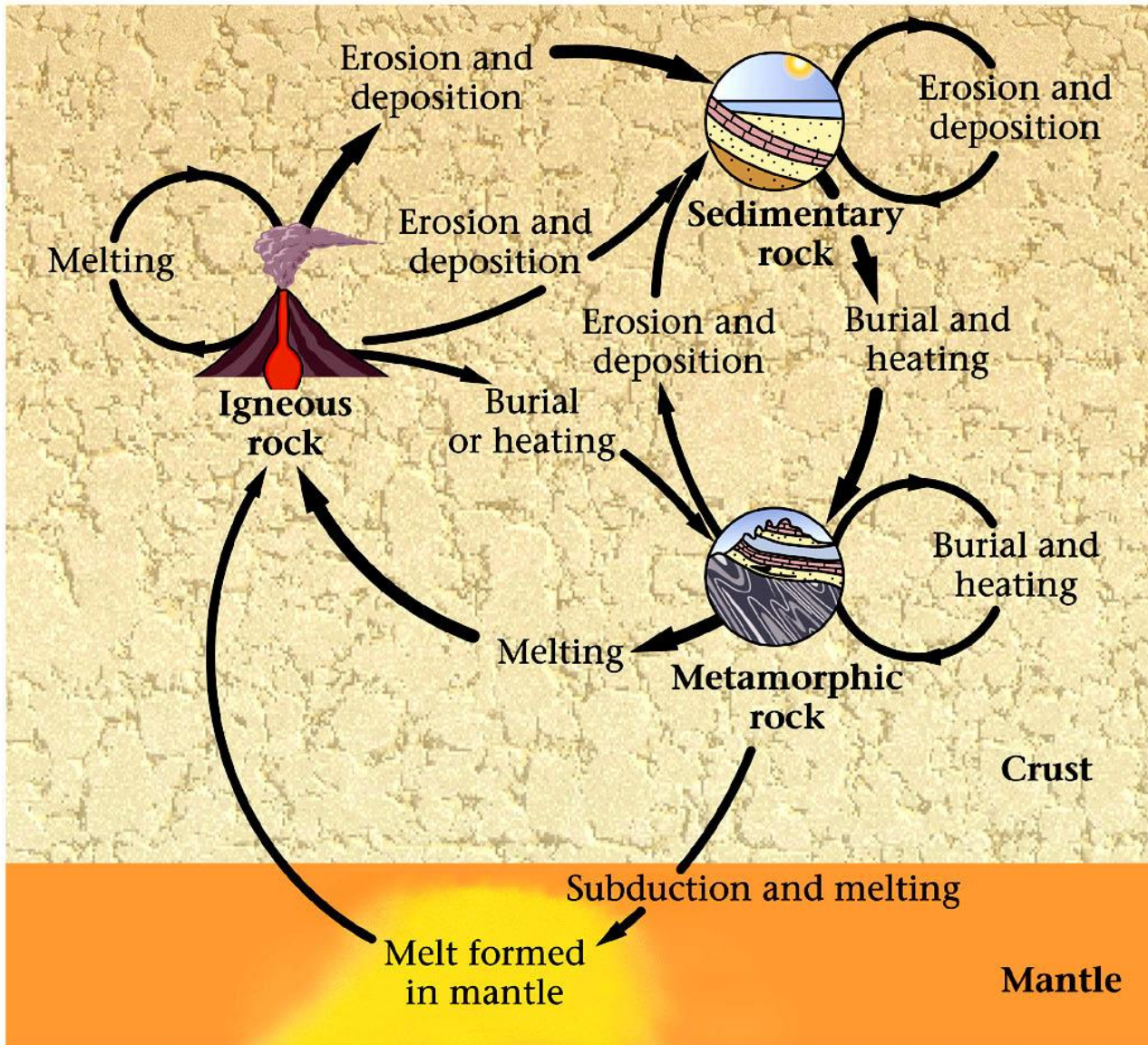


The Rock Cycle



Metamorphosed Sedimentary Rock



Formation of new
minerals



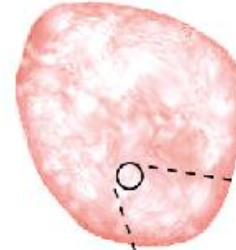
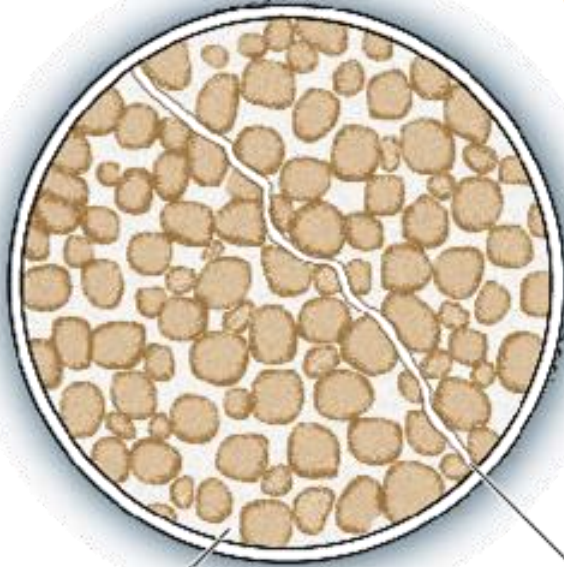
Recrystallization/deformation

Recrystallization

Sandstone

Quartzite

Recrystallization



Cement

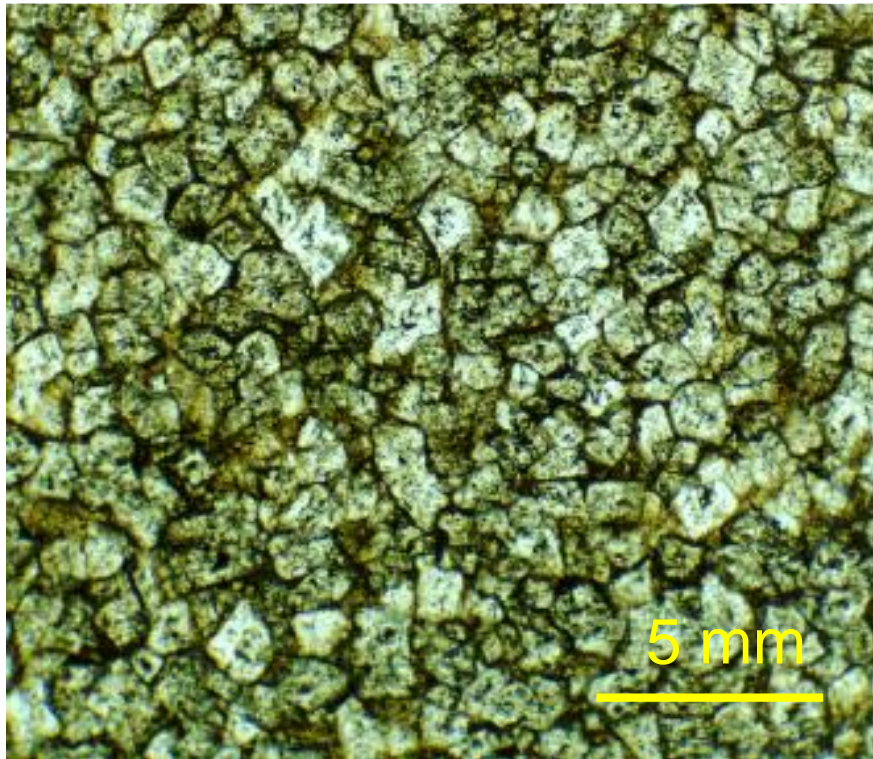
Crack

Crack

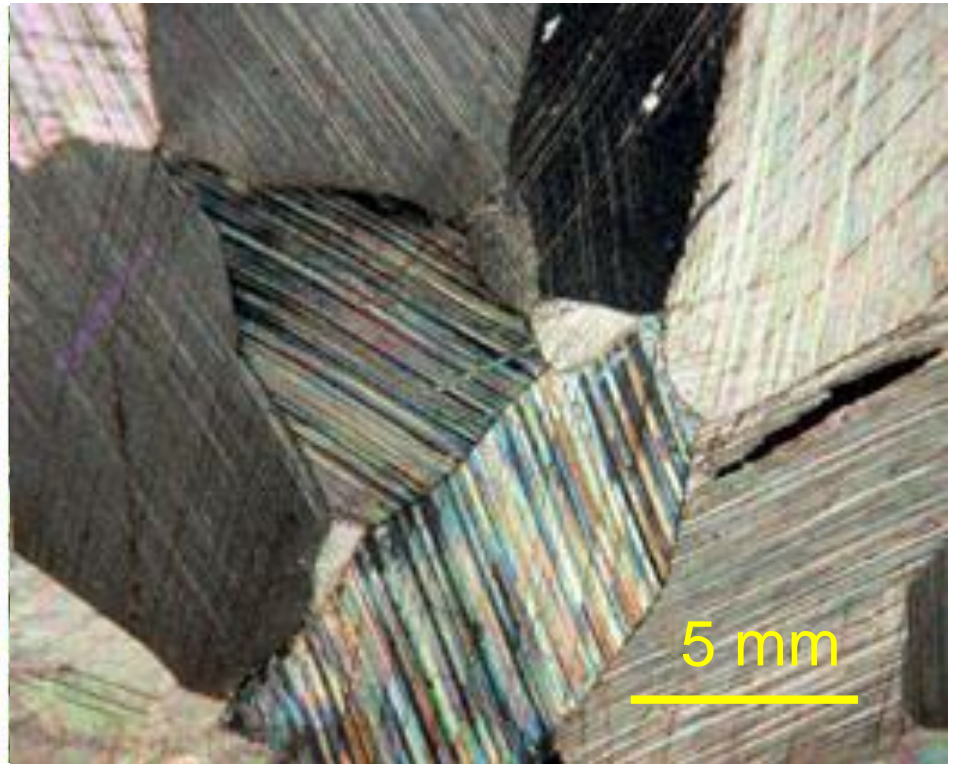


Recrystallization

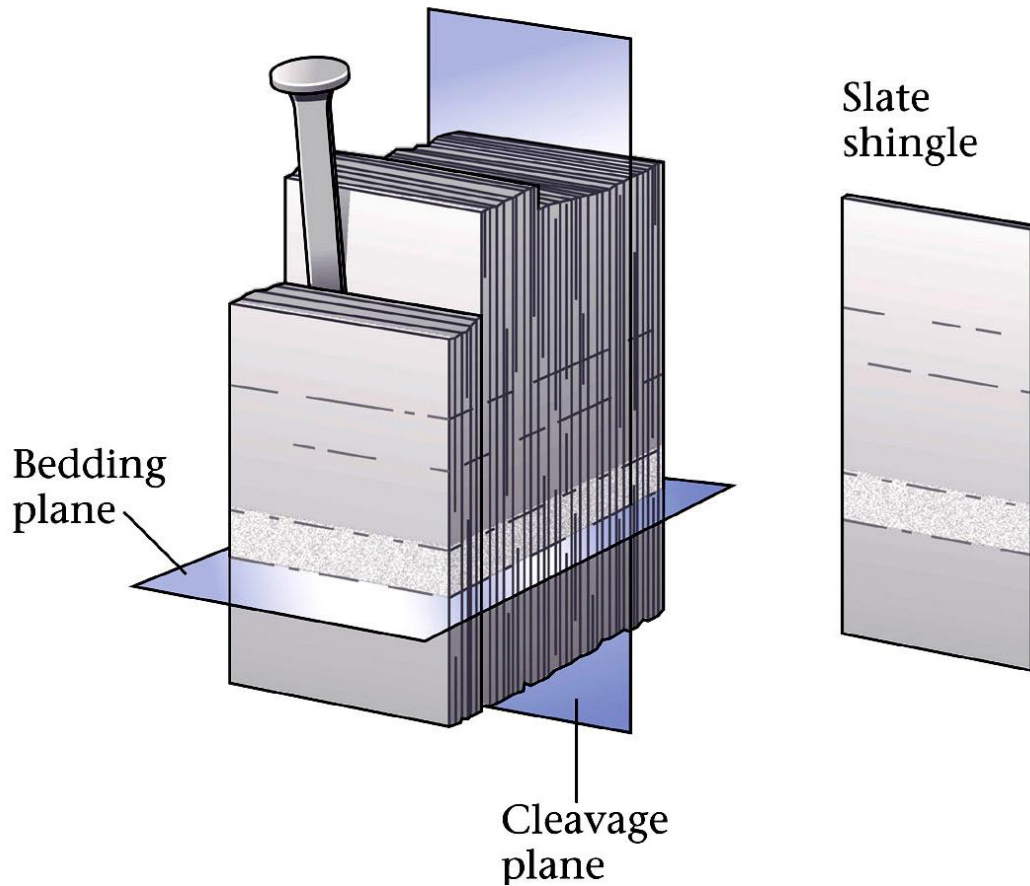
Limestone under microscope



Marble under microscope



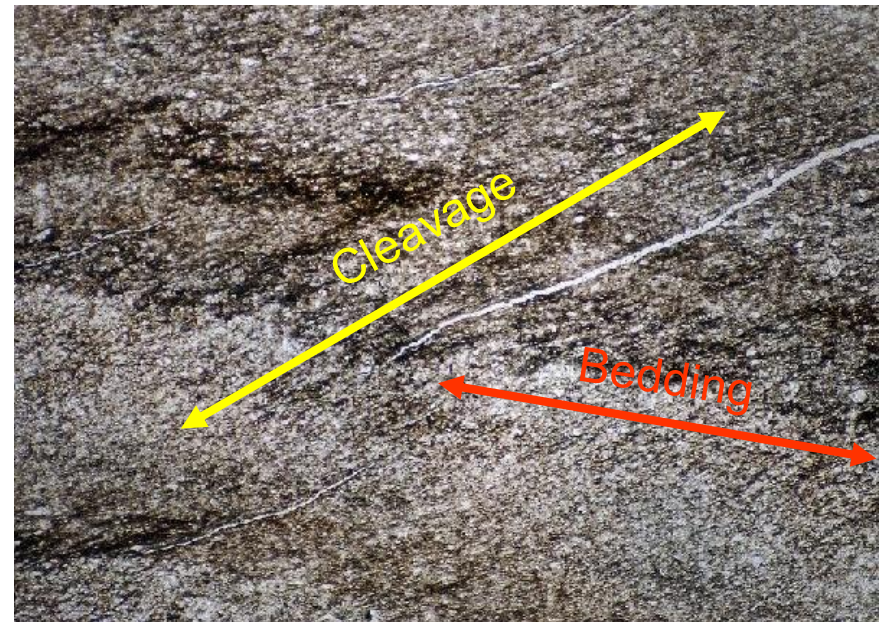
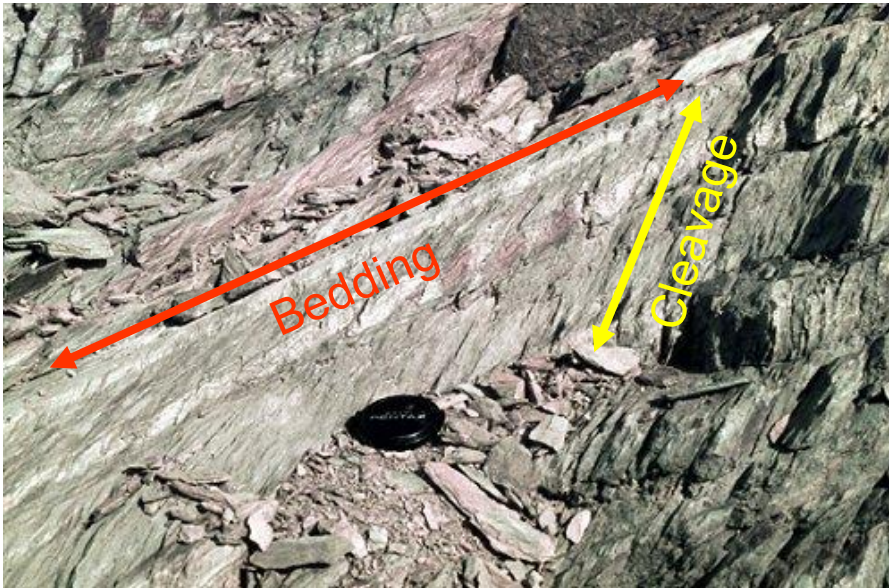
Differential stress and the development of Slate



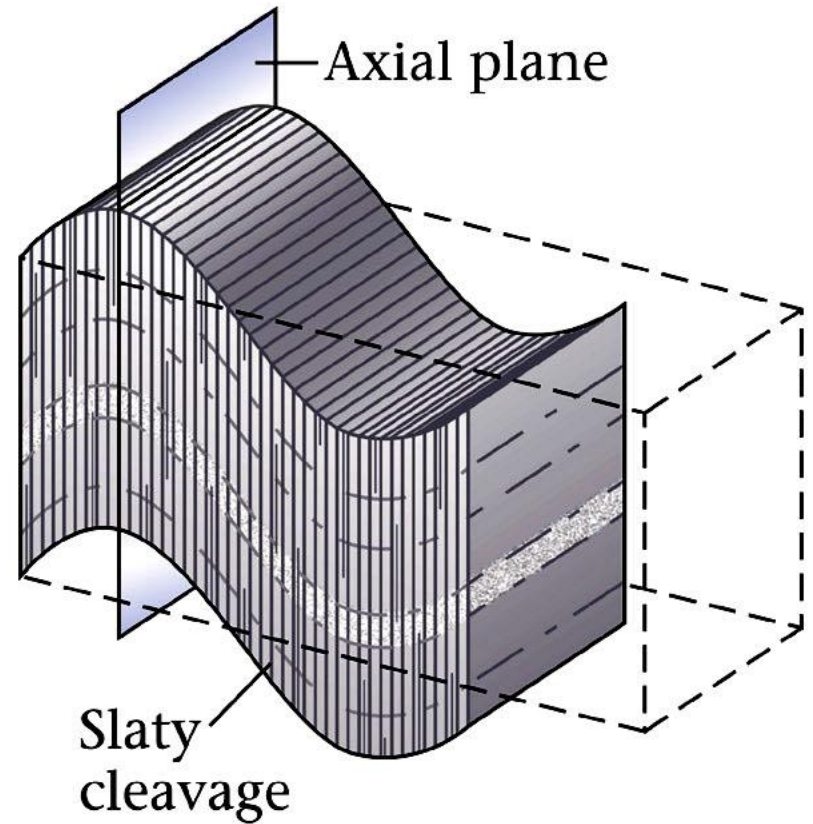
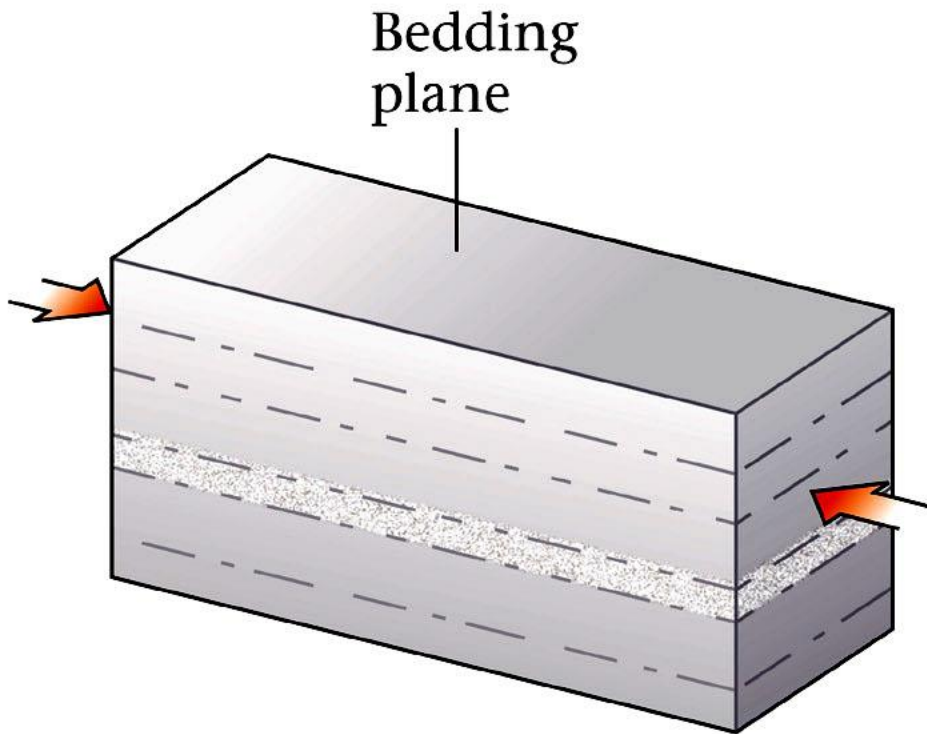
Slate and Slaty cleavage

Product of differential stress at low metamorphic grade

Slate under the microscope



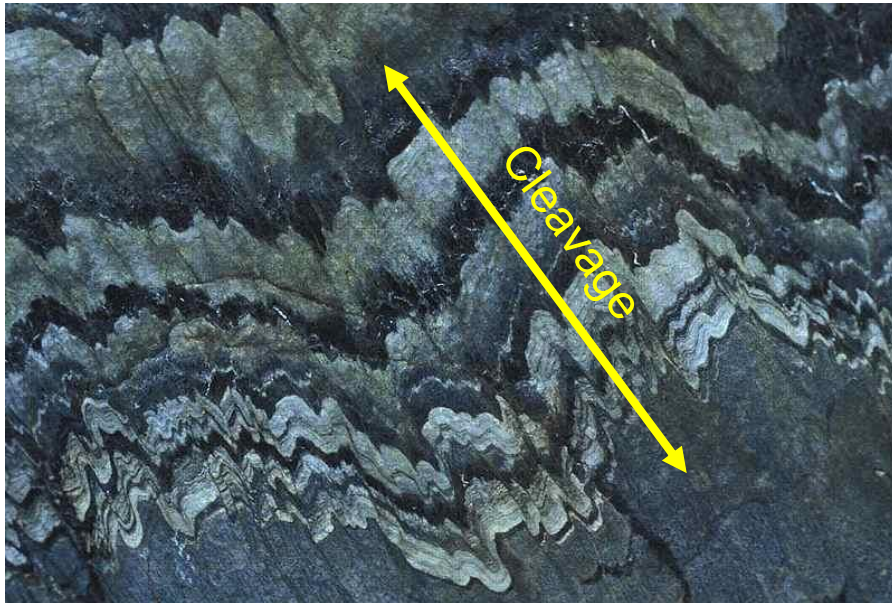
Differential Stress and Folding





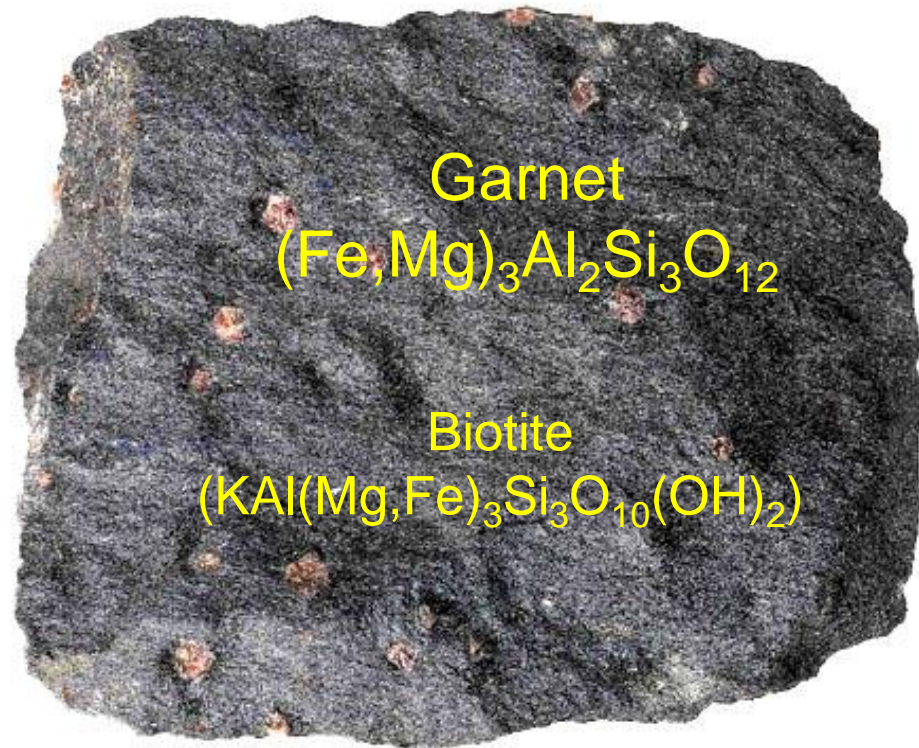
Slaty cleavage and folding

Fold under the microscope



Metamorphism and the formation of new minerals

Chlorite + muscovite = garnet + biotite + H₂O





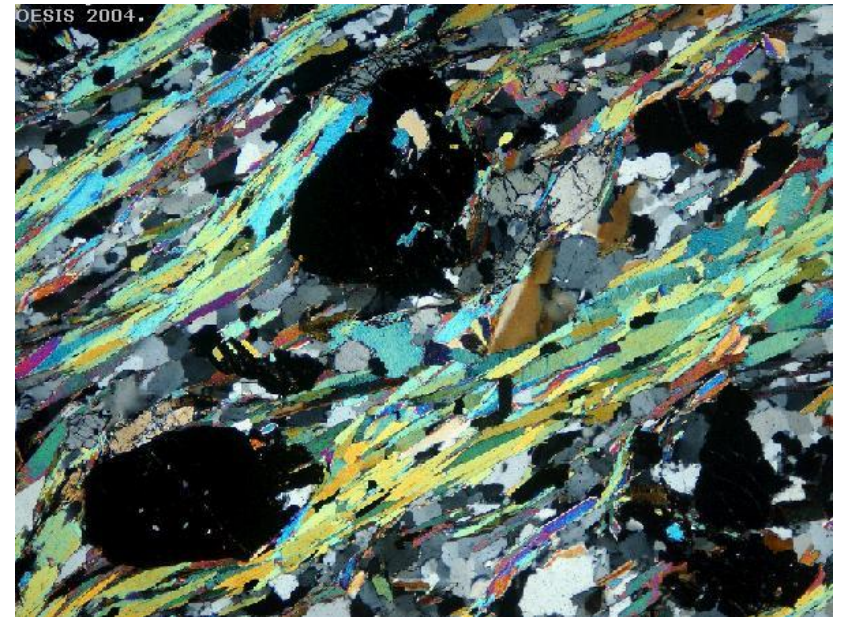
Muscovite schist

Schist

Shistosity defined by
muscovite



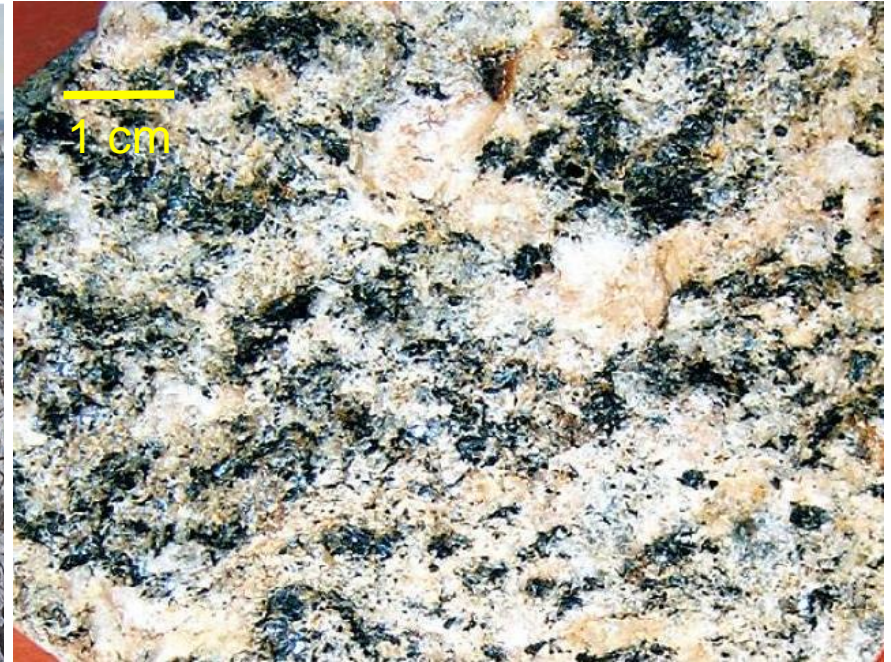
Garnet-biotite schist



Gneiss

Highest metamorphic grade

Muscovite converted to feldspar

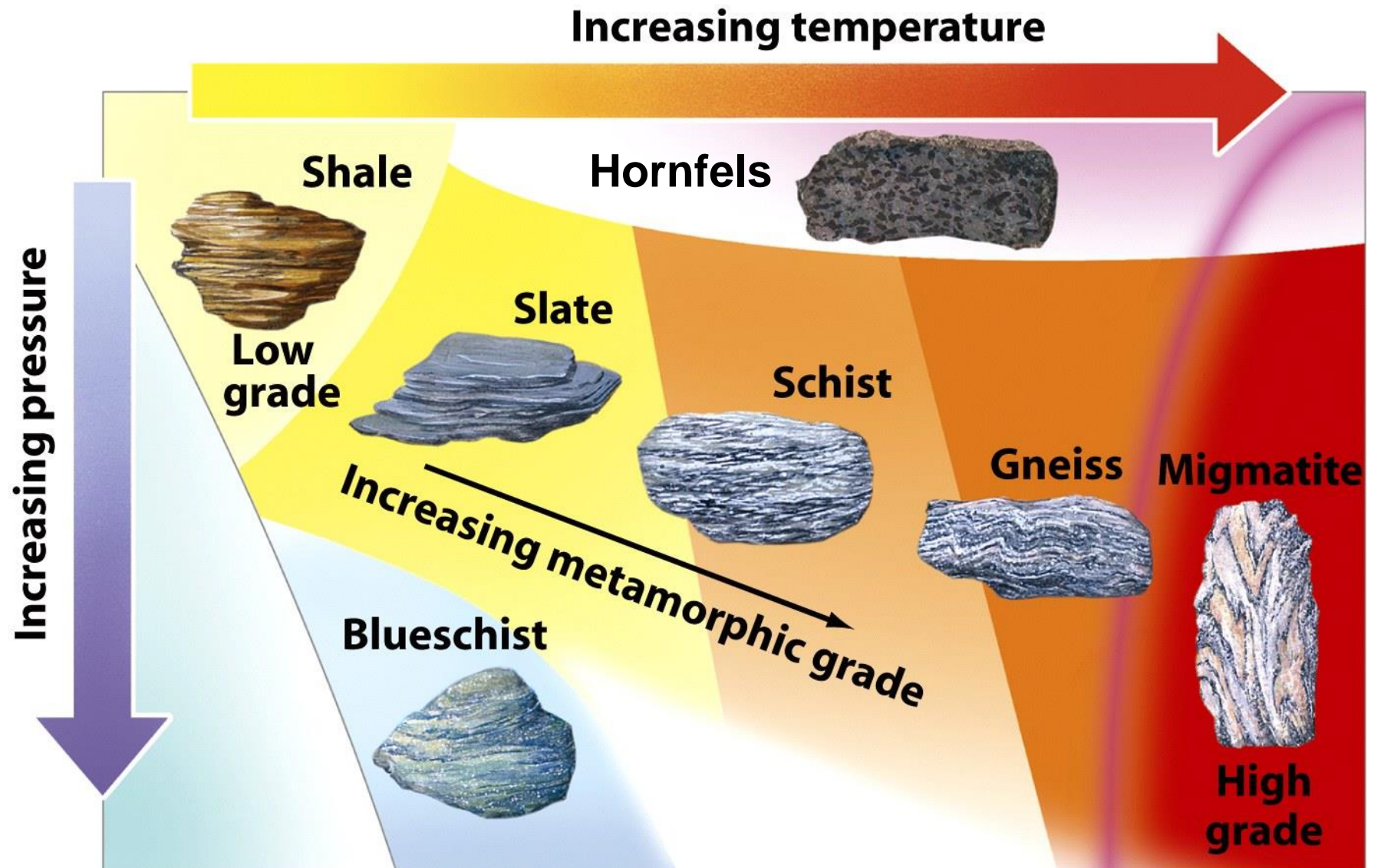


Partial melting

Formation of migmatites



Metamorphism of Shale

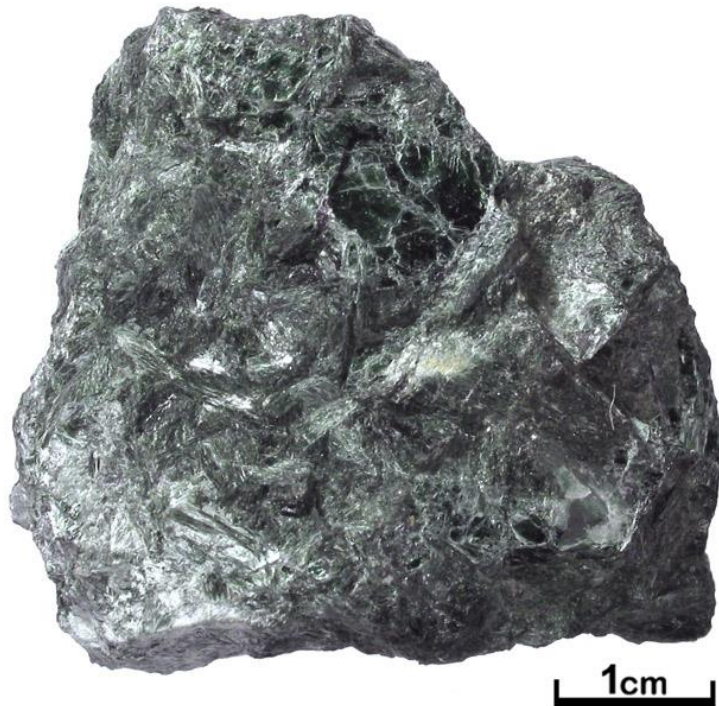


Sheet silicates in Metamorphism

Muscovite
 $(KAl_3Si_3O_{10}(OH)_2)$



Chlorite
 $(Mg,Fe)_6(Si,Al)_4O_{10}(OH)_8$



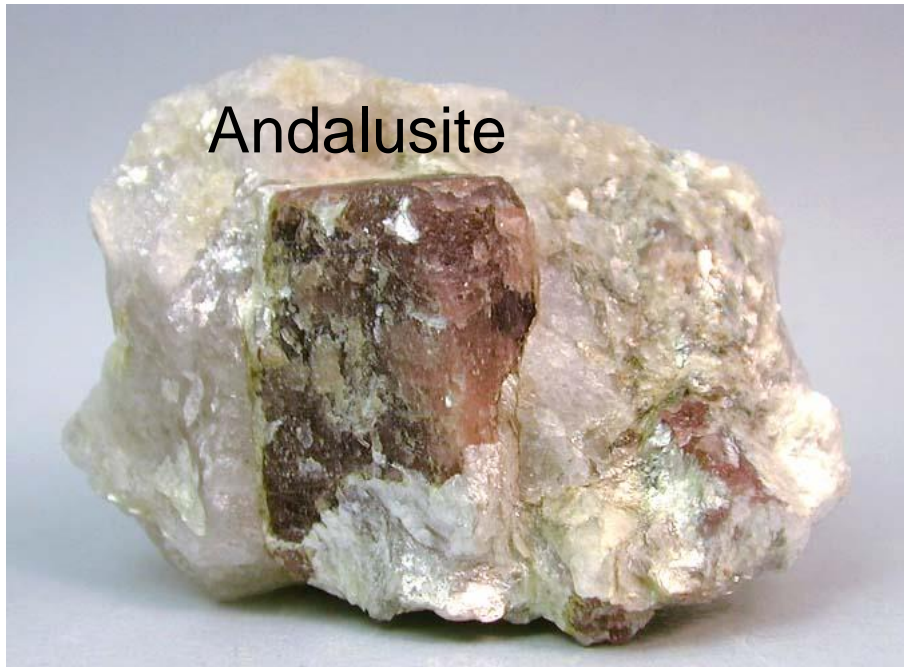
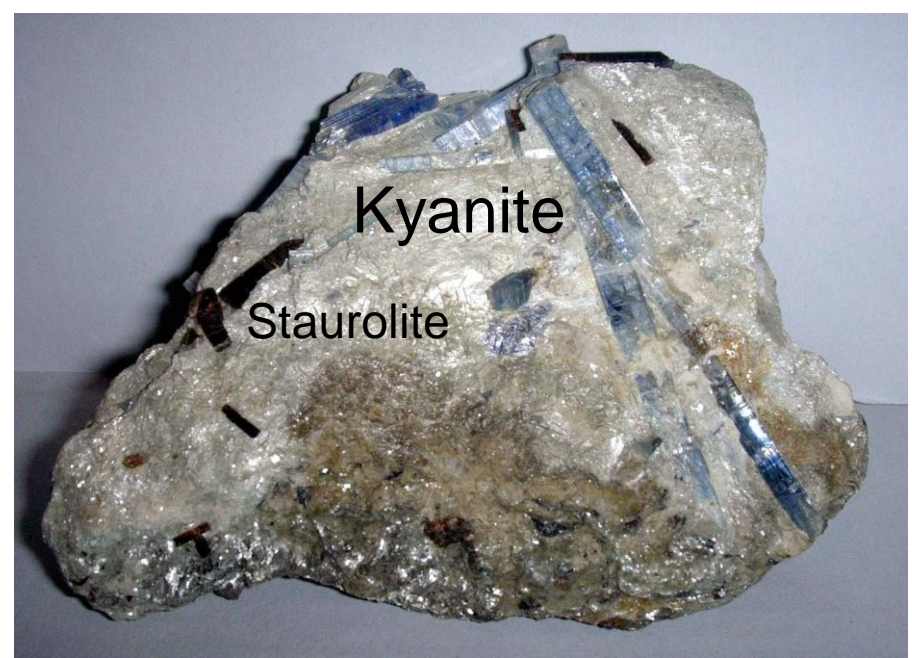
Biotite
 $(KAl(Mg,Fe)_3Si_3O_{10}(OH)_2)$



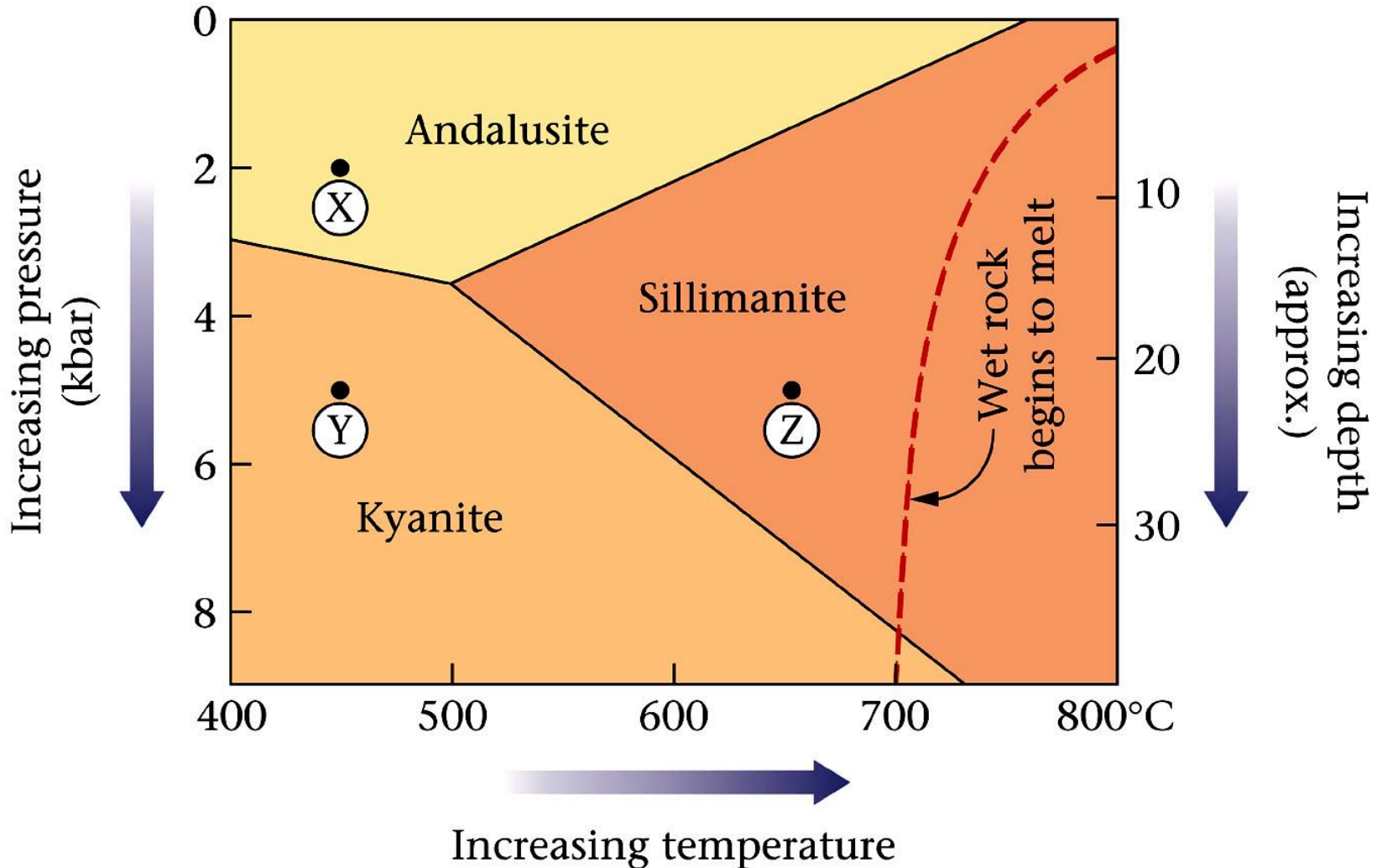
Metamorphic Index Minerals



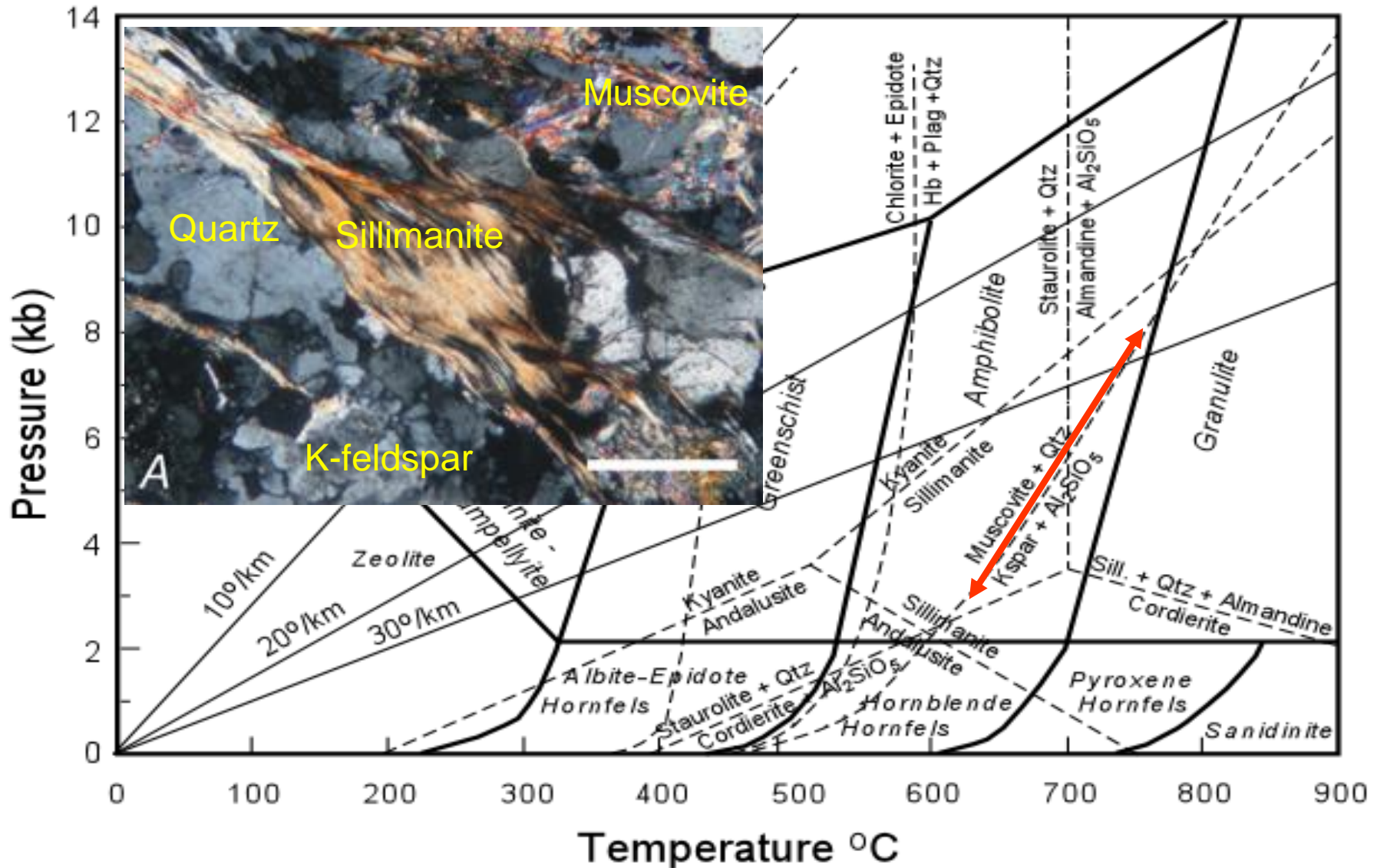
The Aluminosilicate
minerals (Al_2SiO_5)
and metamorphic
grade



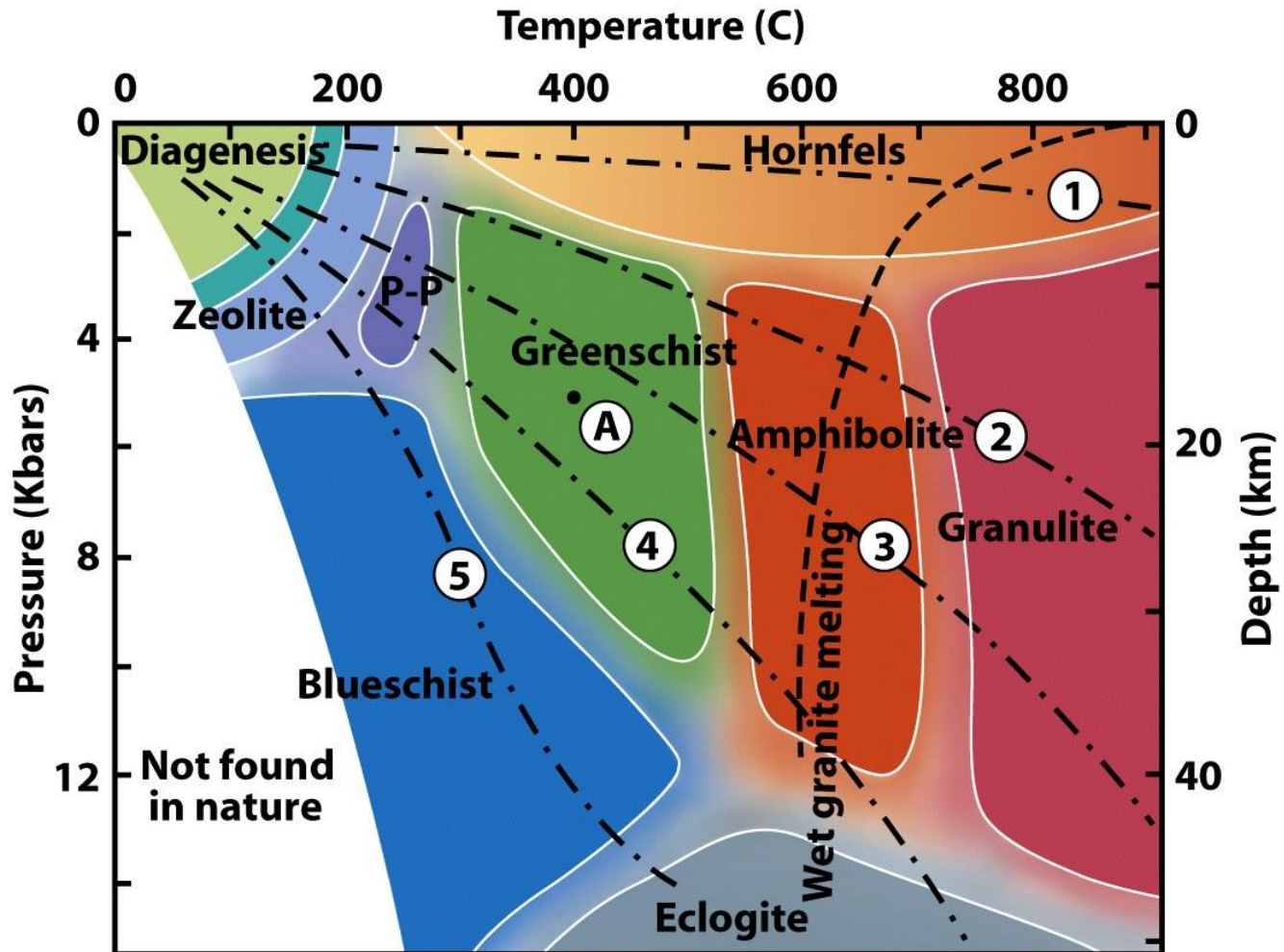
The Aluminosilicate minerals and metamorphic grade



Metamorphic reactions and metamorphic grade



Metamorphic Facies



- ① Contact (thermal) metamorphism
- ② Volcanic arc
- ③ Collisional mountain belt
- ④ Stable continent
- ⑤ Accretionary prism

Greenschist facies
(chlorite)



Basalt
metamorphosed to
different facies

Blueschist facies
(Na-amphibole)



Amphibolite facies
(Ca-amphibole)



Basalt at very high metamorphic grade

Granulite facies
Pyroxene, garnet



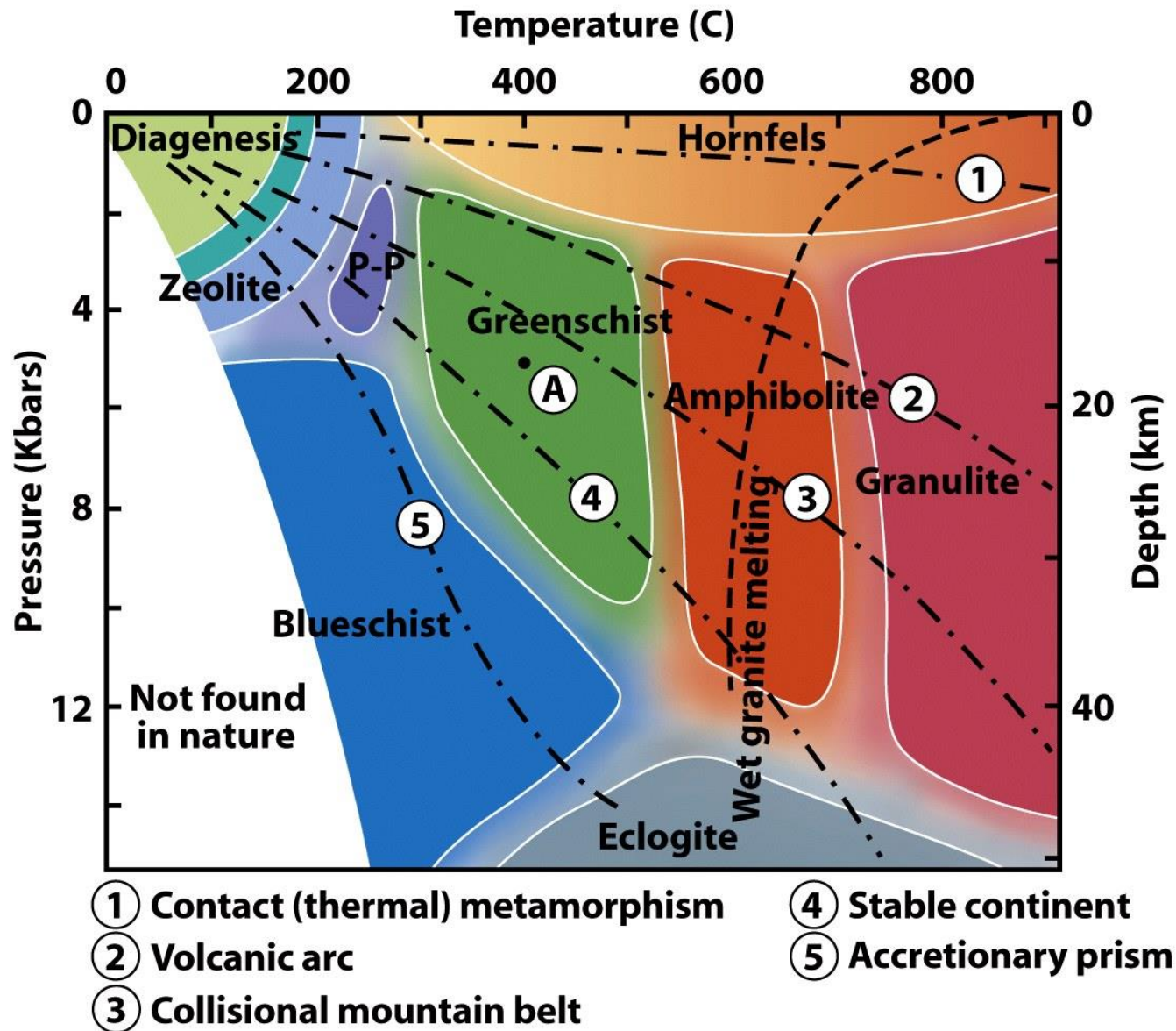
Eclogite facies
Na-pyroxene, garnet



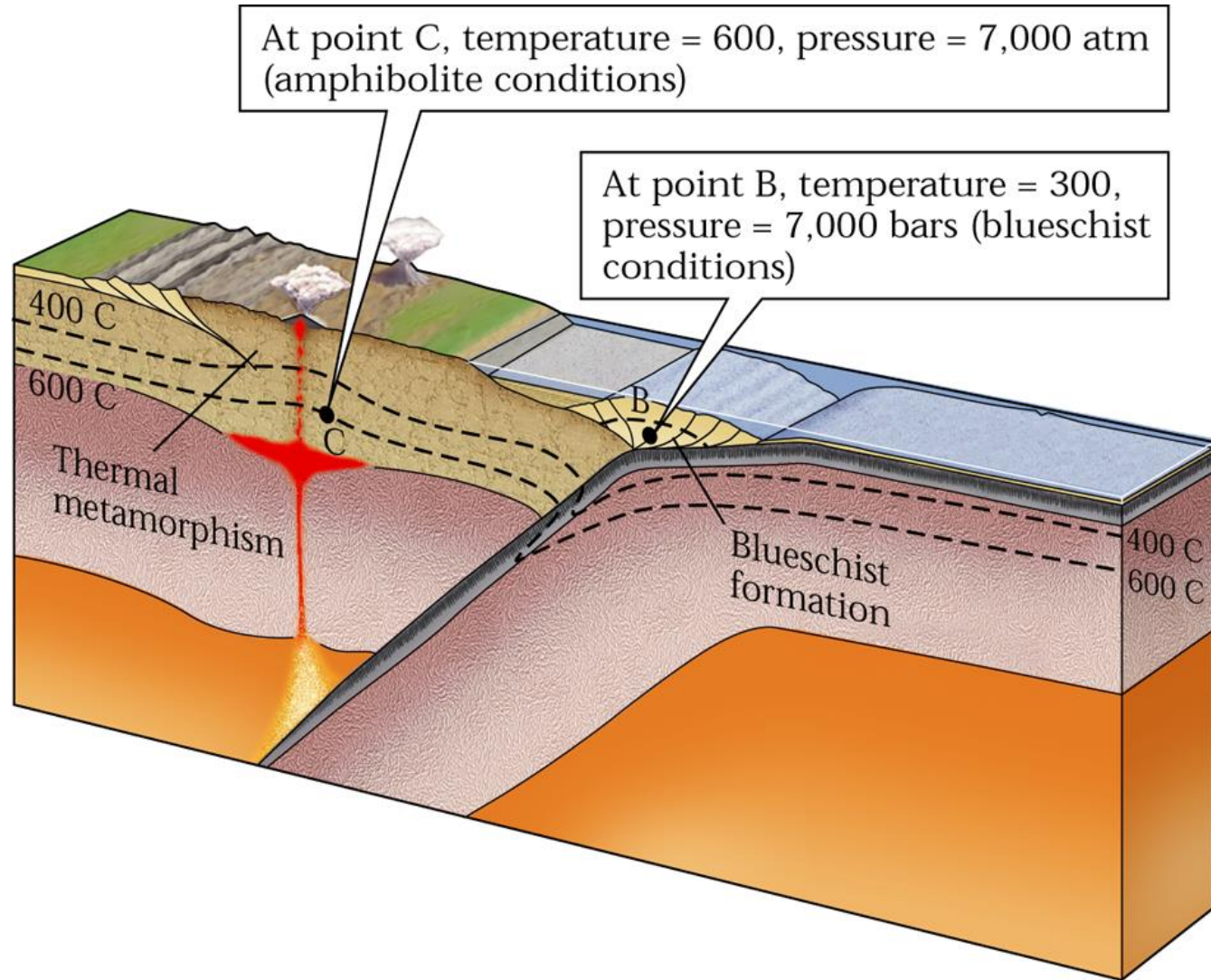
Mineralogy and Metamorphic Facies

Grade	NONMETAMORPHIC (PROTOLITH)	LOW GRADE	INTERMEDIATE GRADE	HIGH GRADE	PARTIAL MELTING*	
Rock name	Basalt	Greenschist	Amphibolite	Mafic Granulite	(not common)	
Mineral occurrence		Zeolite Chlorite Epidote NoAl Amphibole		Al Garnet Pyroxine		
Rock name	Shale	Slate	Phyllite	Schist	Gneiss	Migmatite
Mineral occurrence	Clay	Chlorite	Quartz/Feldspar Muscovite Biotite	Garnet Staurolite Kyanite	Sillimanite	

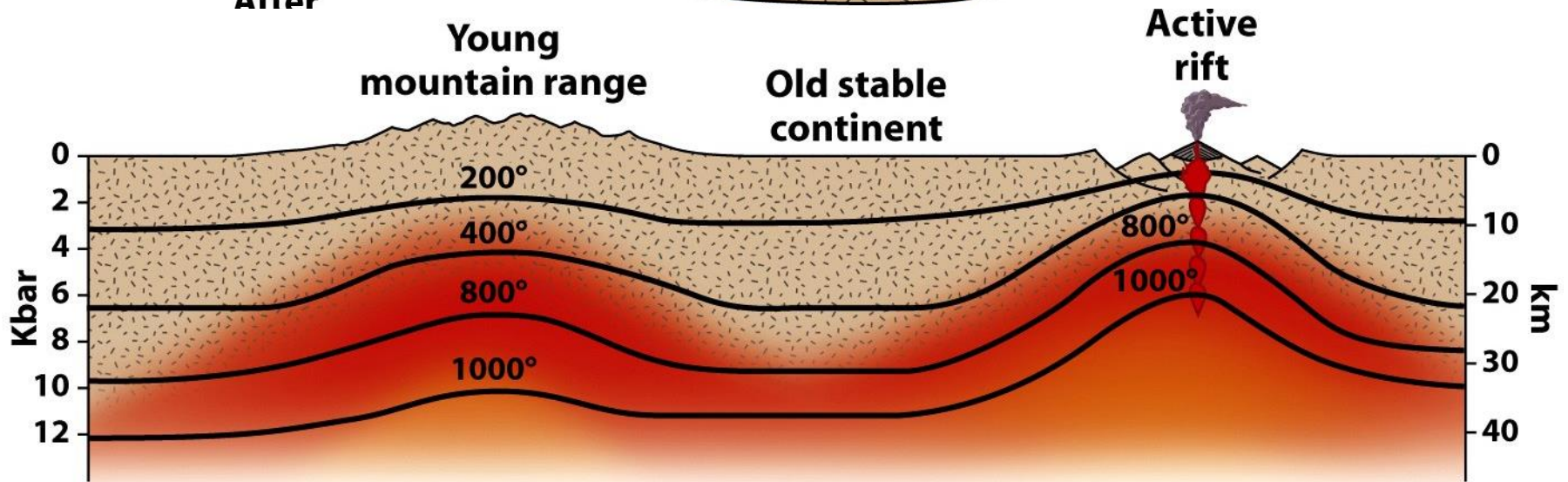
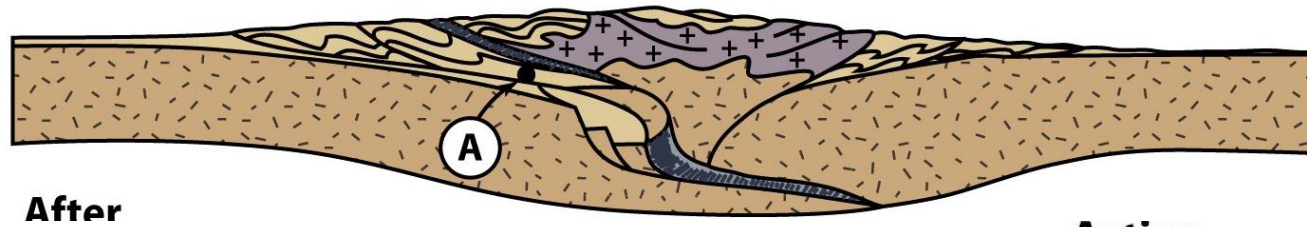
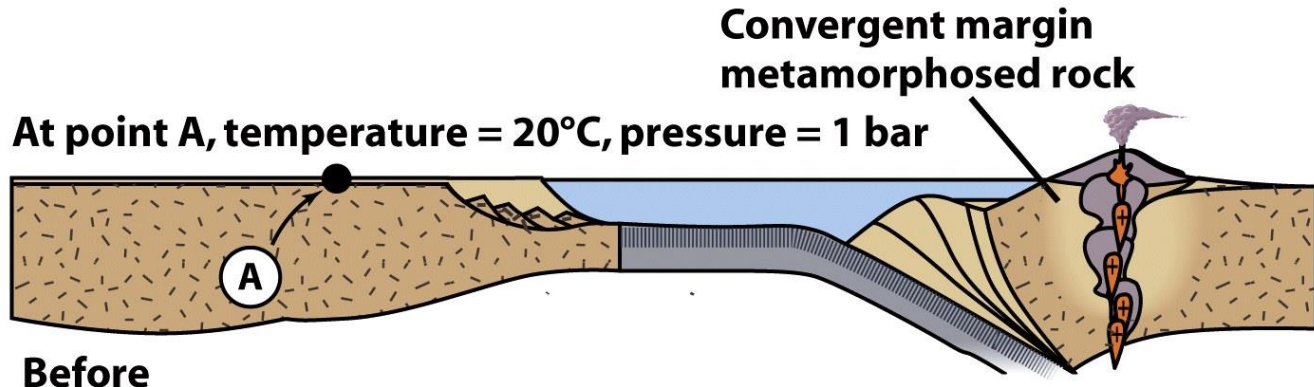
Metamorphic Facies and P-T Paths



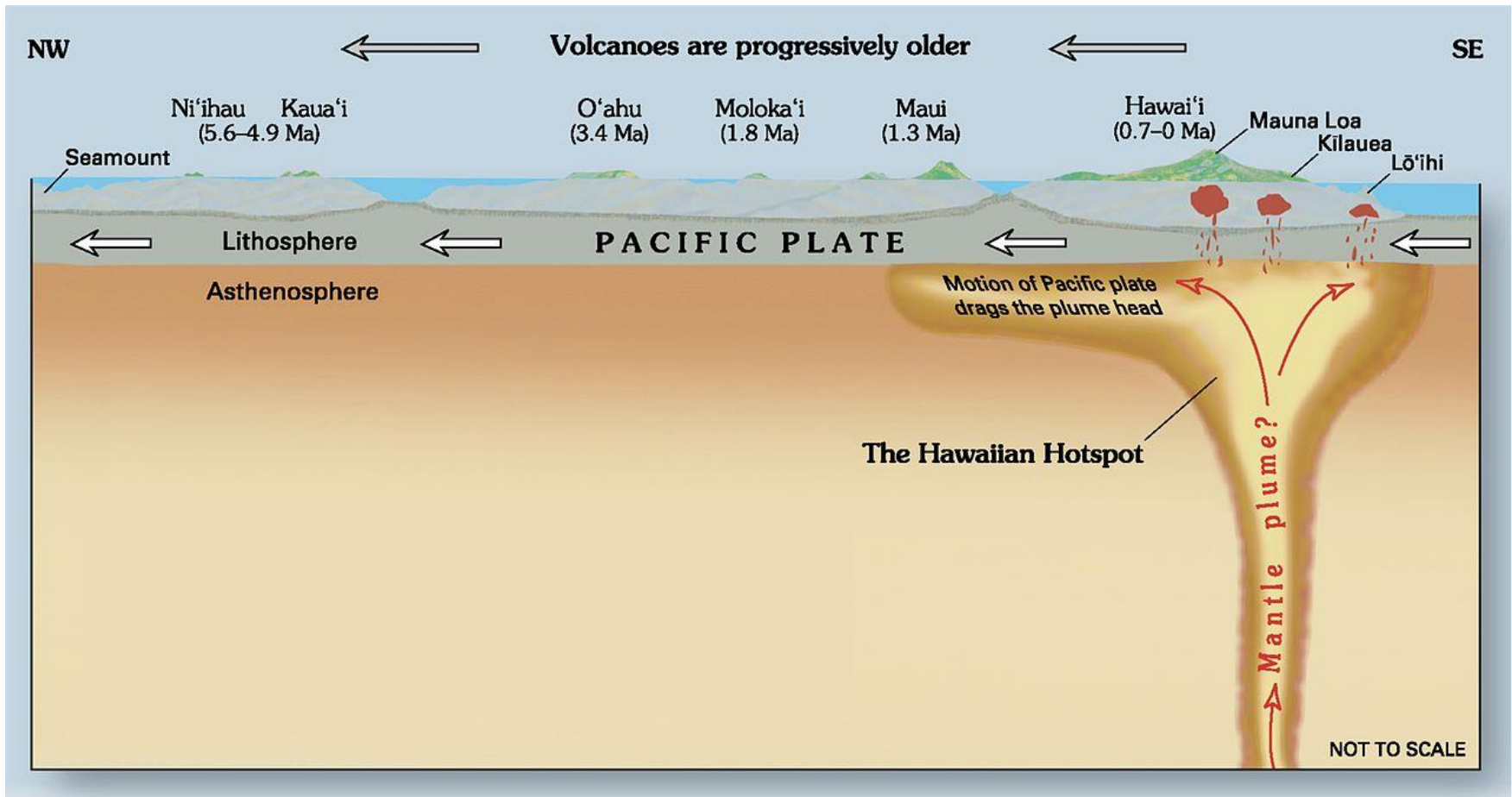
Metamorphic path during subduction



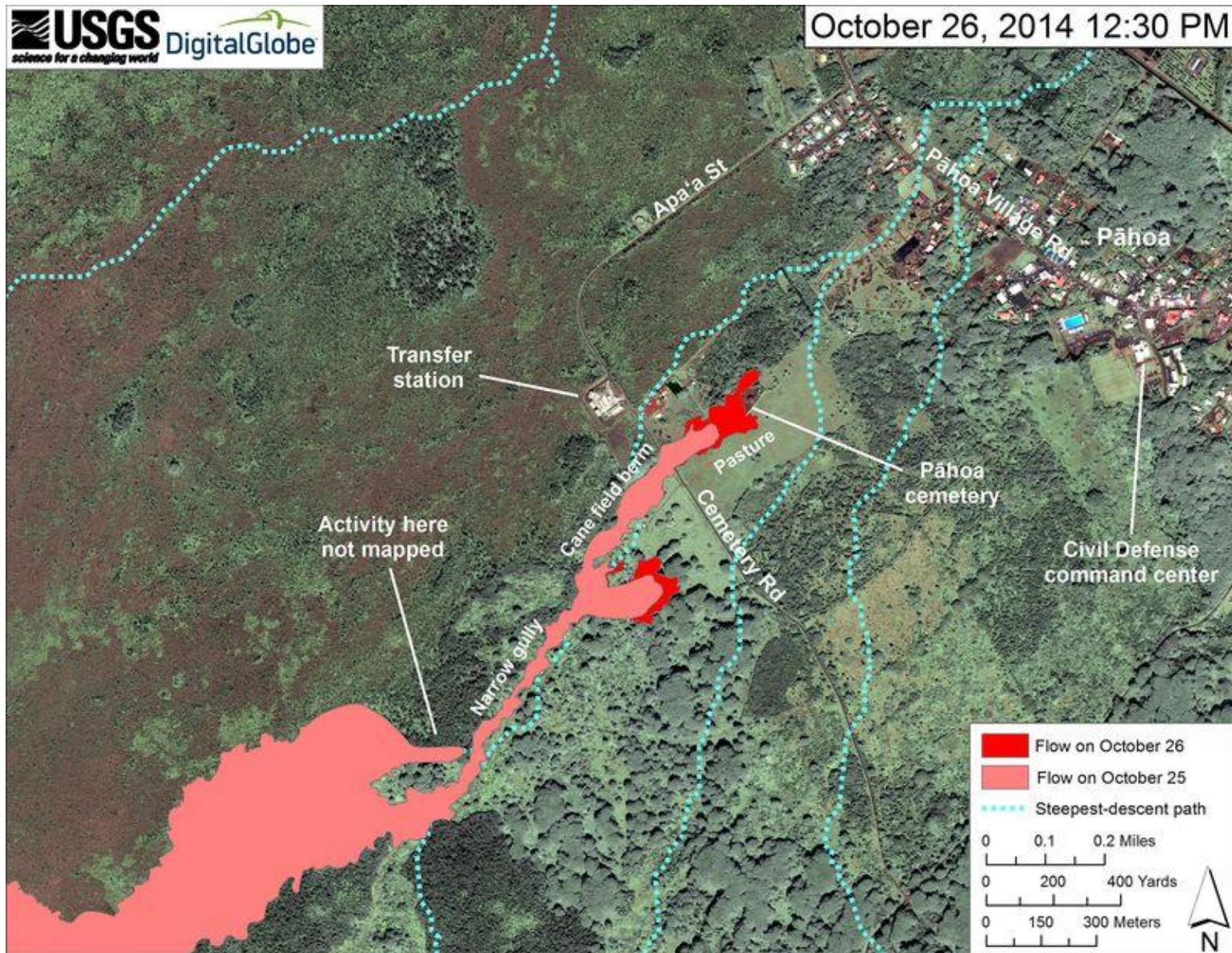
Metamorphic path during continental collision



Kilauea eruption of 2014



Kilauea 2014 eruption in late October



Kilauea eruption in late October 2014



Kilauea eruption in late October 2014



Kilauea eruption in late October 2014



Measuring the temperature of the Kilauea lava flow



Metamorphic Map

