

Wave, tide and fluvial dominated coasts

Classification and categorisation

Coastal length

Geographical area	Length km	% GB coast
Great Britain total	18838	
England	5496	29%
Scotland (mainland)	6482	35%
Scotland (islands)	5295	28%
Wales	1562	8%

From the Joint Nature Conservation Committee (JNCC)

2 broad types:

1. Elevated landscapes bordered by cliffs of both less resistant and resistant rock types
2. Low lying areas of less resistant rocks (principally in the south and east)

A classic description of the UK's coastal geomorphology is Steers (1960). Classic natural history of the coast is Freethy (1983) and Soper (1989). Traditionally comprehensive conservation, ecological and human impact descriptions have been provided by JNCC

Coastal Habitats

Habitat above Mean High Water length (km):	ENGLAND	SCOTLAND	WALES	TOTAL
Shingle vegetation	297	125	61	483
Sand dune	325	894	149	1368
Cliffs >20m	877	1391	437	2705
Cliffs <20m	205	1069	84	1358
Embankment (artificial)	1764	226	180	2170
Other	2028	8075	651	10754
Total length	5496	11780	1562	18838

Terrestrial habitat

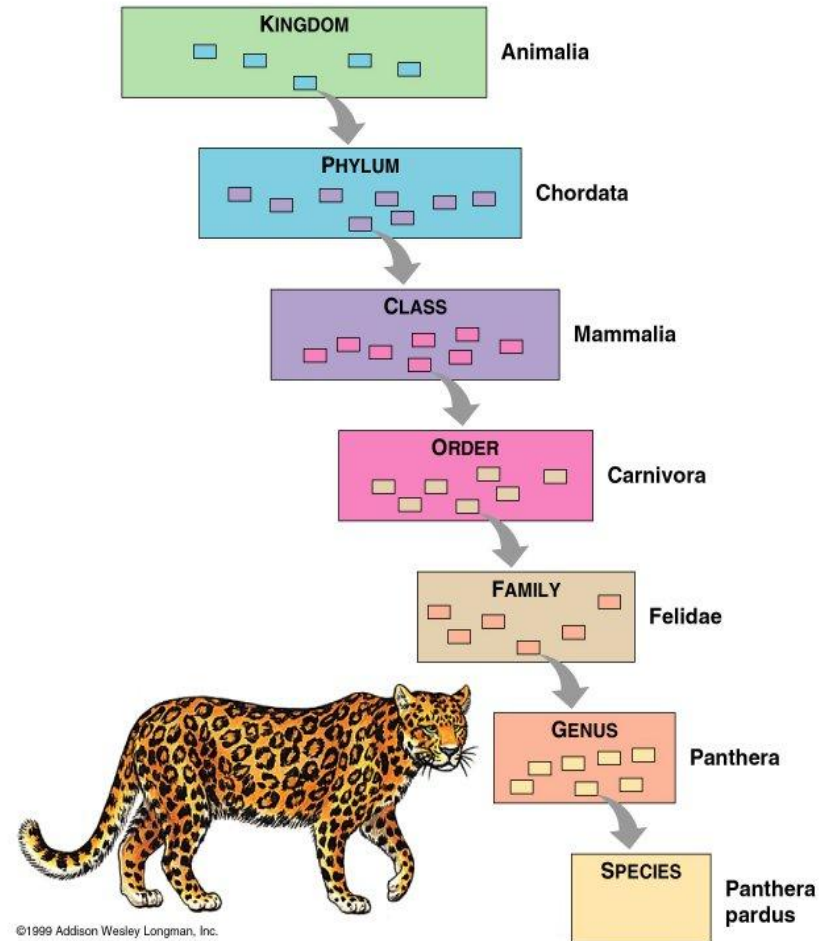
Terrestrial habitat area in (ha)	ENGLAND	SCOTLAND	WALES	TOTAL
Tidal flats	150865	53562	30840	235267
Saltmarsh	28923	5055	4871	38849
Sand dune/machair	9276	40011	7058	56345
Vegetated shingle	3415	692	112	4219

UK Coastal descriptions

- * European Continental shelf rarely deeper than 60m
- * By its very nature, the coast is an incredibly complex and diverse environment, one that may defy organisation into neat compartments (USGS Marine and Coastal Geology Programme, 2013)
- * Nevertheless, the quest for understanding how shorelines form and how human activities affect these processes has led the creation of classification schemes.
- * Most group coastal areas into classes that have similar features because of having developed in similar geological and environmental settings.

CLASSIFICATION

- * Why Classify?
- * How can we classify coasts?
- * What are the implications?
- * Is it important for integrated management?
- * Construct a coastal classification based on your knowledge.



Classification (Shepard, 1973)

- * Divides the world's coasts into **primary** coasts formed mostly by non-marine agents and **secondary coasts** - shaped primarily by marine processes
- * Further subdivisions occur according to which specific agent,
 - * **terrestrial or marine** (greatest influence)
 - * **coastal development.**
- * Although gradational shore types exist, which are difficult to classify, most coasts show only **one** dominant influence.

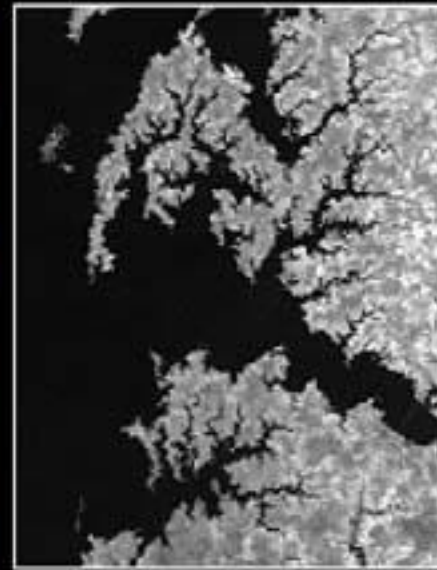


Primary Coasts

Land Erosion Coasts

Land erosion coasts: Shaped by subaerial erosion and partly drowned by postglacial rise of sea level.

1. Ria Coasts (Chesapeake Bay)
2. Dendritic (flooded drainage in horizontal beds)
3. Trellis (glacial erosion, fjords, Gulf St. Lawrence)
4. Drowned Karst Topography (northwest Florida)

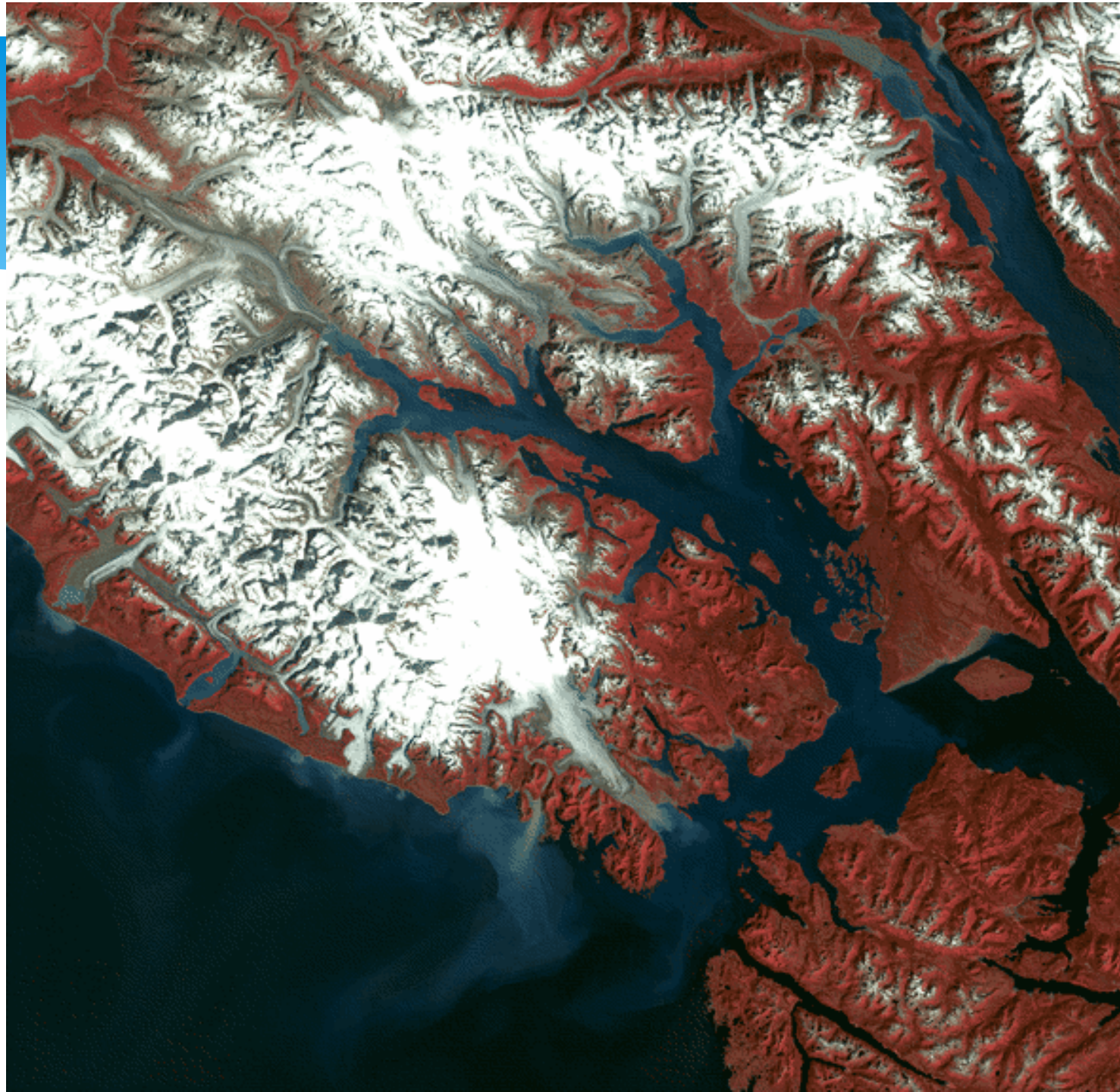


Land Erosion Coast – Ria Coast

Florida,
flooded karst
erosion due to
dissolution
flooded by
sea-level rise



Glacier Bay,
flooded fjord
erosion by
glaciation
flooded by
sea-level rise



Primary Coasts

Subaerial Deposition Coasts

- * **River deposition coasts**
- * **Deltaic coasts** (*Mississippi Delta*)
- * **Compound delta coasts** (*north slope - Pt. Barrow to MacKenzie River*)
- * **Compound alluvial fan** (*straightened by erosion*)
- * **Glacial deposition coasts** (*Cape Cod*)
- * **Wind deposition coasts** (*Sleeping Bear St. Park*)
- * **Landslide coasts** (*Martinique*)



Cape Cod region
glacial deposition



Mississippi
delta
subaerial
deposition



Sleeping Bear,
Michigan
subaerial
deposition, dune

Primary Coasts

Volcanic Coasts

- * **Lava Flow Coasts** (*Big Island*)
- * **Tephra Coasts**
- * **Volcanic Collapse Coasts** (*Hanauma Bay*)



Primary Volcanic Coast

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N=19114 152.61

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Collapsed
Volcanic
Coast



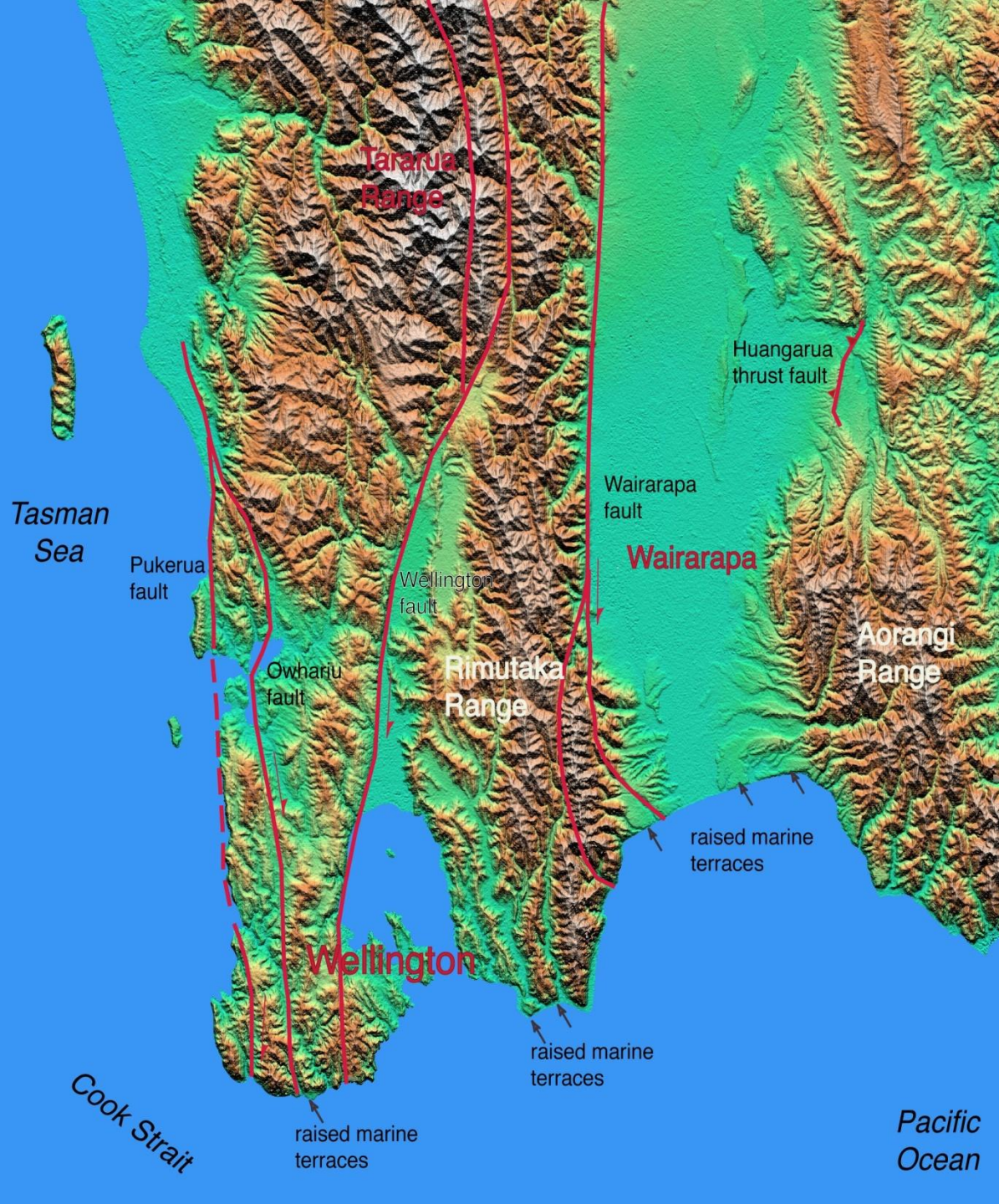
Pyroclastic surge
Montserrat

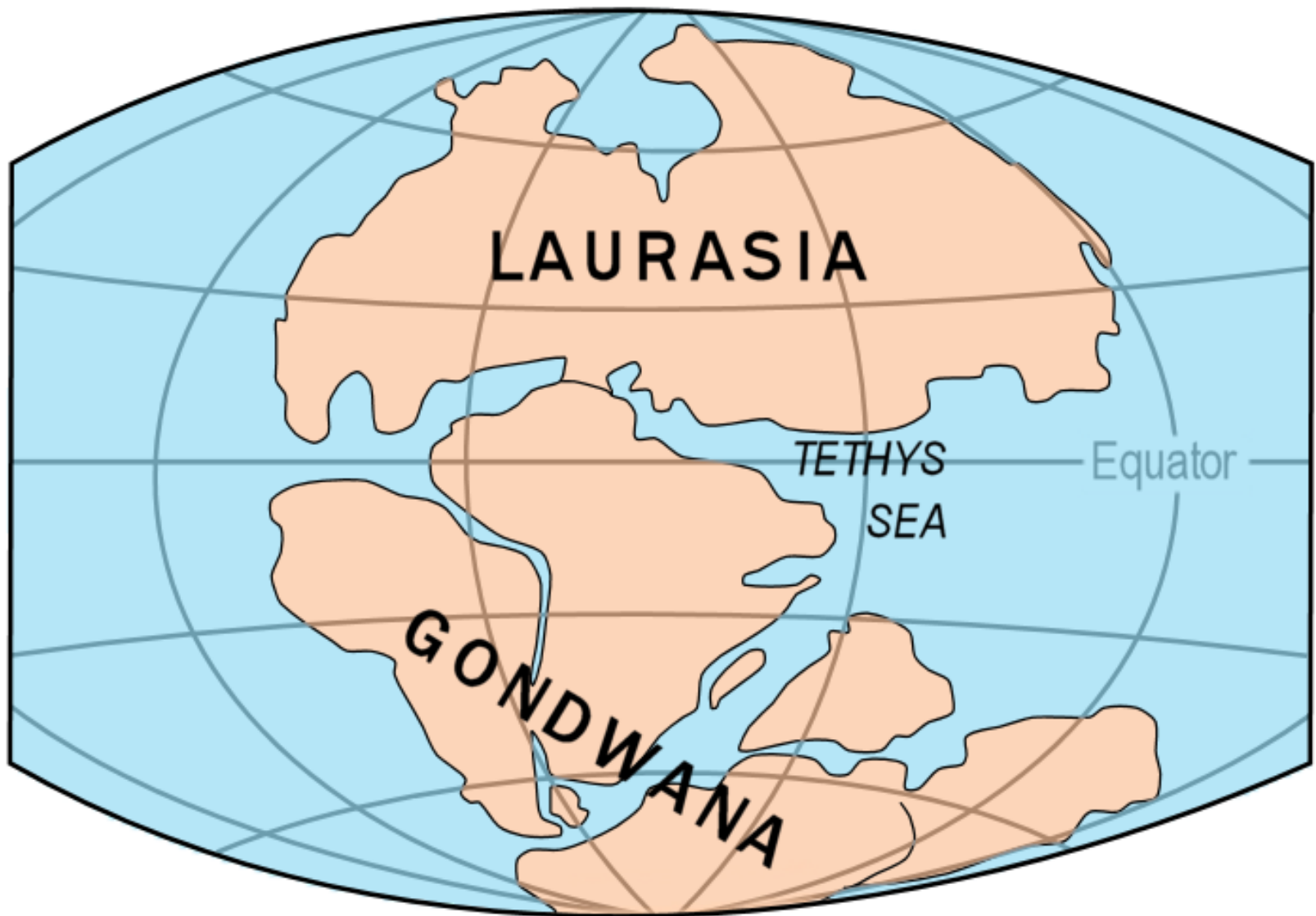
Primary Coasts

Shaped by Diastrophic Movements

Diastrophism – movement of the crust

- * Fault Coasts
- * Fold Coasts
- * Sedimentary Extrusions (*salt domes, mud lumps, Red Sea*)





TRIASSIC
200 million years ago

Primary Coasts

Ice Coasts

- * Glacial Ice and Sea Ice



Primary Ice Coast
Collapsing Larson
B ice shelf



Secondary Coasts

Wave Erosion Coasts

- * Wave-straightened cliffs
- * Made irregular by wave erosion



Wave straightened cliffs

Maui lava flows – irregular erosion resistance

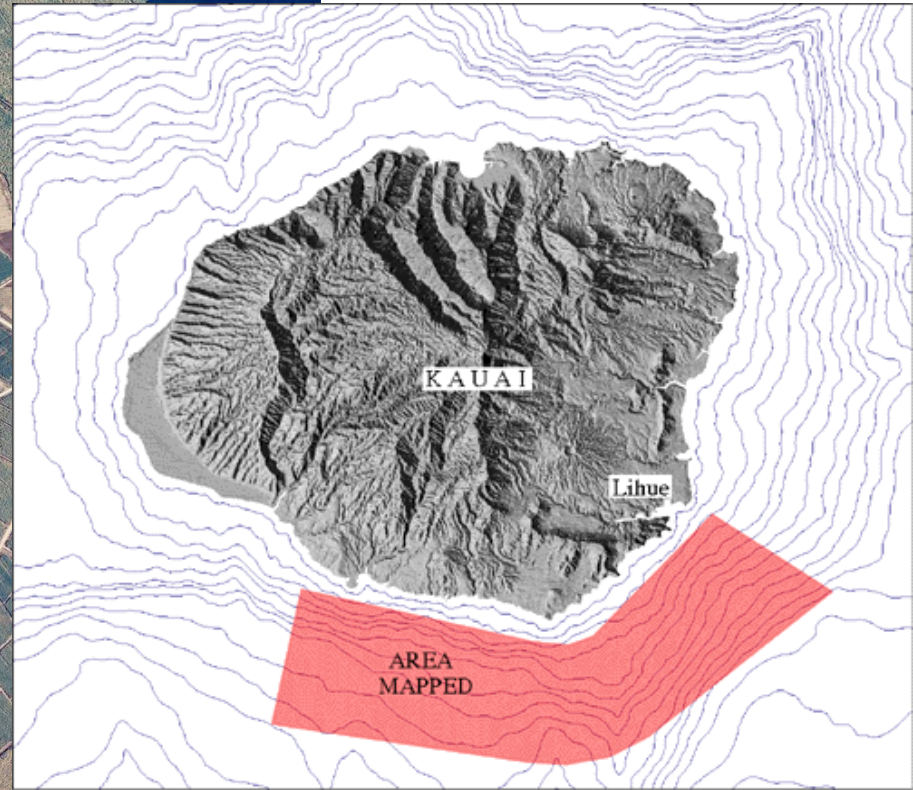


Secondary Coasts

Marine Deposition Coasts

- * Barrier Coasts
- * Cuspate forelands
- * Beach Plains
- * Mud Flats/Salt Marshes

Primary Marine Deposition Cuspate Foreland Coast



Holocene beach
Strand plain





Secondary Coasts

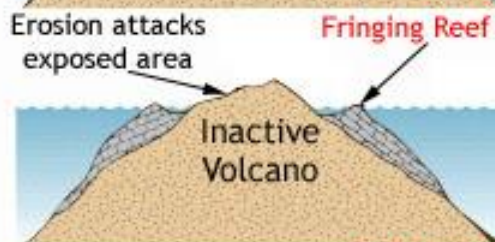
Coasts Built by Organisms

- * Coral Reef Coast
- * Serpulid Reef Coast (*Serpula vermicularis*)
 - * By far the best developed and largest area of serpulid reefs in the world occur in Loch Creran, west Scotland just north of Oban
 - * Serpulid reefs are very fragile and extremely vulnerable to mechanical disturbance, for example from mobile and static fishing gear, movement of anchors and mooring chains and even divers' fins. They may also be sensitive to water quality and changes in water flow (Scottish Natural Heritage, 2013) [SNH](#)
- * Oyster Reef Coast
- * Mangrove Coast
- * Marsh Grass Coast

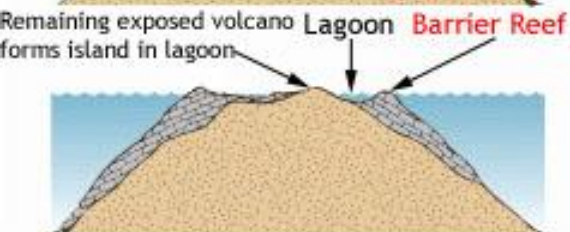




Step 1



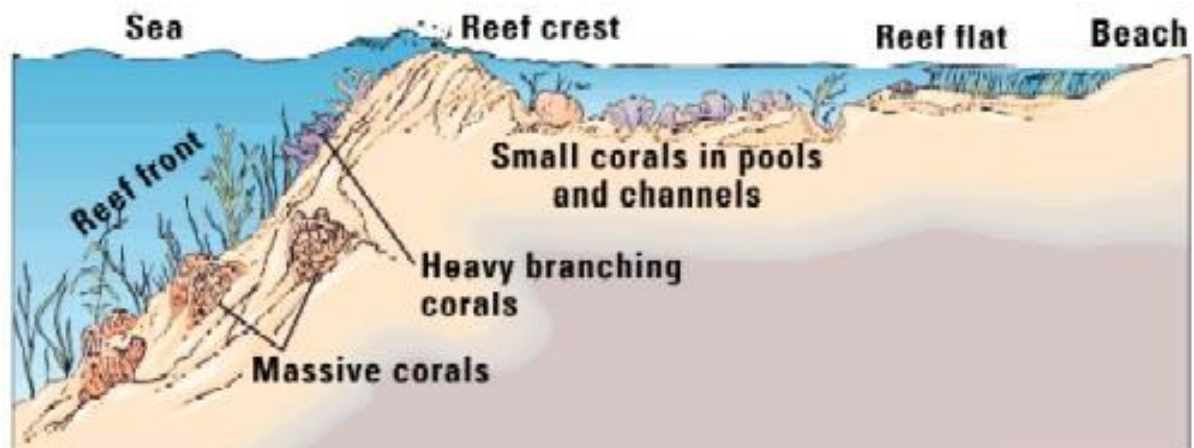
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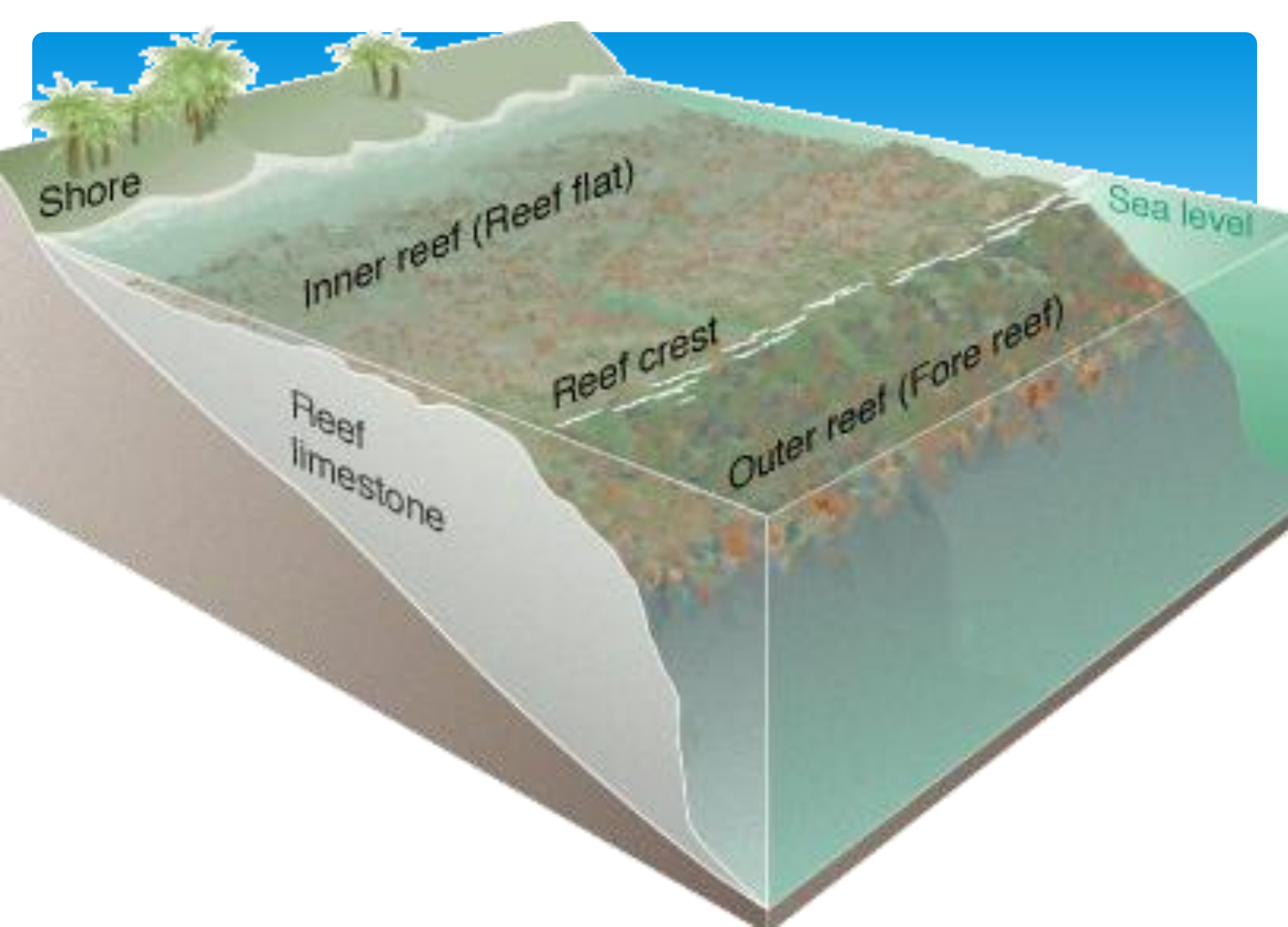


Step 3

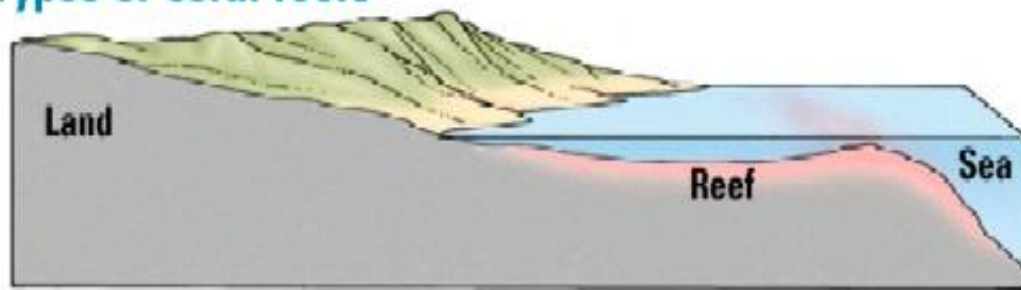


Step 4

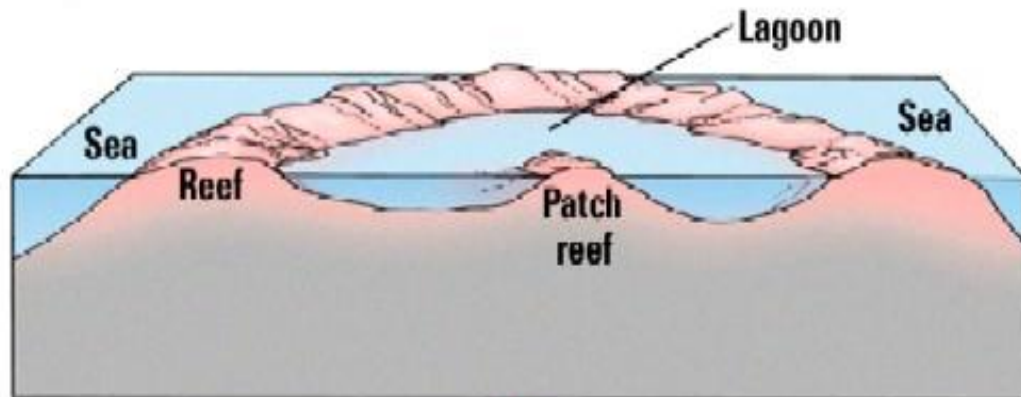




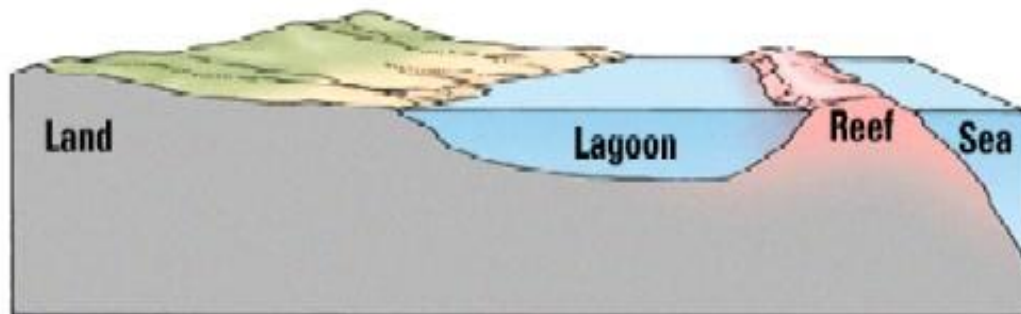
Types of coral reefs



Fringing reef



Atoll



Barrier reef



Intertidal Oyster Reef

Other Classification Schemes

Submergent Coasts

Relative sea level is rising
Estuaries formed in drowned
river mouths

Emergent Coasts

Relative sea level is falling
Tectonics or isostasy responsible
for most types

Depositional Coasts

Wide sandy beaches, stream
deltas, overabundance of sediment

Erosional Coasts

Irregular coastline, narrow
beaches, eroding headlands

Convergent Coasts

Sea Cliffs common, narrow
continental shelf, relatively straight
and mountainous

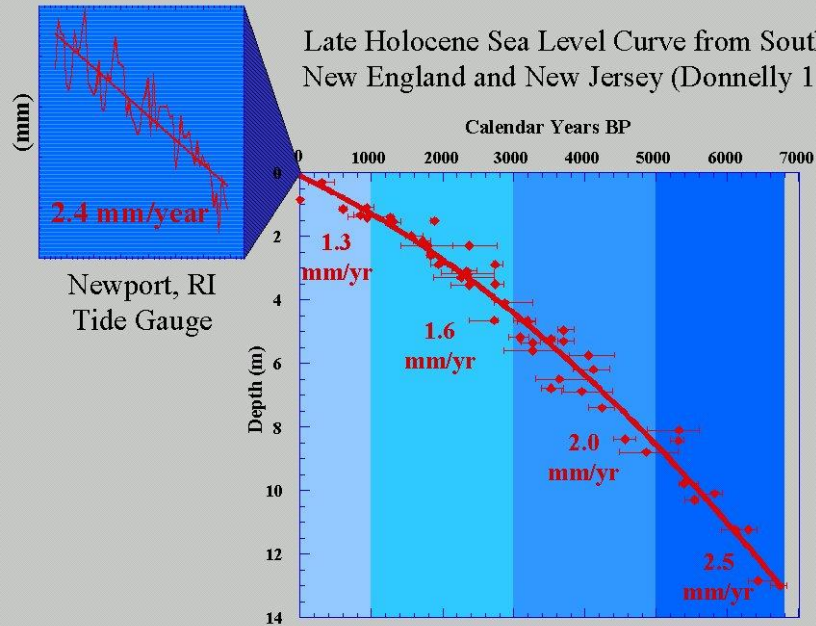
Passive Margin Coasts

Broad continental shelf
plate trailing edge

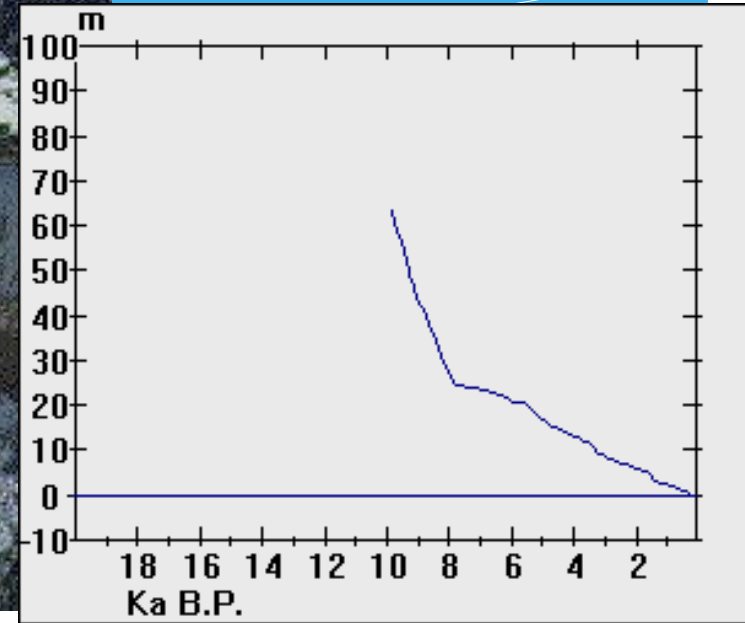
Submergent Coast

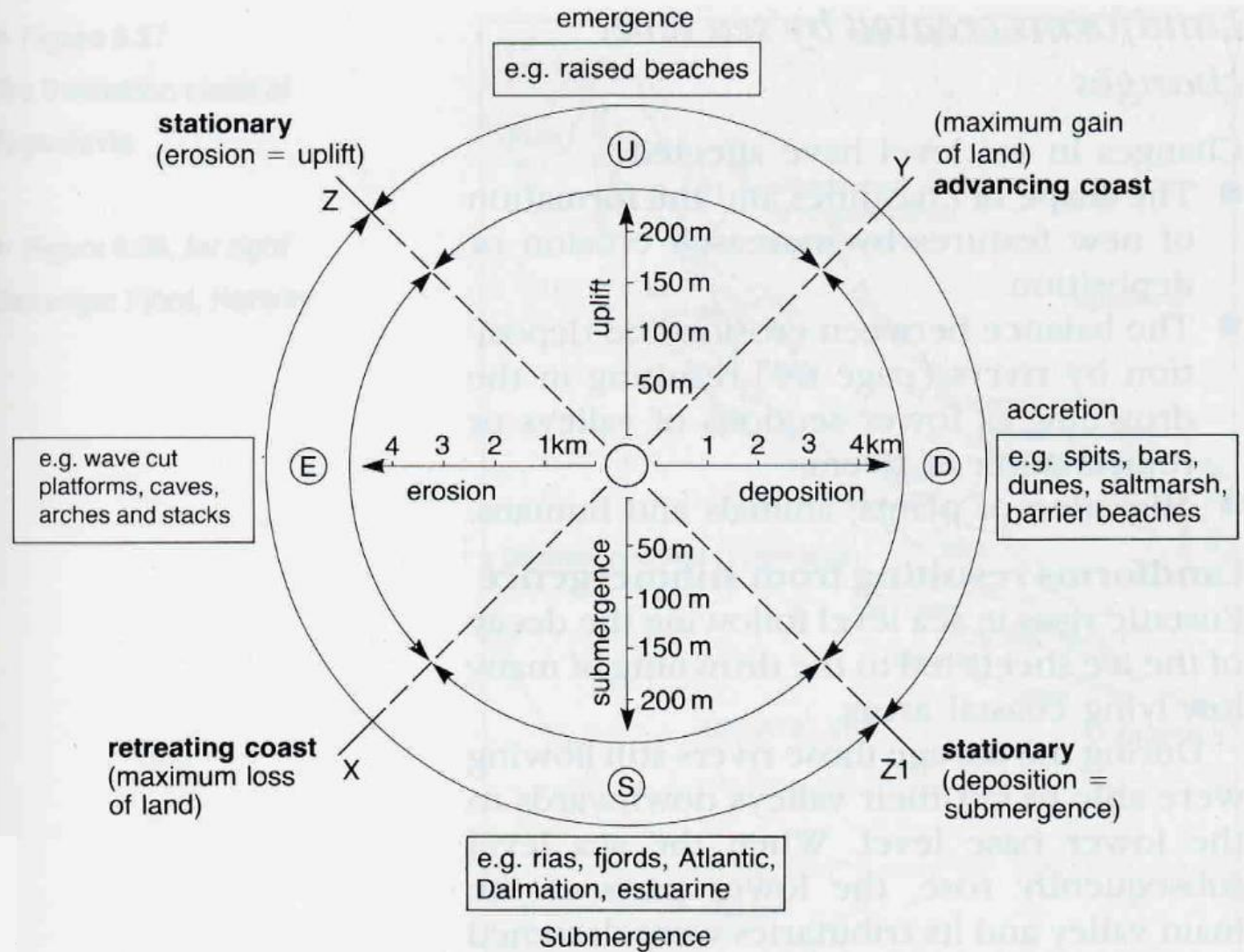


1994 AD $\longleftrightarrow$ 1931 AD



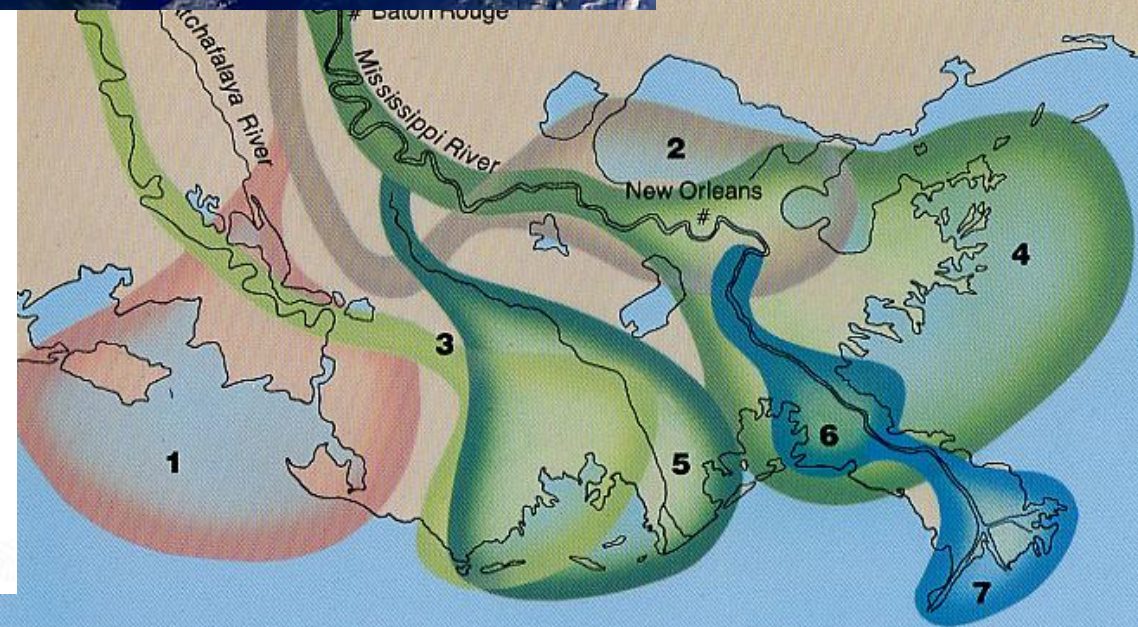
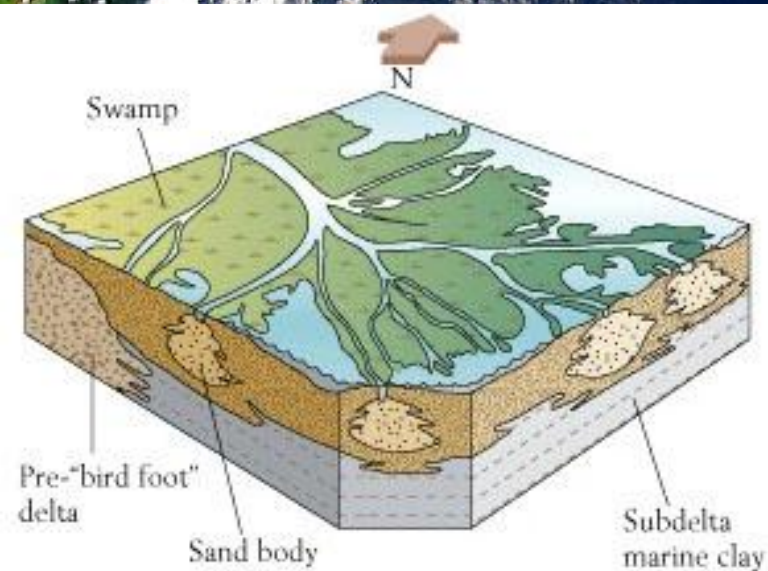
Emergent Coast



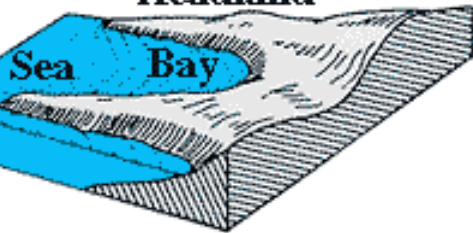


Valentin's classification of coasts — this shows the conditions under which the maximum advance or retreat of the coast will occur and how it is possible for a coast to be in equilibrium where there is neither advance or retreat

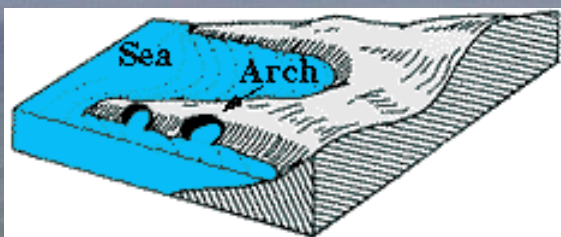
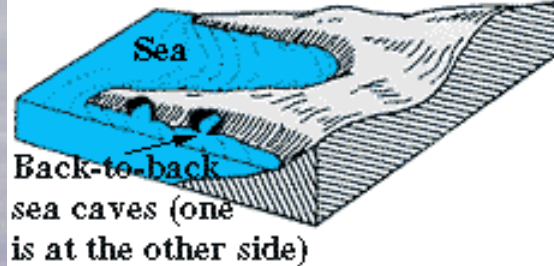
Depositional Coast – Mississippi River Delta



Headland

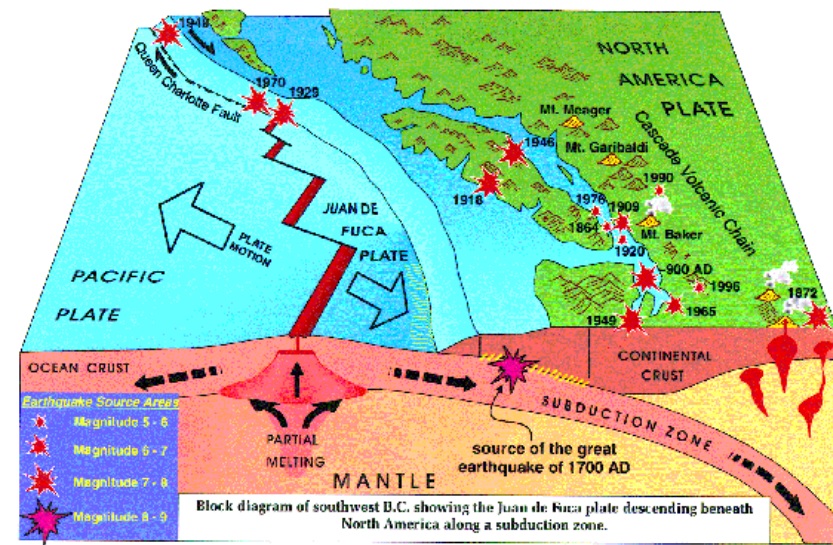


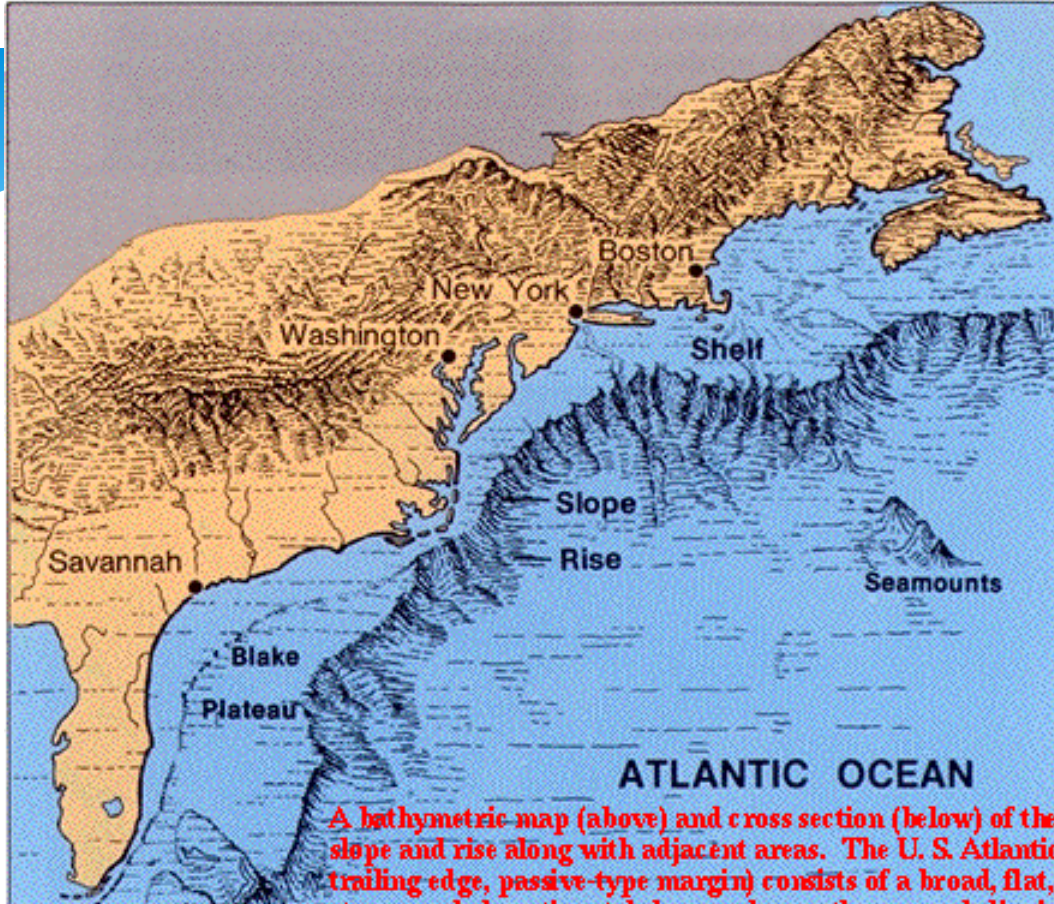
Headland



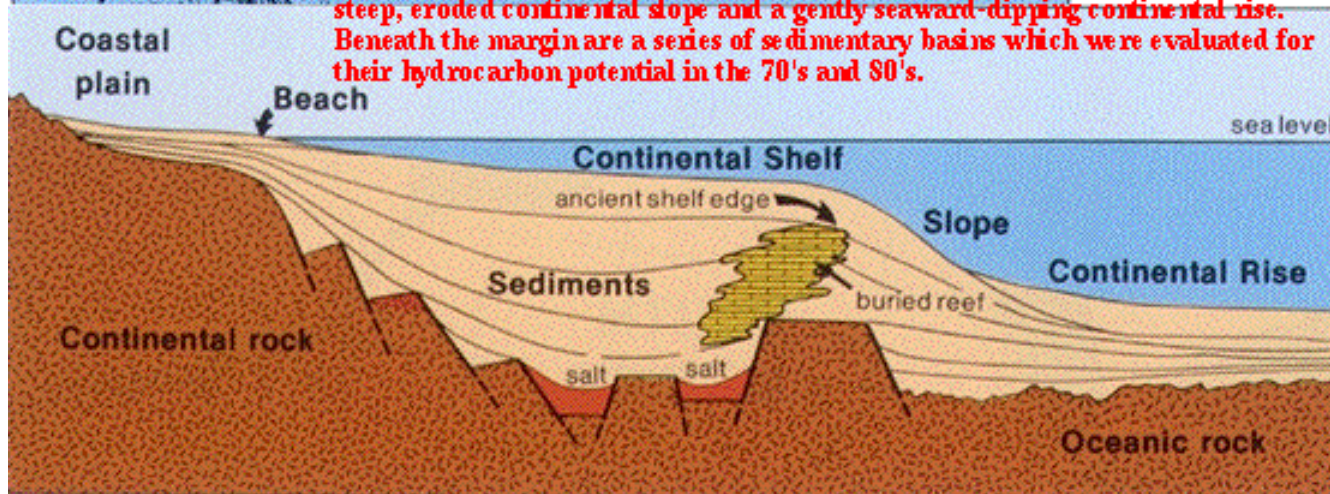
Erosional Coast –
“12 Apostles”

Convergent Coast –





A bathymetric map (above) and cross section (below) of the continental shelf, slope and rise along with adjacent areas. The U. S. Atlantic continental margin (a trailing edge, passive-type margin) consists of a broad, flat, continental shelf, a steep, eroded continental slope and a gently seaward-dipping continental rise. Beneath the margin are a series of sedimentary basins which were evaluated for their hydrocarbon potential in the 70's and 80's.



Passive
margin coast:
Trailing Coast



Delta Classification

- tide dominated
- river dominated
- wave dominated

Boyd et al (from Masselink)

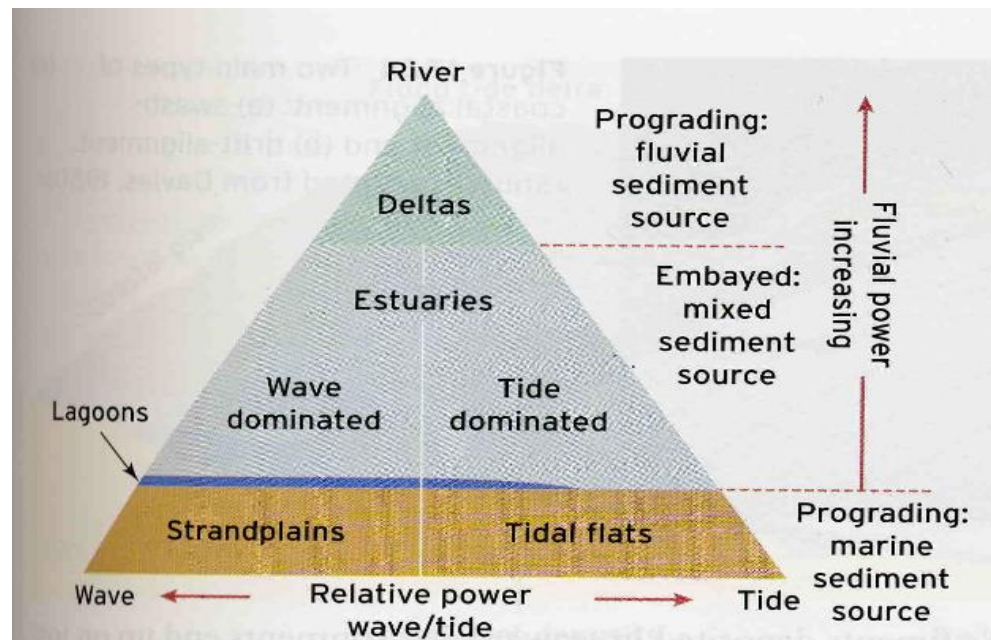


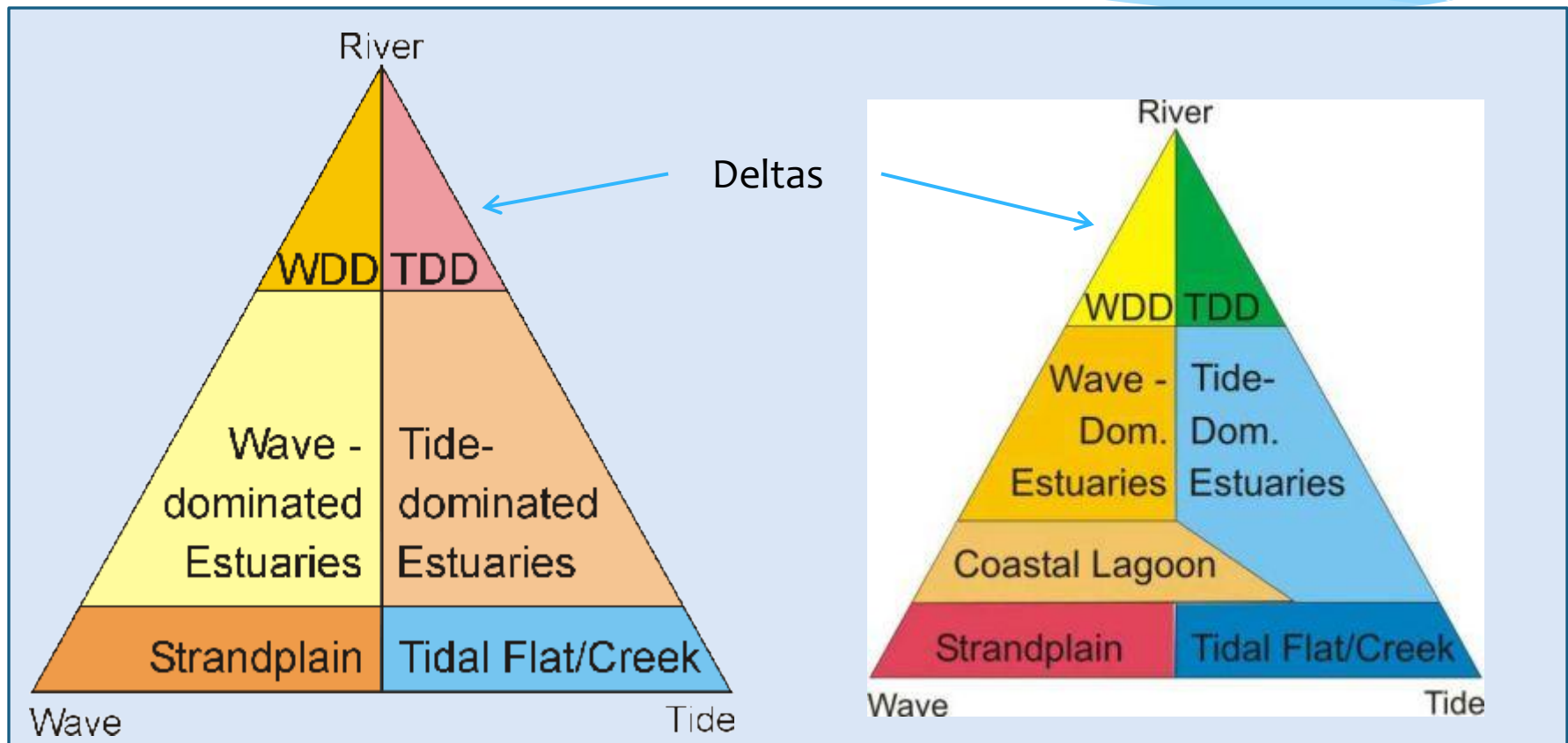
Figure 17.22 Process-based coastal classification based on the relative importance of wave, tide and river processes. (Source: after Boyd et al., 1992)

Reflective question

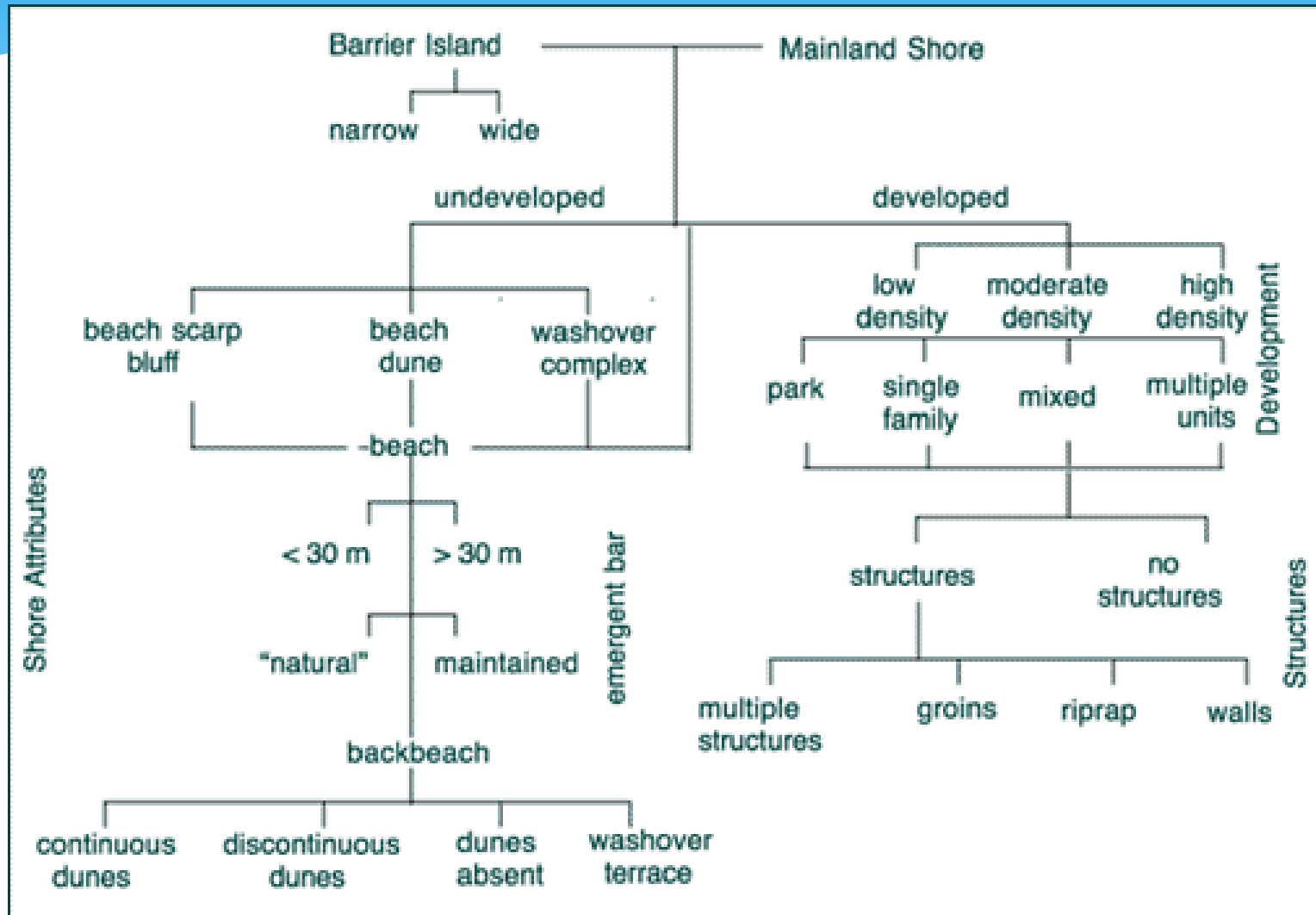
- What is the point of classifying coastlines in distinct types?

Australian Government 2012

- * Classification used for policy development
- * What are they based/not based on?

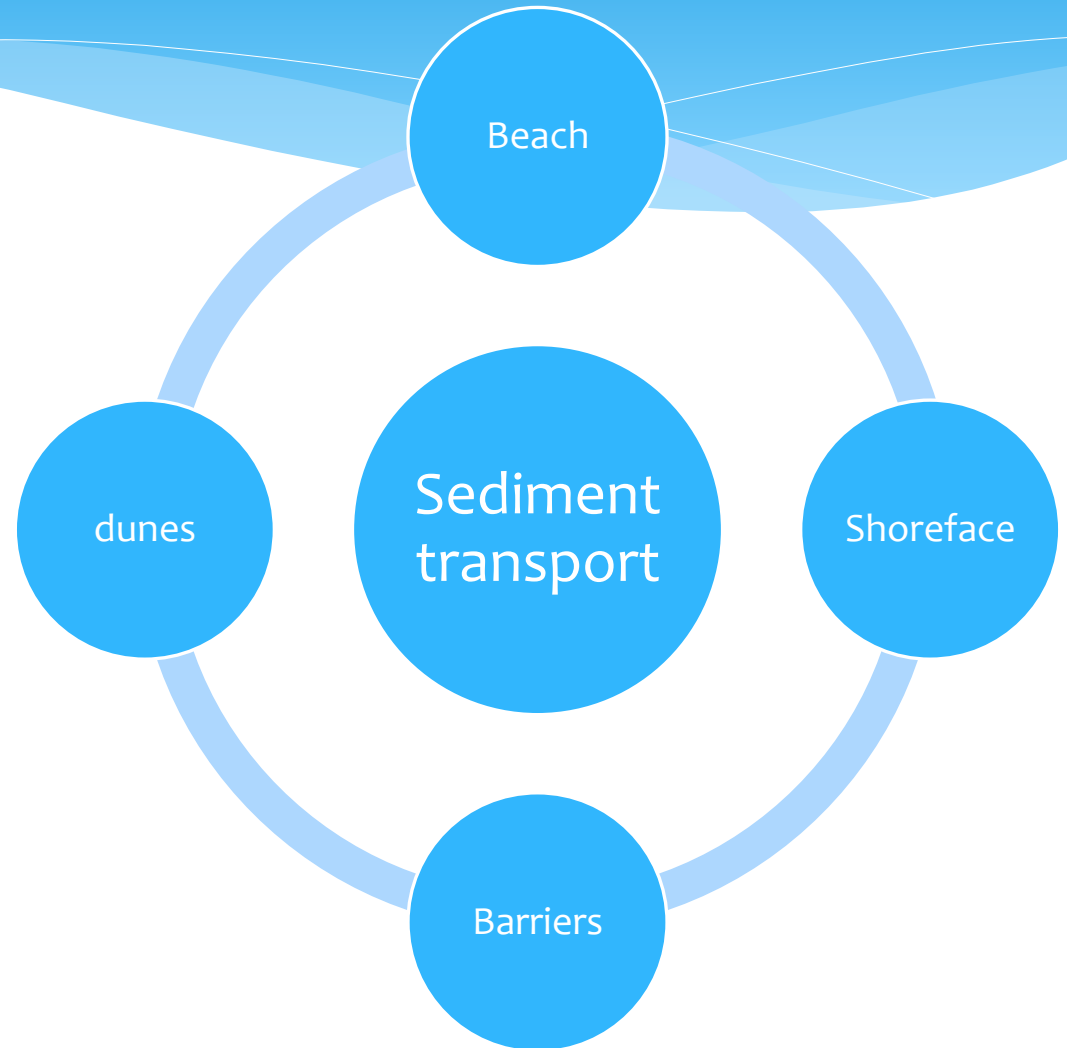


USGS (2012) <http://coastal.er.usgs.gov/coastal-classification/class.html>



A. WAVE-DOMINATED COASTS

- * Sediment is linked by sediment transport pathways



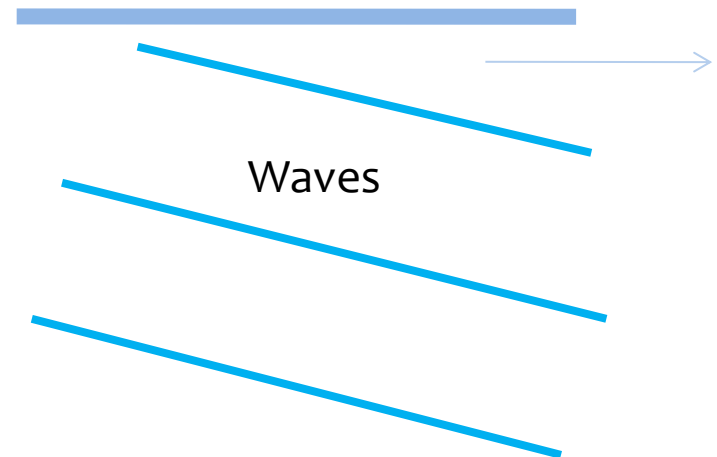
Barriers

- * Barrier islands with shallow coastal lagoons (e.g. Netherlands)
- * Swash aligned
 - * Closed to LSD
 - * Long term stability
 - * Seasonal change
- * Drift aligned (e.g. spits)
 - * LSD Spits
 - * Sensitive to change (esp. Sediment supply) (Masselink & Hughes, 2003)
- * Transgressive (refer to next slide)
 - * Migrate landwards due to rising SL
 - * Neg- sediment budget
 - * Lagoon VG for conservation
- * Regressive
 - * Migrate seaward due to receding SL / pos+sediment budgets
 - * Landward sediments are deposited.
 - * Aolian deposits

Swash aligned beach



Drift aligned



Barriers

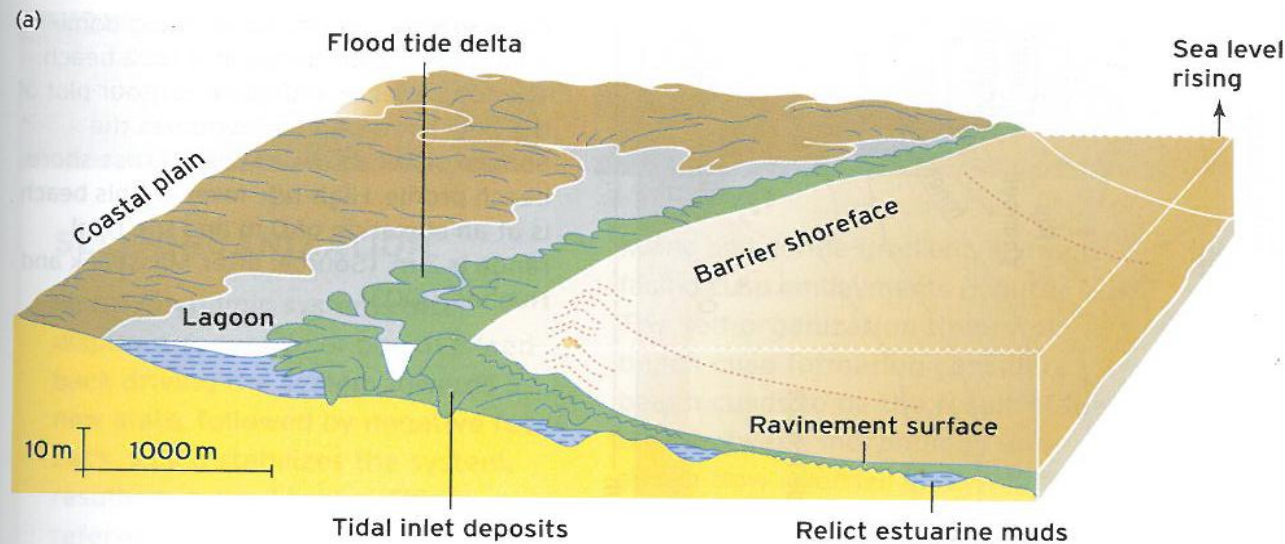
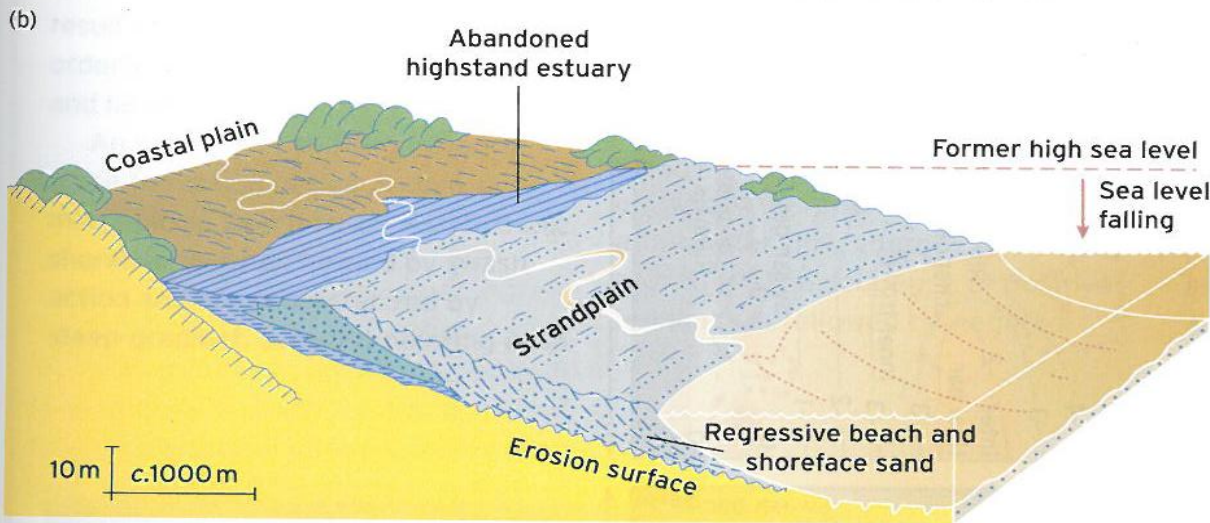


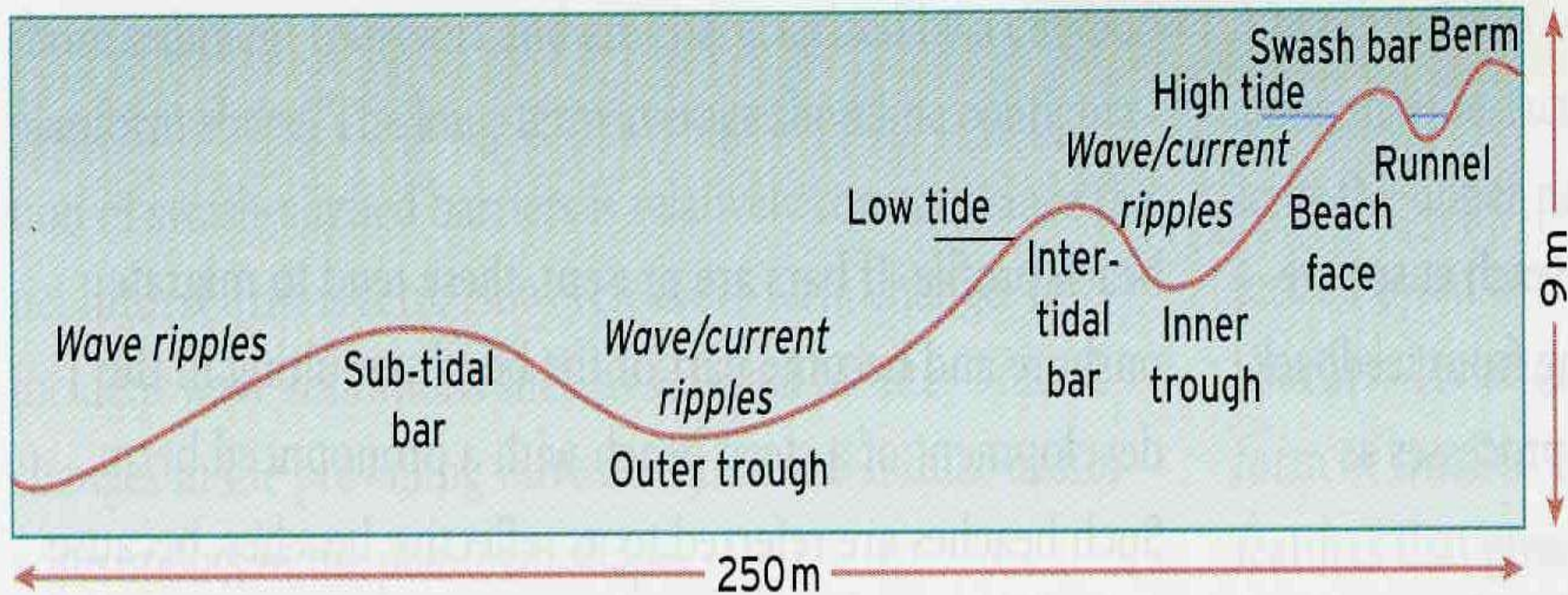
Figure 17.25 (a) Model of transgressive barrier during sea-level rise. Transgressive barriers are almost entirely composed of tidal delta and washover deposits. The barrier migrates into estuarine and lagoonal environments as sea level rises. (b) Model of regressive barrier during sea-level fall. The surface of the regressive barrier forms a wide strandplain, generally without estuaries. (Source: after Roy *et al.*, 1994)



Natural protection

- * Beaches

- * Concave (with micro features)
- * Underwater beach called the shoreface
- * Self organisation
- * Berm Protects (steep in gravel beaches)
- * Beaches respond to changing wave conditions e.g. Seasonal profiles



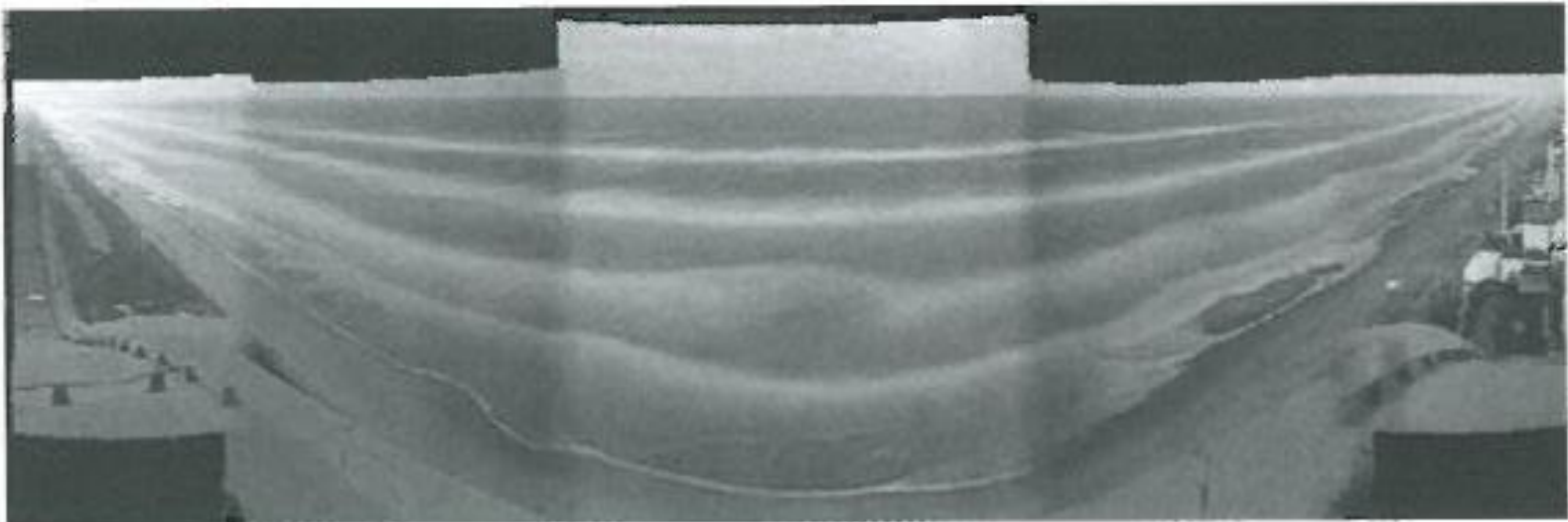
Beach cusps (pos+ & Neg- feedback leads to equilibrium



Figure 17.28 Beach cusps on a gravel beach. The longshore spacing of the cusps is approximately 3 m.

Research

- In recent decades our understanding significantly improved with the use of video monitoring



Dune

(a)



- Denmark 2013

B. TIDE-DOMINATED COASTS

* Estuarine



(a)

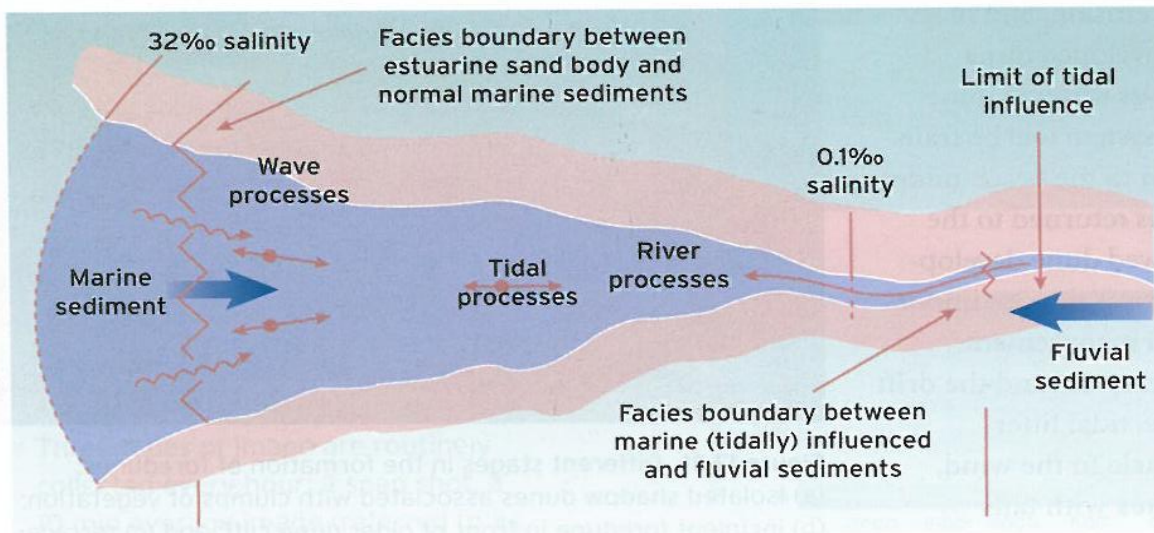
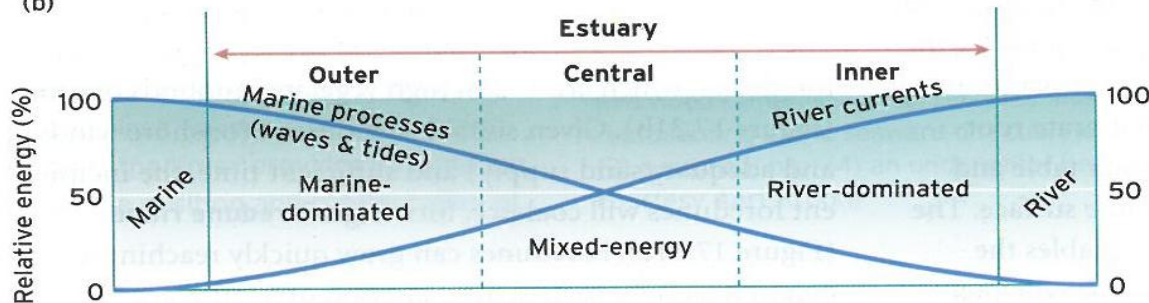


Figure 17.32 (a) Plan view of an estuary showing sediment and hydraulic boundaries. (b) Chart showing the changing mix of wave, tide and river processes along the estuary axis. (Source: after Dalrymple *et al.*, 1992, SEPM (Society for Sedimentary Geology))

(b)



Wave and Tide dominated estuaries

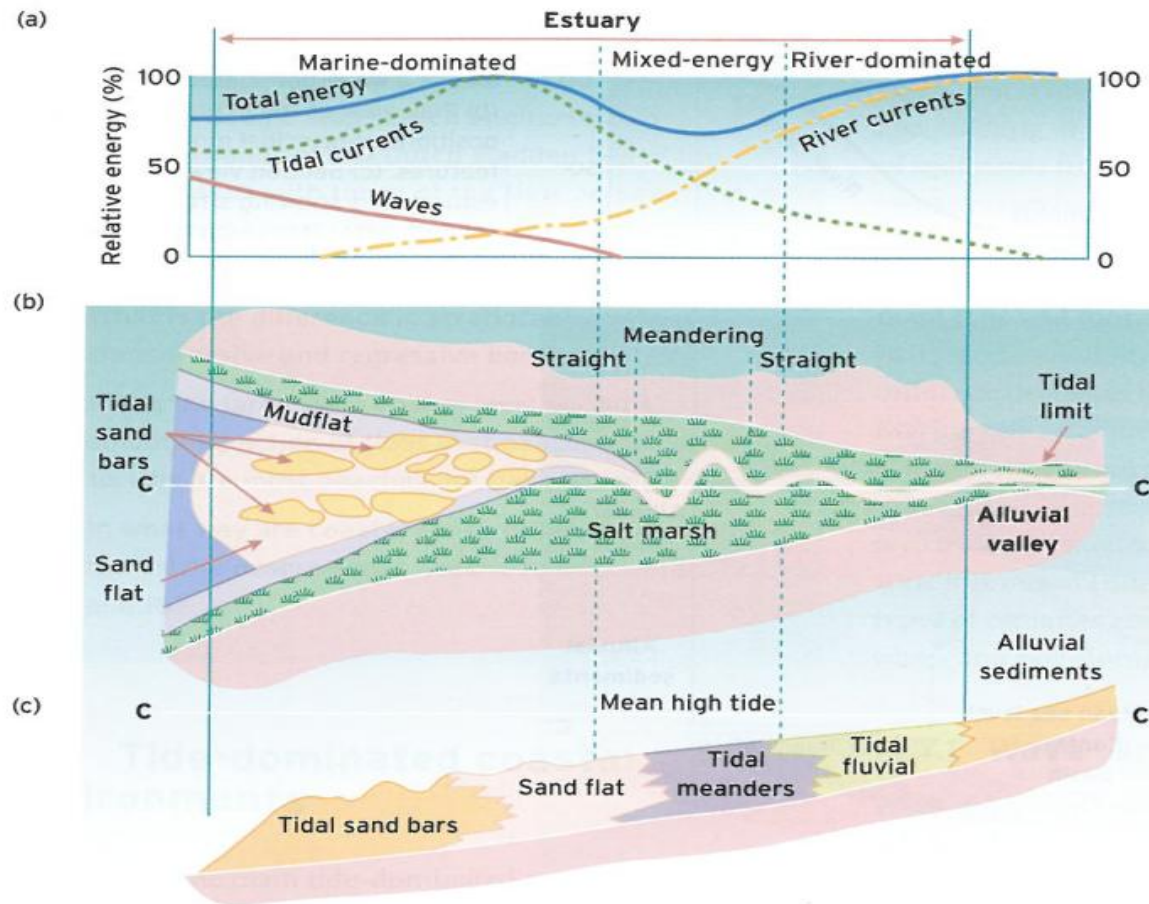


Figure 17.34 (a) Chart showing the change in energy regime along the axis of a tide-dominated estuary. (b) Plan view of the estuary showing positions of principal morphological features. (c) Section view along the estuary axis showing stratigraphy. (Source: after Dalrymple *et al.*, 1992, SEPM (Society for Sedimentary Geology))

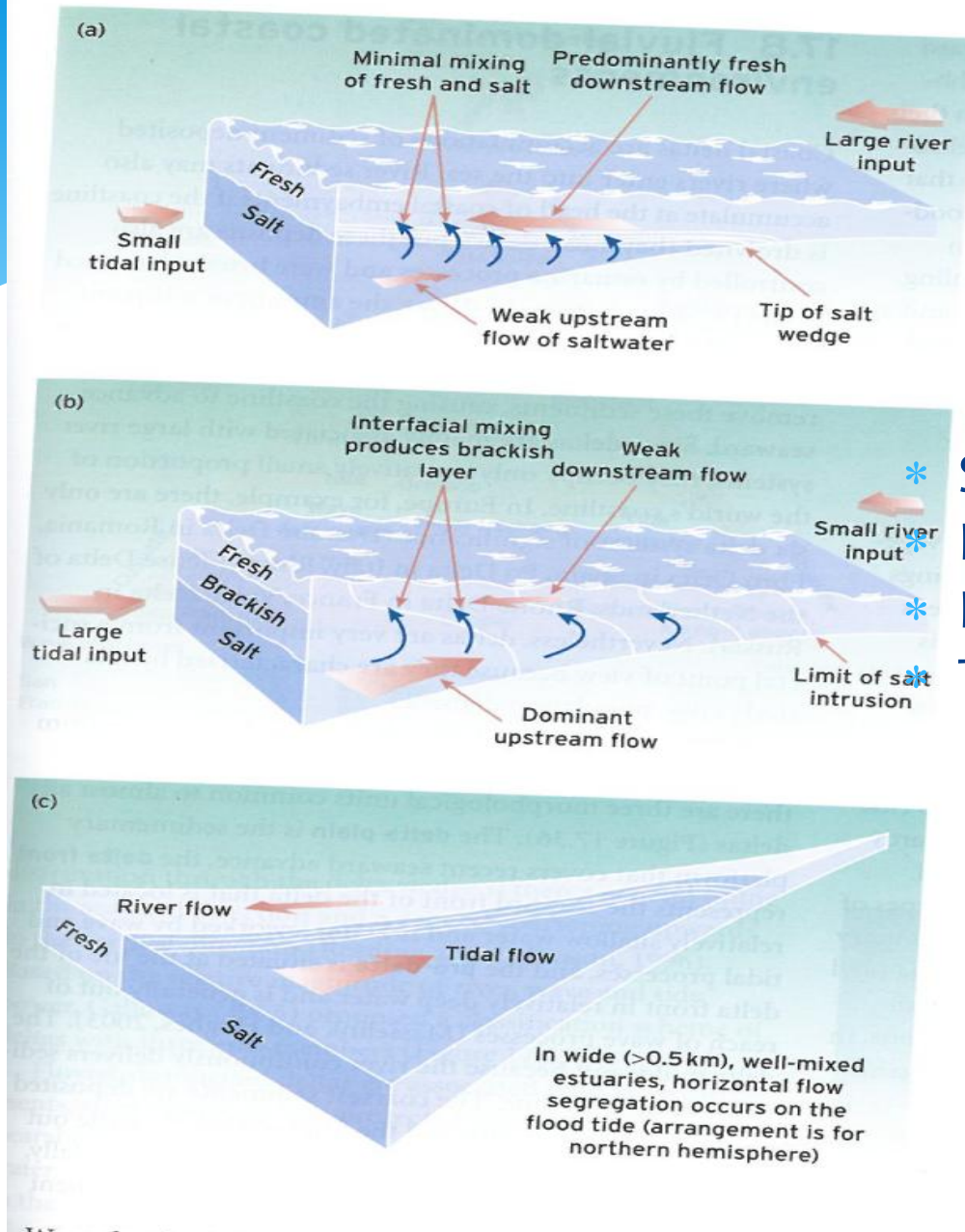


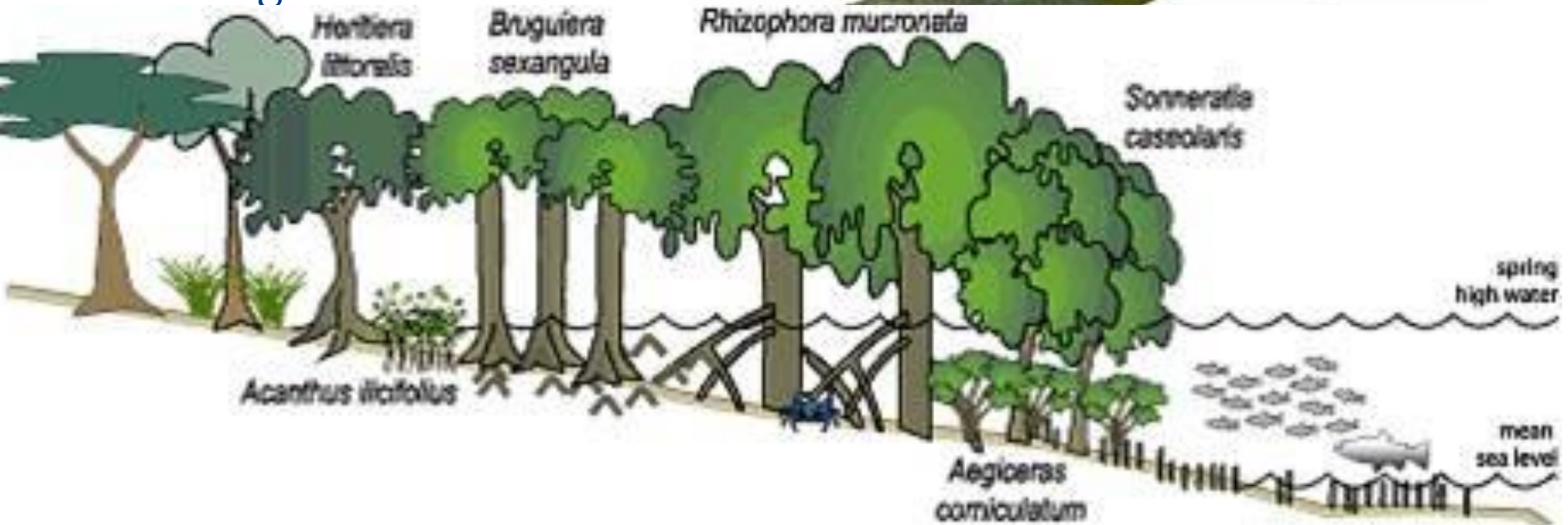
Figure 17.35 Diagram illustrating three main types of estuaries based on density stratification: (a) stratified; (b) partially mixed; and (c) well-mixed estuary. Water masses are indicated by shading on the front face of each block. Salinity contours (arbitrary scale) are indicated by thin lines on the side face of each block in (a) and (b) and on the top face of the block in (c). In (a) and (b) vertical mixing is indicated by thin arrows and non-tidal currents are indicated by thick arrows. (Source: after Pethick, 1984)

Salt and freshwater Ecologically important Density differences Types

- * Stratified (Halocline: Fresh on top of salt) Micro tidal/river discharge
- * Partially mixed (meso tidal)
- * Mixed (meso/macro tides) Large rivers coriolis = horizontal separation

Upper intertidal zone

- * Salt marsh
 - * temperate
- * Mangrove
 - * Tropical
- * Both have distinct ecological zonation



C. FLUVIAL-DOMINATED

- * Deltas
 - * Sediment from rivers is > than the erosion from coastal processes
 - * Large rivers (only 6 in Europe)
 - * Very imp. For ecological and demographics

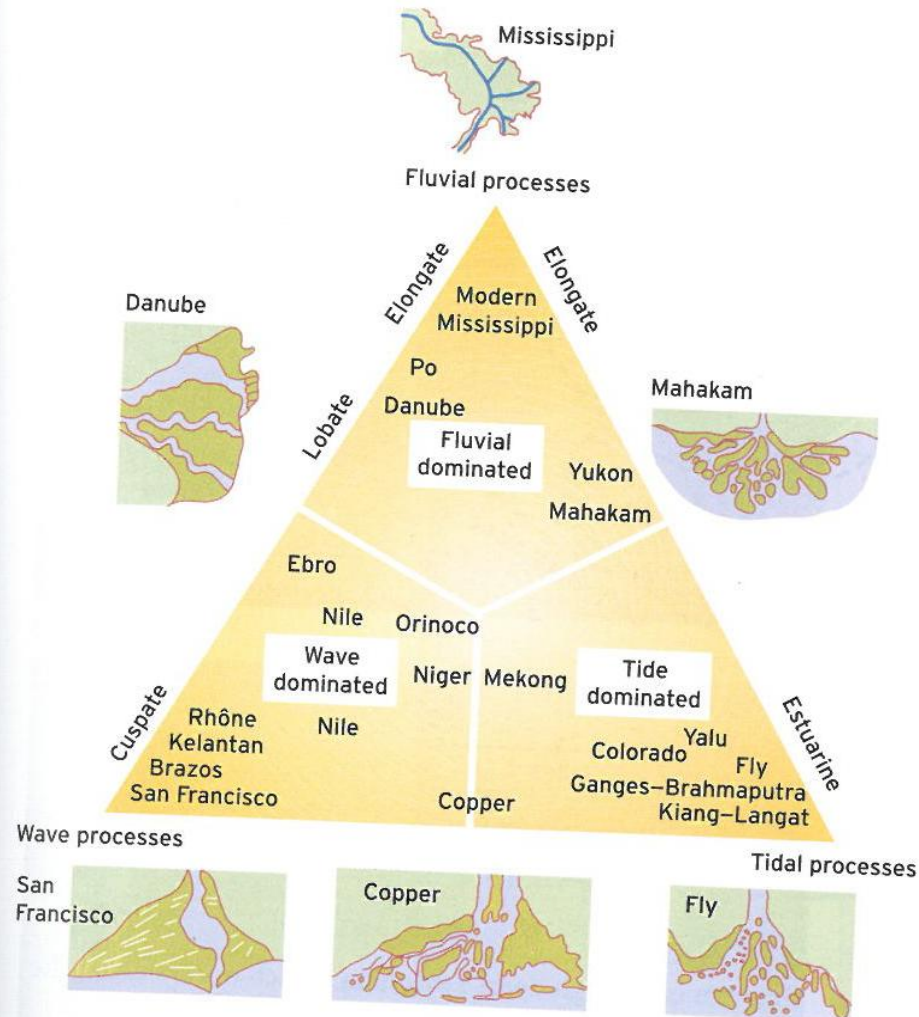


Figure 17.38 The Mississippi Delta is shaped like a 'bird's foot' and is the classic example of a river-dominated delta. The scene shown in this false-colour image covers an area of 54 km by 57 km and represents the currently active delta front of the Mississippi known as the Balize.

Deltas

dominated coastal environments

Figure 17.37 Classification of fine-grained deltas proposed by Galloway (1975). The end-member types are fluvial-, tide- and wave-dominated. (Source: From Briggs *et al.*, 1997)



Dynamic environment (Delta switching)

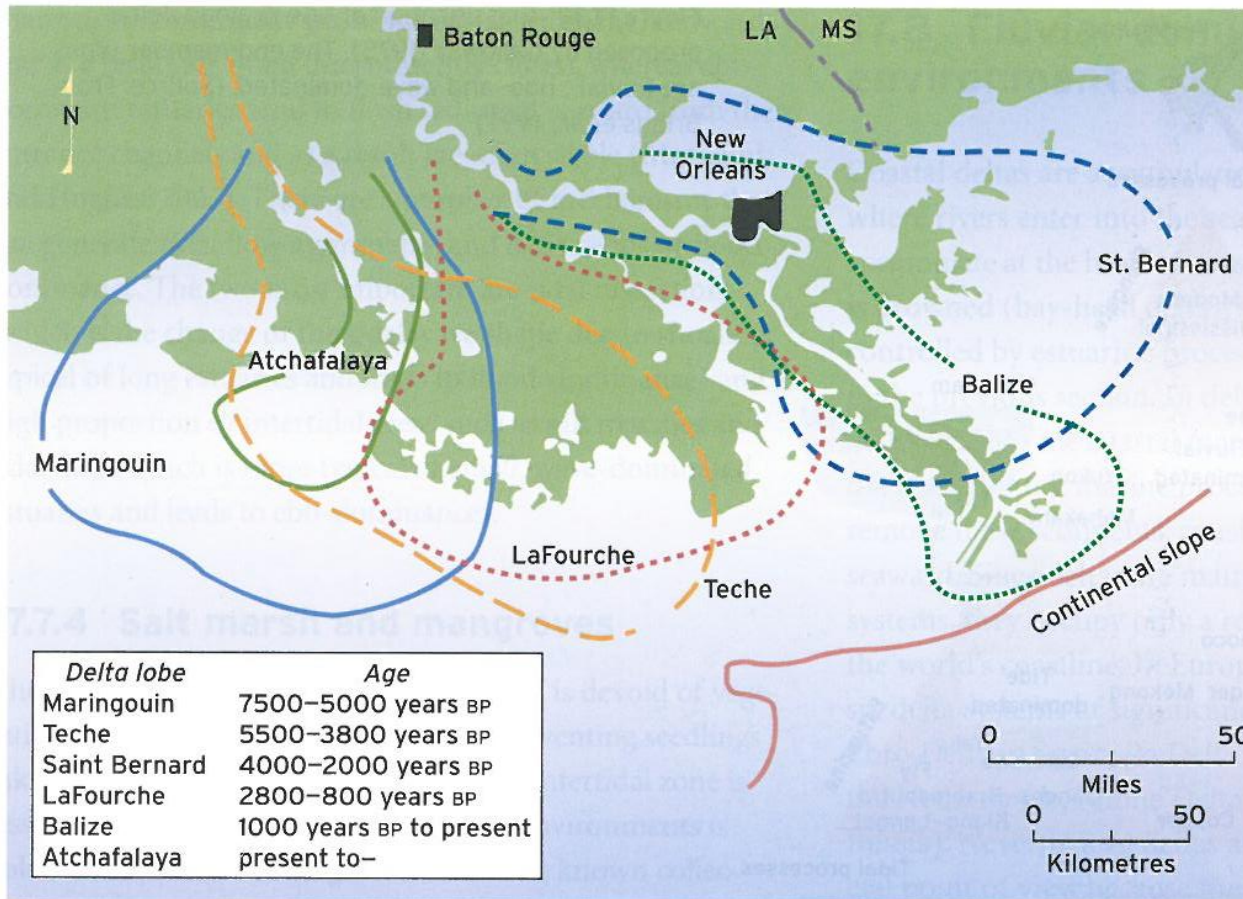


Figure 17.39 Outlines of the five delta lobes that make up the Mississippi Delta. The currently active delta lobe, the Balize, is shown in Figure 17.38. The youngest delta lobe is the Atchafalaya, which is not yet fully occupied by the river. (Source: adapted from Pilkey, 2003)

Conclusion

- * Coastal processes and habitat management
- * Coastal management and conservation
- * SL rise and conservation

