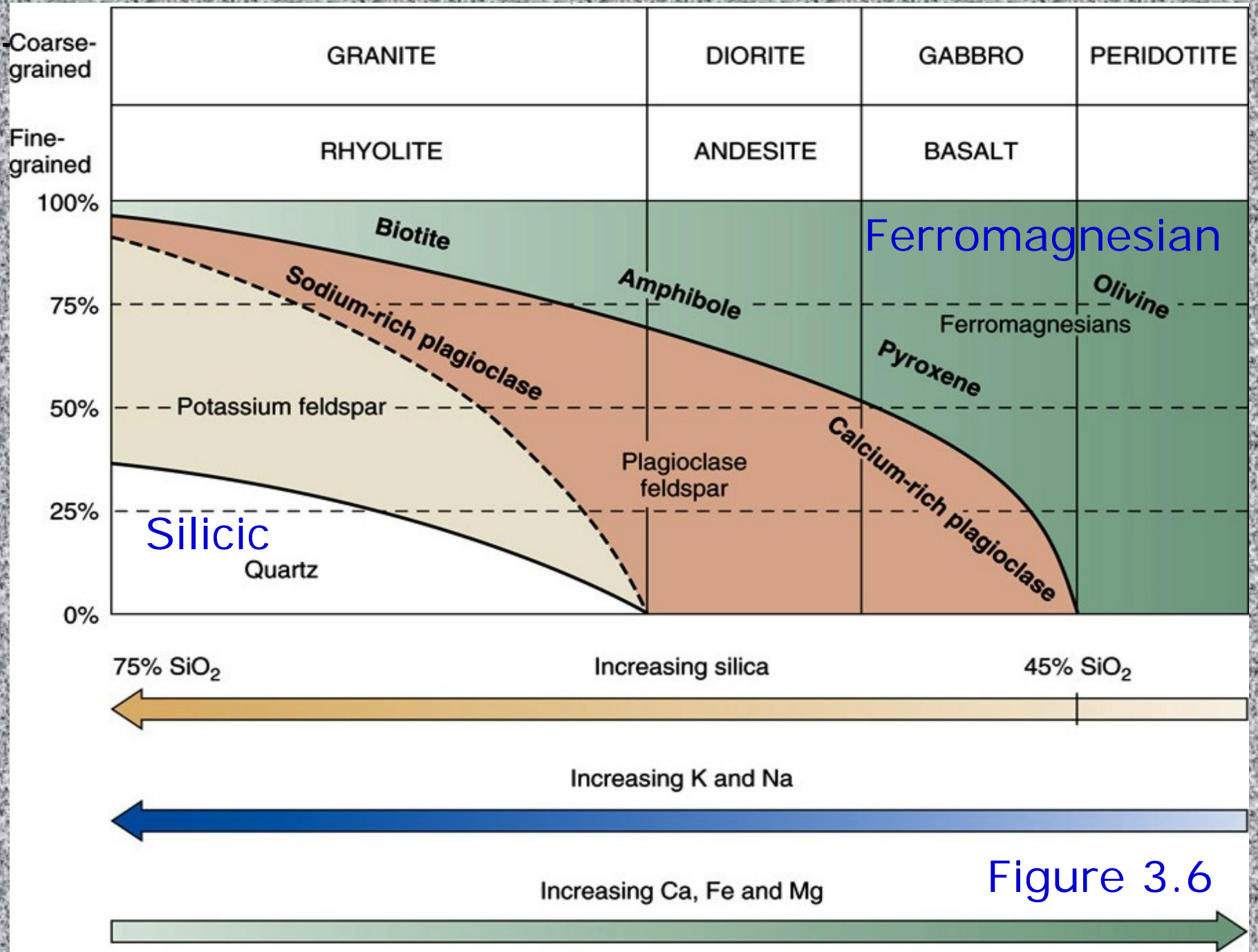
**Andesite**

Silicic

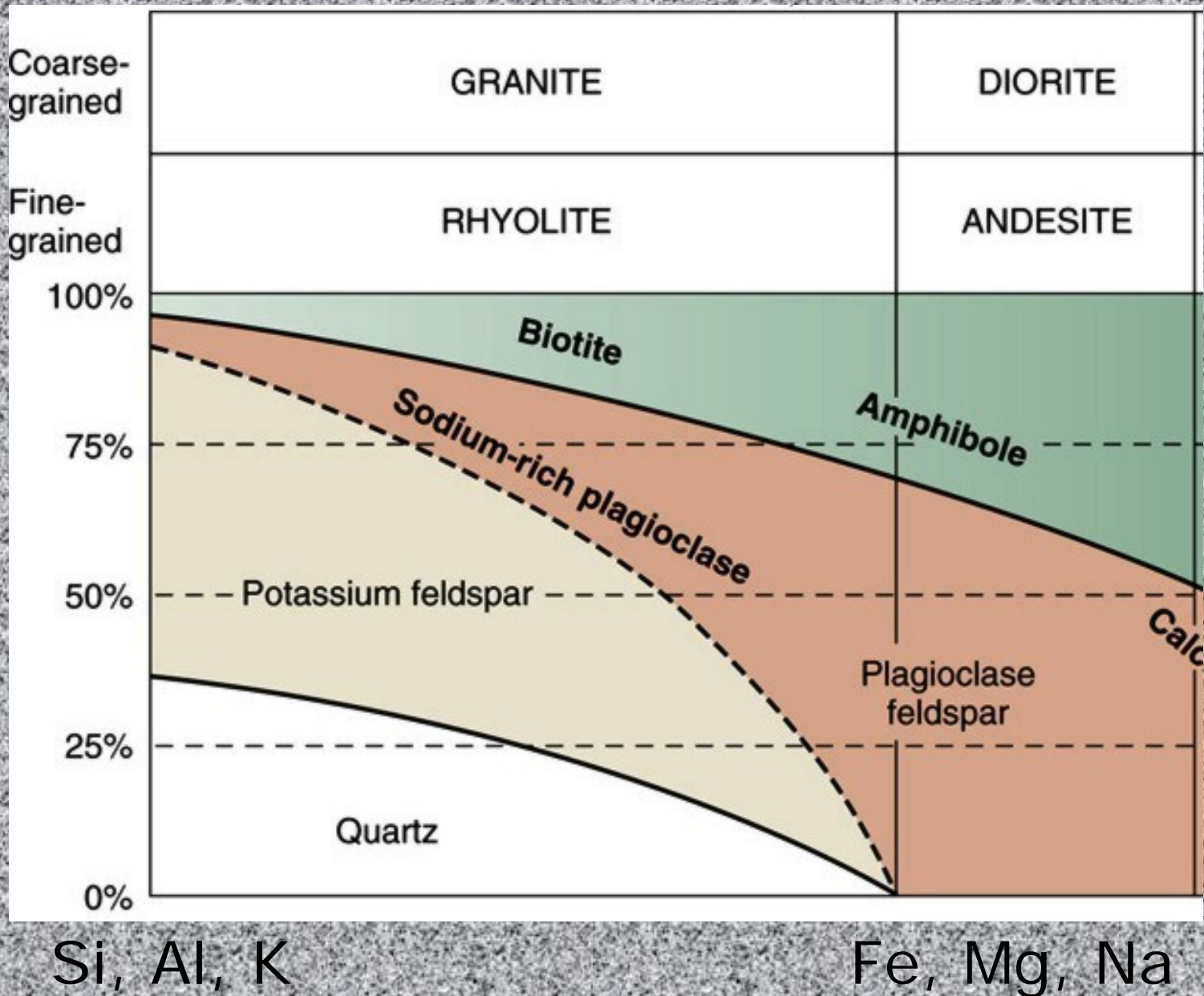
**Granite**

**Rhyolite**





# Granite and diorite

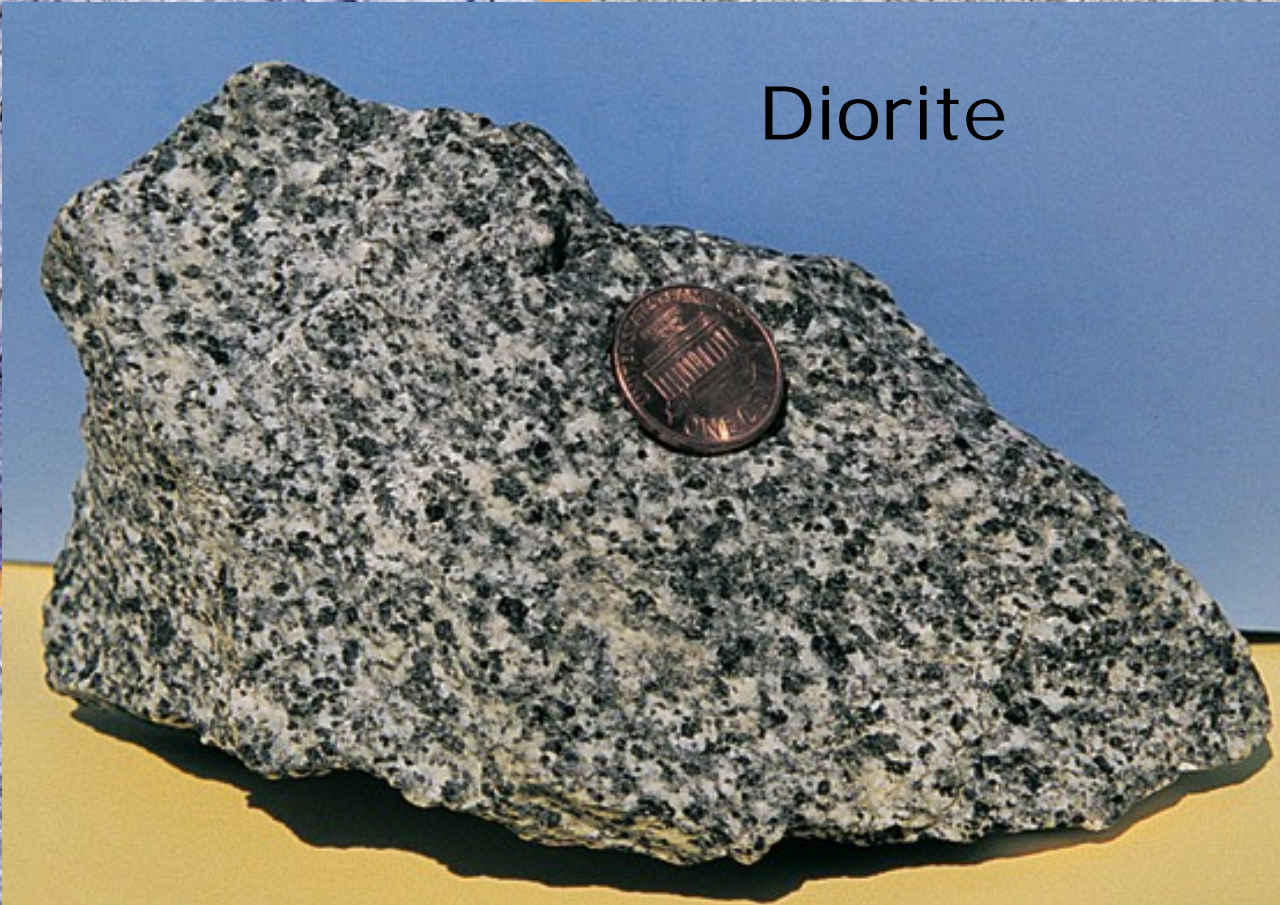




# Granite and diorite



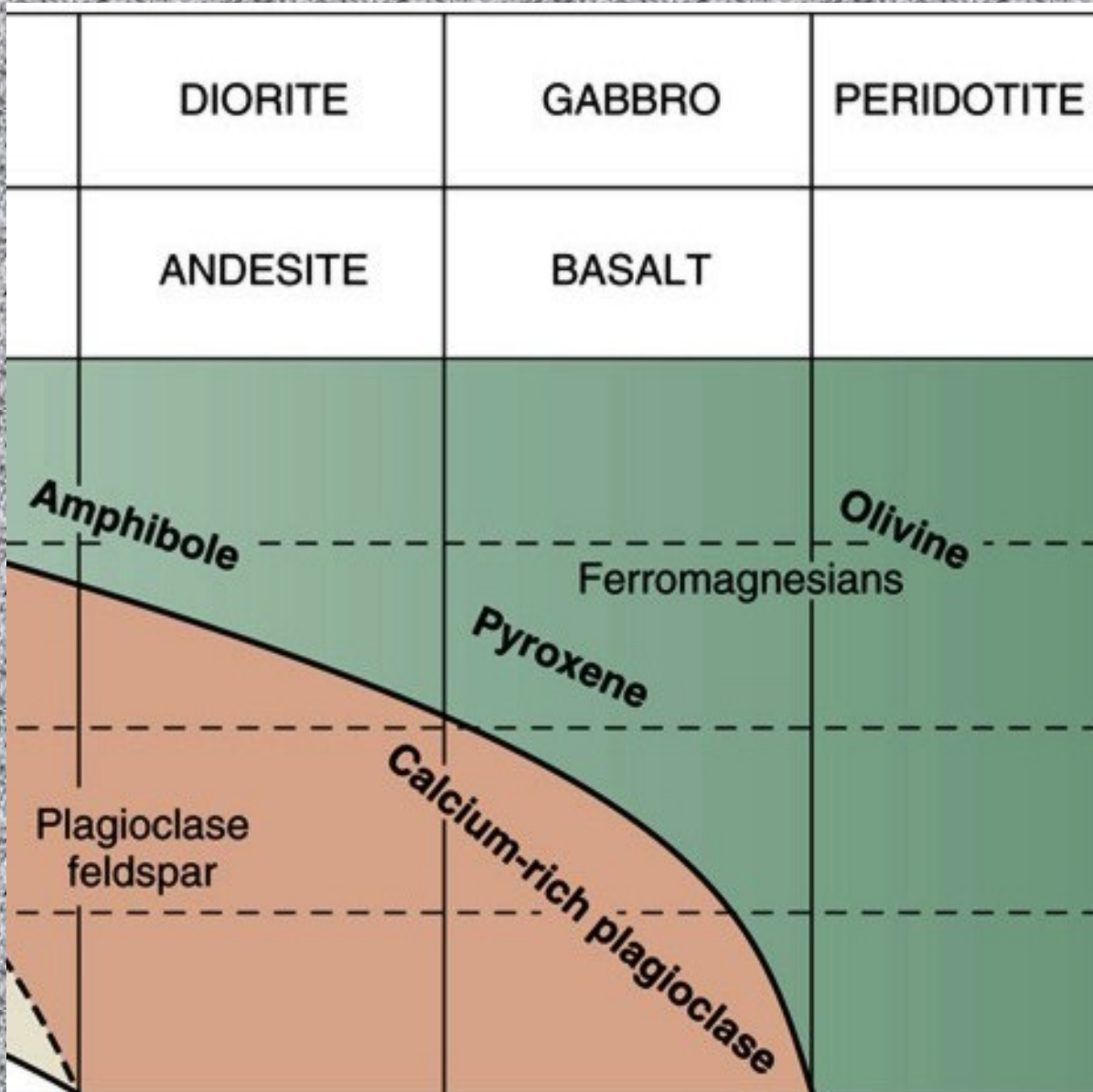
Granite



Diorite



# Diorite and gabbro



Na,  
less  
Fe, Mg

Ca,  
Fe, Mg



# Diorite and gabbro

Diorite



Gabbro





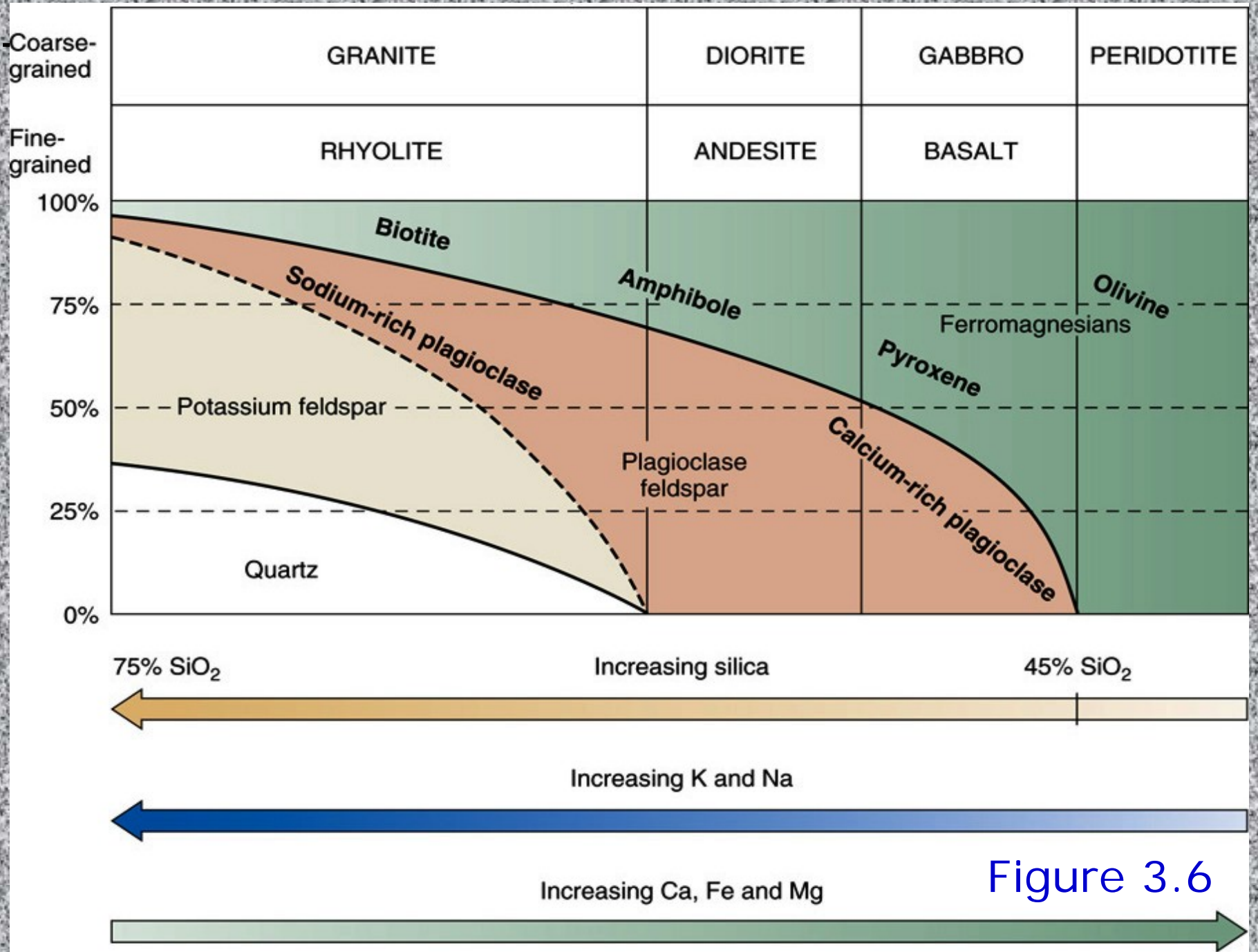


Figure 3.6



# Intrusive (granite) vs. extrusive (rhyolite)



Granite



Rhyolite

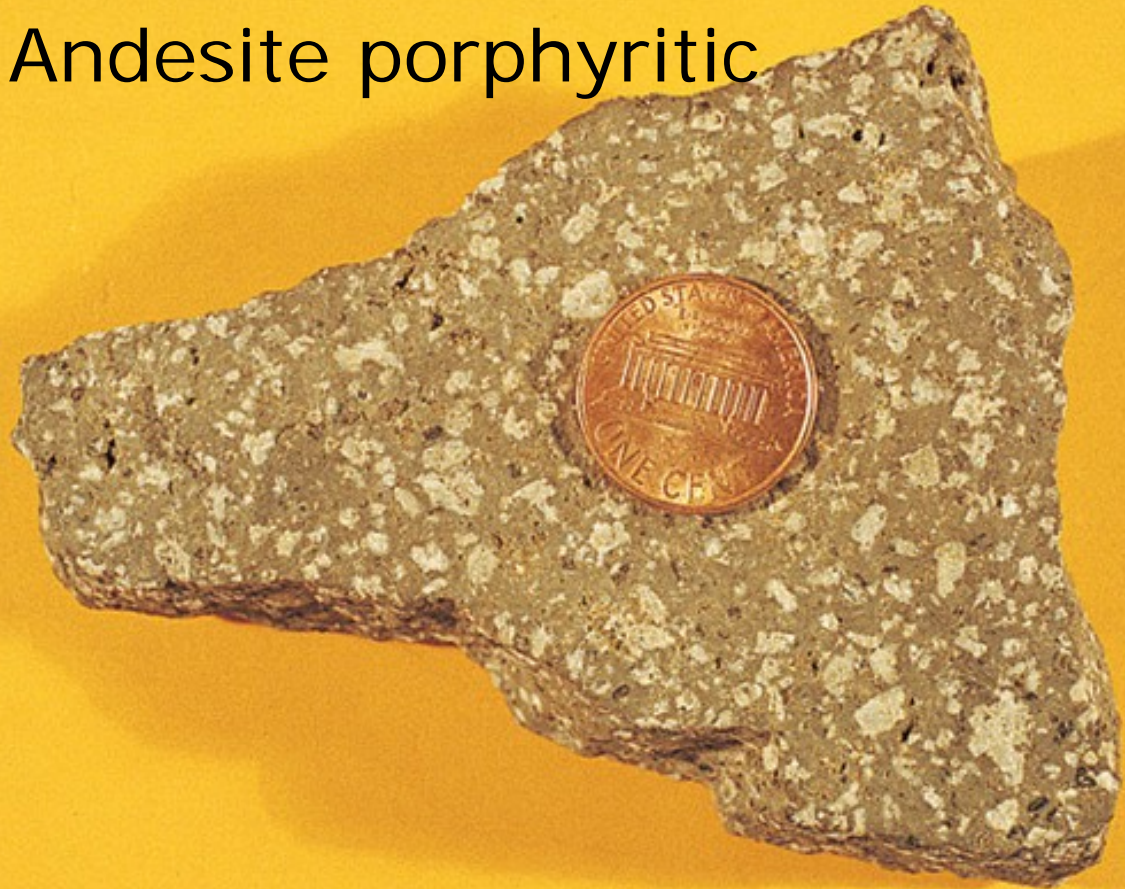


# Intrusive (diorite) vs. extrusive (andesite)

Diorite



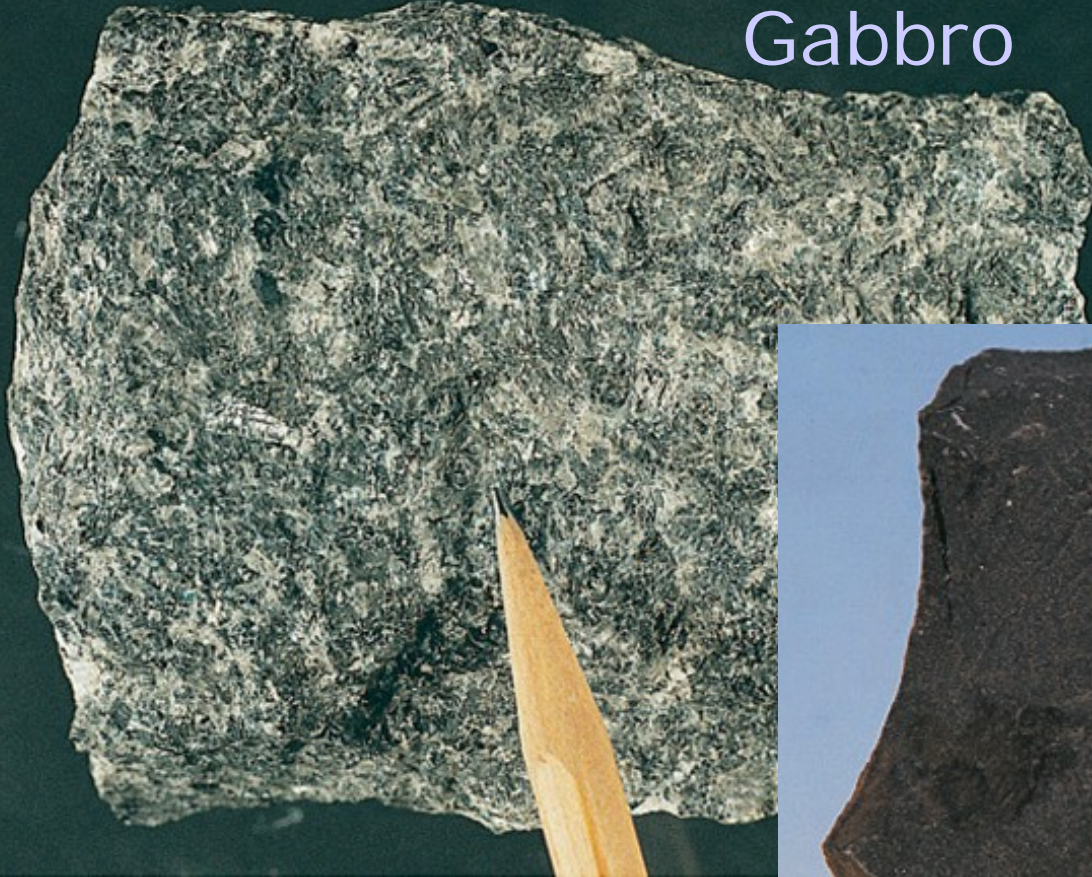
Andesite porphyritic





# Intrusive (gabbro) vs. extrusive (basalt)

Gabbro



Basalt





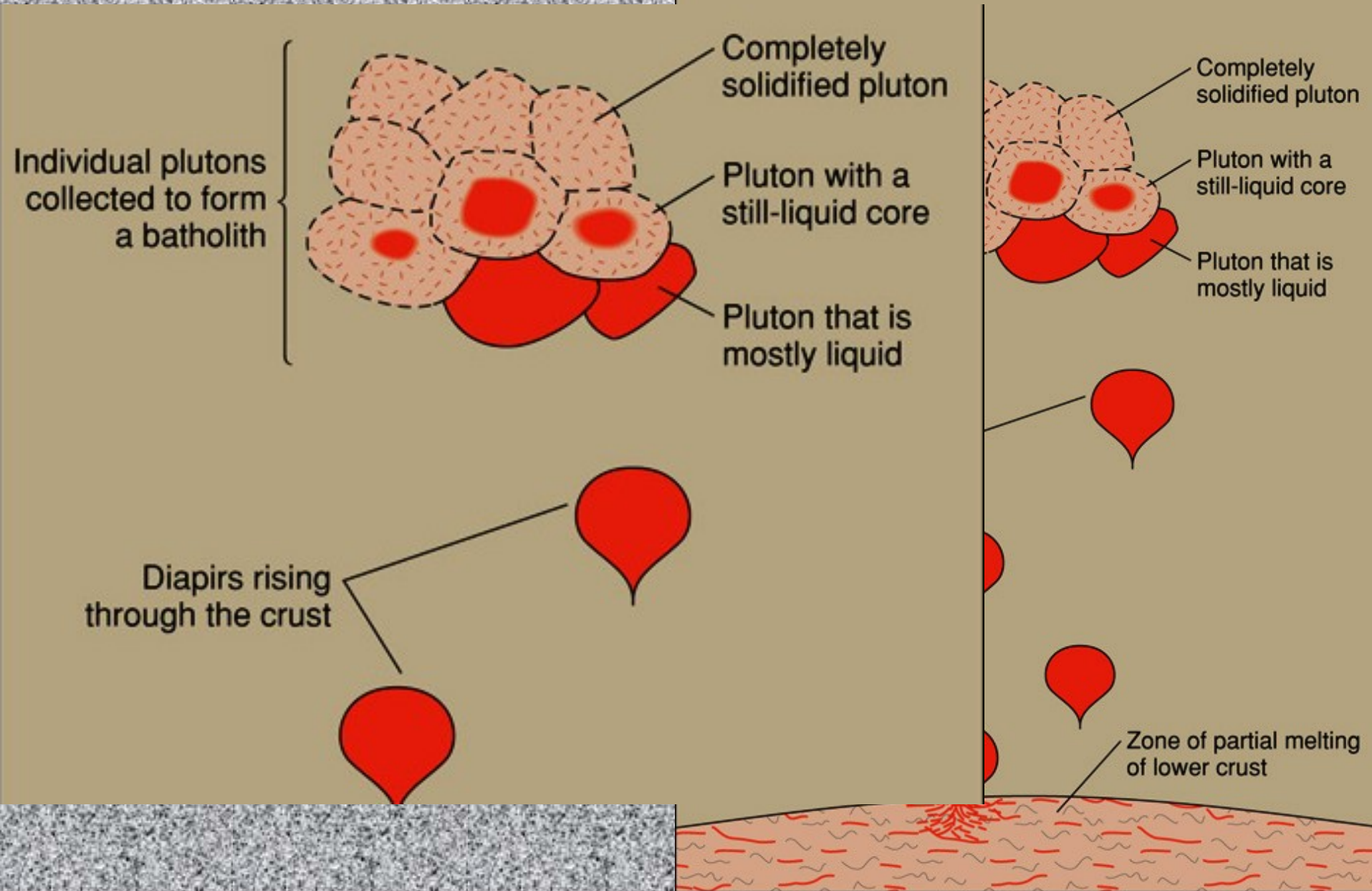
# Sierra Nevada batholith



Photo by C. C. Plummer

# Forming a batholith

Mountains at the earth's surface

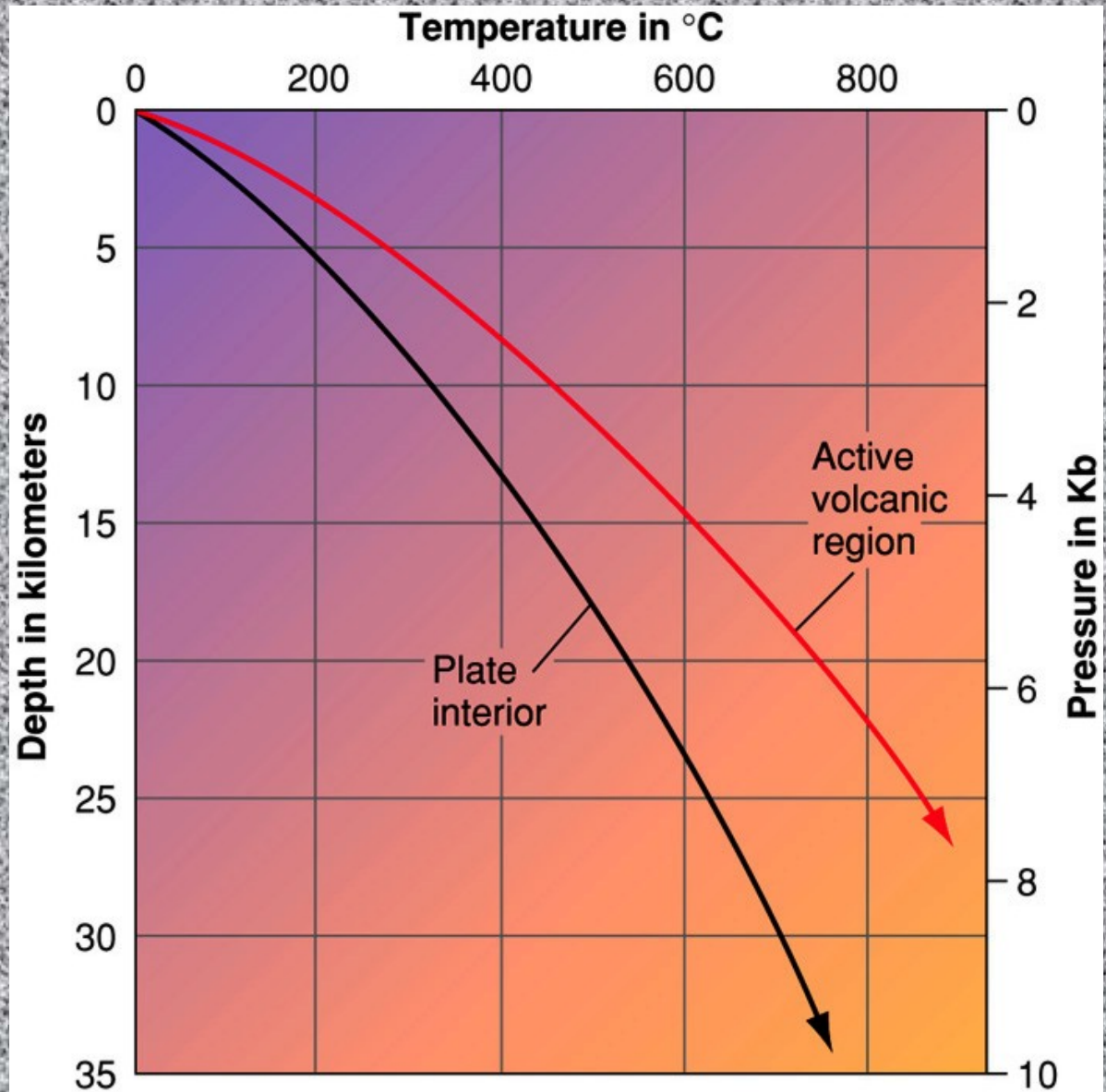




# How magma forms

The **geothermal gradient**

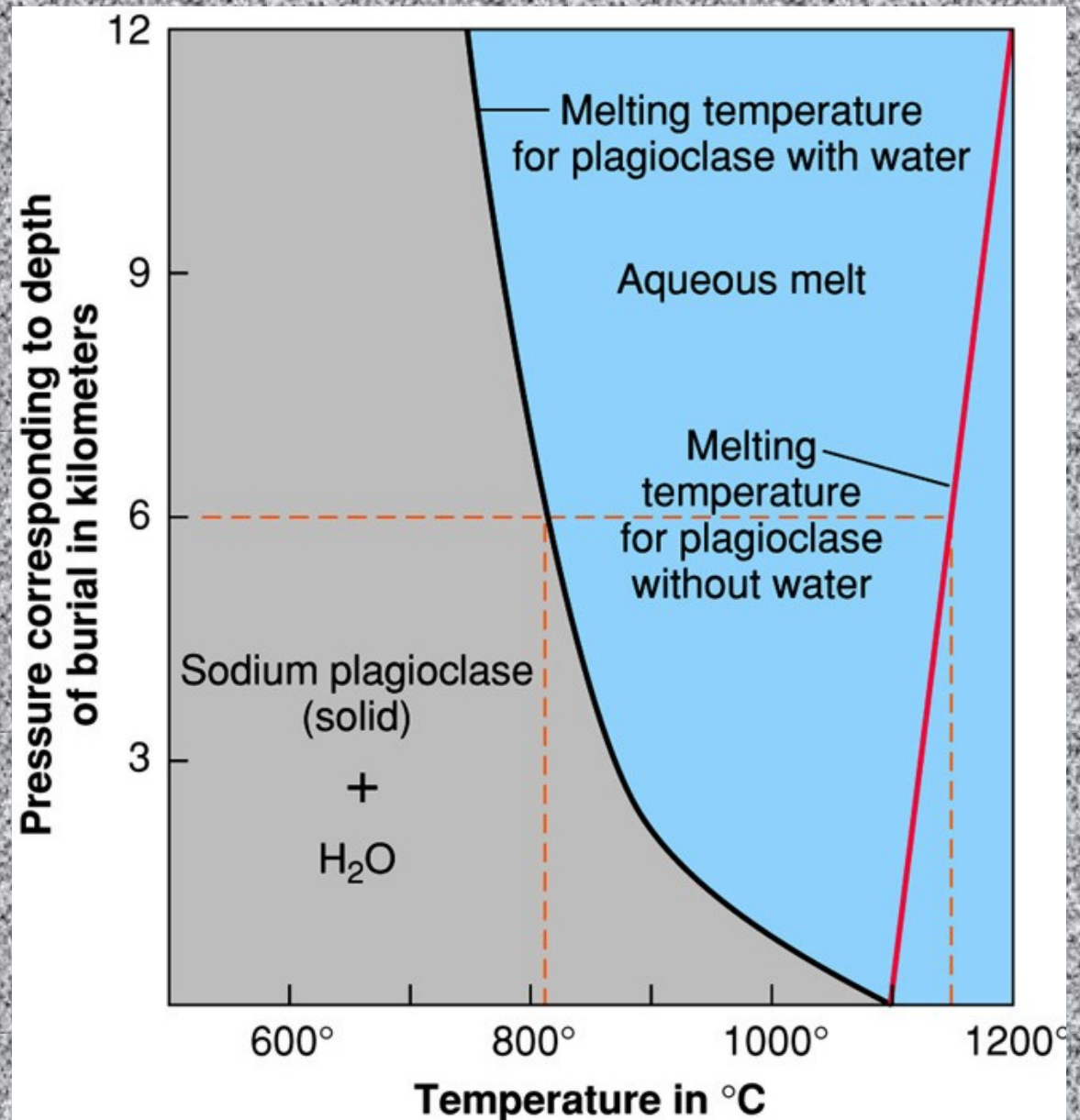
about  $3^{\circ}\text{C}$   
in 100 m



# Factors that control melting temperatures

*Pressure*

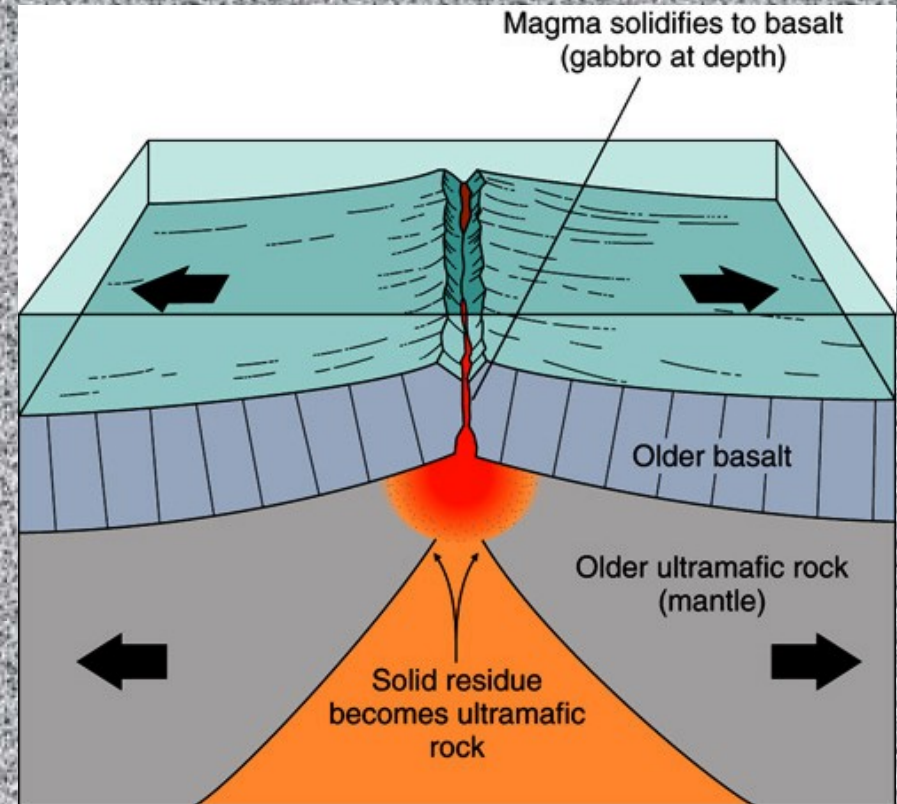
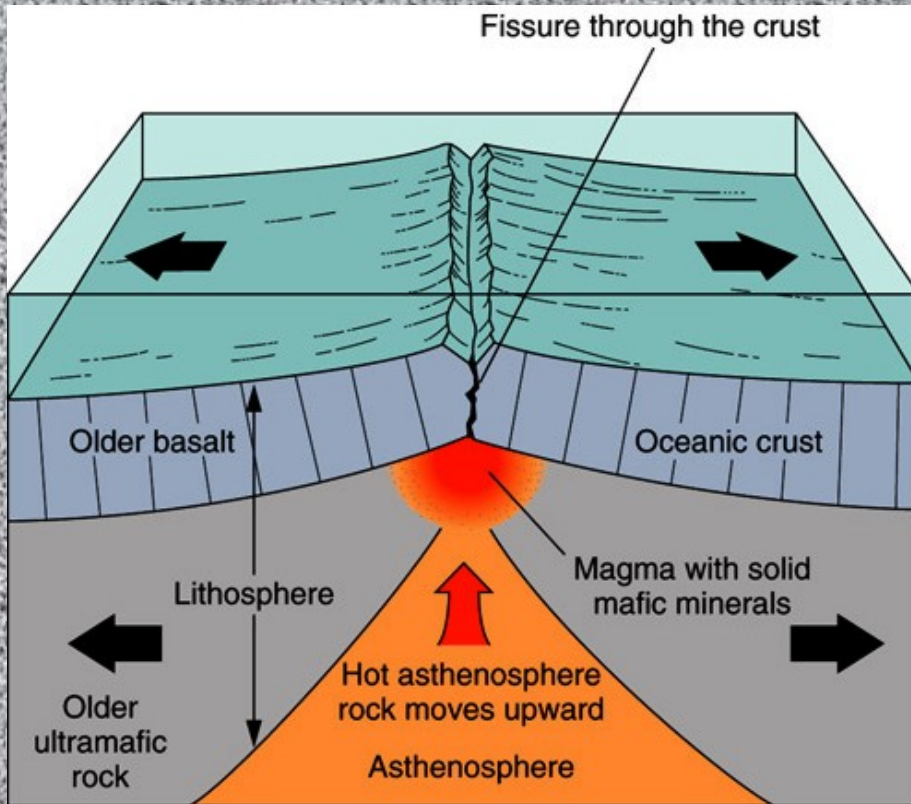
*Water*





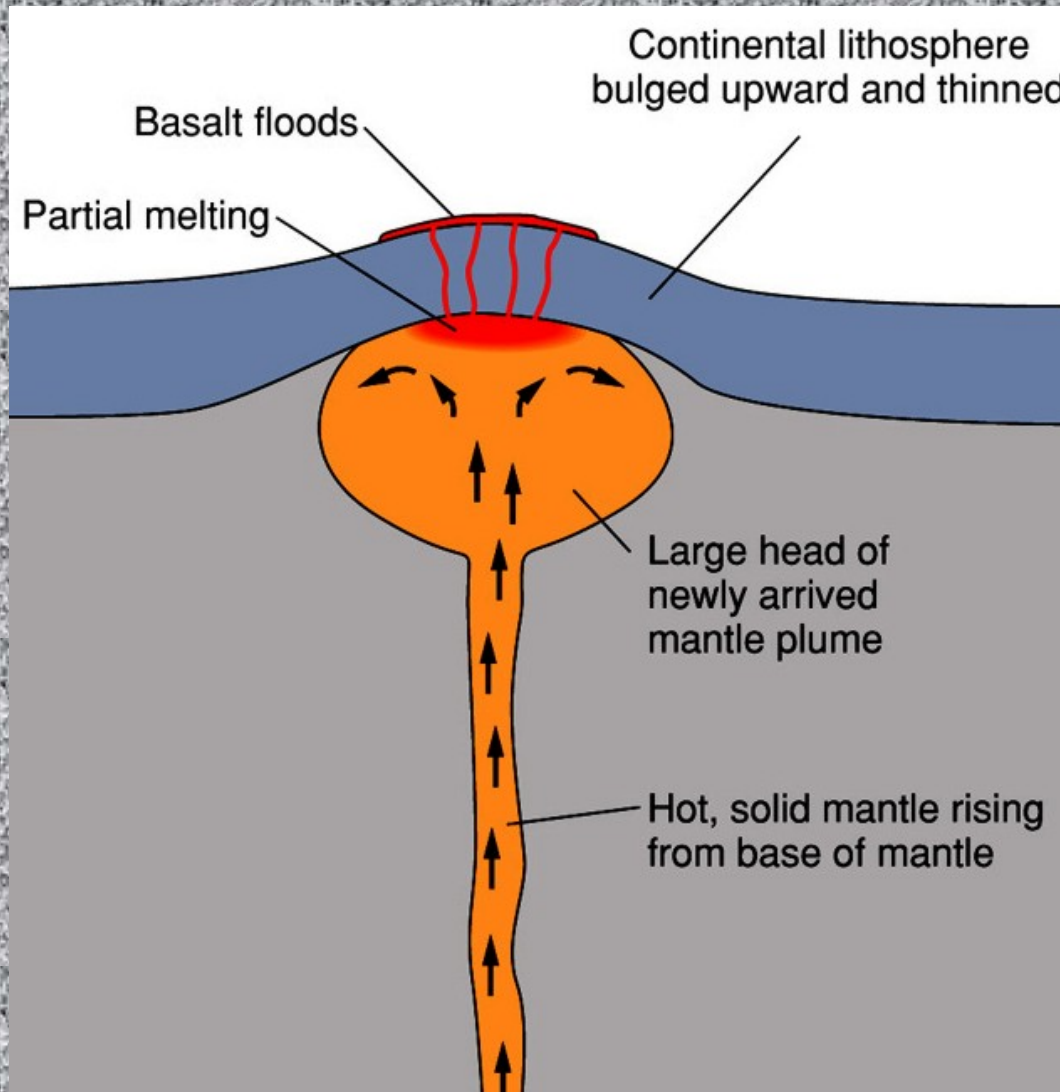
# Igneous activity & plate tectonics

## Divergent boundaries – seafloor spreading



# Igneous activity & plate tectonics

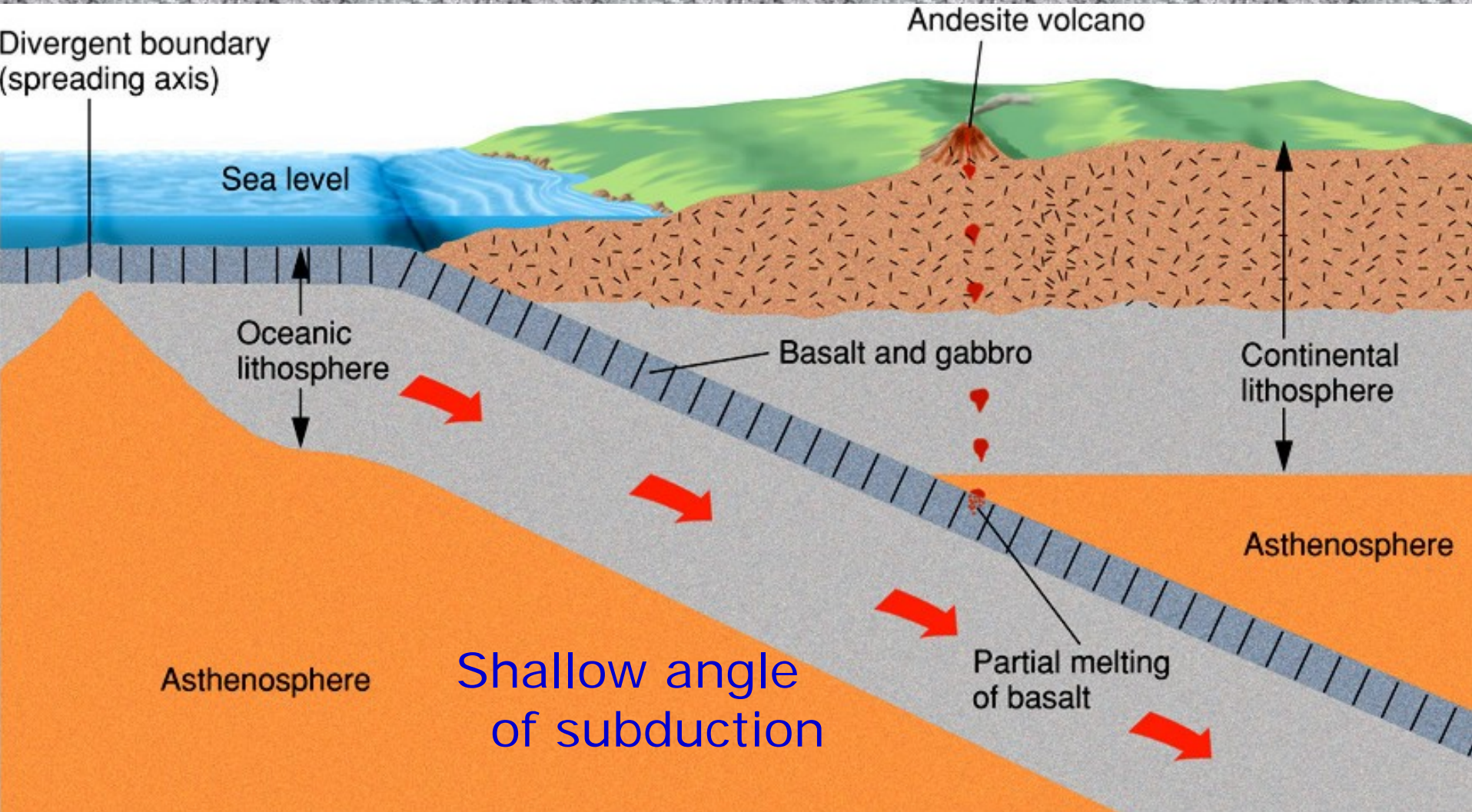
## Mantle plume under continental crust



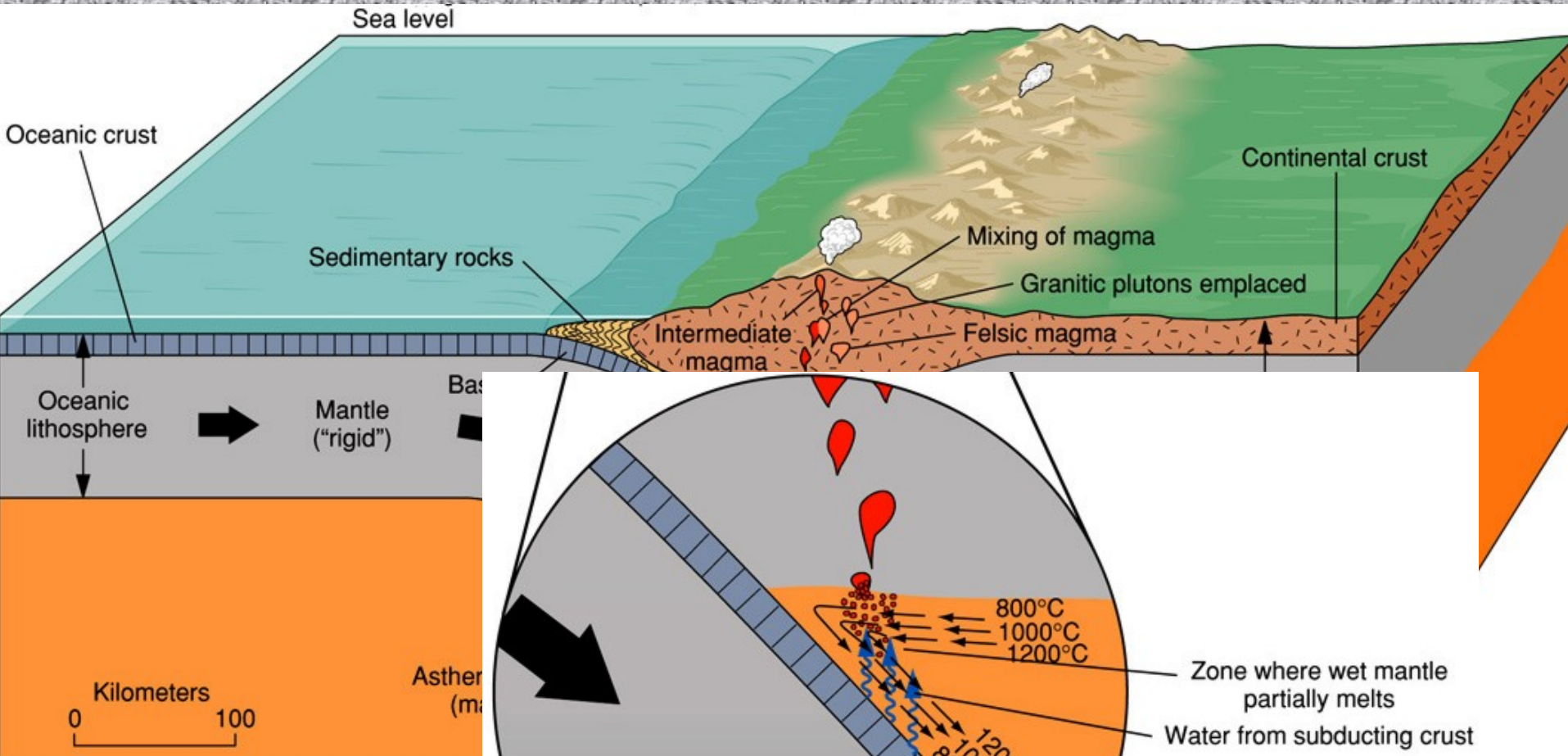


# Igneous processes at convergent margins

Washington-Oregon coast      Juan de Fuca Ridge offshore



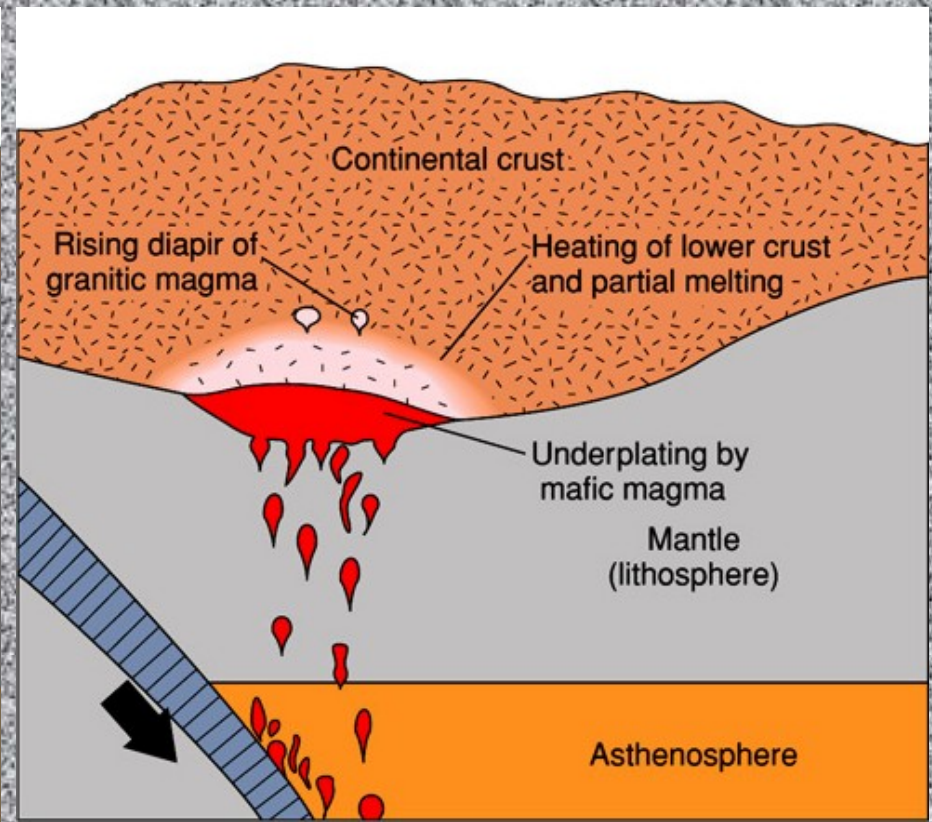
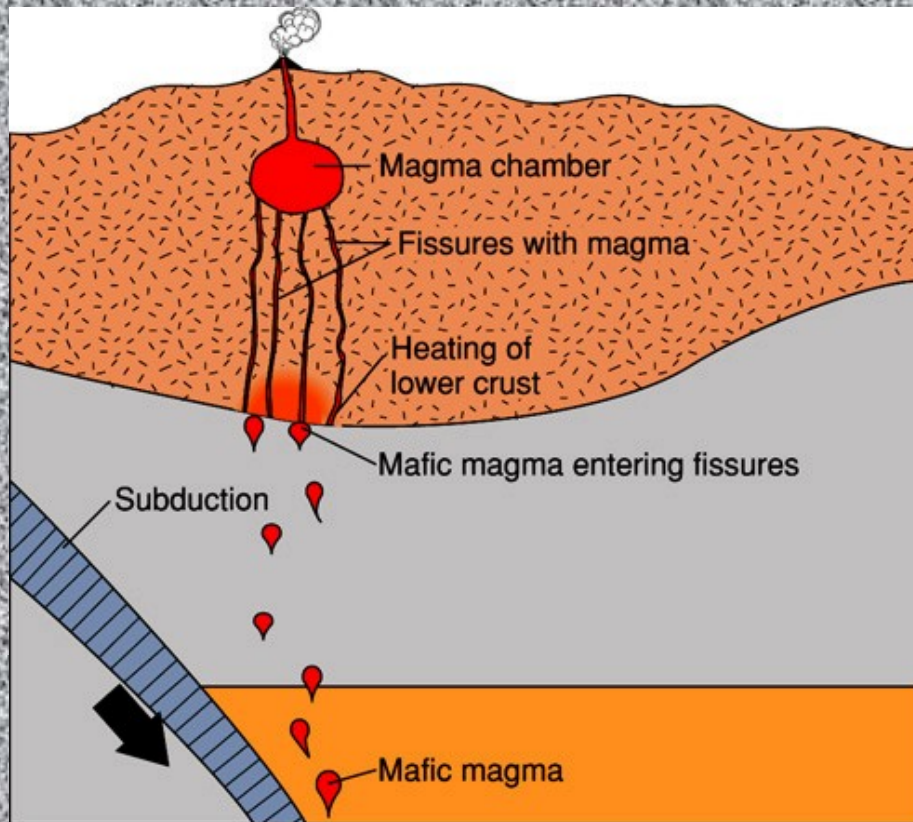
# Igneous processes at convergent margins





# Two modes of forming magma

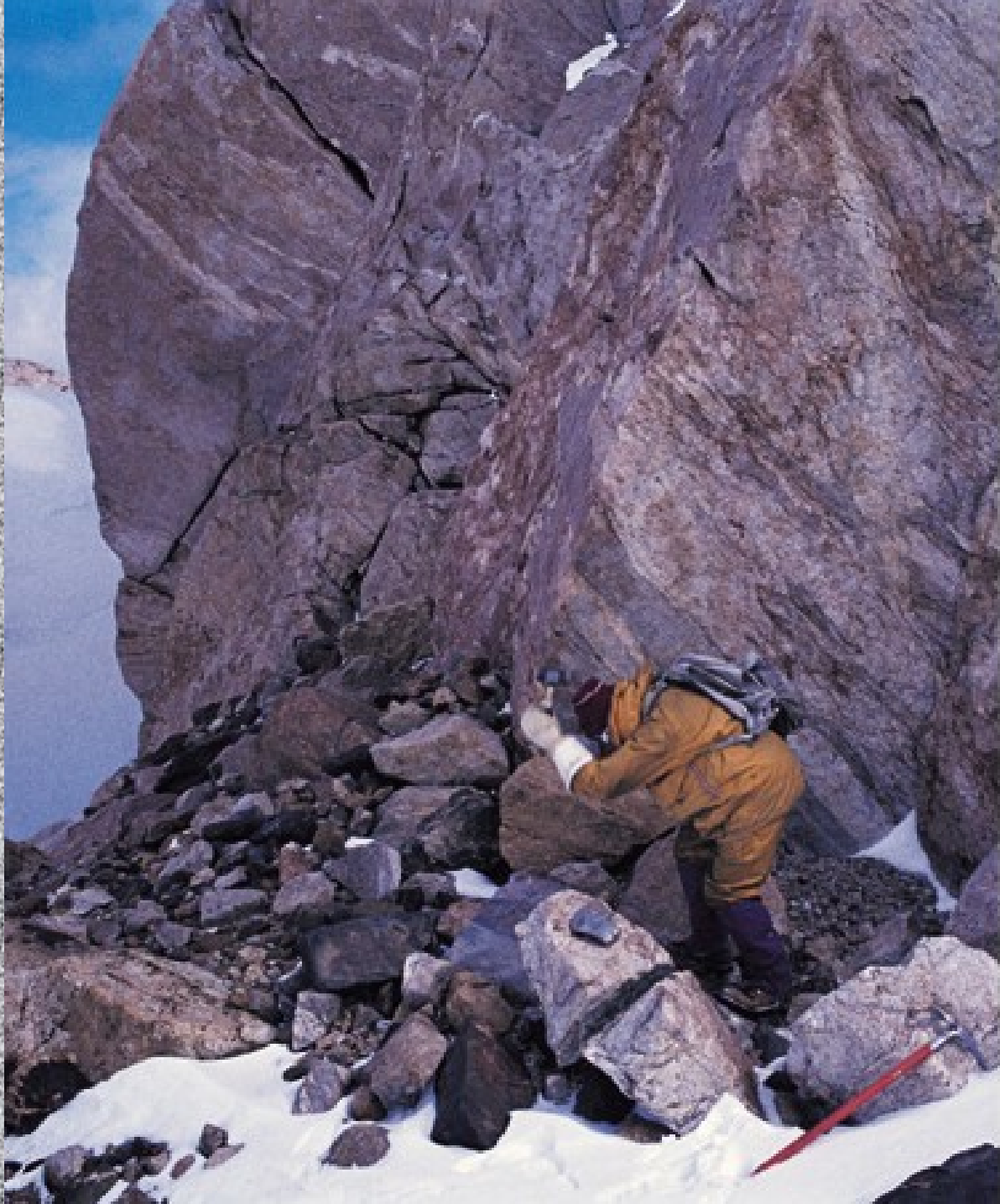
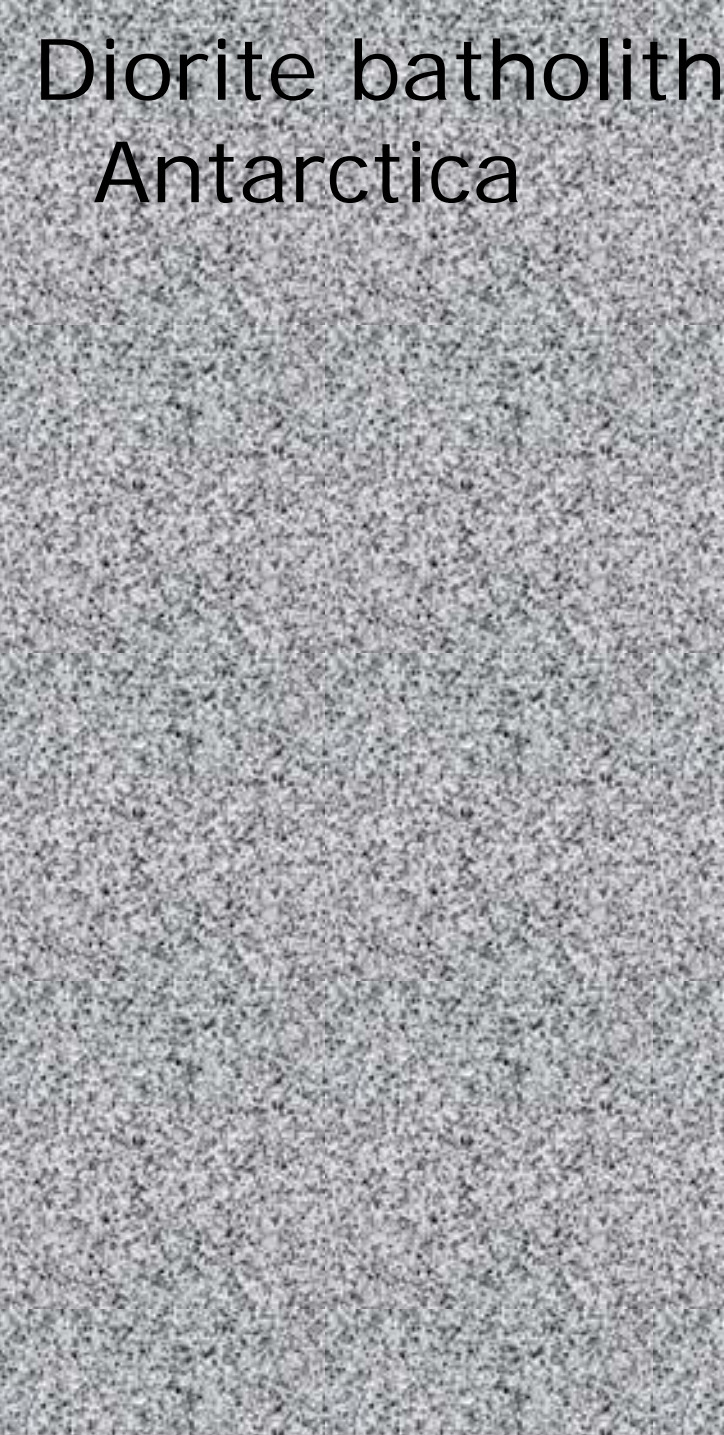
Many batholiths are mostly granite, not diorite



Intermediate magma produces diorite

Heating of crust produces granite

# Diorite batholith Antarctica





# Granite batholith, Chile



End