LECTURE: CLASSIFICATION OF SEDIMENTARY ROCKS

1. Clastic (siliciclastic)
   - Sandstones
   - Mudstones (shales)
   - Conglomerates

2. Chemical/Biochemical
   - Carbonates
   - Siliceous Oozes/Cherts
   - Evaporites

CLASTIC SEDIMENTARY ROCKS
(siliciclastic)

Rock composed mainly of silicate particles from weathering of rocks

- SANDSTONES
- CONGLOMERATES
- SHALES
**Sandstones**

- 20 to 25% of all sedimentary rocks

**Environments:**
- Coastal/shelf marine, fluvial, sub-aerial

**Composition:**
- **Grain Size:**
  - framework fraction: particles 125 to 2000µm in diameter
- **Mineralogy:**
  - **Quartz** ($SiO_2$) dominant mineral - 50 - 60% framework
    - monocrystalline form - single large grains
    - polycrystalline form - weathered bedded chert / chert nodules
  - **Feldspars** ($AlSi_3O_8$) second most abundant mineral - 10-20% of the framework
    - less stable than quartz
    - Alkali (Potassium - K) Feldspars (orthoclase, microcline), Plagioclase Feldspars
      - K-feldspars more abundant
      - Plagioclase more abundant in sandstones derived from volcanic rocks
- **Clay Minerals** <5% matrix
- **Accessory Minerals** - < 1 to 2%
  - micas (muscovite, biotite)
  - heavy minerals (zircon, rutile, magnetite, pyroxenes, amphiboles)
- **Mineral Cements:**
  - **Silicate** ($SiO_2$) based cements (mainly Quartz, some opal (contains water & is metastable))
    - form rims of cements called overgrowths
    - syntaxial - maintain crystallographic continuity of the grain
  - **Carbonate** ($CaCO_3$) based cements
Sandstones

Classification

• **Arenites** - grain supported, well sorted sandstones (<5% matrix)
  1. quartz arenite
     • extensive chemical weathering - product of multiple recycling, mature
     • Marginal marine facies (beach, offshore)
  2. feldspathic arenite (>25% arkose)
     • limited chemical weathering - either very cold and dry climate, or rapid erosion and deposition
  3. lithic (rock fragments) arenites
     • limited chemical weathering - mountainous region, rapid transport
     • alluvial fans, or other fluvial environments
     • Laminations, x-bedding possible

Sandstones

Classification:

• **Wackes** - abundant matrix, poorly sorted (>15% matrix)

Deep water facies - waning turbidity current

1. quartz wacke, feldspathic wacke
2. lithic (rock fragments) wacke
3. graywacke
   • matrix rich sandstone of any composition
   • very hard, and dense - undergone deep burial
**Conglomerates**
- 1% of all sedimentary rocks
- HIGH ENERGY environments
  - mountains, margins-fans, glacial

**Composition:**
- **Grain Size:**
  - 30% gravel size (>2mm in diameter) rounded clasts

2 Types:
1. **oligomict conglomerate** - clasts predominantly one composition
   - several generations of recycling eliminated unstable clasts
2. **polymict conglomerate** - assortment of clast compositions
   - unstable components (limestones, basalt)
- **matrix**
  - various clay minerals and micas
  - cemented with quartz, calcite, hematite, clay

**Shales**
- LOW ENERGY Environments;
  - Deep-quiet water
  - Abundant fine sediment

**Composition:**
- **Grain Size:**
  - silt and clay (< 63 µm)
- **Mineralogy:**
  - fine grain quartz
  - clay

**Classification:**
1. **siltstone** (>66% silt)
2. **mudstone** (<66% silt, >33% clay)
3. **claystone**: (>66% clay)
CARBONATE SEDIMENTARY ROCKS

Rock composed mainly of carbonate minerals

3 most common carbonates:
- **Calcite** - CaCO$_3$ (Rhombohedral)
- **Aragonite** - CaCO$_3$ (Orthorhombic)
- **Dolomite** - CaMg(CO$_3$)$_2$ (Rhombohedral)

Textures: (3 primary textures)

A. **Carbonate Grains** -
- **silt size** or larger particles of calcite
- **clasts** - rock fragments derived from weathering of limestones
- **skeletal particles** - microfossils or fragments or macrofossils
  - zooplankton (foraminifera), corals, molluscs,
- **ooids** - coated carbonate grains with “seed” nucleus (ie., qtz grain, shell frag.)
  - mainly aragonite
A. Carbonate Grains

- crinoids (white fragments) and brachiopods (dark)
- Bivalve (oyster) shells
- bryozoan
- Coral (aragonite)

Textures: (3 primary textures)

B. microcrystalline calcite - (micrite)
  - clay size or smaller particles of calcite
  - mud - needle shaped aragonite crystals (1 - 5µm)
  - nannofossils (coccoliths) - calcareous phytoplankton precipitate tests comprised of shields (1 - 5µm)
B. microcrystalline calcite (micrite)

Calcareous nannofossils

C. sparry calcite (spar)

- large crystals of calcite (0.02 to 0.1 mm)
  - limestones/marbles
- Primarily diagenetic in origin -
  1. Precipitation of secondary calcite in voids
  2. Recrystallization of fossil calcite

Recrystallized molluscs
Calcitization of aragonite

A. Castle Hayne Limestone (Eocene), North Carolina
B. Castle Hayne Limestone (Eocene), North Carolina
3. SILICEOUS SEDIMENTARY ROCKS (Chert)
rock composed mainly of fine grained, silica minerals

- comprise <1% of all sediments
- abundance through time varies

Composition

- Diatoms & Radiolaria (Silica shells)
- Opal (hydrous SiO$_2$)-
  - unstable -Transforms to chert
- Microquartz (SiO$_2$)

![Permian Kaibab Limestone, Grand Canyon](image1)

![Silicification of calcite (chert)](image2)