Lecture 5 – Sedimentary rocks Recap+ continued

and Metamorphic rocks!

This weeks reading: Ch 7: Metamorphism: A process of change

Wednesday Lab: Metamorphic Rocks

Midterm today: Last hour of class

7 Days left on Homework 1!

Sedimentary rocks

Clastic sedimentary rocks

Biochemical sedimentary rocks

Organic sedimentary rocks

Chemical sedimentary rocks

Four steps to form clastic sedimentary rocks

1. Weathering

   Produces raw materials

2. Erosion & Transport

   Moves the material

3. Deposition

   Leaves the material somewhere

4. Lithification

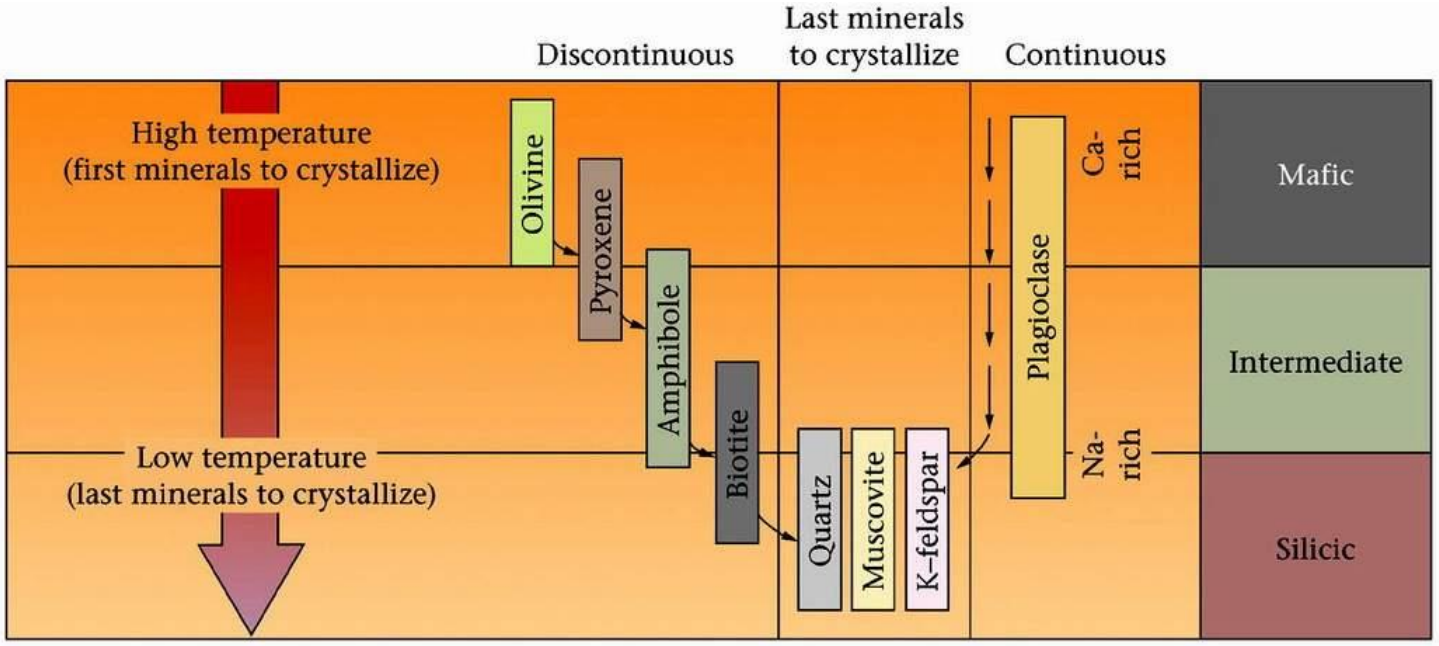
   Turns it into a rock

Mechanical and chemical

Bowen's reaction series again….

More unstable at Earth's surface

More stable at Earth's surface



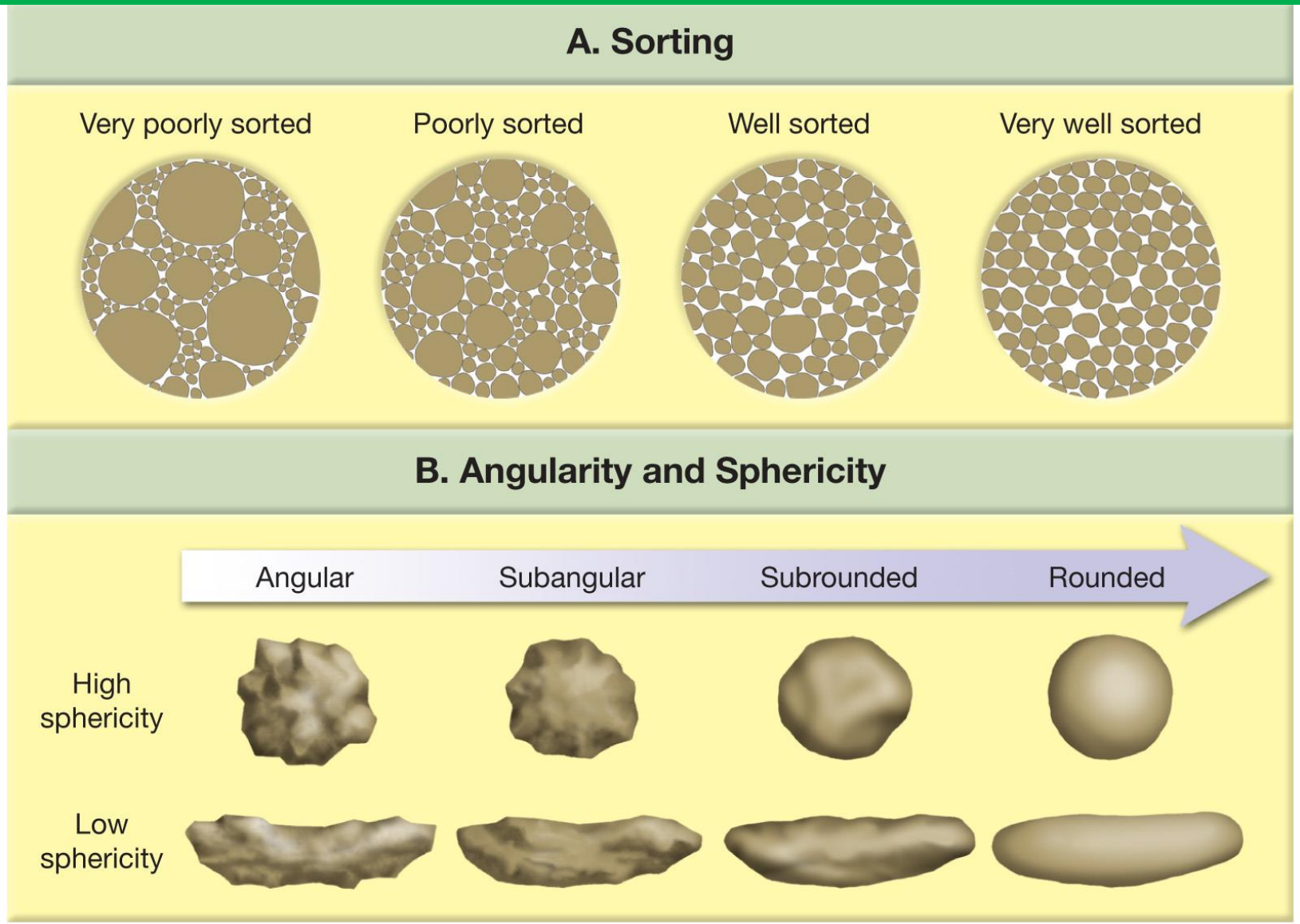
1. Chemical Weathering: Hydrolysis

- Chemical weathering of silicates is primarily by hydrolysis (reaction with water and/or acid).
  - H^+ ion attacks minerals, replaces other positive ions in the crystal (e.g. K+, Na+, Ca++)
- Silicates react with acidic water to form:
  1. Clay minerals
  2. Dissolved ions
  3. Dissolved silica

$$CaSiO_3 + 2CO_2 + 2H_2O \Rightarrow CaCO_3 + SiO_2 + CO_2 + 2H_2O$$

This is a REALLY important process to the earth system – why?

2. Erosion and transport



Deposition: Sedimentary rocks

- Sedimentary rocks form in “basins” where tectonic activity creates space, e.g. continental rift
- Basins are important locations for natural resources
  - E.g. coal, oil, and gas

- All types of sedimentary rocks need this

Four steps required to form sedimentary rocks

3. Deposition
   - *Caused by a change in energy of transport system*

- *Information about depositional environment can be inferred from:*
  - *Composition of sediment*
  - *Roundness, shape and sorting of sediment grains (where appropriate)*
  - *Fossils*
  - *Sedimentary structures*

3. Deposition: Chemical sedimentary rocks

- Consist of precipitated material that was once in solution (dissolved products of chemical weathering)

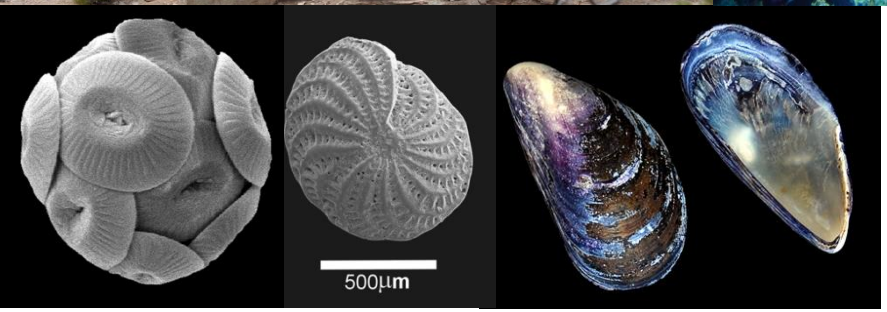
- Precipitation of minerals occurs by
    - Inorganic processes
    - Organic processes (biochemical origin)

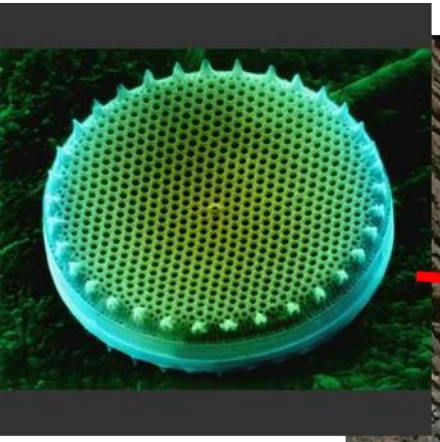
- Classified primarily based upon mineral composition

Can you think of any chemical sedimentary rocks?

Limestone ($CaCO_3$)

Evaporites e.g. halite, gypsum





Chert (SiO_2)

3. Deposition: Sedimentary Structures

- Features imparted to sediments at or near deposition
  - Layering (stratification/“bedding”)
  - Surface features on layers
  - Arrangement of grains
- Help decipher conditions at or near time of deposition

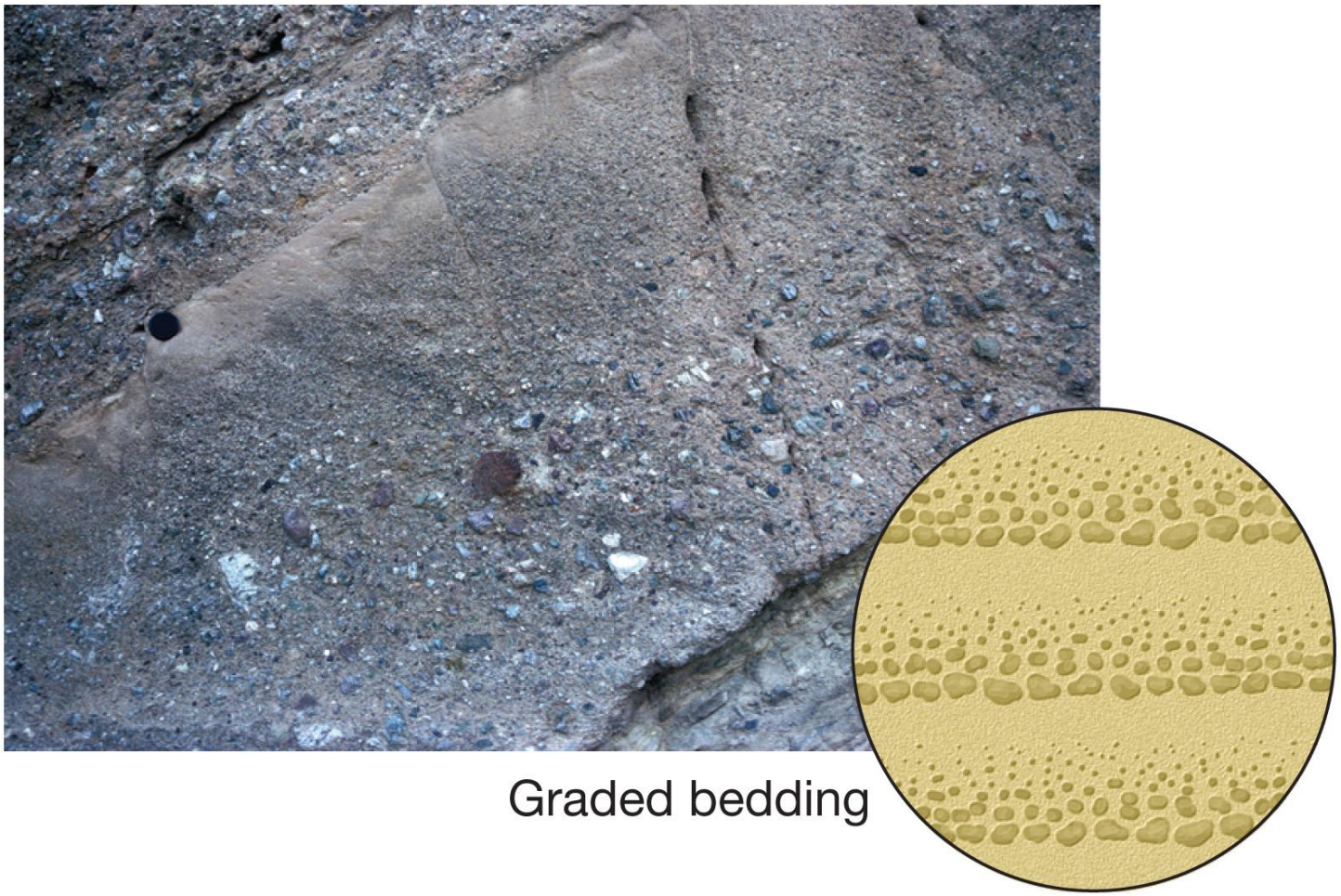
3. Deposition: Sedimentary Structures

- Sedimentary rocks are usually layered or “stratified”
  - Arranged in planar, close-to-horizontal “beds”
  - Bedding is often laterally continuous for long distances
  - Beds are often similar in composition, color and texture

a) Left to right
b) Right to left

3. Deposition: Sedimentary Structures

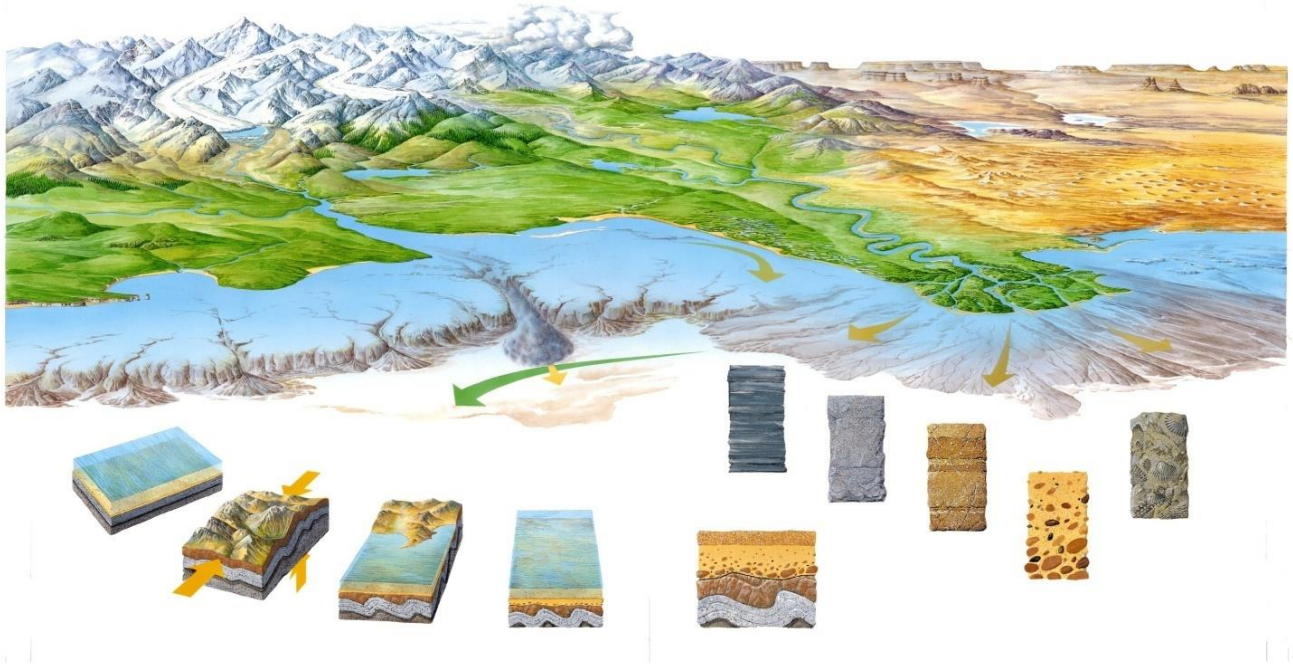
- Graded bedding - formed when sediment laden current (turbidites) slows quickly, coarse grains settle out first



Graded bedding

Depositional Environments

- Locations where sediment accumulates. They differ in…
  - Energy regime
  - Sediment delivery, transport, and depositional conditions
  - Chemical, physical and biological characteristics
- Environments range from terrestrial to marine

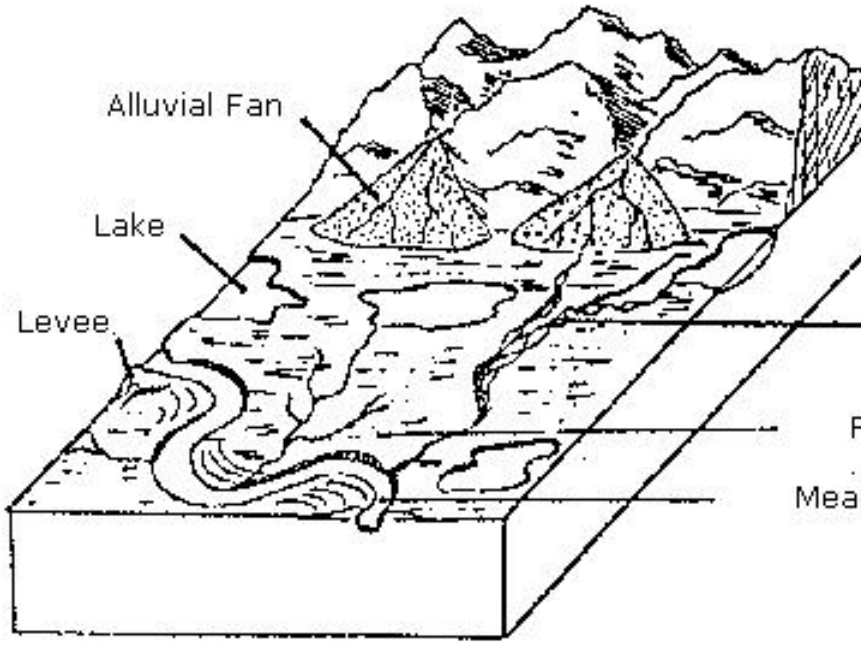


3 types of depositional environment

1. Terrestrial environments
   - Deposited above sea level
2. Transitional environments
   - Deposited where land meets sea
3. Marine environments
   - Deposited below sea level

Terrestrial environments

- Glacial
- Rivers & Streams
  - Most important!
- Alluvial fans
- Lakes (lacustrine)
- Deserts



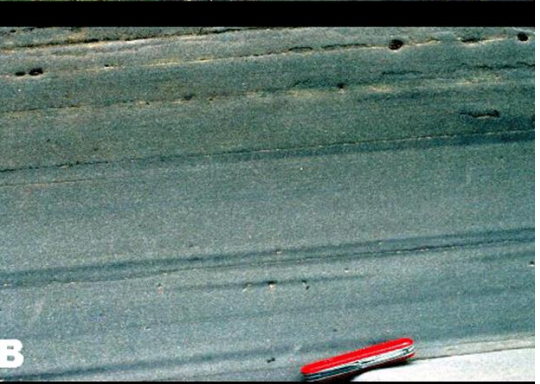
Group question

- Which of the following is the most likely depositional environment for a rock which consists of:

Very well rounded and well sorted sand sized grains of mainly quartz with cross-bedding visible and no obvious fossils.

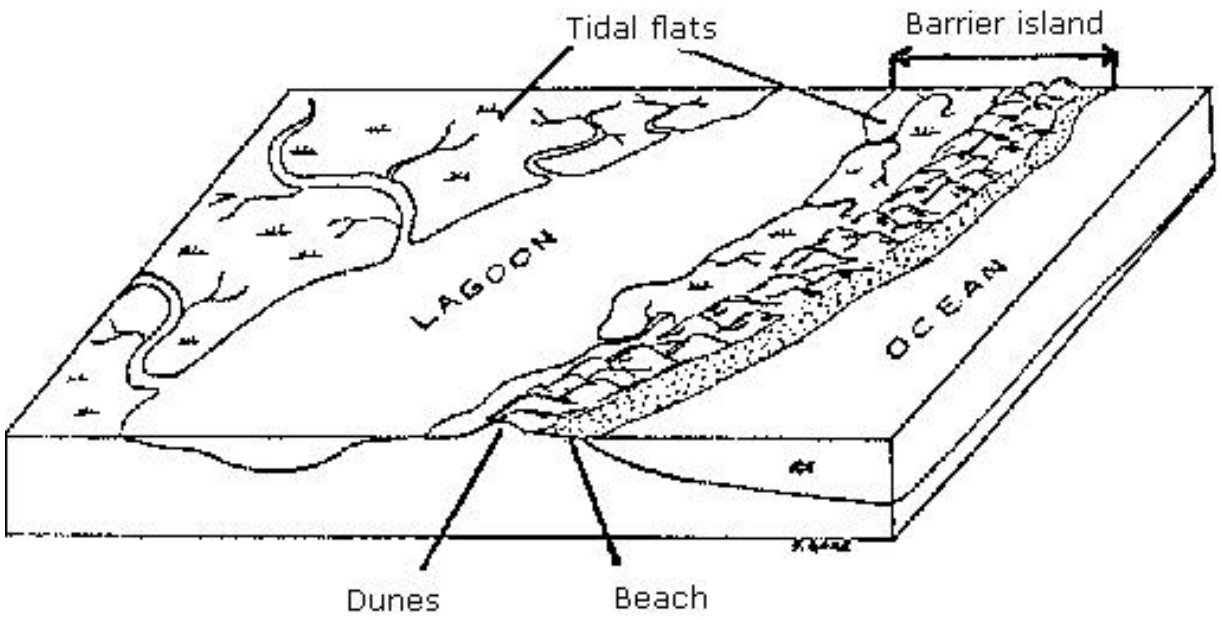
a) River b) Beach c) Desert d) Alluvial fan

Terrestrial environments

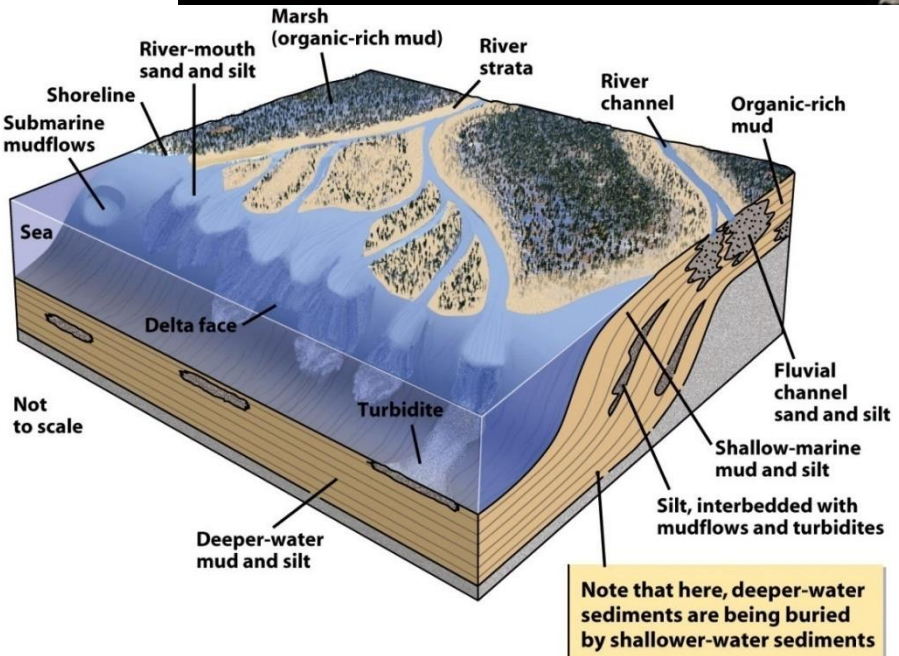


Transitional environments: Where land meets sea

- Deltas
- Beaches
- Lagoons
- Tidal flats

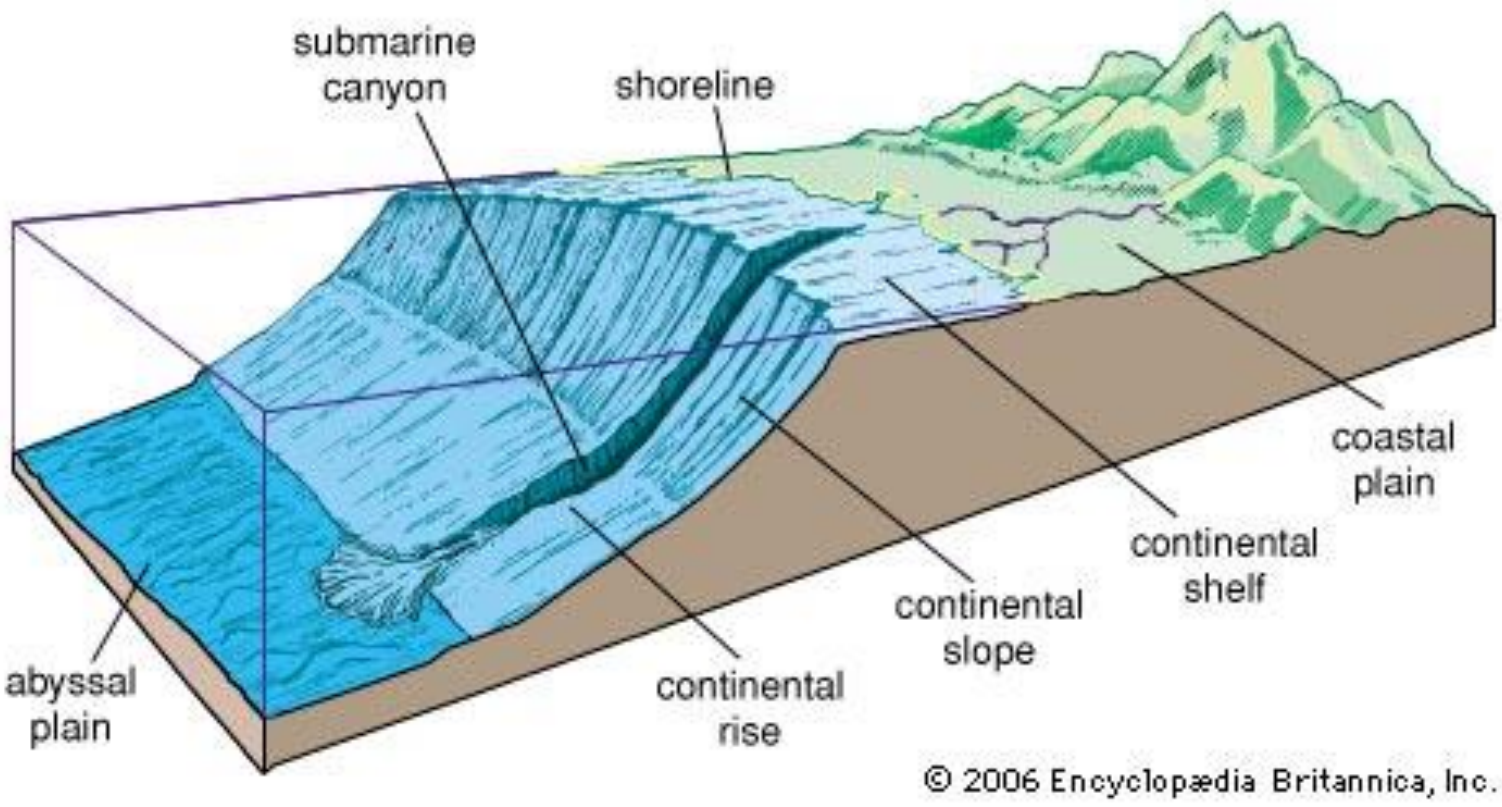


Transitional environments: Where land meets sea



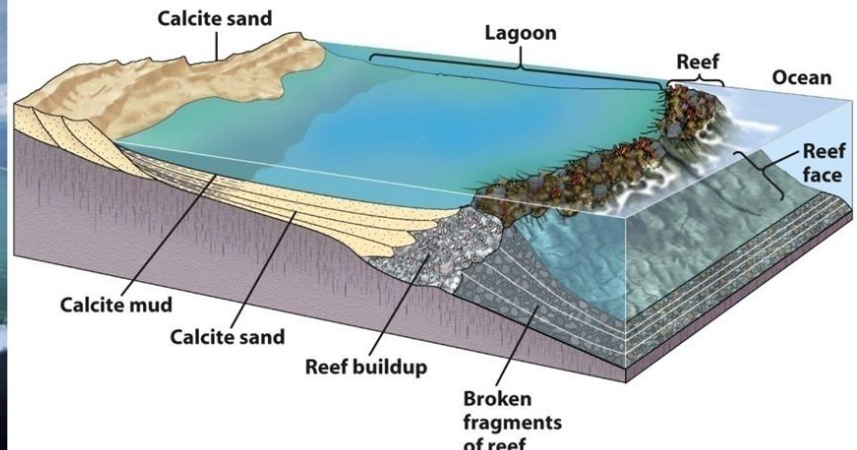
Marine environments

- Shallow (to about 200 meters deep)
- Deep (seaward of continental shelves)



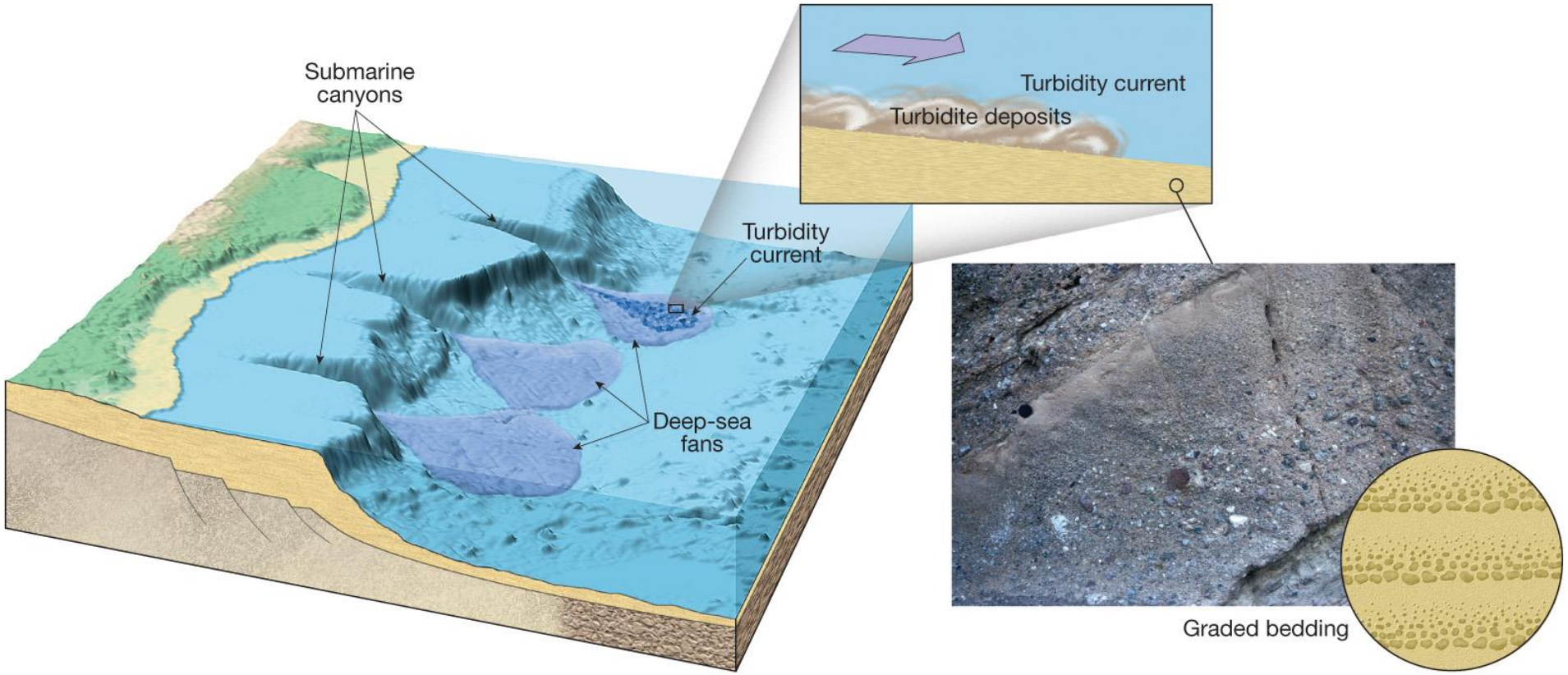
Shallow marine environment

- Nearshore receives sediment from land
  - Clastic sedimentary rocks – sand, silt, and mud
- Far from river mouths, with low clastic input:
  - Carbonate deposits
    - Skeletal debris (shells)
    - Coral reefs = warm water tropics
- Hot, dry regions with restricted circulation:
  - Evaporites



Continental slope – transition to deep sea

- Turbidite deposits – submarine landslides!



Deep sea sediments

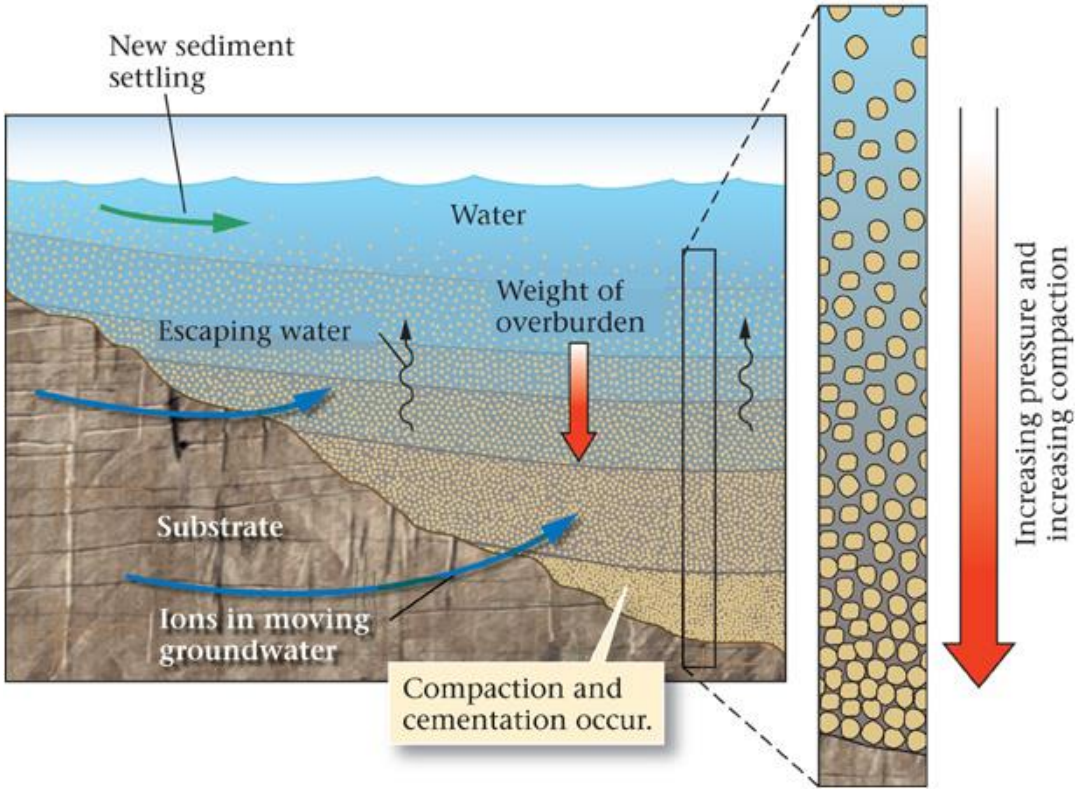
- Very fine grained sediments
  - Clays
    - Shales & mudstones
  - Shells of microorganisms (plankton)
    - Calcite shells
      - Chalk (coccoliths) or limestone (foraminifera etc)
    - Silica shells
      - Chert

Four steps required to form sedimentary rocks

1. Weathering
   - *Produces raw materials*
2. Erosion & Transport by wind, water, or ice
   - *Affects shape, composition, and sorting (size distribution) of particles*
3. Deposition
   - *Caused by a change in energy of transport system*
4. Lithification
   - *Transformation of loose sediment in to rock*

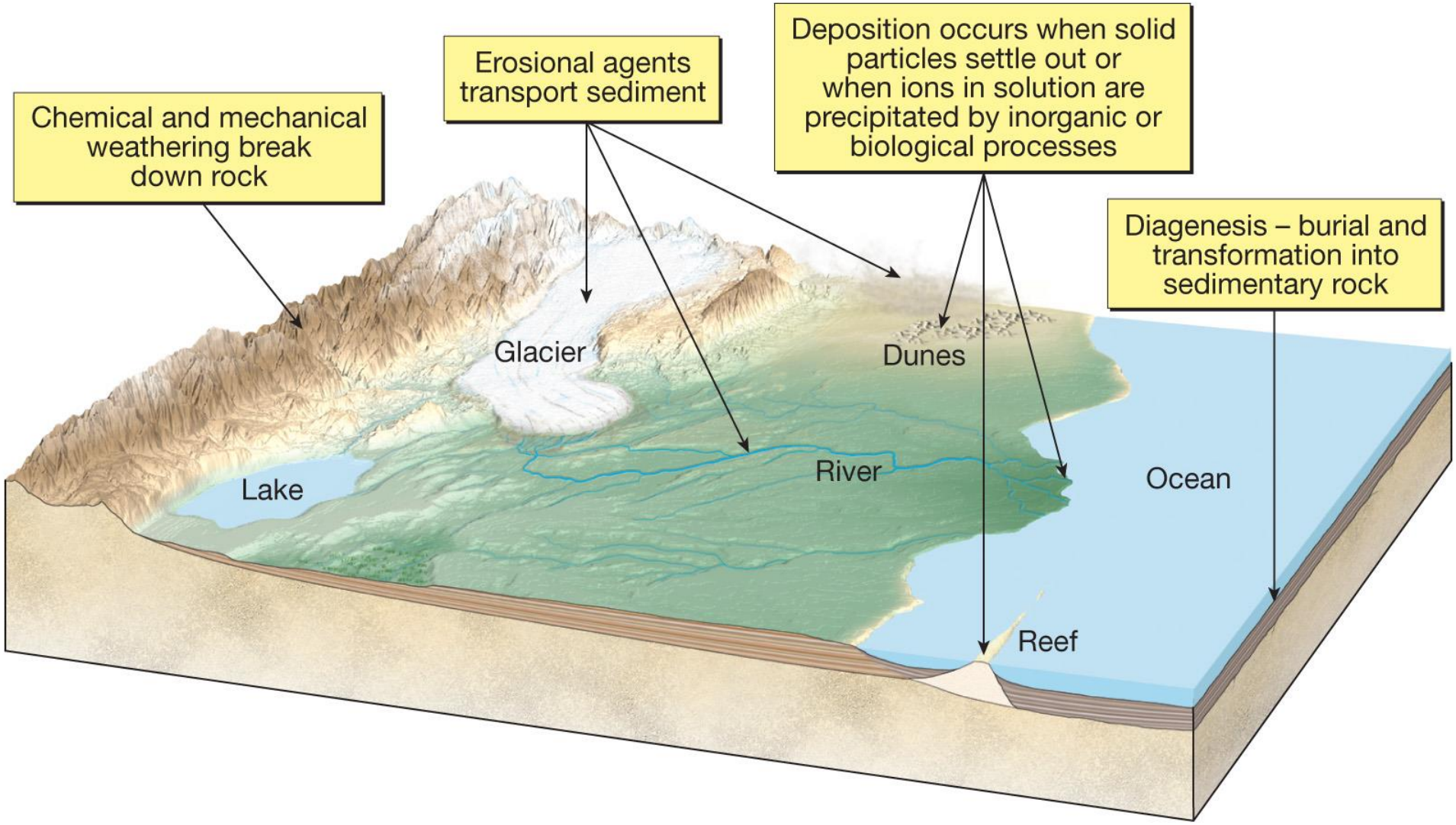
4. Lithification: Turning sediment to rock

- Compaction
  - Weight of overlying sediments decreases pore space (or porosity)
- Cementation
  - Fluids circulating through sediments precipitate quartz, hematite, or calcite cement.



- Degree of lithification can vary – weak and strong rocks!

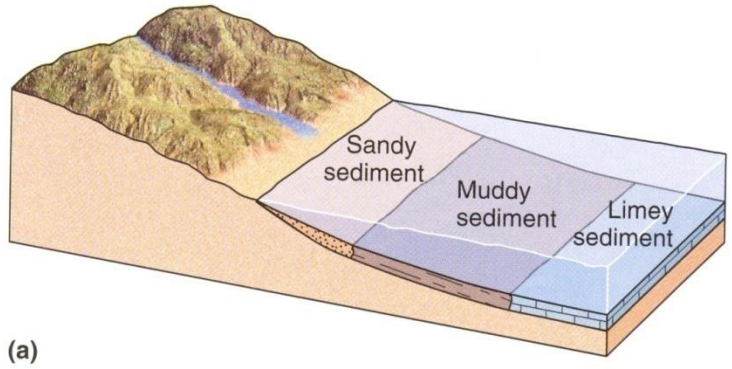
Sedimentary Rocks Summary



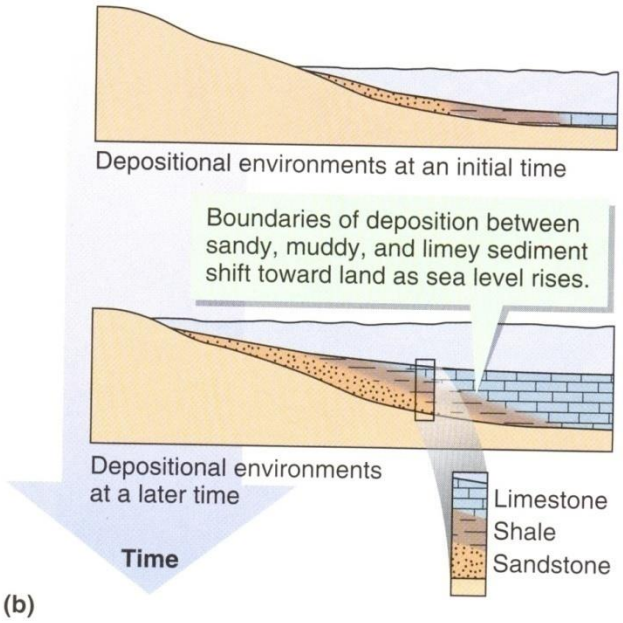
Sea-level change and sedimentary deposition

- Changes in sea level occur frequently on geologic timescales.
- Transgression – Flooding due to sea-level rise
- Regression – Exposure due to sea level fall

How do depositional belts shift laterally and vertically?

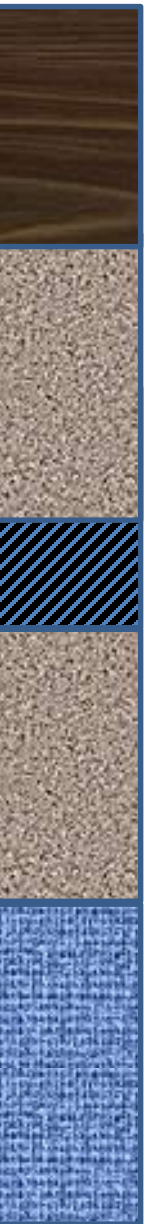


(a)



(b)

Group Question



Silt and mud with graded bedding and some marine microfossils

Sandstone with ripples and marine bivalves

Gravel and cross-bedded sandstone

Sandstone with ripples and marine bivalves

Limestone consisting of foraminifera