

November 10, 2005

Handout: Sedimentary Rocks

Beginning of metamorphic petrology: sedimentary protoliths

### Sedimentary protoliths

Siliclastics – by size, categorized as conglomerates, sandstones, or shales; by chemistry, categorized as graywackes, lithic sandstones, arkoses (“red beds”), or quartzites

Carbonates + Evaporites

Shales are the dominant type of sedimentary rock on earth (70% of sedimentary rock mass), full of aluminous clays

Diagenesis – chemical alteration of sediment at low T

See handout for background on sedimentary rocks.

### Metamorphic rocks

Oldest crustal rocks:

Acasta granitic gneisses 4.0 B.y. old

Isua greenstone belt (granite gneisses, metaboninites) 3.8 B.y. old

Focus on **solid state** changes in rocks

Metaigneous, metasedimentary

Interactions with H<sub>2</sub>O or CO<sub>2</sub> rich fluids

Concept of isochemical reactions (not correct)

Metasomatism – adding or removing elements by action of metasomatizing agent ← fluid

### Concept of metamorphic grade

Low T – diagenesis

↕ in between, metamorphism

High T – melting (anatexis) – melting T depends on protolith

	melting
shales	600-700 °C
basalts	600-900 °C
marble	1000-1300 °C

### Types of metamorphic environments

- Contact metamorphism – near igneous plutons, result of heat of intrusive magma  
Sometimes intrusions are fluid-rich → set up hydrothermal circulation systems that also influence the surrounding rocks

Skarns – calcite and qtz protoliths, calc-silicate minerals

Fluids carry metals, make ore deposits

- Shock metamorphism – meteorite impacts impose very high P-T conditions  
Example minerals are stishovite (VI fold coordination), wadsleyite (sorosilicate), ringwoodite (spinel)
- Regional metamorphism
  - Burial metamorphism – P + T imposed by burial
  - Anorogenic metamorphism – burial in sed. Basins
  - Orogenic – deformation @ plate margins, subduction zones and continent-continent collision
- Pyrometamorphism – by fire, where coal seams burn underground  
Also possible to metamorphose rocks at lightning strikes

### Metamorphic variables

T most important var, requires a heat source – in contact metamorphism, it's intrusion, while in burial, it's radioactive decay of elements like K, U, and Th

P usually lithostatic pressure,  $\rho gh$

Granite	$\rho = 2700 \text{ kg/m}^3$
Basalt	3000
Peridotite	3300

Fluid

Bulk composition of protolith –  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{K}_2\text{O}$ ,  $\text{FeO}$ ,  $\text{MgO}$ ,  $\text{H}_2\text{O}$   
Pelites – quartzofeldspathic

High P, low T – subduction zones

High T, low P – ocean floor spreading centers