Metamorphic Rocks

Metamorphism

- *Meta* = change, Greek
- Morph =form, Greek
- Metamorphic rocks form from other rocks (**protolith**) by essentially **solid-state** changes in mineralogy and/or texture as a result of a change in chemical and/or physical environment.

Metamorphism is characterized by:

- **phase changes** growth of new physically discrete, separable components (minerals), either with or without (isochemical) addition of new material (*results in new index minerals*); and/or
- **textural changes** recrystallization, alignment and/or grain size, usually as a result of unequal application of stress...*results in foliation*

Agents of Metamorphism

- Have been recrystallized as the result of
 - Temperature
 - Pressure
 - Confining pressure (compressive stress)
 - Directed pressure (differential stress), including shearing
 - Chemical Activity
 - the composition of pore fluids

Pore Fluids

- A fluid that occupies the empty spaces between particles
- May come from
 - Partial melting of the rock
 - Groundwater

Metasomatism can result...this occurs when fluids passing through a rock pickup ions of one element and dropoff ions of another, changing the chemical composition of the rock.

Metamorphic Processes

- 1) Recrystallization
- 2) Phase Changes that result in mineral changes
- 3) Neocrystallization: transformation of one mineral into a new one, depending on the new environment.
- 4) Pressure Solution and Plastic Deformation
 - a. Mineral Orientation
 - b. Mineral Segregation

Metamorphic Processes-How it is Done

1) Temperature changes

- Below 200° not much happens
- Metastability can occur
- Migmatite can form from igneous rocks
 - Half igneous, half metamorphic

2) Pressure Changes

a. Makes minerals pack themselves closer (mineral segregation)

3) Chemically Active Fluids

- a. Volatiles (H₂O, CO₂) play an important role
 - Source is self-contained
- b. Metasomatism (open system)
 - Usually from an igneous intrusion
 - Hot water
 - Hydrothermal alteration
 - Plays a part in the formation of ores

Effects of Metamorphism

- 1) Foliation-according to metamorphic grade (from mineral segregation and mineral orientation)
 - Slaty
 - Phyllitic
 - Schistose
 - Gneissic

Chemical Composition of Metamorphic Rocks depends on the source rock. There are four major groups of source rocks that create metamorphic rocks.

- 1) Pelitic: A sedimentary protolith like Shale. These rocks are typically high in aluminum, which results in the formation of muscovite as an example.
- 2) Mafic: Contain little silica and more iron and magnesium. Result in rocks that contain biotite and other iron and magnesium rich minerals.
- 3) Calcareous: Calcium carbonate rich. Typically from a sedimentary carbonate source like limestone.
- 4) Quartzo-Feldspathic: Form from granite and rocks rich in quartz and feldspar.

Classification of Metamorphic Rocks

Foliated Rocks Rock Name	Foliation Type	Index Minerals	Characteristics
Slate			
Phyllite			
Schist			
Gneiss			
Non-Foliated or Poo Rock Name	orly Foliated Rocks	Index Minerals	Characteristics
Marble			
Quartzite			

Hornfels

Eclogite

Serpentinite

Other Special Metamorphic Rocks

- 1) Anthracite Coal
- 2) Metaconglomerate
- 3) Migmatite

Types of Metamorphism

1) Contact or Thermal Metamorphism

2) Regional or Dynamothermal Metamorphism

Special Cases:

- 3) Dynamic: near faults, from shearing
- 4) Burial: from overburden...important to the oil industry
- 5) Hydrothermal at MOR
- 6) Shock Metamorphism

Metamorphic Facies

Facies =set of characteristics that distinguish a rock

- Hornfels
- Zeolite
- Blueschist
- Greenschist
- Amphibolite
- Granulite
- Eclogite
- Migmatite
- (Magma)

Insert your beautiful diagram here: