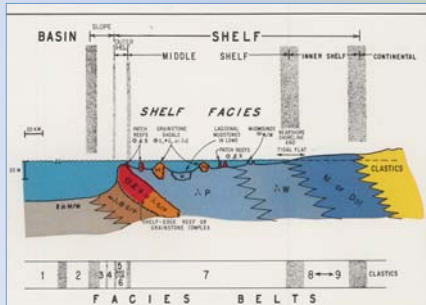


## Shelf Environment



## Lecture Outline

- Restricted Shelf
  - Characteristics
  - Typical sequence
- Open Shelf
  - Characteristics
  - Typical sequence

## Restricted shelf

- Low energy, shallow water carbonates
- Geographically form within bays or lagoons
- Partially enclosed body of slow moving water of abnormal salinity (high or very low), often fluctuating or depleted nutrient levels, oxygenation, and temperatures.
- May or may not have topographic restriction (exp. eperic seas)

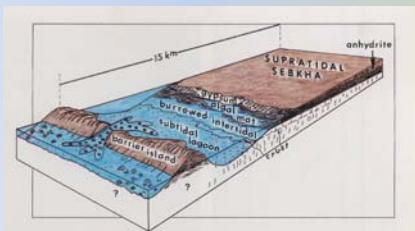
## Bay

- Recessed shoreline between headlands formed depositively, erosively, or structurally.
- Can be very shallow to very deep



## Lagoons

- More completely enclosed than a bay and cutoff from open ocean by reefs or barrier islands.
- Generally shallow, but can reach depths of 70m.



## Restricted Shelf Characteristics: Paleogeographic Settings

- Is there a seaward source of restriction such as islands?
  - Ex. Florida Keys seal off Florida Bay, barrier bars, oolite shoals, or reefs.
- Is there a low energy shoreline facies landward associated with tidal flat facies?
- If restriction is a large, high mass like an island the most restricted facies will occur directly adjacent to the restriction mass (Bahamas). Otherwise degree of restriction increases progressively inland.



### Restricted Shelf Characteristics: Severe Restriction Indicators

- Extensive evaporite or penecontemporaneous dolomite deposition.
- Euxinic, organic-rich sedimentation like dark, black laminated facies.
- Usually not a very thick or continuous section of this kind of facies.
- Usually alternates with more oxygenated conditions.

### Restricted Shelf Characteristics: Facies mosaic

- Rapid and apparently random shifts vertically and laterally in facies.
- On broad, semi-restricted shelves slight changes in topography (less than a foot) can result in a completely different facies.
- As a result get these patchy facies assemblages, with little evidence of current reworking.

### Restricted Shelf Characteristics: Monotonous muddy facies

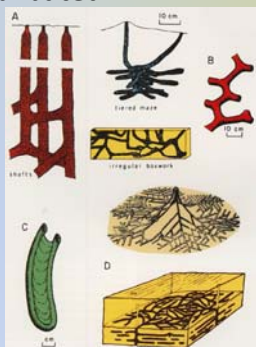
- Extensive mud-rich facies (dominantly mudstone to wackestone) deposited over 100's of kilometers.
- Mud-rich sediment contains abundant organic matter, pyrite, or evaporates.
- Indicates little or no topographic relief on a broad platform. Ex: Great Bahama Bank

### Restricted Shelf Characteristics: Restricted Fauna

- Depauperate fauna=low diversity, high abundance and dwarf faunas).
- Abundance of algae (mats and stromatolites), high-spired gastropods, forams, serpulid worms, lingulid (phosphatic) brachs, ostracods, and clams.

### Restricted Shelf Characteristics: Highly Bioturbated

- Completely churned or mottled.
- Indicates slow sedimentation rates.
- Usually all one type of burrow present.

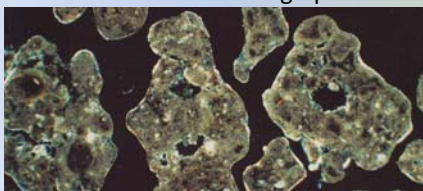


### Restricted Shelf Characteristics: Suspension Settling Lamination

- Millimeter scale lamination quiet water slow sedimentation.
- No evidence of algal binding.
- No burrowers to disturb sediment

### Restricted Shelf Characteristics: Peloidal Dominated Sediments

- Pelletal origin and completely micritized skeletal material indicating slow sedimentation rates.
- Peloids often cemented into grapestone.

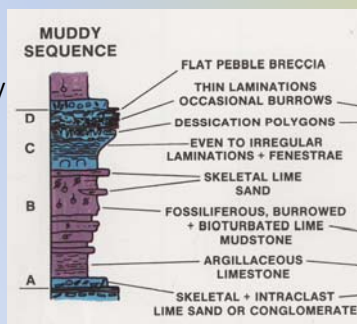


### Restricted Shelf Characteristics: Abundant Tempestitute Horizons

- Grainy beds derived from seaward banks intercalated into muddy, slow sedimentation norm.

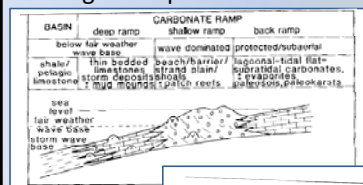
### Typical Restricted Shelf Sequence or Shallowing Upward Cycle

- **supratidal and exposure** - grainy beaches or muddy tidal flats



### Open Shelf

- Commonly form on ramp settings with slightly higher slopes than restricted ramp setting.

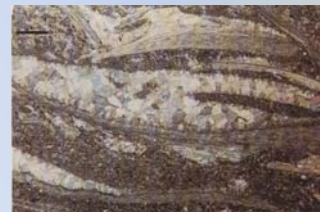


### Open Shelf Characteristics: Paleogeographic setting and lateral facies changes.

- No restricting buildup offshore and landward facies show higher energy beach deposits.
- Water depths range from 10's to 100's of meters.
- Below normal wave base, but above storm wave base.
- Facies do not show signs of restriction, but were deposited under normal marine conditions
- Facies are usually low in organic content and light in color because well oxygenated
- Facies tend to be in broad linear bands with nearshore muddier facies, central sandy facies, and offshore, deeper water muddier facies.
- May get local irregular shaped biohermal buildups or patch reefs that do not produce any restriction.


### Open Shelf Characteristics: Normal Marine Fauna

- *Diverse fauna* and contains things like corals, echinoderms, bryozoans, brachiopods, cephalopods, etc that are stenohaline.
- Codiacean green algae = phylloid algae. Forms small bioherms, that are not grazed.




### Open Shelf Characteristics: High Energy Deposits

- Current sorted and cross-bedded skeletal and non-skeletal sands with little bioturbation reflecting migrating sediments with rapid sedimentation rates.




### Open Shelf Characteristics: Bioturbation

- Abundant and diverse types.
- Generally not completely churned because have higher sedimentation rates.




### Open Shelf Characteristics: Intercalated clay-rich zones of calcareous marls

- **Marls** may be extremely fossiliferous.
- Suggests proximity to shoreline.

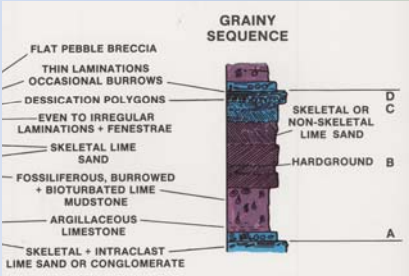


### Open Shelf Characteristics: Irregular, variable bedding thickness

- Beds vary from thick, massive, homogenous, tabular or undulous, strata to thin bedded carbonates intercalated with shales.
- Beds retain their thickness over large areas.
- Laminations are rare.
- Oscillation ripples and hummocky cross-strata are relatively common.



### Open Shelf : Typical Shallowing Upward Sequence



The diagram shows a vertical sequence of rock layers labeled A through D from bottom to top:

- A:** Skeletal + intraclast lime sand or conglomerate
- B:** Hardground
- C:** Skeletal or non-skeletal lime sand
- D:** Skeletal or non-skeletal lime sand

Labels on the left side of the column include:

- FLAT PEBBLE BRECCIA
- THIN LAMINATIONS
- OCCASIONAL BURROWS
- DESSICATION POLYGONS
- EVEN TO IRREGULAR LAMINATIONS + FENESTRAE
- SKELETAL LIME SAND
- FOSSILIFEROUS, BURROWED + BIOTURBATED LIME MUDSTONE
- ARGILLACEOUS LIMESTONE
- SKELETAL + INTRACLAST LIME SAND OR CONGLOMERATE