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الفصل الدراسى الأول

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Sedimentary Depositional Environments

For 4 th Geology Students

(Geology, Geolology & Chemistry and Geophysics)

First Term

Duration of lecture: (1h/W)

By

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Definition:

involves the physical, chemical and biological characteristics which control sedimentation at any point on the earth's crust and which make it distinctive.

The depositional environments are defined by processes and products.

1- Physical processes determine:

- Grain size, sorting, roundness.
- Bedding style (including sedimentary structures) and geometry.

2- Chemical processes determine:

- Types of minerals formed at the site of deposition and during burial.

3- Biological processes determine:

- Fossil content.
- Biological disruption of original stratification.

Study of modern depositional environments used to infer how ancient rocks formed ("present is key to past").

Main Types of Sedimentary Depositional Environments

1- Continental Environments (above sea level)

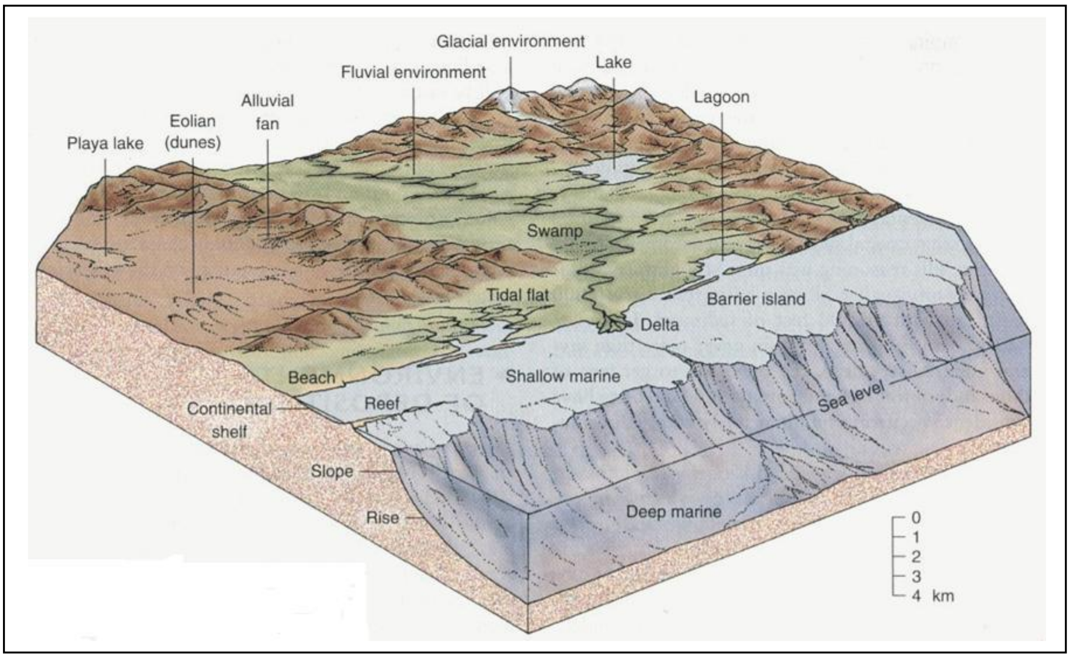
- Aeolian (desert dune, Playa).
- Alluvial fan.
- Fluvial (stream); stream channel and floodplain.
- Glacial; direct deposits and outwash deposits.
- Lacustrine (lake).

2- Transitional Environments (Continental and Marine)

- Delta.
- Estuary and lagoon.
- Tidal flat
- Beach.

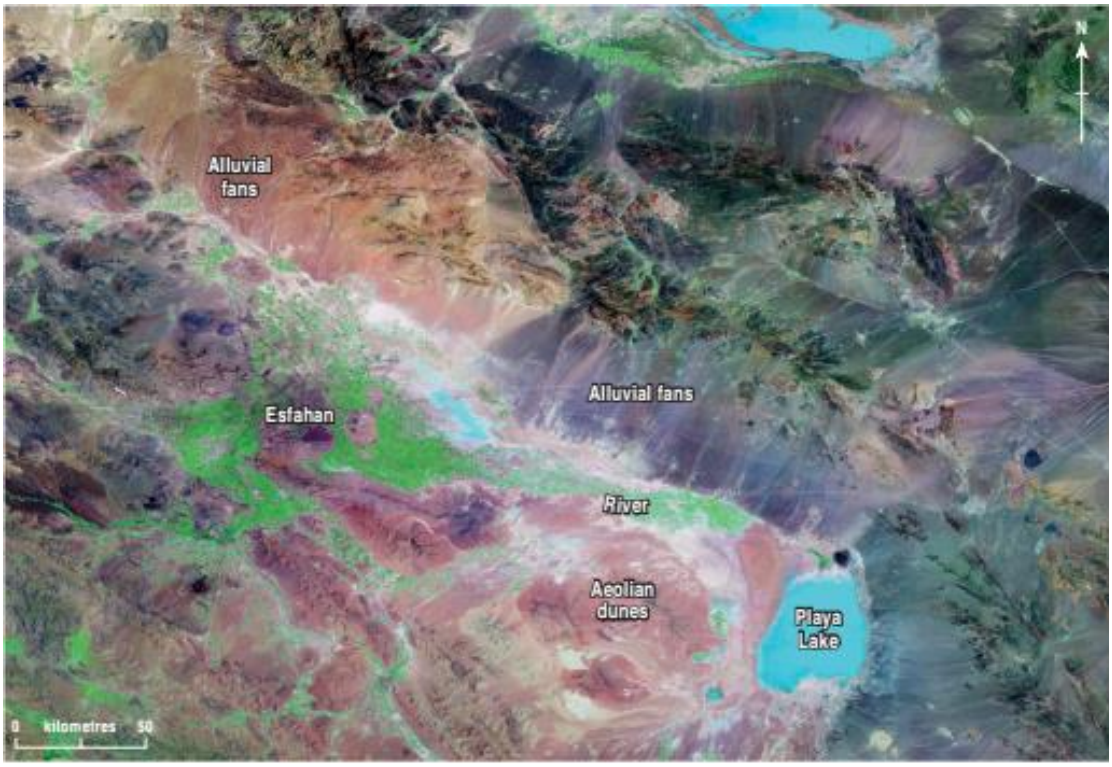
3- Marine Environments (below sea level)

- Shallow marine and reefs.
- Deep marine (Pelagic environments; abyssal plains environment).



1- *Continental (Terrestrial) Environments*

- Fluvial systems (Alluvial fans, Rivers & streams)
- Lakes (lacustrines).
- Deserts (Aeolian, Playa)
- Glacial Systems.

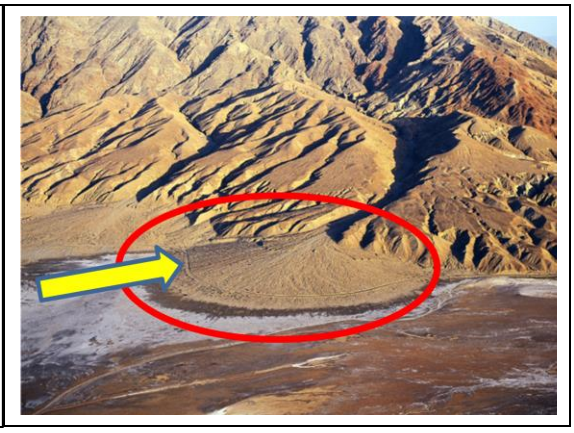


Alluvial Fans

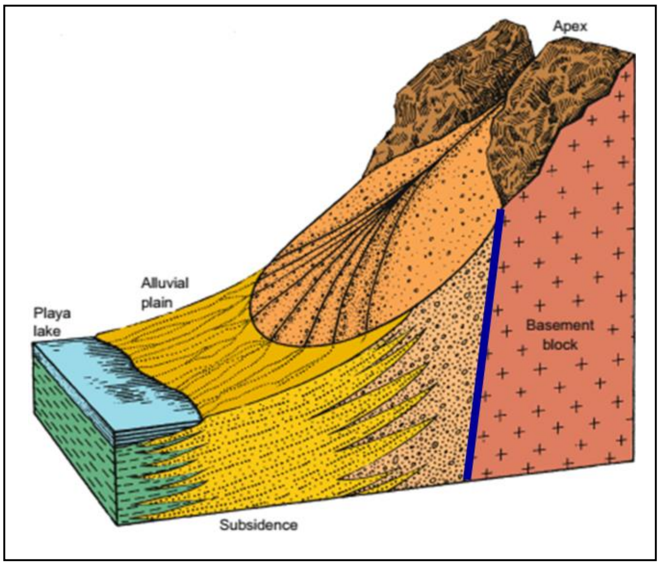
Definition

- Alluvial fans are best developed in arid or semi-arid regions and in more humid areas where rainfall is intense.
- They are also best developed in tectonically active areas.
- Alluvial fans are cone-shaped in plane view, with network of branching distributary channels that cross the fan.
- Alluvial fans can be huge. Some extend for over 100 km away from the mountains.

Alluvial fans are accumulations of sediments that have been transported by fluvial processes or different forms of mass transport (e.g. mud flows and debris flows) and deposited in valleys or on slopes near the erosion area.



- Many fans have fairly steep depositional slopes.
- The fans form in areas that have high relief and are usually associated with faults which keep uplifting the erosion area in relation to the area of deposition.
- This tectonic subsidence of the alluvial fans is a necessary condition for their being preserved in the geological series.
- Erosion on the uplifted block will form inverted V-shaped canyons, and these will drain into the valley.
- Sediments on alluvial fans are typically poorly sorted and include abundant gravel-size detritus.



Types of Alluvial Fans

On the basis of depositional process, alluvial fans can be divided into debris-flow dominated fans and stream-flow dominated fans.

<u>Type 1 : Debris-flow dominated fans:</u>

- Debris flow dominated fans occur in areas with a ready source of mud (i.e., areas with exposed fine-grained sedimentary or volcanic rocks).
- A debris flows occurs when a viscous combination of sediment saturated with water moves, and is transported down fan and then is deposited.
- Debris-flow deposits are characteristically poorly sorted and lacking in sedimentary structures.
- They show interbedding of fine and coarse material that reflects the extreme ranges in flood magnitudes on these fans.
- They may contain blocks of various sizes, including large boulders, and they are typically impermeable and nonporous due to their high content of muddy matrix.
- Landslides are commonly associated with debris flows, and in many cases landslide deposits form a source of sediment for the debris flows.
- The surface of debris-flow dominated fans tends to be steep with little vegetation.

<u>Type 2 : Stream-flow dominated fans</u>

Stream flow dominated fans tend to form in areas of permanent flow.

- Formerly they were termed "wet fans" or "humid fans“.

- They tend to be better sorted and display a more uniform grain size.

- Sediment concentration in water flows is typically about 20 %.

- Progradation of fan causes common upward thickening and coarsening.

Morphology of Alluvial Fans

• **Upper fan (proximal part, fan head):**

– The depositional slope usually be steep.

– Small number (1-3) of deeply incised channels.

– The sediments are usually poorly sorted and generally contain few sedimentary structures.

– Debris flow deposits are common.

- **Middle fan:**

– Numerous shallower channels with longitudinal bars separating channels

– Contain both stream flow and debris flow sediments

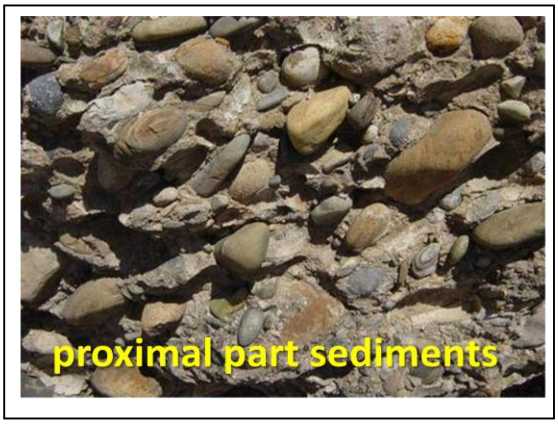
– Deposits consist of gravel/sand couplets that display both planar and trough cross bedding.

- **Lower fan (distal part):**

– Braided channel patterns similar to middle fan but with smaller channels and less dense braiding.

– Deposits are largely sand and silt deposits, with thin conglomerate layers. Trough cross stratification is common.

– Commonly interfinger with basinal sediments (playa lake deposits, fluvial deposits, etc.)



Fan Evolution

Early stages of a fan dominated by rock avalanche and rock-slide deposits result from very high depositional slope angles characteristic of "mature" talus or colluvial cones.

• **Stage 2:** fans are dominated by coarse gravelly debris flows (Debris Flow-dominated) or sheet floods (sheet flood dominated) result from lower depositional slope and large drainage basin.

• **Stage 3:** fans contain cobbly, pebbly, and sandy debris flows (type 1 fans) or sheet flood deposits and incised channel flows (type 2 fans),

- depositional slope continues to decrease

- drainage basin size continues to increase

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Fluvial Systems

River Forms:

The proposed factors that influence channel sinuosity and braiding include:

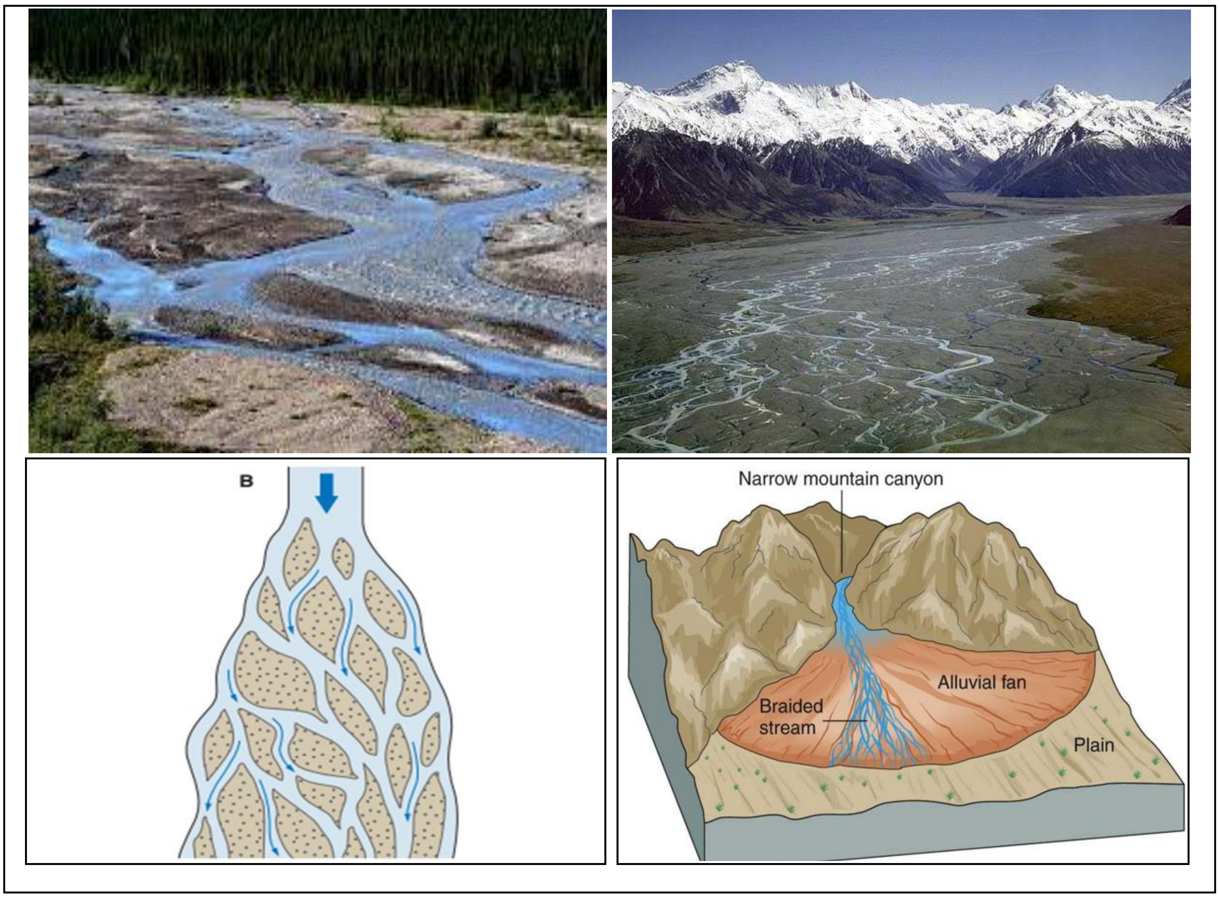
- The magnitude and variability of stream discharge,
- Channel slope, grain size of sediment, bed roughnesss,
- The amount and kind of sediment load (bedload vs. suspended load)
- The stability of the channel banks.

1. A straight channel without bars:

is the simplest form but is relatively uncommon.

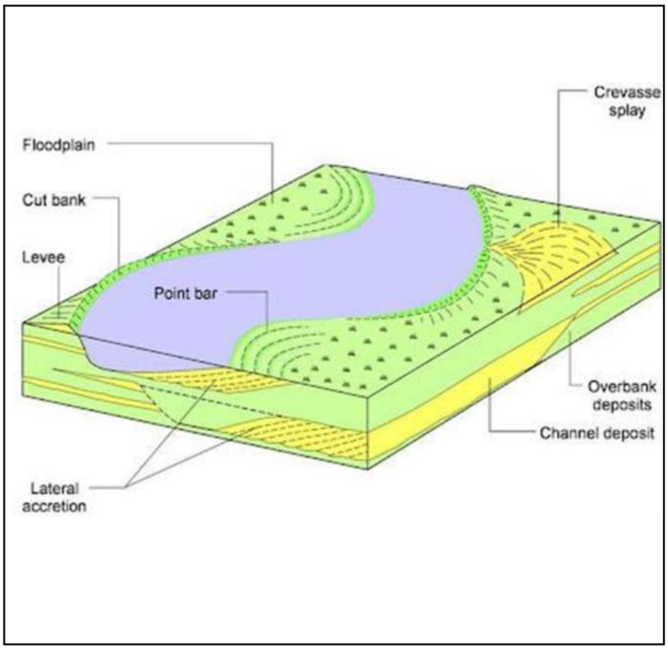
2. **Braided rivers (streams) (multiple-channel):**

- Characterized by low sinuosity;
- Characterized by many channels separated by bars or small islands.
- Characterized by a wide and shallow channels.
- Best developed in distal parts of alluvial fans (at the end of alluvial fans).
- The streams are heavily loaded with sediments and have banks that are easily eroded.
- Sediments are typically coarse grained, with abundant cross-bedded and current-rippled bar deposits.
- Fining upward sequences are common. but are not well developed as in meandering systems.



3. Meandering Streams (single-channel)

- Characterized by single, highly sinuous channel with cohesive banks.
- Form on lower slope gradients than braided systems, commonly downstream of braided fluvial systems and upstream of delta systems.
- Meandering rivers transport and deposit a mixture of suspended load and bedload* **(mixed load).**
- Deposits include channel sediments; point bars; natural levees; fine-grained flood basin deposits; and sandy crevasse splay deposits interbedded with fine deposits of floodplain.



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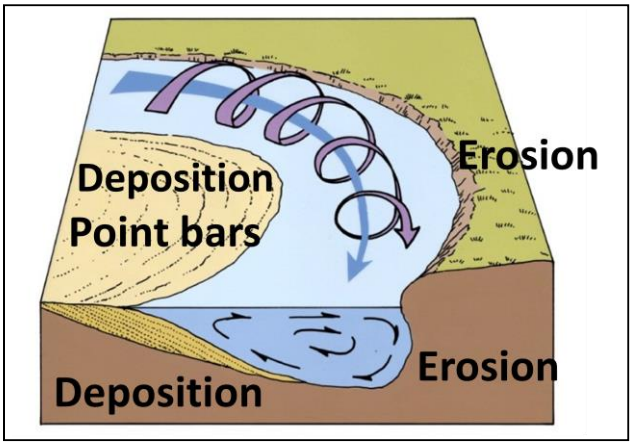
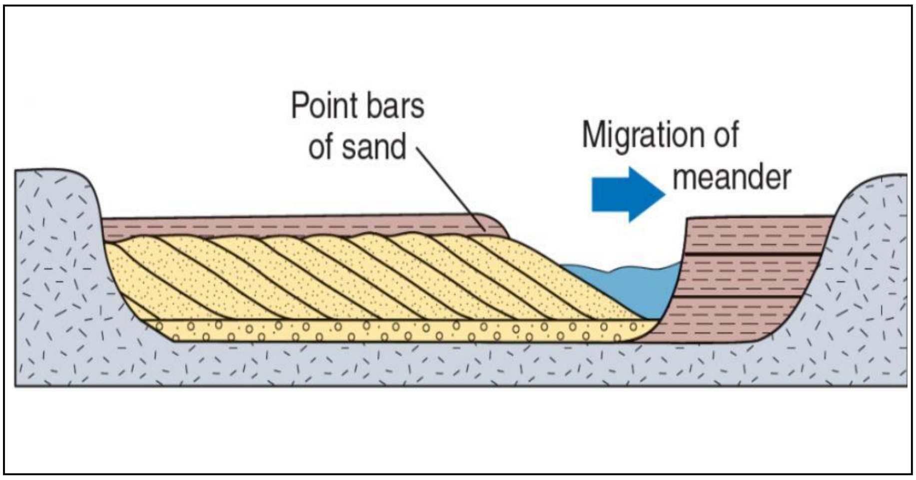
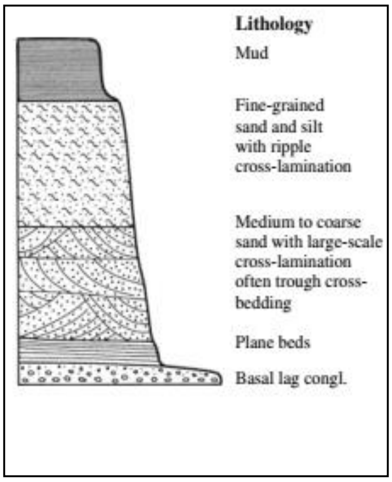
* The bedload is carried by the flow in the channel, with the coarsest material carried in the deepest parts of the channel. Finer bedload is carried in shallower parts of the flow and is deposited along the inner bend of a meander loop .

- Meandering rivers move in loops, with the greatest velocity at the outer convex bank so that **erosion** is concentrated there. The velocity along the inner convex bank is much lower, so sediments are deposited there and form **“ a point bar ”**.

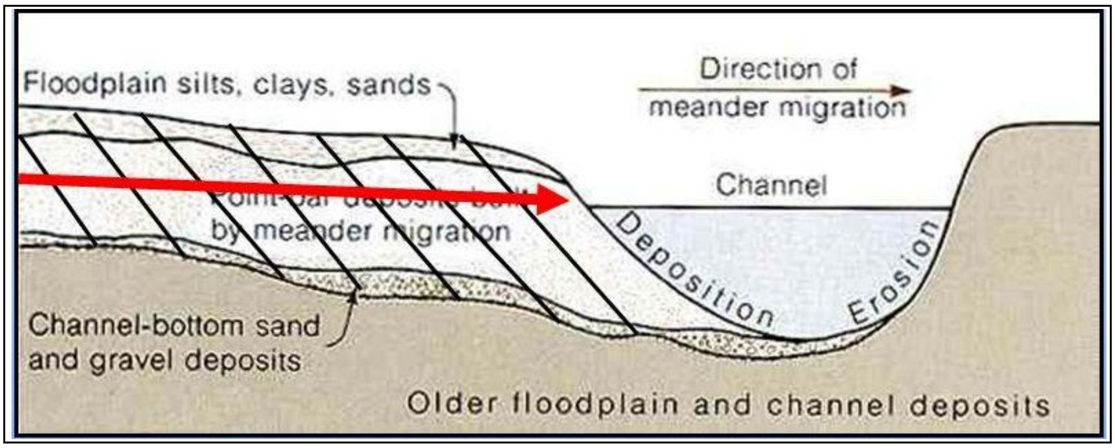


- Erosion causes the migration of river’s course.
- A point bar deposits show a fining-upward from coarser material at the base to finer at the top.



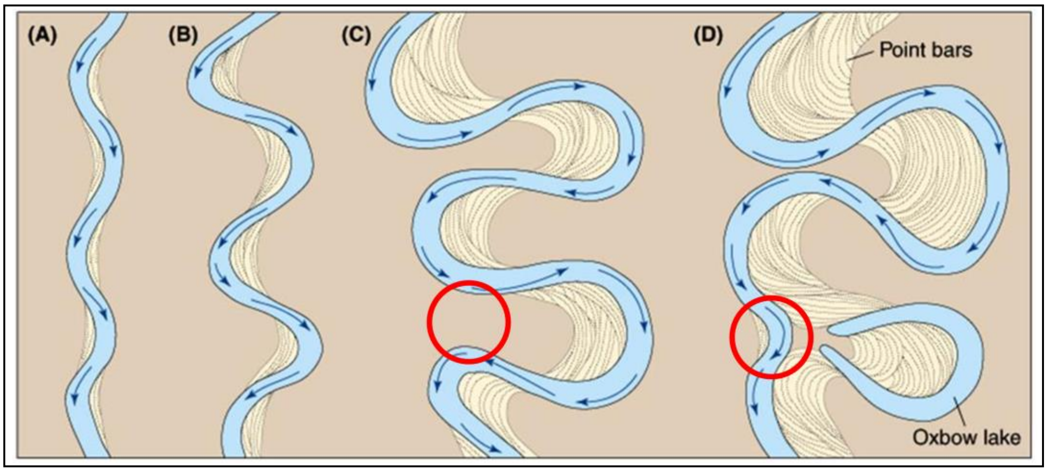


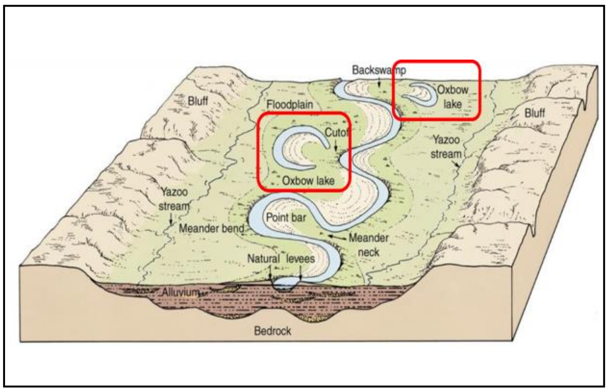
- As the channel migrates the top of the point bar becomes the edge of the floodplain and the fining-upward succession of the point bar will be capped by overbank deposits.
- Stages in the lateral migration of the point bar of a meandering river can sometimes be recognized as inclined surfaces within the channel-fill succession. These surfaces are termed "lateral accretion surfaces".



Oxbow Lake

- The river flow may take a short-cut between meander loops when the river floods: this may result in a new section of channel developing, and the longer loop of the meander built becoming abandoned.
- The abandoned meander loop becomes isolated as **an oxbow lake** and will remain as an area of standing water until it becomes filled up by deposition from floods and/or choked by vegetation.





4. Anastomosed Stream systems

- Volumetrically minor.
- Characterized by low gradients and low stream power.
- Lateral migration of channels is minimal, producing isolated channels bounded by fine grained floodplain deposits, both of which aggrade vertically rather than accrete laterally.

Lacustrine Systems

Introduction

- Lakes cover about 1–2 % of Earth's surface.
- Lake chemistry is sensitive to climatic conditions, making lake sediments useful indicators of past climates.
- For example, several studies have shown that ancient episodes of wet and dry climates can be deciphered on the basis of lake sediment chemistry and mineralogy.
- Also, some lake deposits contain economically significant quantities of oil shales, evaporite minerals, coal, uranium, or iron.
- Many lake sediments also contain abundant fine organic matter that may act after burial as a source material for petroleum (Katz, 1990).

Origin of Lakes

The basins, or depressions, in which lakes form can be created by a variety of mechanisms, including:

- Tectonic movements such as faulting and rifting;
- Glacial processes such as ice scouring, ice damming, and moraine damming;
- Landslides or other mass movements;
- Volcanic activity such as lava damming or crater explosion and collapse;
- Deflation by wind scour or damming by windblown sand.
- Fluvial activity such as the formation of oxbow lakes and levee lakes.

Size of Lakes

- Modern lakes range in areal dimensions from a few tens of square meters to tens of thousands of square kilometers.
- The largest modern lake is the inland Caspian Sea with a surface area of 436,000 km^2 (Van der Leeden, 1975).
- Water depths of modern lakes range from a few meters to more than 1700 m in the world's deepest lake, Lake Baikal, Siberia.
- Preserved lacustrine sediments show that ancient lakes also ranged in size from small ponds to large bodies of water exceeding l00,000 km^2.

Lake Settings

Modern lakes occur in a variety of environmental settings, including:

- Glaciated inland plains and mountain valleys,
- Non-glaciated inland plains and mountain regions,
- Deserts, and
- Coastal plains.

- Lakes exist under a different climatic conditions ranging from very hot to very cold and from highly arid to very humid.
- Most lakes are filled with freshwater, but others, such as many lakes in arid regions are highly saline.
- Many lakes are associated with other types of depositional systems, such as glacial, fluvial, eolian, and deltaic systems.

The depositional processes that occur in lakes are influenced by:

1. Climatic conditions .
2. Variety of physical, chemical, and biological factors that include:
   - The chemistry of water.
   - Fluctuations in their shorelines.
   - Siliciclastic sediment supply.

Principal Kinds of Lakes

1. **Open lakes:**
   - That have an outflow of water and a relatively stable (fixed) shoreline.
   - Inflow and precipitation are approximately balanced by outflow and evaporation.
   - Siliciclastic sedimentation commonly predominates.
   - Chemical sedimentation can occur in open lakes that have a low supply of clastic sediments.
2. **Closed lakes:**
   - Do not have a major outflow and have fluctuating shorelines.
   - Inflow is commonly exceeded by evaporation and infiltration.
   - These conditions lead to concentration of ions in lake water and a predominance of chemical sedimentation.
   - Siliciclastic sediments may accumulate also.

Factors Controlling Lake Sedimentation

The kinds of sediments deposited in lakes are the result of a complicated balance among physical, chemical, and biological processes.

1. **Physical processes:**

Physical processes that transport sediments and deposit them in lakes include wind, river inflow, and atmospheric heating.

- **Wind processes:** are of major importance because winds create waves and currents in lakes.

- **River inflow:** may generate turbidity currents, that carry sediments along the bottom toward the basin center. River inflow can also create currents along the margins of lakes.

- **Atmospheric heating:** which is a function of climate, is responsible for density differences in lake water.

- **Density differences:** can cause stratification of water (heating of surface water) or under some conditions, generation of density currents (by cooling of surface water) that produce mixing and lake overturn.

- **Also, temperature variations** may cause alternate freezing and melting of lake surface waters, thereby affecting sediment transport within the lake.

2. Chemical processes:

- Deposition of chemically formed sediments is particularly common in closed lakes.
- The chemistry of lake water varies from lake to lake but is dominated by Ca^{2+}, Mg^{2+}, Na^{1+}, K^{1+}, $(CO_3)^{2-}$, $(SO_4)^{2-}$, and $(Cl)^{1-}$ ions.

The kind of chemical sedimentation in lakes strongly reflects climatic conditions. For example,

- In humid regions the most common chemical sediments in the lakes are Carbonates.
- In arid regions where rates of evaporation are high, chemical lake sediments are dominated by carbonates, sulfates (gypsum, anhydrite) and chlorides (halite).

3. Biological processes:

Organisms play an important role in lake sedimentation by extracting chemical elements from lake water to build their shells and the subsequent deposition of these shells. For example extraction of CO_2 during photosynthesis (thereby aiding precipitation of $CaCO_3$).

- Pelecypods, gastropods, calcareous algae, and ostracods are important contributors of calcium carbonate sediments.
- Siliceous diatoms are also widespread. Diatoms are the important type of lake organism that produce siliceous tests and consequently siliceous deposits.
- Plant remains contribute to form plant deposits.

Under the reducing conditions and high sedimentation rates in some lakes, the remains of higher plants may be partially preserved to eventually form peat and coal.

Characteristics of Lacustrine Deposits

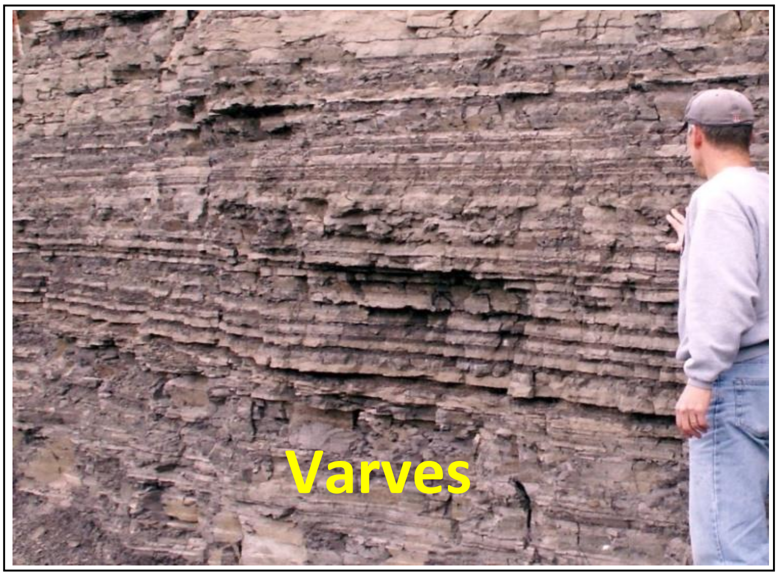
- The sediments of most open lakes are dominated by siliciclastic deposits, derived mainly from rivers.
- Much of these sediments are deposited along the shores of lakes, particularly near river mouths.
- Gravelly sediments may be present in the toes of alluvial fans may extend to the lake edge or into the lake.
- Sand likewise accumulates mainly along the lake shore. Sand may also be carried by turbidity currents into the middle of the lake.
- Deeper parts of the lake are characterized by the presence of fine silt and clay.
- **In open lakes** where the clastic sediments supply is low, chemical and biochemical processes predominate, resulting in deposition of chemical sediments.
- Various amounts of non-carbonate organic matter and some siliciclastic sediments may be present.
- **Closed lakes** occur in regions of interior drainage where lake levels may experience considerable fluctuation owing to seasonal flooding.

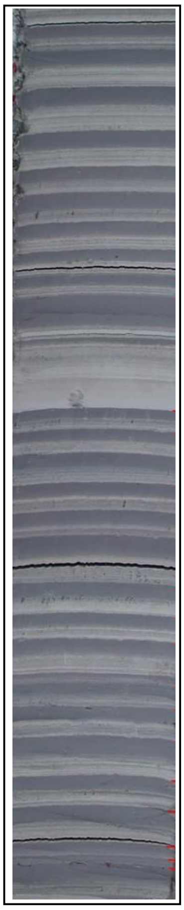
- Most sedimentation in closed lakes takes place by chemical/biochemical processes in saline waters due to high rates of evaporation.

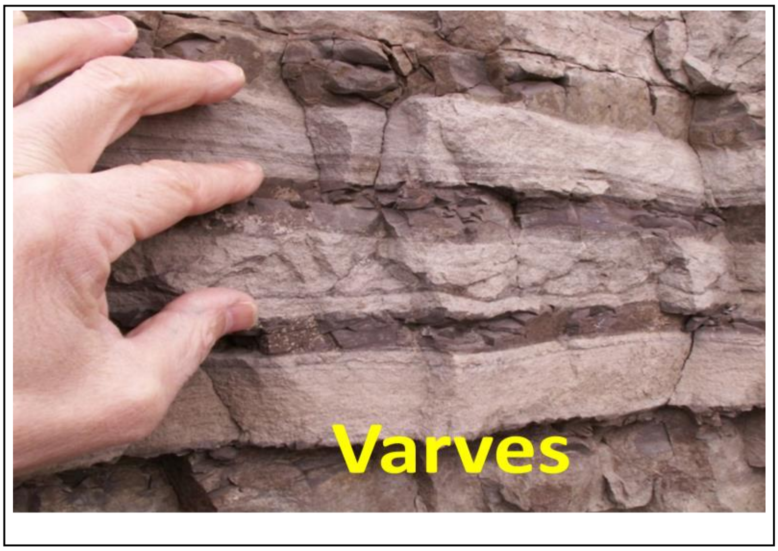
Two kinds of closed lakes are recognized,

1. Perennial basins: receive inflow from at least one perennial stream. They commonly do not dry up completely throughout the year.
    - Most perennial lakes are saline, but some are dilute.
    - The deposits of perennial lakes include carbonate muds, silts, and sands, commonly with intergrowths of evaporite minerals.
2. Ephemeral salt-pan basins: are fed by ephemeral runoff, springs, and groundwater and are generally dry through part of each year.
    - Ephemeral salt-pan deposits may also contain carbonate sediments, such as spring travertine or tufa, but bedded salt deposits are much more important.
    - Saline deposits interfinger with siliciclastic sand flat deposits around the margin of the salt pan.

Numerous kinds of sedimentary structures occur in lake sediments, including laminated bedding, varves, cross-bedding, graded bedding, ripple marks, groove casts, load casts, burrows and worm trails, raindrops, mud-cracks, and vertebrate footprints.







Tidal Flat System

Introduction

- Tides are generated by the gravitational attraction of the moon and sun for Earth in conjunction with the rotation of Earth.
- Tidal influence is manifested at any given coastal locality by daily rise and fall of the sea over an average range of about 1–4 m on open coasts.
- Vertical rise and fall of tides is accompanied by horizontal movements of water that are termed "tidal currents".
- The currents generated on the continental shelf by tides are bidirectional but asymmetrical with respect to velocity. That is, flood-tide and ebb-tide velocities are commonly different.
- Tidal-current velocity decreases with water depth; thus, tidal-current transport is most important in shallow water.
- Tidal-current velocities ranging up to about 2m/s in some enclosed basins.
- Tidal currents on some continental shelves, have velocities that may exceed 1.5 m/s.
- However, tidal velocities on most continental shelves are less than about 1 m/s.
- Much of the movement of sediment by tidal currents occurs when tidal currents are aided by wave action.

Main Zones of Tidal Flats

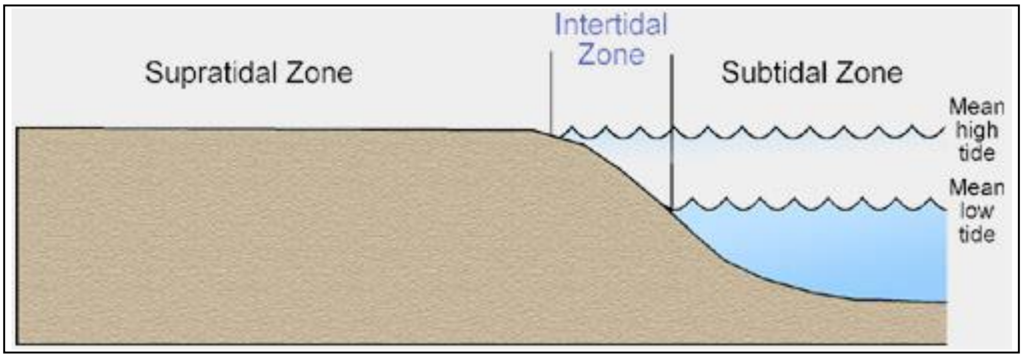
1. **Subtidal zone:** below mean low tide.
   a) If velocities of flow are perfectly symmetrical, herringbone cross-stratification will be formed.
   b) With Asymmetrical currents, beds are mostly in one direction will be formed .

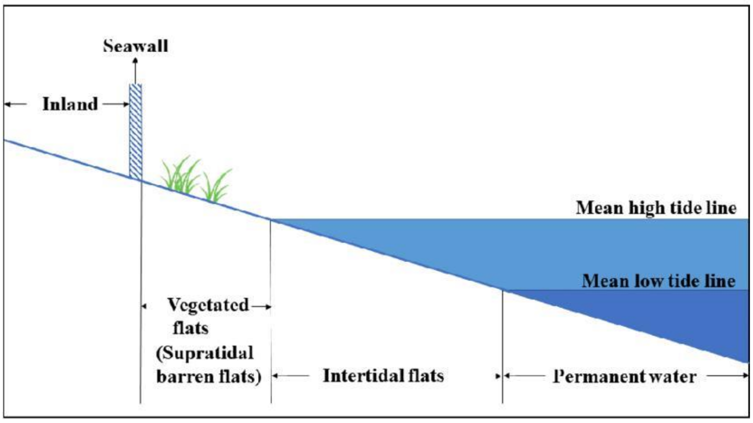
2. **Intertidal zone:** flooded and exposed once or twice a day.
   a) Small distributary channels containing sand.
   b) Traction Deposits may also be found
   c) may be lenticular and flaser bedding will be formed.
   d) The sediments are well sorted.

3. Supratidal zone: flooded by spring tides or by seasonal storm surges.

a) Common to see salt marsh vegetation or mangrove trees.

b) Roots destroy bedding but beds are often existing.





Sediments of Tide-Dominated Shelves

- Tide-dominated shelves are characterized particularly by sand bodies of various types and dimensions.
- Sand waves may have symmetrical cross-sectional shapes produced by tidal currents with equal ebb and flood peak speeds;
- Asymmetrical shapes of sand waves caused by unequal ebb and flood velocities are more common.

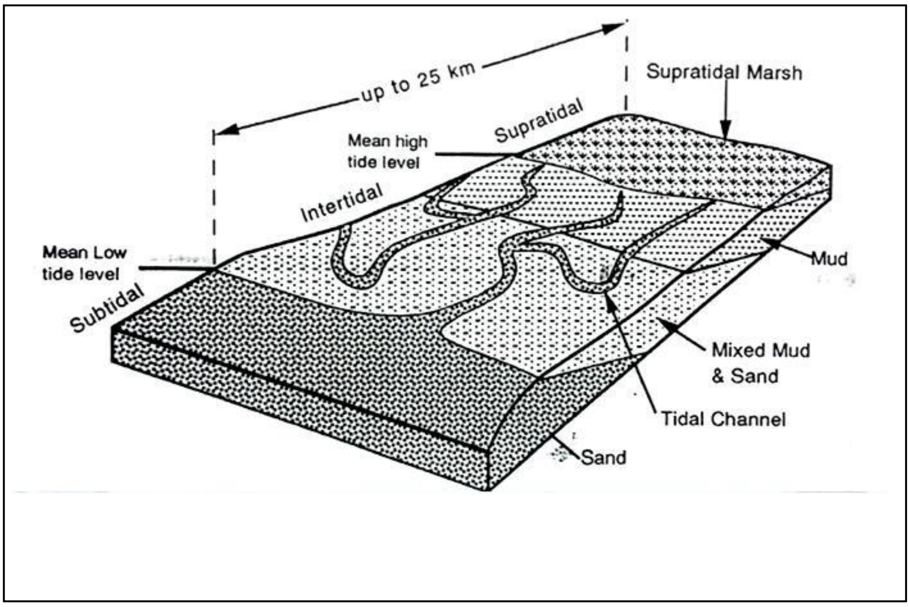
- Tide-dominated shelves also include sand sheets, sand patches, and gravel sheets, all characterized by small-scale bedforms, and patches of bioturbated muds in areas sheltered from tidal currents and waves.
- At high tidal velocities of about 150 cm/s, the seafloor may be eroded, leaving furrows and gravel waves.
- With progressively diminishing velocity farther down the transport path, eroded sediments are deposited to form flow-parallel sand ribbons, large sand dunes, small sand dunes, a rippled sand sheet, and finally sand patches.
- Most tidal shelf sands are characterized by cross-bedding.
- Small-scale cross-bedding and ripple cross-lamination, produced by migration of ripples and small dunes,
- Large-scale cross-bedding generated by migration of large dunes.

Facies Models

The main facies produced by a tidal system are the subtidal, intertidal, and supratidal.

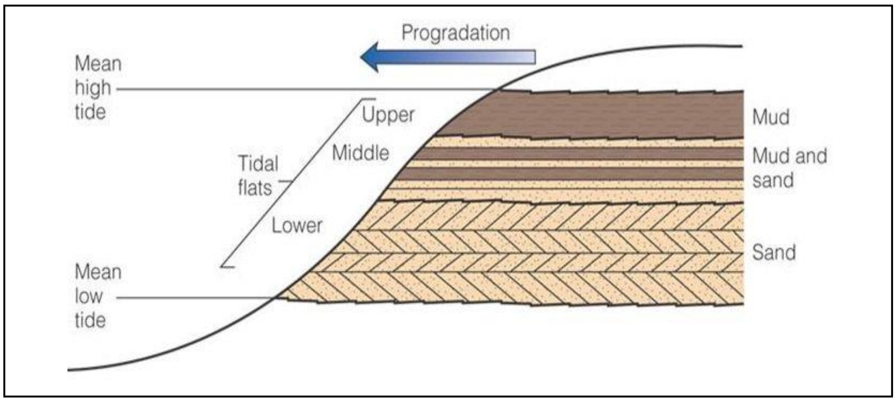
- The subtidal zone mainly composed of sand with fossils present and ripples.
- The intertidal zone composed of sand and mud and have mud cracks, burrows, and ripples,

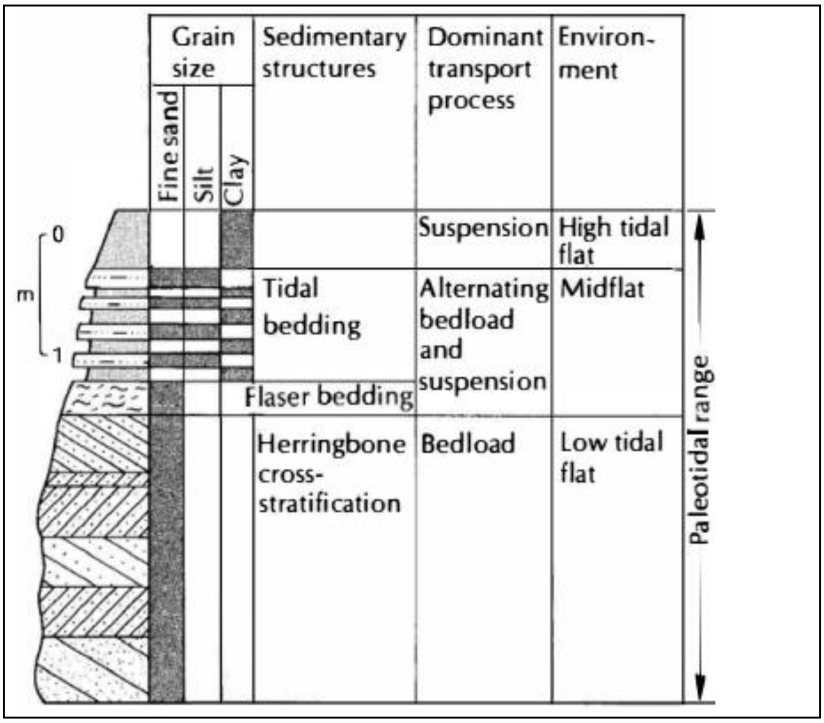
- The supratidal zone have mainly mud with mud cracks and burrows and potentially some roots.



The typical tidal flat sequence shows a fining-upward column.

- The lower tidal flat is coarser (mostly sand) and is dominated by herringbone cross-stratification.
- The mid-flat region shows flaser bedding and tidal bedded sands and muds .
- The upper tidal flat is formed entirely of suspended muds, which may be mudcracked, bioturbated, and colonized by salinity tolerant organisms and algal mats.




Grain size
Fine sand
Silt
Clay
Sedimentary structures
Dominant transport process
Environment
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m
1
Suspension
High tidal flat
Tidal bedding
Alternating bedload and suspension
Midflat
Flaser bedding
Herringbone cross-stratification
Bedload
Low tidal flat
Paleotidal range


Herringbone cross-bedding


Flaser bedding

Shallow Marine Carbonate and Evaporite Environments

Introduction:

- Limestones are common and widespread sedimentary rocks that are mainly formed in shallow marine depositional environments.
- Most of the calcium carbonate that makes up limestone comes from biological sources, ranging from the hard, shelly parts of invertebrates such as molluscs to very fine particles of calcite and aragonite formed by algae.
- The accumulation of sediment in carbonate-forming environments is largely controlled by factors that influence the types and abundances of organisms that live in them.
- Water depth, temperature, salinity, nutrient availability and the supply of terrigenous clastic material.
- All influence carbonate deposition and the build up of successions of limestones.

Some depositional environments are created by organisms. For example, reefs built up by colonial organisms such as corals.

- In arid settings carbonate sedimentation may be associated with evaporite successions formed by the chemical precipitation of gypsum, anhydrite and halite from the evaporation of seawater.

Carbonate and Evaporite Depositional Environments

There are a number of distinctive features of shallow marine carbonate environments.

1. They are largely composed of sedimentary material that has formed in situ (in place), mainly by biological processes.
2. The grain size of the material deposited is largely determined by the biological processes that generate the material.
3. The biological processes can determine the characteristics of the environment, principally in places where reef formation strongly controls the distribution of energy regimes.
4. The production of carbonate material by organisms is rapid in geological terms, and occurs at rates that can commonly keep pace with changes in water depth due to tectonic subsidence or eustatic sea-level rises.

Areas of shallow marine carbonate sedimentation are known as "carbonate platforms".

- They can occur in a wide variety of climatic and tectonic settings provided that two main conditions are met:
  (a) isolation from clastic supply and
  (b) shallow marine waters.
- The types of carbonate grains deposited and the facies they form are mainly controlled by climatic conditions and they have varied through time with the evolution of different groups of organisms.
- The places where carbonate platforms occur are determined by tectonic controls on the shape and depth of sedimentary basins.

- Tectonic subsidence factors also strongly influence the stratigraphy of successions on carbonate platforms (Bosence 2005).
- Patterns of depositional sequences are also affected by sea-level fluctuations.

Controls on evaporite sedimentation

- Precipitation of evaporite minerals, principally calcium sulphates (gypsum and anhydrite) and sodium chloride (halite) occurs where bodies of seawater become wholly or partially isolated from the open ocean under arid conditions.
- The fundamental controlling factor in the formation of evaporite deposits is climate, because the seawater become sufficiently concentrated for precipitation to occur when the rate of loss through evaporation exceeds the input of water.
- These arid environments are principally found in subtropical regions where the mean annual temperatures are relatively high and the rainfall is low.
- Modern marine evaporite deposits are all found in coastal settings where precipitation occurs in semi-isolated water bodies such as lagoons or directly within sediments of the coastal plain places where recharge by seawater is limited.
- In the past, larger areas of evaporite precipitation resulted from the isolation from the open ocean of epi-continental seas and small ocean basins.

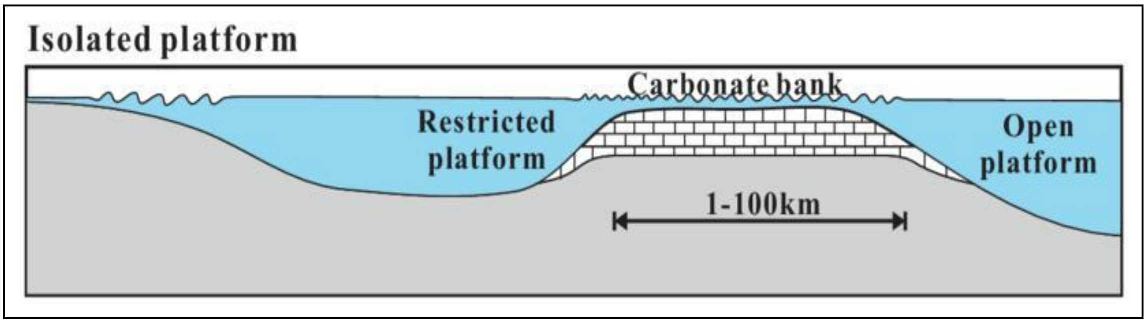
Morphologies of shallow marine carbonate-forming environments

The term “carbonate platform” can be generally applied to any shallow marine environment where there is an accumulation of carbonate sediments.

1. If the platform is attached to a continental landmass it is called a “carbonate shelf”.

- A carbonate shelf may receive some supply of material from the adjacent landmass (clastic supply).

2. Carbonate banks are isolated platforms that are completely surrounded by deep water and do not receive any terrigenous clastic supply.
3. A carbonate atoll is a particular class of carbonate bank formed above a subsiding volcanic island.

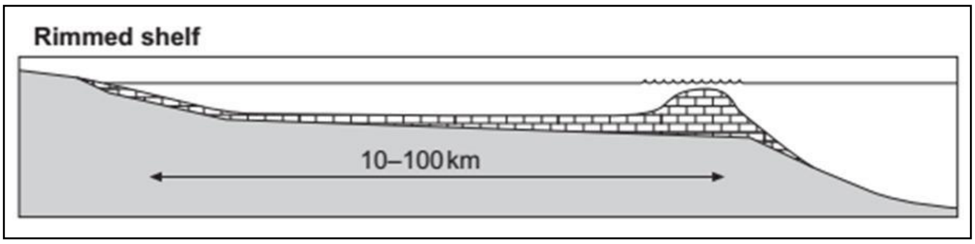


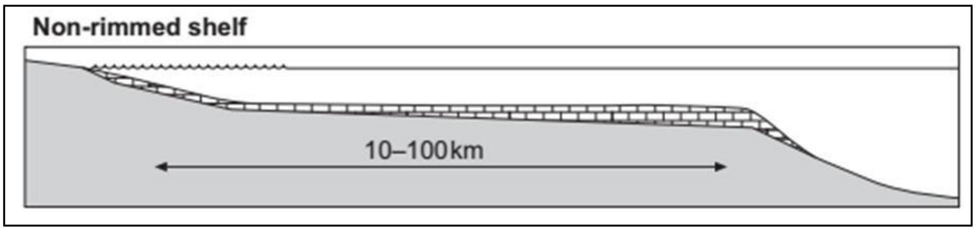
Definition of Atolls

- **Atolls** are circular to elliptical coral reefs that encircle a lagoon and are surrounded by deep water of the open ocean (Bates and Jackson, 1987).
- Atolls range in diameter from approximately **1 km** to more than **130 km.**
- Original foundations were volcanic islands that eroded away or other topographically high structures on the seafloor.

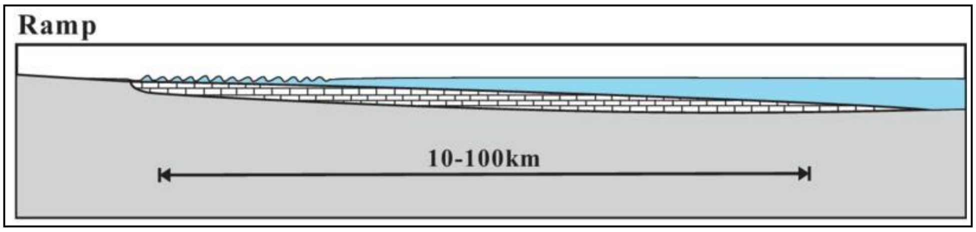
Three morphologies of carbonate platform are recognized (James 2003):

- They may be flat-topped with a sharp change in slope at the edge forming a steep margin, either as **"a rimmed"** or "**non-rimmed shelf".**





They may have a ramp morphology, a gentle slope (typically less than 1˚) down to deeper water with no break in slope.



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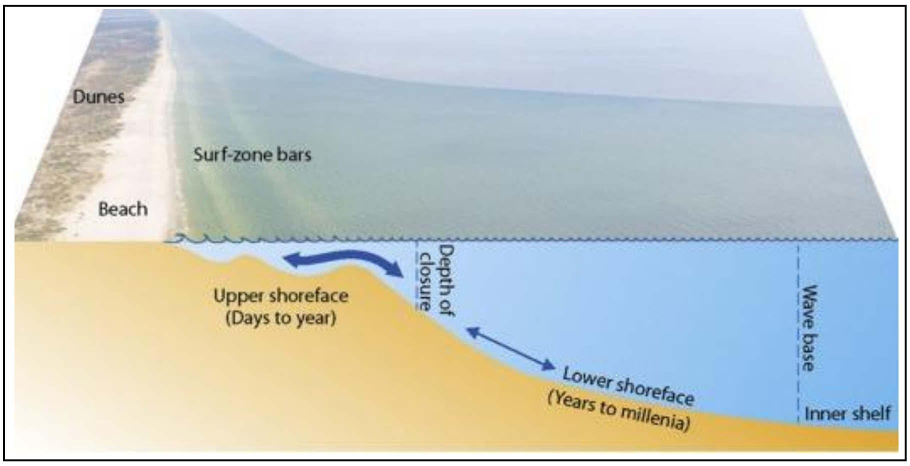
Coastal carbonate and evaporite environments

1. **Beaches:**

Carbonate material in the form of bioclastic debris and ooids is reworked by wave action into ridges that form strand plains along the coast or barrier islands separated from the shore by a lagoon.

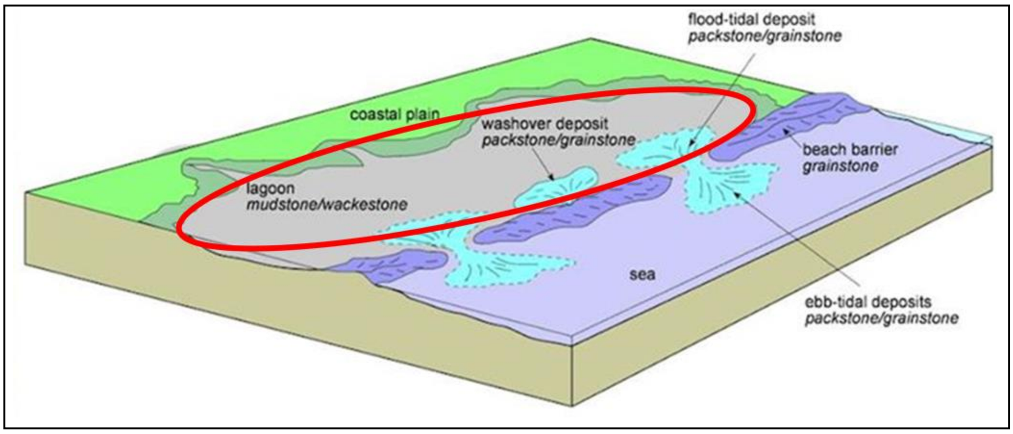
- The texture of carbonate sediments deposited on strand plain beaches and barrier islands is typically well-sorted and with a low mud matrix content (grainstone and packstone).
- Almost all of the carbonate detritus is reworked from the shoreface.
- Carbonate-rich beaches are characterized by the formation of "beach-rock".



2. Beach barrier lagoons:

Lagoons form along carbonate coastlines where a beach barrier wholly or partly encloses an area of shallow water. The character of the lagoon deposits depends on the salinity of the water and this in turn is determined by two factors:

1. the degree of connection with the open ocean and
2. the aridity of the climate.



3. Carbonate lagoons :

Carbonate lagoons are sites of fine-grained sedimentation forming layers of carbonate mudstone and wackestone with some grainstone and packstone beds deposited near the beach barrier.

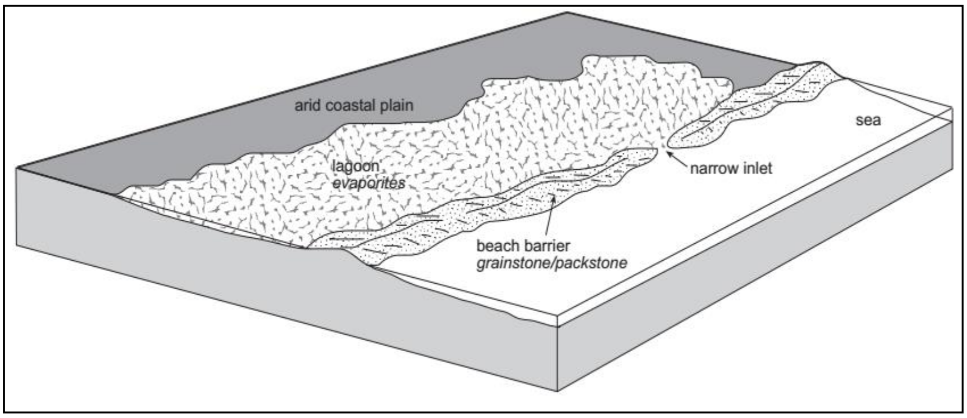
- The source of the fine-grained carbonate sediment in lagoons is largely calcareous algae living in the lagoon, with coarser bioclastic detritus from molluscs.
- Pellets formed by molluscs and crustaceans are abundant in lagoon sediments.

- The nature and diversity of the plant and animal communities in a carbonate lagoon is determined by the salinity of water.

4. Arid lagoons:

In hot, dry climates the loss of water by evaporation from the surface of a lagoon is high.

- If it is not balanced by influx of fresh water from the land or exchange of water with the ocean, the salinity of the lagoon will rise and it will become "hypersaline", more concentrated in salts than normal seawater.



An area of hypersaline shallow water that precipitates evaporite minerals is known as a "saltern".

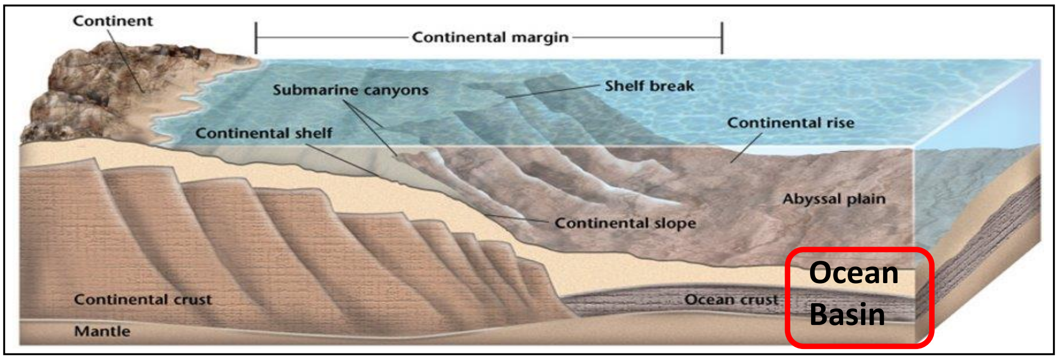
- Deposits are typically layered gypsum and/or halite occurring in units metres to tens of metres thick.
- In the restricted circulation of a lagoon conditions are favourable for large crystals of selenitic gypsum.

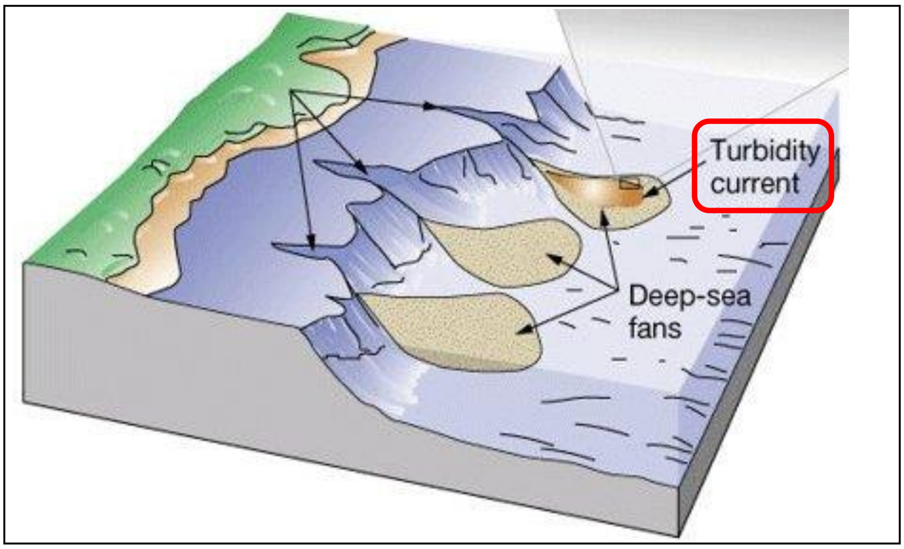
- The precipitated minerals in a lagoon including layers of carbonate deposited during periods when the salinity was closer to normal marine values.
- An alternation between laminated gypsum deposited subaqueously in a lagoon and nodular gypsum formed in a supratidal sabkha around the edges of the water body of a lagoon may represent fluctuations in the area of the water body.

Deep Marine Systems

Introduction

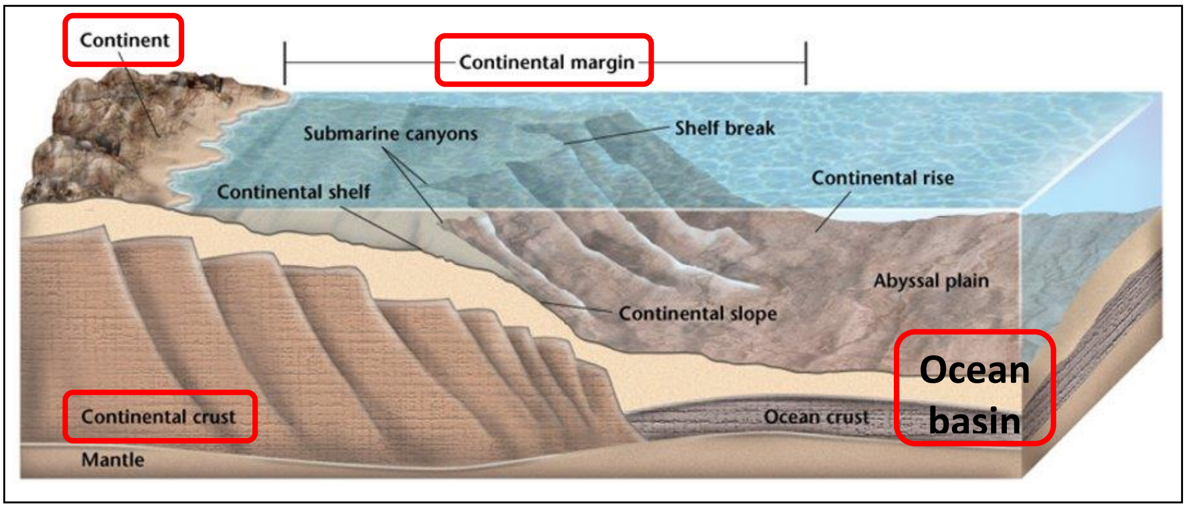
- Deep marine basins provide the largest areas of sediment accumulation on Earth.
- Turbidity currents and debris flows often characterize sedimentation in deep marine environments .
- These processes transport detritus down the continental slope to the deep ocean basin.





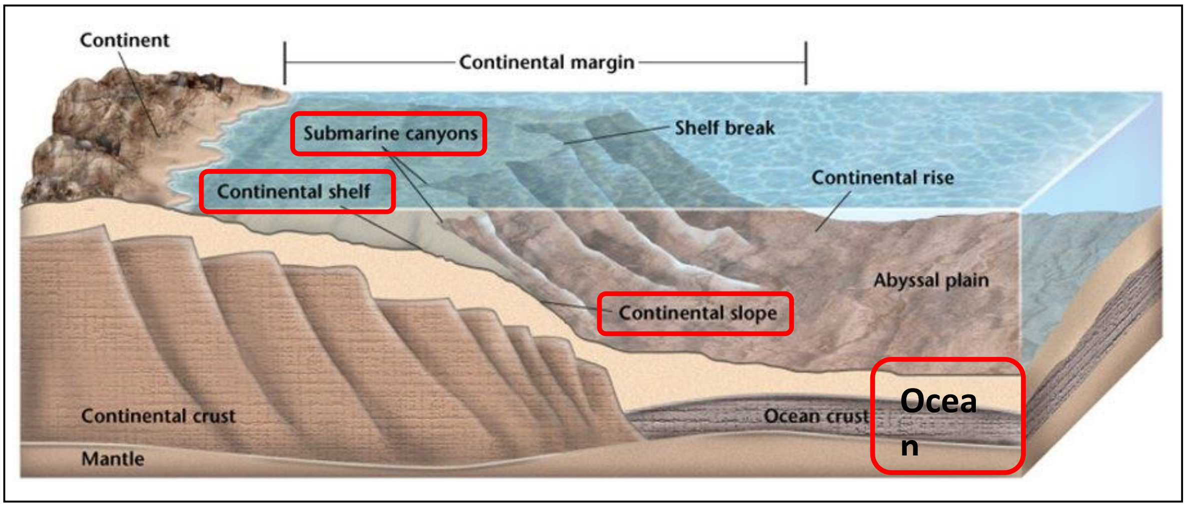
- Wind blown dust, ash, fine particulate matter, and the shells and skeletons of dead marine organisms are also all sources of deep marine sediments.

- The oceans are bound by "continental crust", which contributes huge volumes of sediments to ocean basins and concentrates large clastic depositional systems near the margin of the continents.

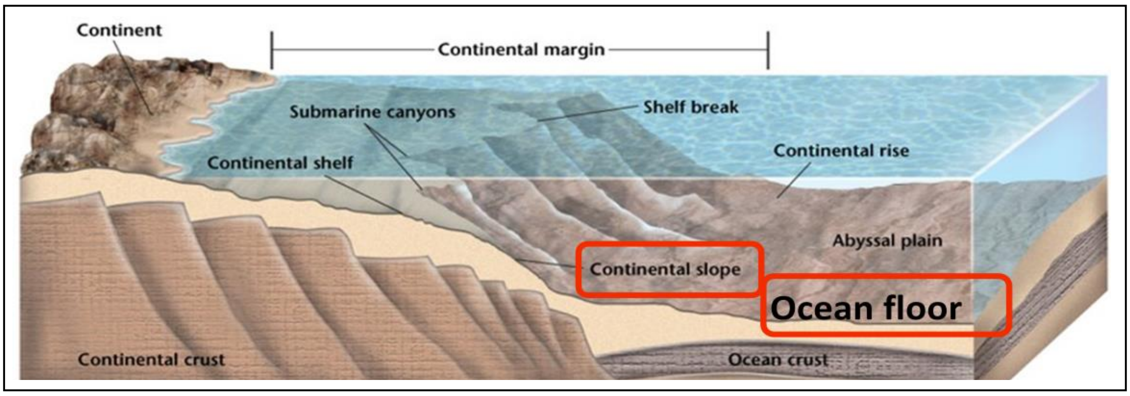


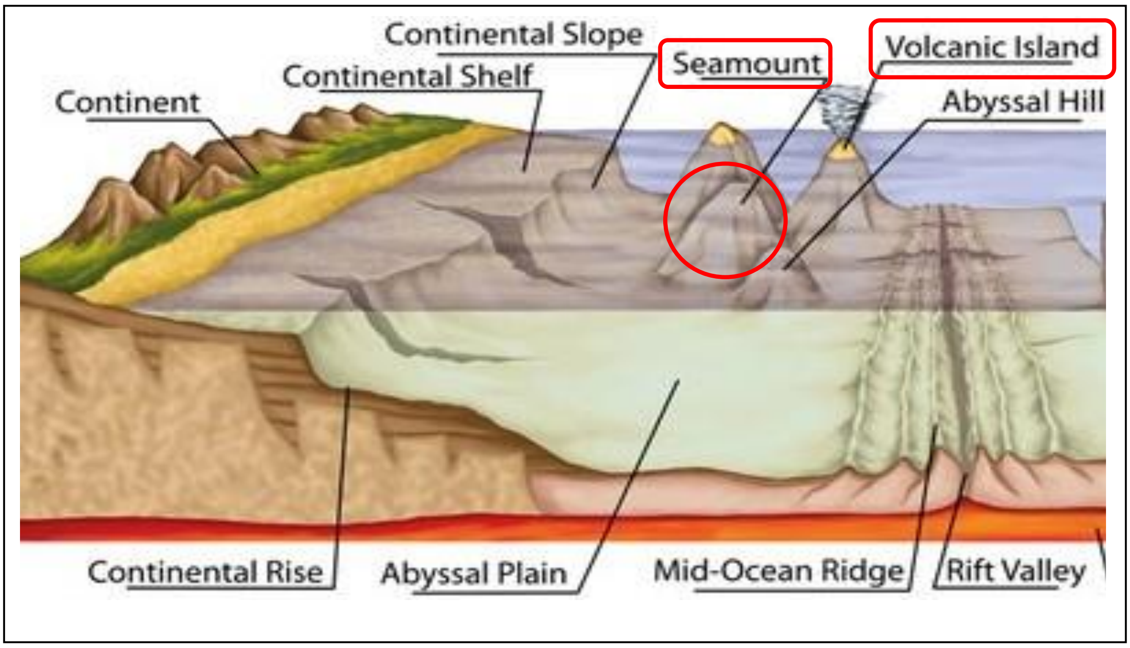
Morphology of ocean basins

- The edges of continental shelves (~200 m below sea level) are connected to the ocean basin floor (~4000-5000 m below sea level) by a series of continental slopes, which extend into the deep ocean for up to hundreds of kilometers.
- The continental slopes are often cut by steep sided submarine canyons, which can serve as pathways for sediment transport from the continent to the deep ocean.



- Beyond the continental slopes, the ocean floor is generally a broad flat plain, except in areas where there are occasional subaqueous volcanoes, known as seamounts.
- Seamounts may be wholly submarine or may build up above water as volcanic islands.
- These can be significant sources of volcaniclastic material to submarine depositional systems.





Depositional Processes in Deep seas

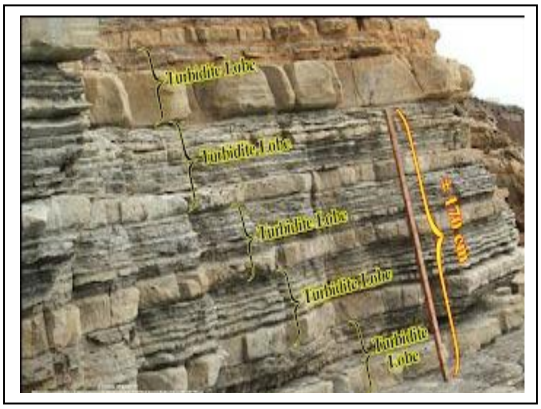
The most common deposits are **debris flows and turbidity currents.**

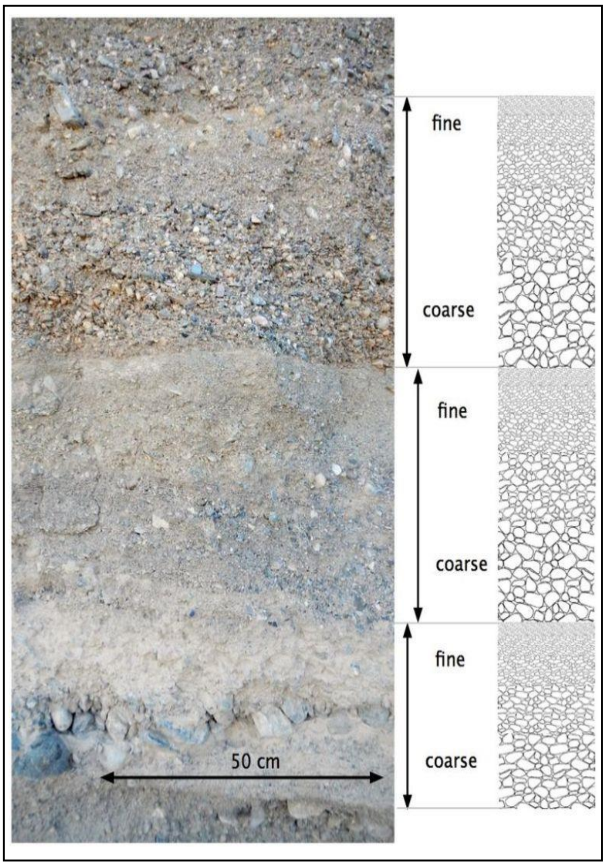
1. Debris-flow deposits:

- Remobilization of poorly sorted, sediments from the edge of the shelf results in a debris flow, which travels down the slope to the oceanic basin plain.
- The upper part of a submarine debris flow deposits will typically grade up into finer deposits due to dilution by the action of water.
- Debris-flow deposits that are tens of meters thick and extending for tens of kilometers are often referred to as **"megabeds"**.

2. Turbidites:

- Dilute mixtures of sediment and water moving as mass flows under gravity are the most important mechanism for moving coarse clastic material in deep marine environments.
- These turbidity currents carry variable amounts of mud, sand and gravel tens, hundreds and even thousands kilometres onto the oceanic basin plain.
- The deposited turbidites can range in thickness from a few millimetres to tens of metres and are carried by flows with sediment concentrations of a few parts per thousand to 10%.





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