9.3 Beach and Barrier Island Systems

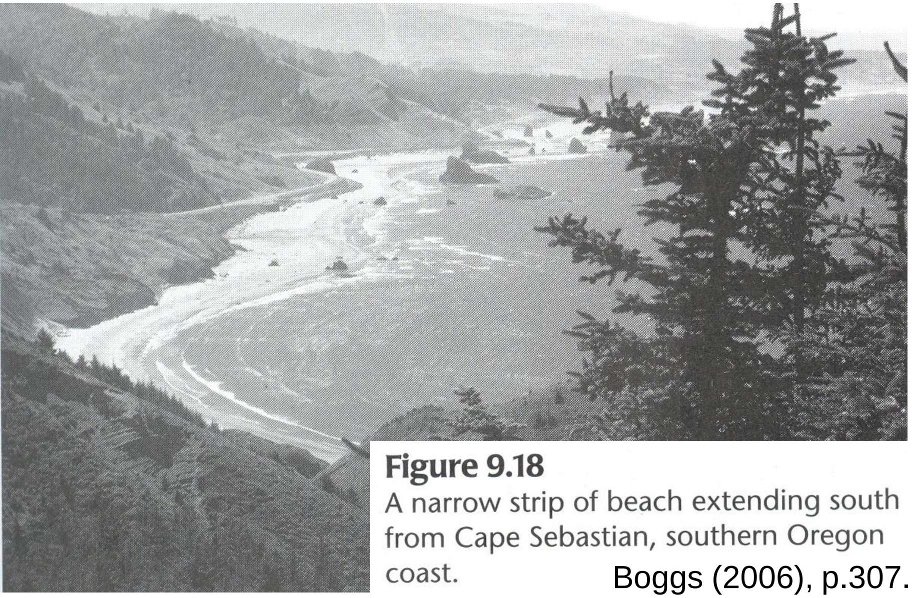
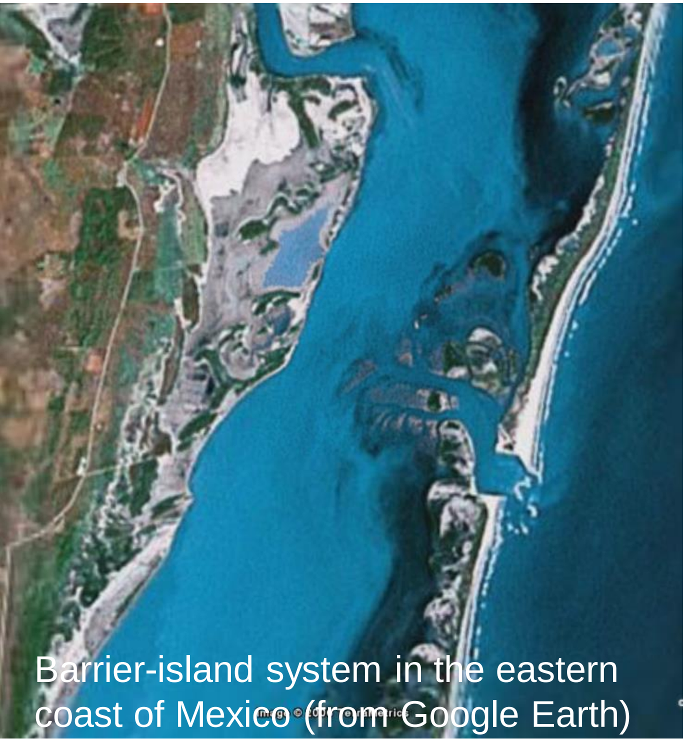


Figure 9.18
A narrow strip of beach extending south from Cape Sebastian, southern Oregon coast.
Boggs (2006), p.307.



Barrier-island system in the eastern coast of Mexico (from Google Earth)

Mainland beaches: long, narrow accumulations of sand aligned parallel to the shoreline and attached to land.

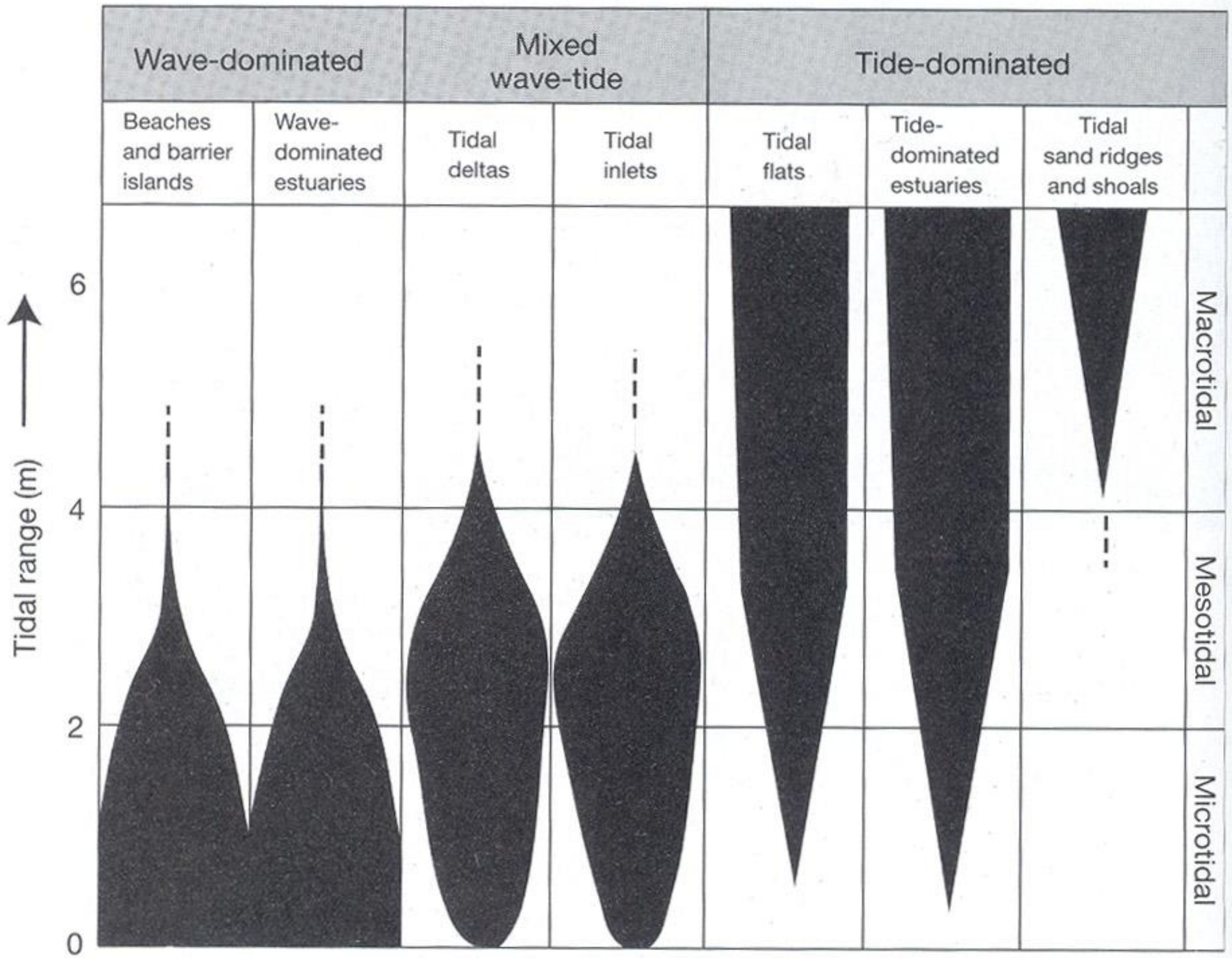
Beach and barrier island occur in three types:

- A **single beach** attached to the mainland,
- A broader **beach-ridge system** that constitutes a strand plain, which consists of multiple parallel beach ridges and parallel swales, but which generally lacks well-developed lagoons or marshes; a type of strand plain consisting of sandy ridges elongated along the coast and separated by coastal mudflat deposits is called a chenier plain,
- A **barrier island** separated wholly or partly from the mainland by a lagoon or marsh.

Barrier island beaches: similar to mainland beaches but are separated from land by a shallow lagoon, estuary, or marsh. Barrier island beaches are often dissected by tidal channels or inlets.

<u>Coasts are classified on the basis of tidal range:</u>

- **Microtidal** (0-2 m tidal range, e.g. northwest, southwest and east Taiwan coast): Barrier-island and associated environments occur preferentially along microtidal coasts.
- **Mesotidal** (2-4 m, e.g., westcentral Taiwan coast): If barriers are present, they are typically short or stunted, with tidal inlets common.
- **Macrotidal** (> 4 m): Barriers are generally absent. The extreme tidal range causes wave energy to be dispersed and dissipated over too great a width of shore zone to effectively from barriers.



Boggs (2006), p.308.

Figure 9.20
Types of coastline with respect to tidal range, grouped into wave-dominated, tide-dominated, and mixed wave-tide types. [After Hayes, M. O.,1979, Barrier island morphology as a function of tidal and wave regime, *in* Leatherman, S. P. (ed.), Barrier islands from the Gulf of St. Lawrence to the Gulf of Mexico: Academic Press, New York, Fig. 2, p. 4, reproduced by permission.]

Depositional setting: beach (海灘) and shoreface (濱面)

Beach environments:
- **Backshore**: landward from the beach berm above high-tide level and commonly includes back-beach dune deposits;
- **Foreshore**: intertidal (littoral) zone between low-tide and high-tide level.

Shoreface (nearshore): from low-tide level to the fair-weather wave base (about 10-15 m).

Main depositional processes:
Fair-weather and storm **waves**, **wave swash and backwash** on beaches, **nearshore currents** (longshore and rip currents).

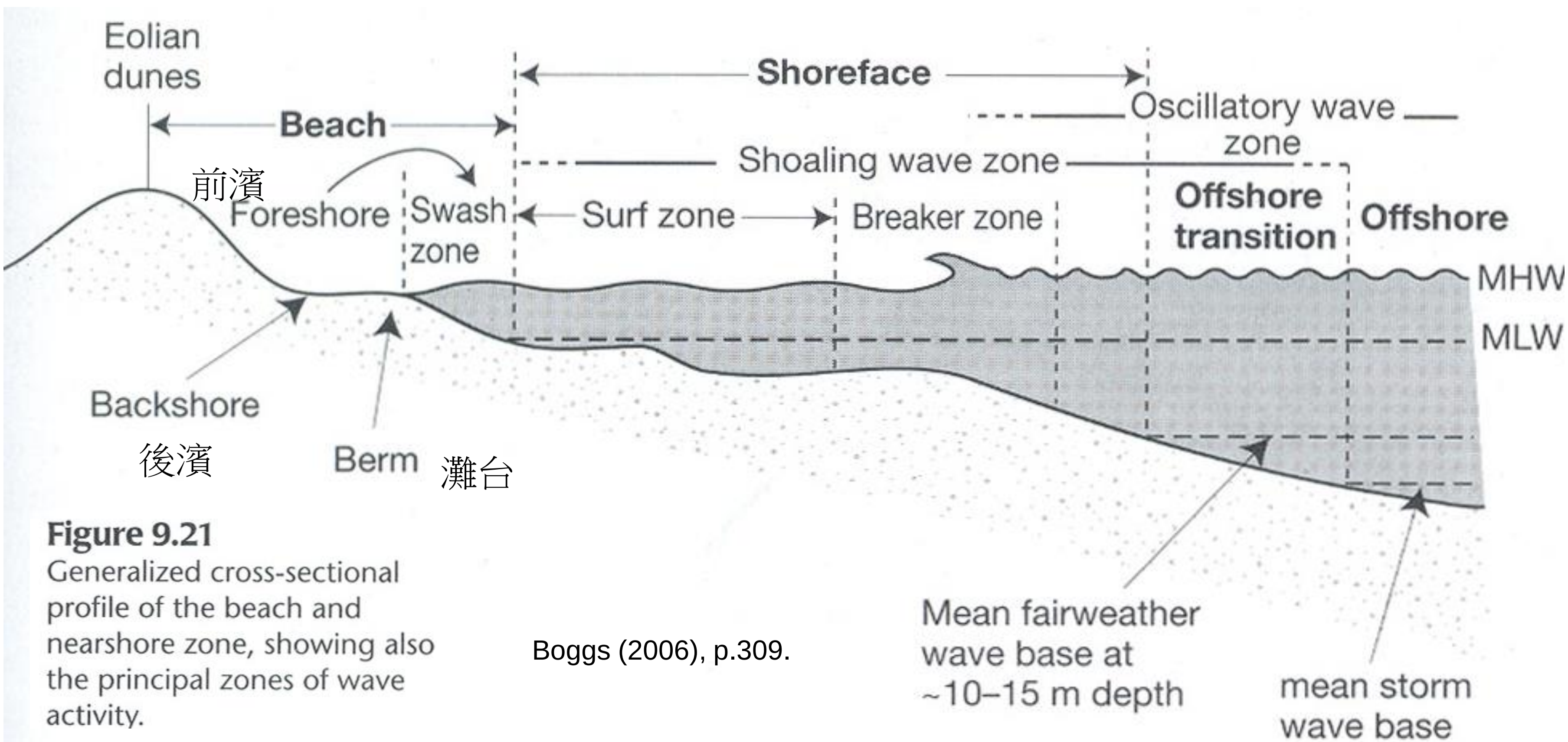


Figure 9.21
Generalized cross-sectional profile of the beach and nearshore zone, showing also the principal zones of wave activity.

Boggs (2006), p.309.

Wave processes

As waves progress shoreward into the shallow shoaling zone, forward velocity of the waves slows, wave length decreases, and wave height increases. The waves eventually steepen to the point where orbital velocity exceeds wave velocity and the wave breaks, creating the **breaker zone (碎浪帶)** . Breaking waves generate turbulence that throws sediment into suspension and also brings about a transformation of wave motion to create the **surf zone (衝浪帶)** **.** In this zone, a high-velocity translation wave (a wave translated by breaking into a current, or bore, is projected up the upper shoreface, causing landward transport of bedload sediment and generation of a short-duration “suspension cloud” of sediment. At the shoreline, the surf zone gives way to the **swash zone (流濺帶)** , in which a rapid, very shallow swash flow moves up the beach, carrying sediment in partial suspension, followed almost immediately by a backwash flow down the beach. The backwash begins at very low velocity but accelerates quickly. (If heavy minerals are present in the suspended sediment, they settle rapidly to generate a thin heavy-mineral lamina).

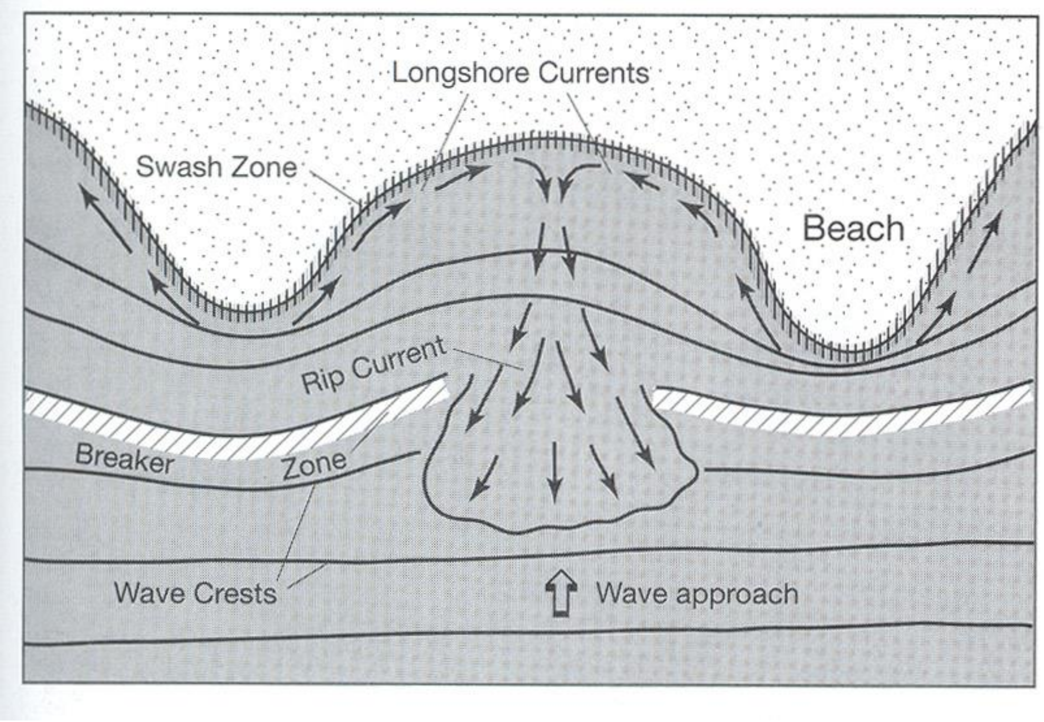
- Normal waves of moderate to low energy tend to produce a net landward and alongshore transport of sediments thus building up beaches.
- Storm waves cause erosion of the beach and a net displacement of sediments in a seaward direction.
- Sediments tend to be well sorted, positively skewed deposits (better sorted coarser half than finer half).
- Heavy minerals tend to accumulated on swash zone due to the slow backwash flow.

Wave-induced currents

As breakers and winds pile water against the beach, they create not only wave but also two types of unidirectional currents:

◆ **Longshore currents**: When waves approach the shore at an angle. These currents move parallel to shore following longshore troughs, which are shallow troughs in the lower part of the surf zone. This system of parallel longshore troughs between shallow beach ridges is referred to as a ridge and runnel system. Together with swash zone processes, longshore currents are primary agents of alongshore sand movement.

◆ **Rip currents**: Where two opposite-directed longshore current meet and there is a topographic low between sand bars, the current moves seaward as a narrow, near-surface currents. These currents may entrain considerable sediments in suspension and carried out to sea by surface flow.



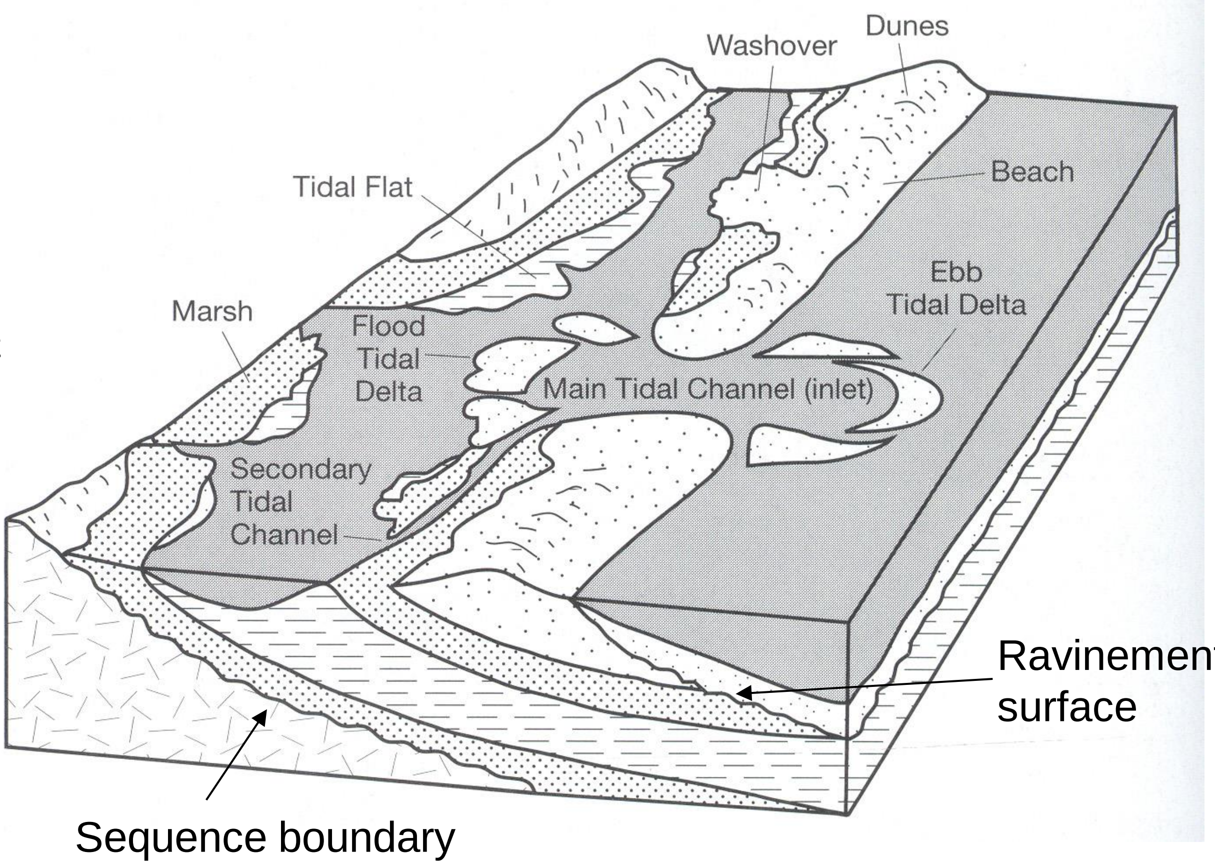
Boggs (2006), p.311.

Figure 9.22
Schematic representation of longshore currents that move locally in opposite directions, generated owing to bending (refraction) of wave crests as they move over an irregular seafloor, leading to the formation of rip currents that flow seaward through the breaker zone.

Depositional setting: Barrier-island system

Three environments: Recognition of ancient barrier-island complexes requires that this intimate association of the three environments be recognized.

- Sandy-barrier chain: subtidal to subaerial barrier-beach complex.
- Enclosed lagoon, estuary, or marsh: the back-barrier, subtidal-intertidal region,
- Tidal inlets, flood and ebb tidal deltas: Channels that cut through the barrier and connect the back-barrier lagoon to the open sea

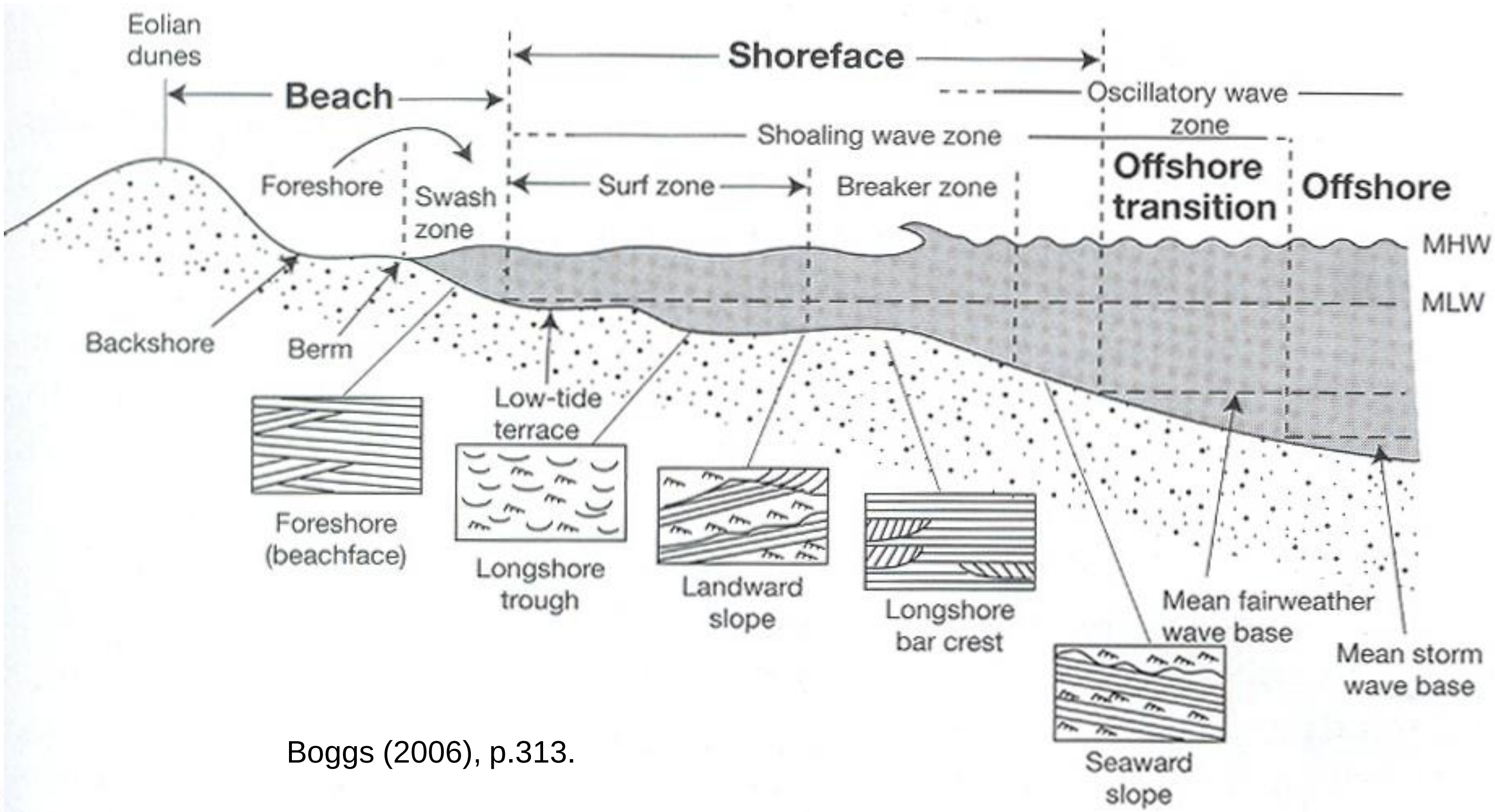


Boggs (2006), p.312

Figure 9.23
Generalized model illustrating the various subenvironments in a transgressing barrier-island system. [From Reinson, G. E., 1992, Transgressive barrier island and estuarine systems, *in* Walker, R. G., and N. P. James (eds.), Facies models, Fig. 3, p. 180, reproduced by permission of Geological Association of Canada.]

Beach deposits: Backshore

- A zone dominated by intermittent storm-wave deposition and eolian sad transport and deposition.
- Faint, landward-dipping, nearly horizontal laminae, interrupted locally by crustacean burrows, record deposition by storm waves. These beds may be overlain by small- to medium-scale eolian trough cross-bed sets, which are commonly disturbed by root growths and burrows of land-dwelling organisms.



Boggs (2006), p.313.

Figure
Typical sedimentary structures formed in the beach and nearshore zone (same profile as shown in Fig. 9.21). [Sedimentary structures after Davidson-Arnott, R. G. D., and

Backshore deposits: Kenting National Park

Beach deposits: Foreshore

- Predominantly of fine to medium sand but may also include scattered pebbles and gravel lenses or layers.
- Sedimentary structures are mainly parallel laminae, which dip gently (2-3 degree) seaward.
- Thin, heavy mineral laminae are commonly present, alternating with layers of quartzose sand.
- Antidues maybe formed.
- High-angle cross bed dips landward caused by migration of foreshore ridges.

Shoreface deposits

Shoreface can be divided into upper, middle, and lower shorefaces, which correspond roughly to the surf, breaker, and outer shoaling zones.

- Upper shoreface (surf-zone) deposits: Form in an environment dominated by strong bidirectional translation waves and longshore currents. Multidiretional trough cross beds are common with trace fossils such as Skolithos.

- Middle shoreface (breaker zone): Form in high-energy conditions owing to breaking waves and associated longshore and rip currents. Sediments are mianly fine- to medium-grained sand, with minor amounts of silt and shell material, that may display both landward- and seaward-dipping trough cross-beds as well as subhorizontal plane laminations. Trace fossils consisting of vertical burrows (such as Skolithos and Ophiomorpha) are common.

- Lower shoreface (outer shoaling zone): Form under relatively low-energy conditions and grade seaward itno open-shelf deposits. They are composed dominatly of fine to very fine sand but may contain thin, intercalated layers of silt and mud. Sedimentary structures can include small-scale cross-stratification; planar, nearly horizontal laminated bedding; and hummocky cross-stratification. Trace fossils such as Thalassinoides may be common.

Back-barrier sediments

Washover fan: occur where storm-driven waves cut through and overtop barriers, washing lobes of sandy beach sediment into the back-barrier lagoon.
Sediment: consists dominantly of fine- to medium-scale landward-dipping foreset bedding.

Tidal-channel: occur where tidal currents cut through barriers into inner lagoons.
Sediments: dominantly of sand, commonly have an erosional base marked by coarse lag sands and gravels; bidirectional large- to small-scale planar and trough cross-beds that may display a general fining-upward textural trend.

Tidal-delta: form on both the lagoonal side of the barrier (flood-tidal delta) and the seaward side of the barrier (ebb-tidal delta). **Sediments**: dominantly of sands attaining a vertical thickness of tens of meters; highly varied succession of planar and trough cross beds that may dip in either a landward or a seaward direction.

Tidal-flat: form along the margins of the mainland coast and the back of the barrier.
Sediments: grade from fine- to medium-grained ripple-laminated sands in <u>lower areas</u> of the tidal flats through flaser- and lenticular-bedded fine sand and mud in <u>midtidal flats</u> to layered muds in <u>higher parts</u> of the flats.

Lagoonal and marsh: occur in low-energy back-barrier lagoon and grade laterally into higher energy, sandy deposits of tidal channels, deltas, and washover lobes. **Sediment**: dominantly of interbedded fine sands, silts, muds, and peat deposits that may be characterized by disseminated plant debris, brackish-water fossils such as oysters, and horizontal to subhorizontal layering.

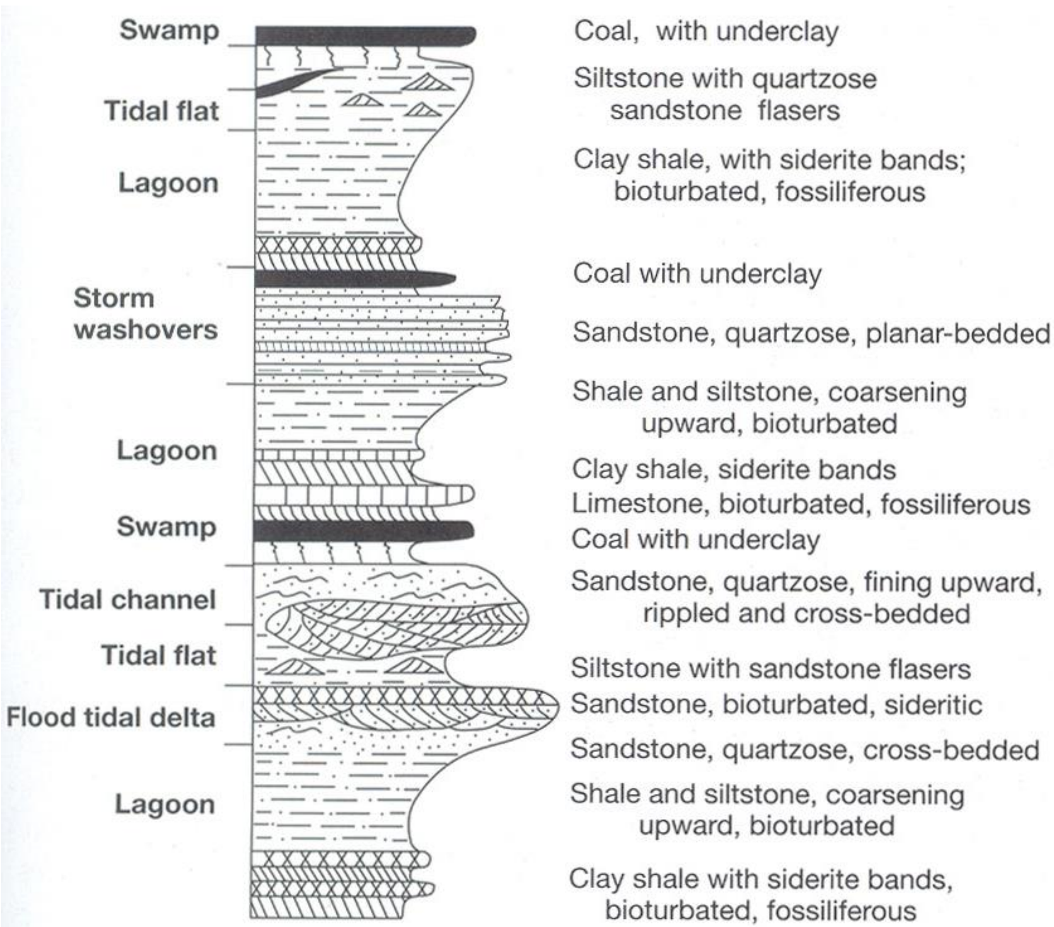


Figure 9.27
Generalized succession of facies deposited in a back-barrier environment, Carboniferous of eastern Kentucky and southern West Virginia. Such successions range from 7.5 to 24 m thick. [After Horne, J. C., J. C. Ferm, F. T. Caruccio, and B. P. Baganz, 1978, Depositional models in coal exploration and mine planning in Appalachian region: Am. Assoc. Petroleum Geologists Bull., v. 62, Fig. 4, p. 2385, reprinted by permission.]

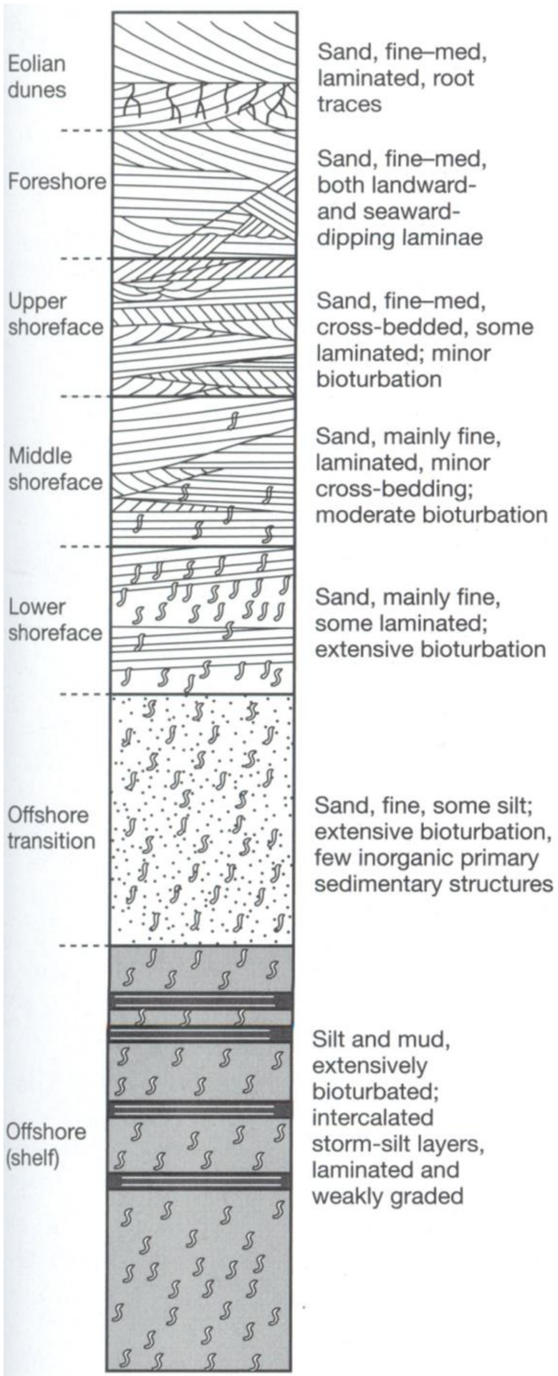
Boggs (2006), p.317.

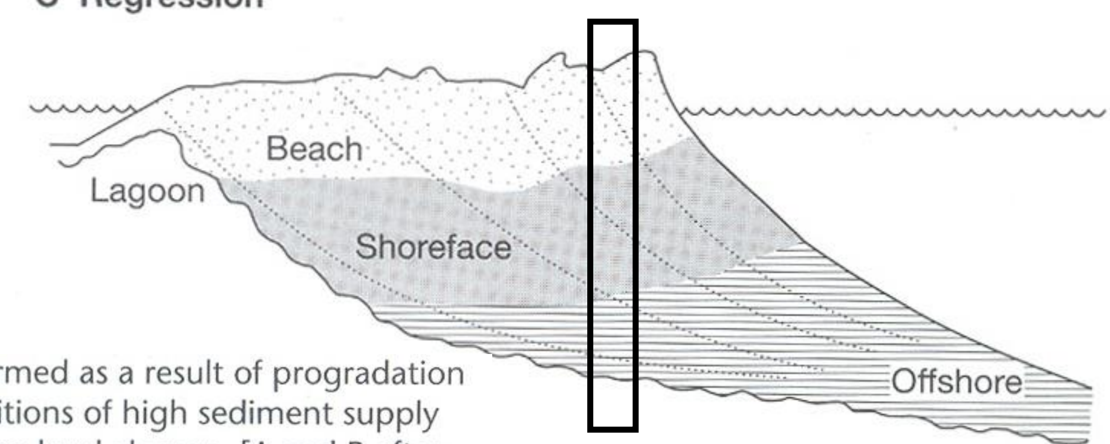
Ancient beach and barrier-island sediments

In response to the change of relative sea level and amount of sediment supply the shoreline may move in a landward direction (transgression) or in a seaward direction (regression).

Regression leads to deposition of back-barrier lagoonal and marsh deposits over sandy deposits of the barrier beach-beach complex.

Barriers tend to be transformed into strand plains, producing dominantly sandy facies in which beach deposits overlie shoreface deposits.





C. Facies formed as a result of progradation under conditions of high sediment supply relative to sea-level change. [A and B after

Figure 9.25
Idealized succession of beach sediments on a low-energy, prograding, Holocene beach. [After Reineck, H. E., and I. B. Singh, 1980, Depositional sedimentary environments, 2nd ed., Fig. 534, p. 387, reprinted by permission of Springer-Verlag, Heidelberg.]

Transgression causes deposition of barrier-beach deposits on top of back-barrier lagoonal and marsh deposits.

Boggs (2006), p.312

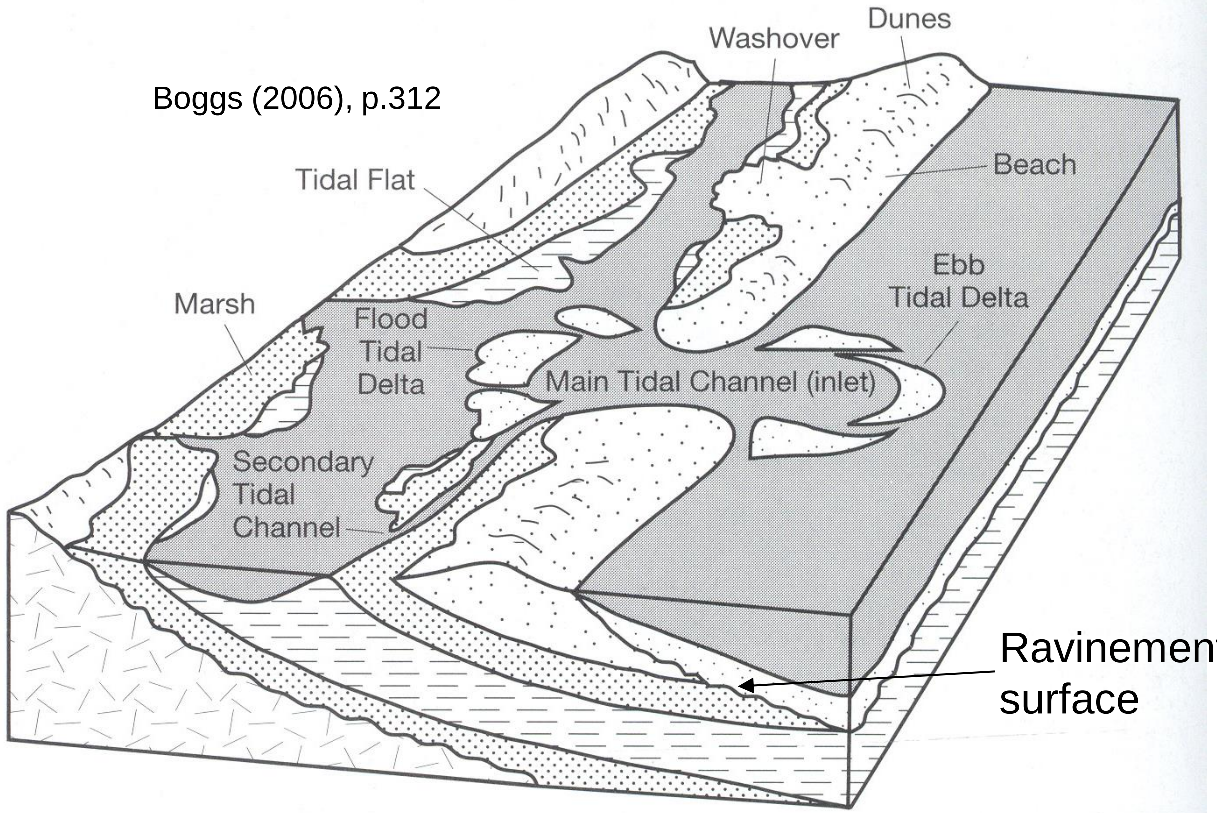


Figure 9.23
Generalized model illustrating the various subenvironments in a trans-gressing barrier-island system. [From

Ravinement surface: A surface generated by marine reworking and erosion during shoreline transgression. Beach and upper shoreface deposits are presumably eroded and transported to the lower shoreface, or offshore as storm beds, or to the lagoon as washover deposits.

Transgression through erosional shoreface retreat

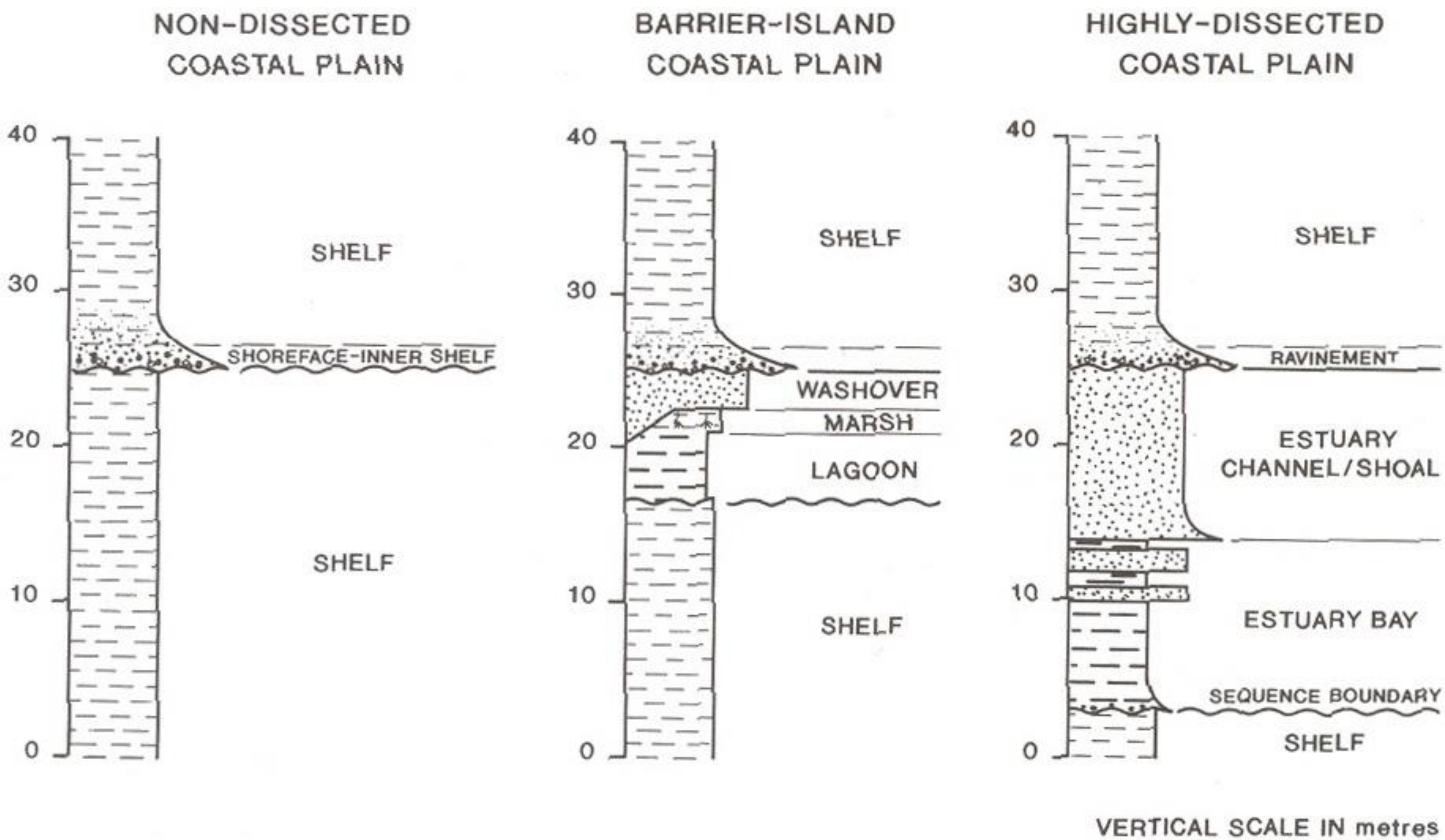


Figure 17 Generalized "end-member" transgressive facies successions for nondissected, barrier-island, and highly dissected coastal plain settings.

Reinson (1992)

Transgressive beach and barrier-island deposits may be generated by two mechanisms

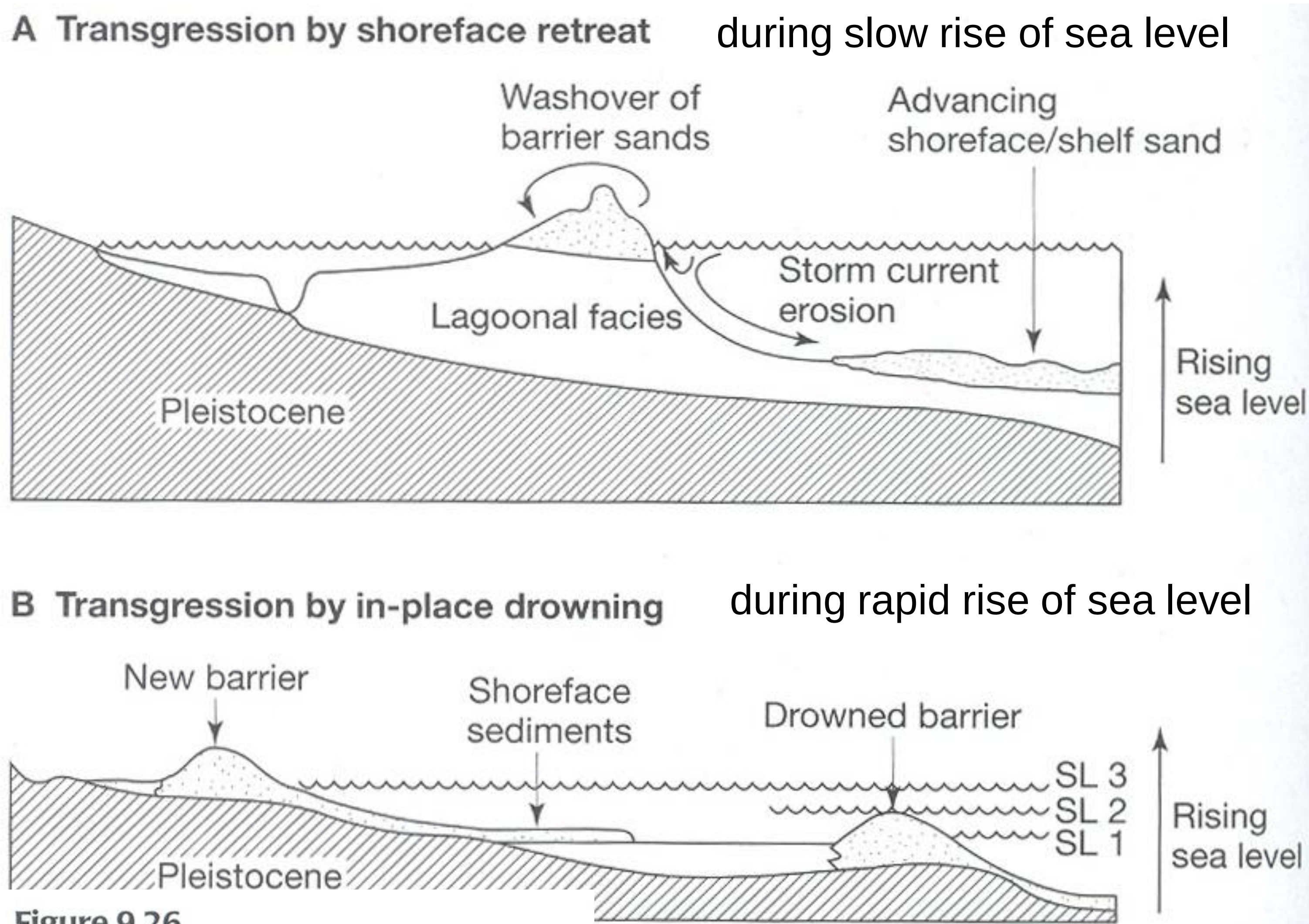


Figure 9.26
Barrier-island facies generated by transgression and regression. A. Transgression owing to shoreface retreat during gradual sea-level rise. B. Effects of rapid sea-level rise, producing in-place drowning (SL = sea level).

Boggs (2006), p.316

9.4 Estuarine Systems

Estuary: The seaward portion of a drowned valley system which receives sediments from both fluvial and marine sources and which contain facies influenced by tide, wave, and fluvial processes. Estuary tends to develop during transgression. Regression (progradation) tends to fill and destroy estuaries, causing them to change into deltas.

Boggs (2006), p.317

Figure 9.28
Wave-dominated estuary of the Klamath River, northern California coast. Note the large, northward-projecting (toward bottom of photograph) spit that partially blocks the mouth of the estuary.

Physiographic, Hydrologic, and Sediment Characteristics of Estuaries

7 types of estuary based on physiographic characteristics of relative relief and degree of channel mouth blocking.

High relief estuary

➢ **Fjord**: high-relief estuaries with a U-shaped valley profile formed by drowning of glacially eroded valleys during Holocene sea-level rise.
➢ **Fjard**: related to fjords but have lower relief.
➢ **Ria**: Estuaries developed in winding valleys with moderate relief.

Boggs (2006), p.318

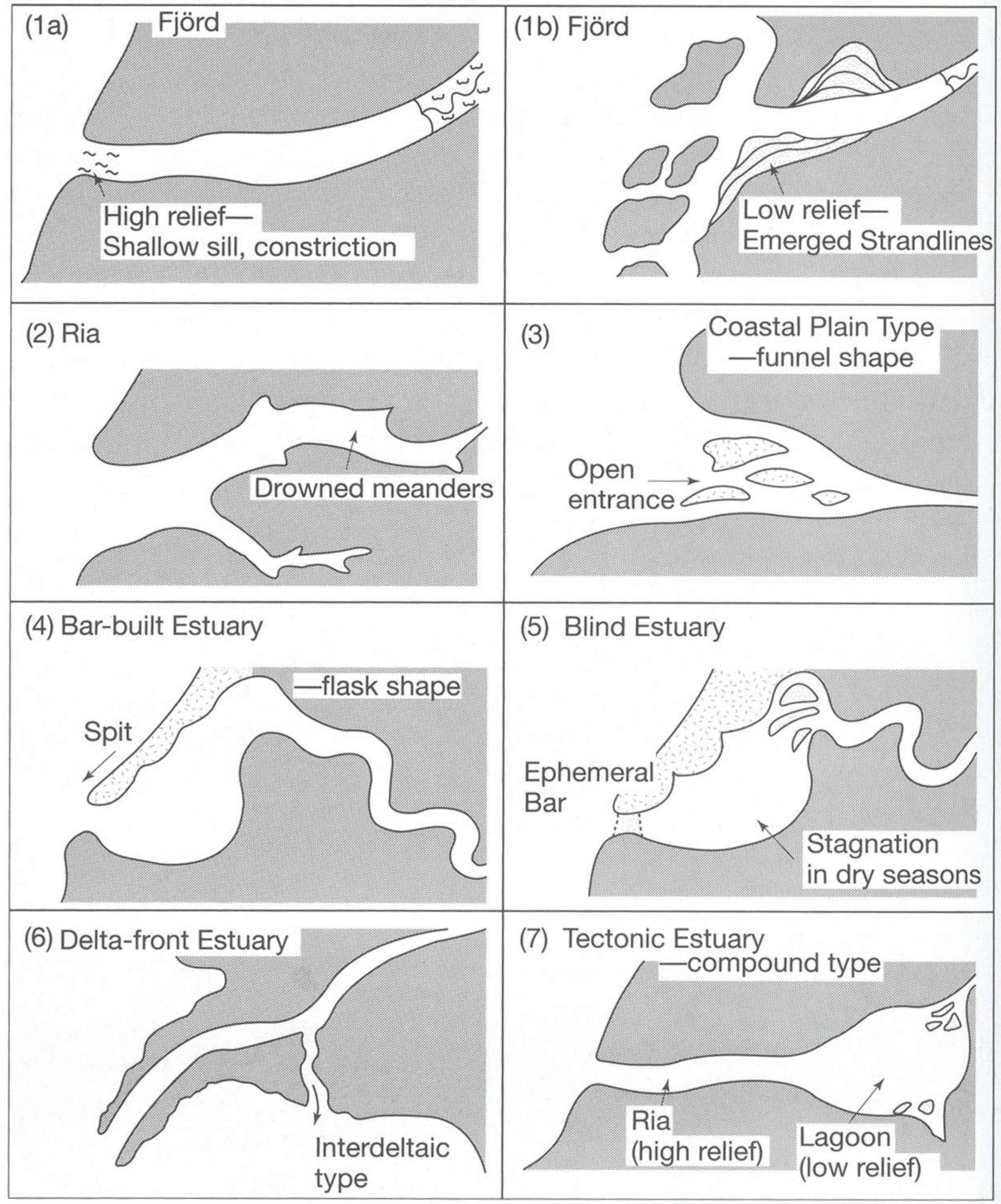


Figure 9.29
Principal types of estuaries based on physiographic characteristics. [From Fairbridge, R. W., The estuary: Its definition and geodynamic cycle, *in* Olausson, E., and I. Cato (eds.), 1980, Chemistry and biochemistry of estuaries, Fig. 2, p. 9, John Wiley and Sons, New York, reprinted by permission.]

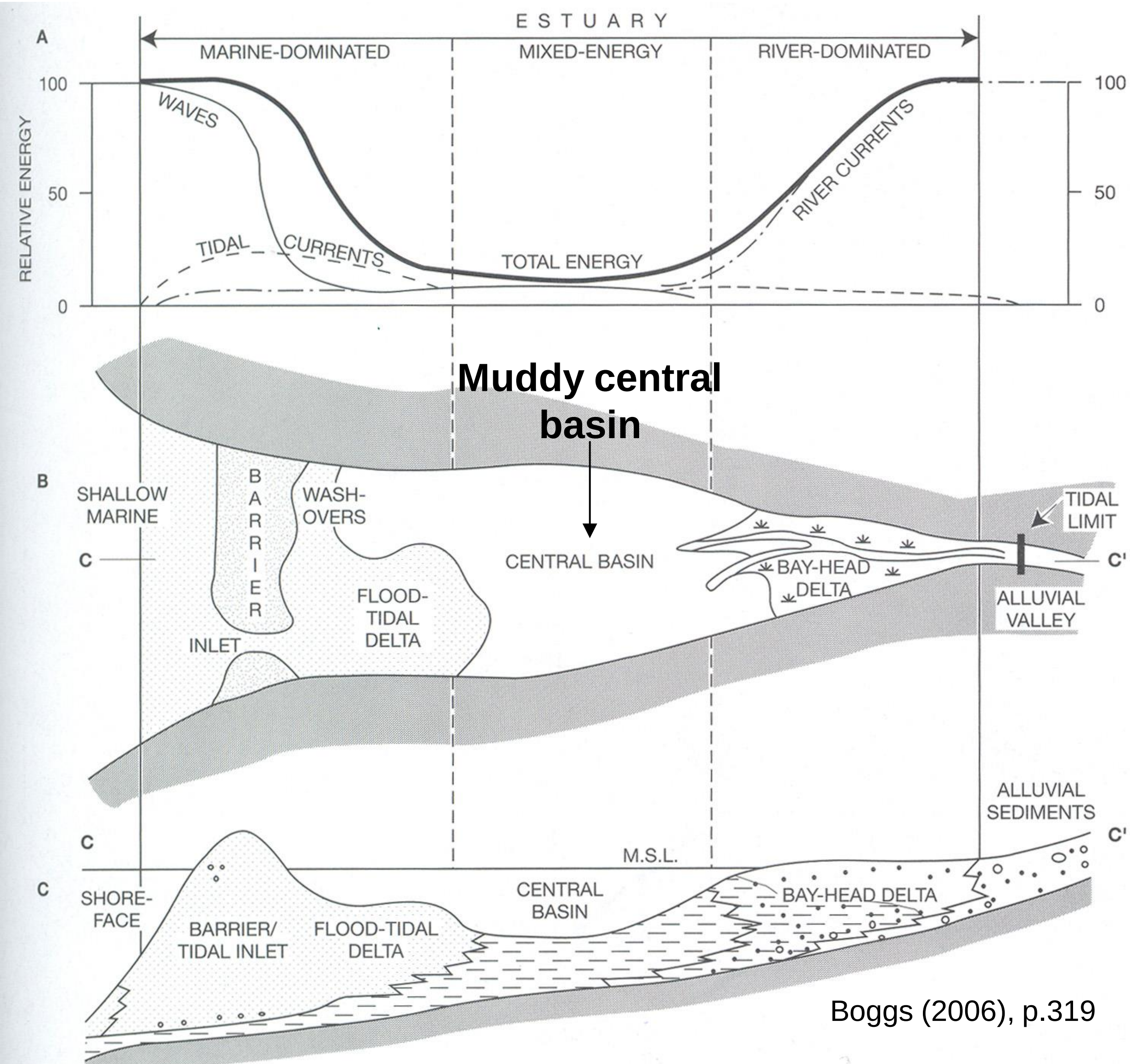
Low relief estuary

- **Coastal-plain estuary**: Low-relief, funnel-shaped in plan view, open to the sea.
- **Bar-built estuary**: Low-relief,, L-shaped in plan view, lower courses paralel to the coast. Similar to lagoon.
- **Blind estuary**: similar to bar-built estuary but are seasonally blocked by longshore drift or dune migration. Similar to lagoon.
- **Deltaic estuary**: occur on delta fronts as ephemeral distributaries.
- **Tectonic estuary** (compound estuary): Flask-shaped, high-relief rias backed by a low-relief plain created by tectonic activity.

Three types of estuary based on hydrologic and sedimentary characteristics: Wave-dominated, tide-dominated, and mixed wave and tide dominated.

Wave-dominated estuary

Estuary mouth experiences high-wave energy. Sediments tend to move alongshore and onshore into the mouth of the estuary, where a subaerial barrier/spit or submerged bar develops.

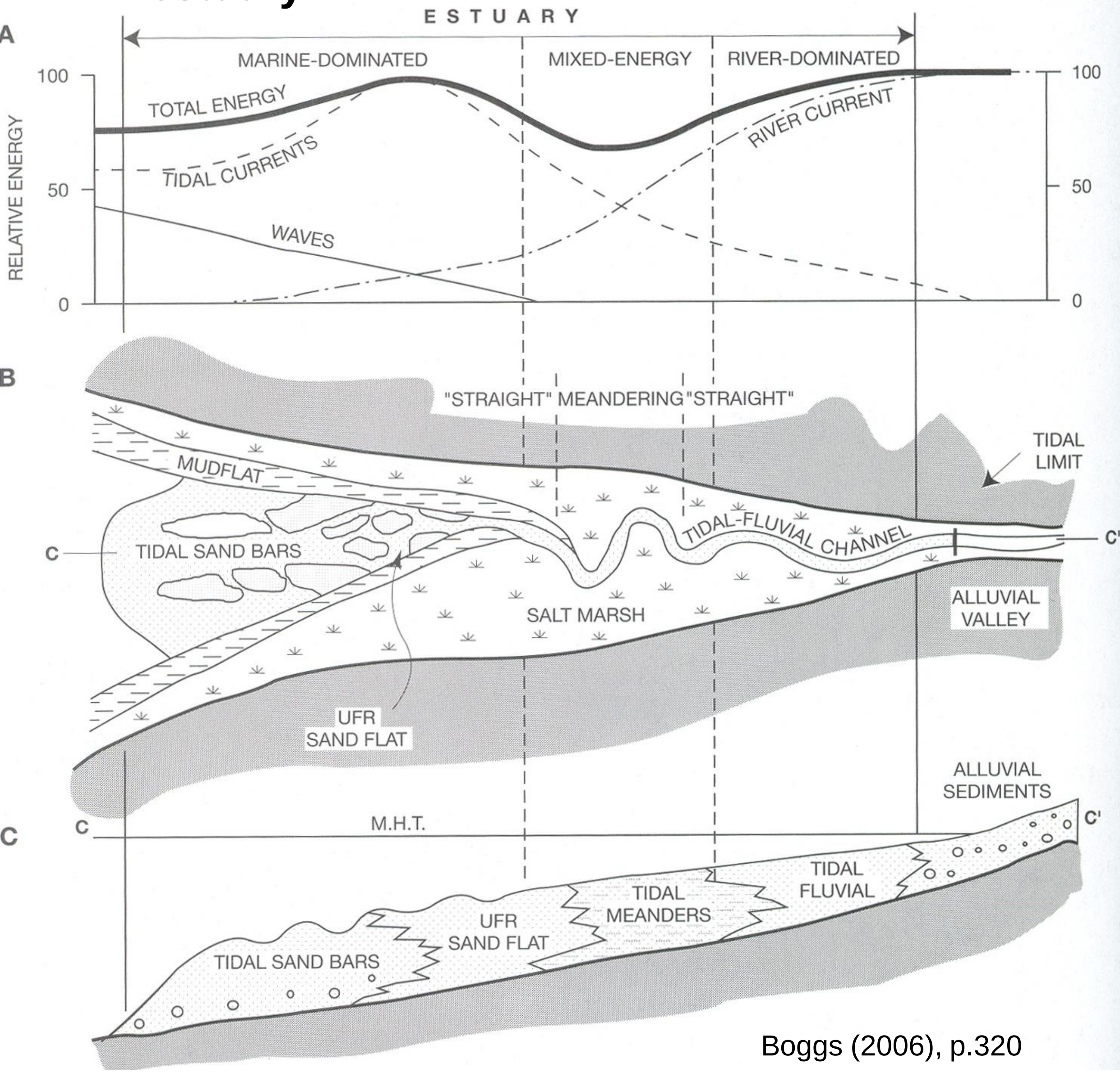


Boggs (2006), p.319

Figure 9.30
Distribution of (A) energy types, (B) morphological components in plan view, and (C) sedimentary facies in longitudinal section within an idealized wave-dominated estuary. The shape of the estuary is schematic. The barrier/sand plug is shown as headland attached; however, on low-gradient coasts, it may be separated from the mainland by a lagoon. The section in Part C represents the onset of estuary filling following a period of transgression. [From Dalrymple,

Tide-dominated estuary

- Elongate tidal sand bars develop parallel to the length of estuary.
- Sandy tidal channels flanked by marshes
- Muddy sediments are characterized by nearly planar alternations of silt, clay, very fine sand, and carbonaceous (plant) debris.
- Bioturbation by burrowing and feeding organisms may locally mix and homogenize these layers.
- Typically contain a brackish-water fauna that may include oysters, mussels etc.



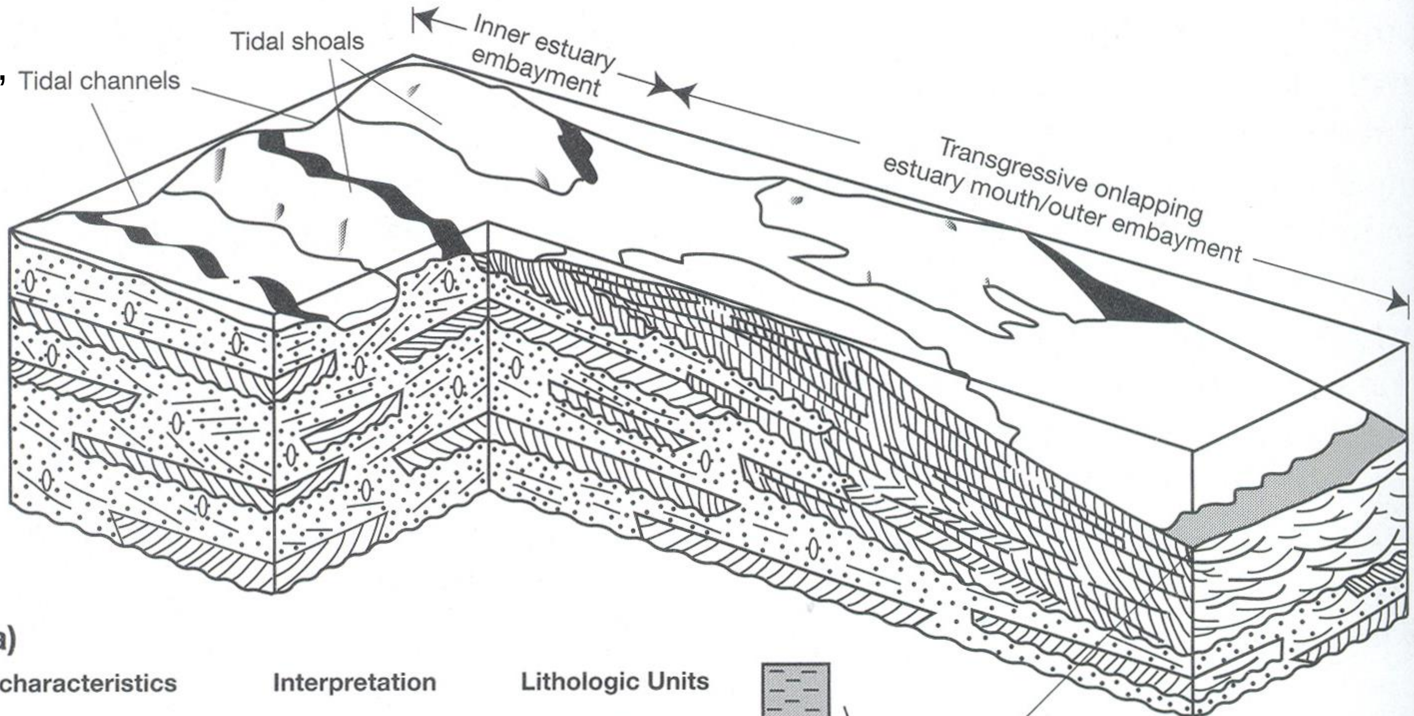
Boggs (2006), p.320

Figure 9.31
Distribution of (A) energy types, (B) morphological components in plan view, and (C) sedimentary facies in longitudinal section within an idealized tide-dominated estuary. UFR = upper-flow regime; M.H.T. = mean high tide. The section in Part C is taken along the axis of the channel and does not show the marginal mudflat and salt-marsh facies; it illustrates the onset of progradation following transgression. [From Dal-

Many estuaries are subjected in time to transgression.

Transgression brings about a landward shifting of environments, resulting in vertical stacking of estuary-mouth sands on top of middle-estuary muds and/or fluvial-tidal channel sands. Regression causes filling and destruction of estuary and seaward progradation, changing it into a delta.

b)



a)

Basic characteristics	Interpretation	Lithologic Units
Fossiliferous clays		Gault Clay
Reworked, fossiliferous, partly cemented sands	Transgressive lag	Transition Series
Well-sorted sands; large-scale, complex cross-bedding; ebb-dominated paleocurrent directions; mainly minor bioturbation	Outer estuarine/ embayment tidal shoals	Silver Sands and Red Sands
Moderately sorted sands with clay layers; ebb- and flood-directed paleocurrents; moderate-strong bioturbation	Inner estuarine/ embankment tidal channels and shoals	Heterolithic Sands Orange Sands
Pre-transgressive deposits		Upper Jurassic Clays

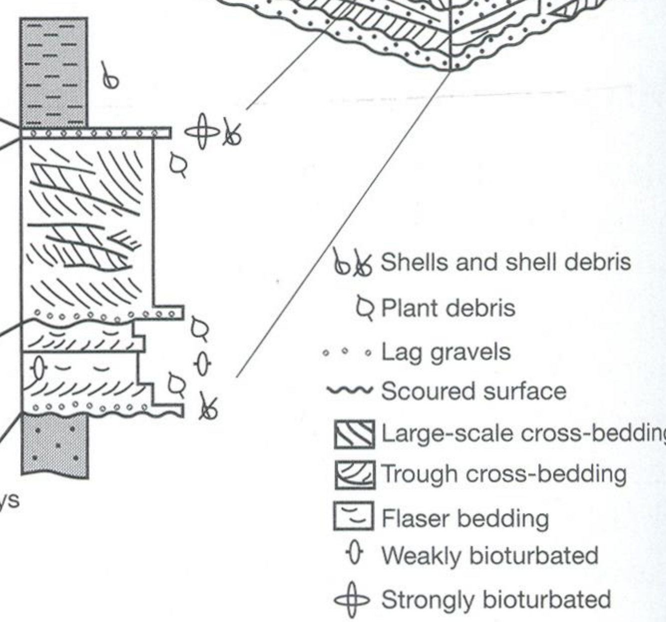


Figure 9.32
Model for a tide-dominated, transgressive estuarine-embayment depositional system based on the Woburn Sands (Lower Cretaceous), southern England. (a) Idealized vertical section showing facies in the more seaward part of the estuary. (b) Block diagram showing sand body characteristics of the inner and outer estuarine embayments. [After Johnson,

Boggs (2006), p.322

9.5 Lagoonal Systems

A coastal lagoon is defined as a shallow stretch of seawater – such as a sound, channel, bay, or saltwater lake – near or communicating with the sea and partly or completely separated from it by a low, narrow elongate strip of land, such as a reef, barrier island, sandbank, or spit. Lagoons commonly extend parallel to the coast, in contrast to estuaries, which are oriented approximately perpendicular to the coast. Many lagoons have no significant freshwater runoff. Lagoons may occur in close association with river deltas, barrier islands, and tidal flats.

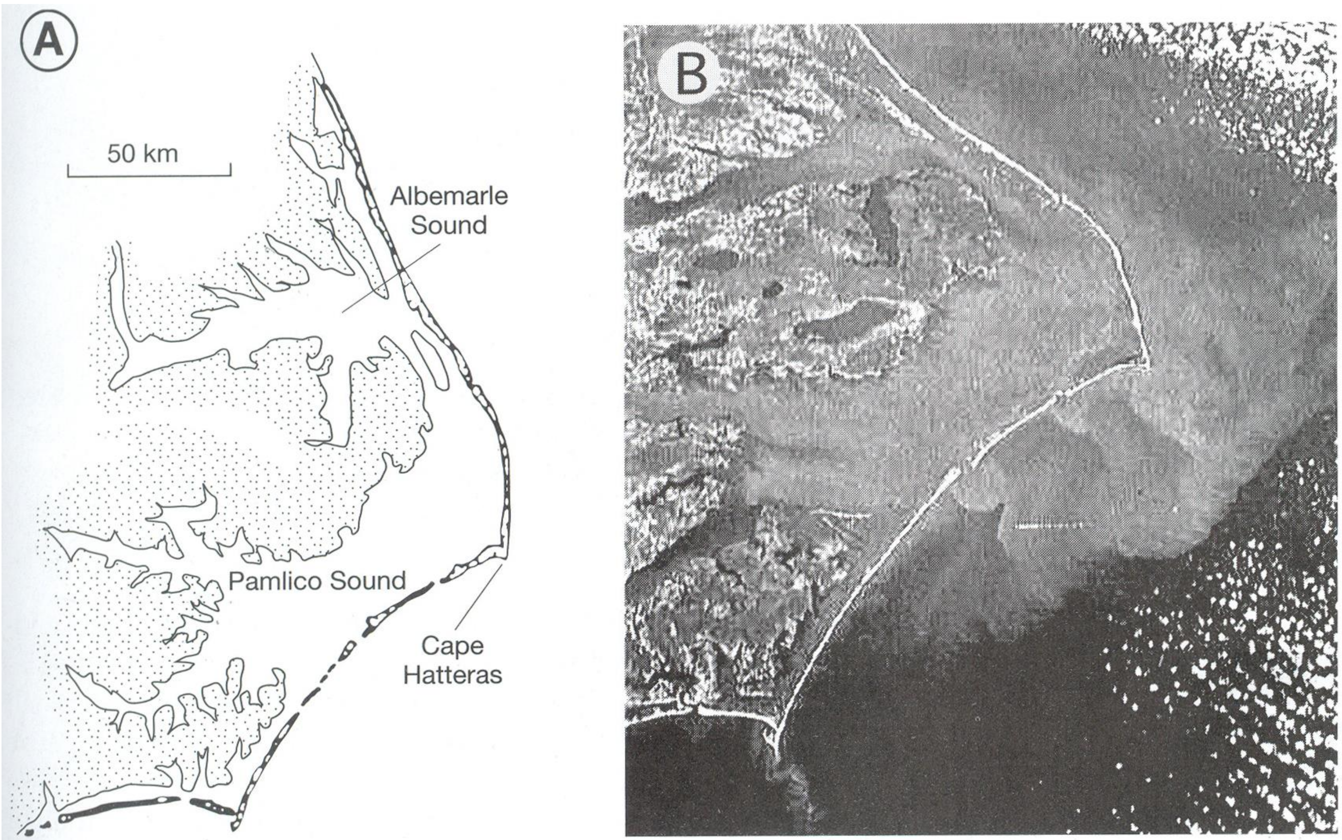


Figure 9.33
Cape Hatteras, South Carolina; a lagoonal system enclosed by a barrier-island chain. A. Diagrammatic sketch of the barrier chain and lagoon. B. Cape Hatteras as seen from Apollo 9; Pamlico Sound is partly obscured by clouds. [A. From Barnes, R. S. K., 1980, Coastal la-

Boggs (2006), p.323

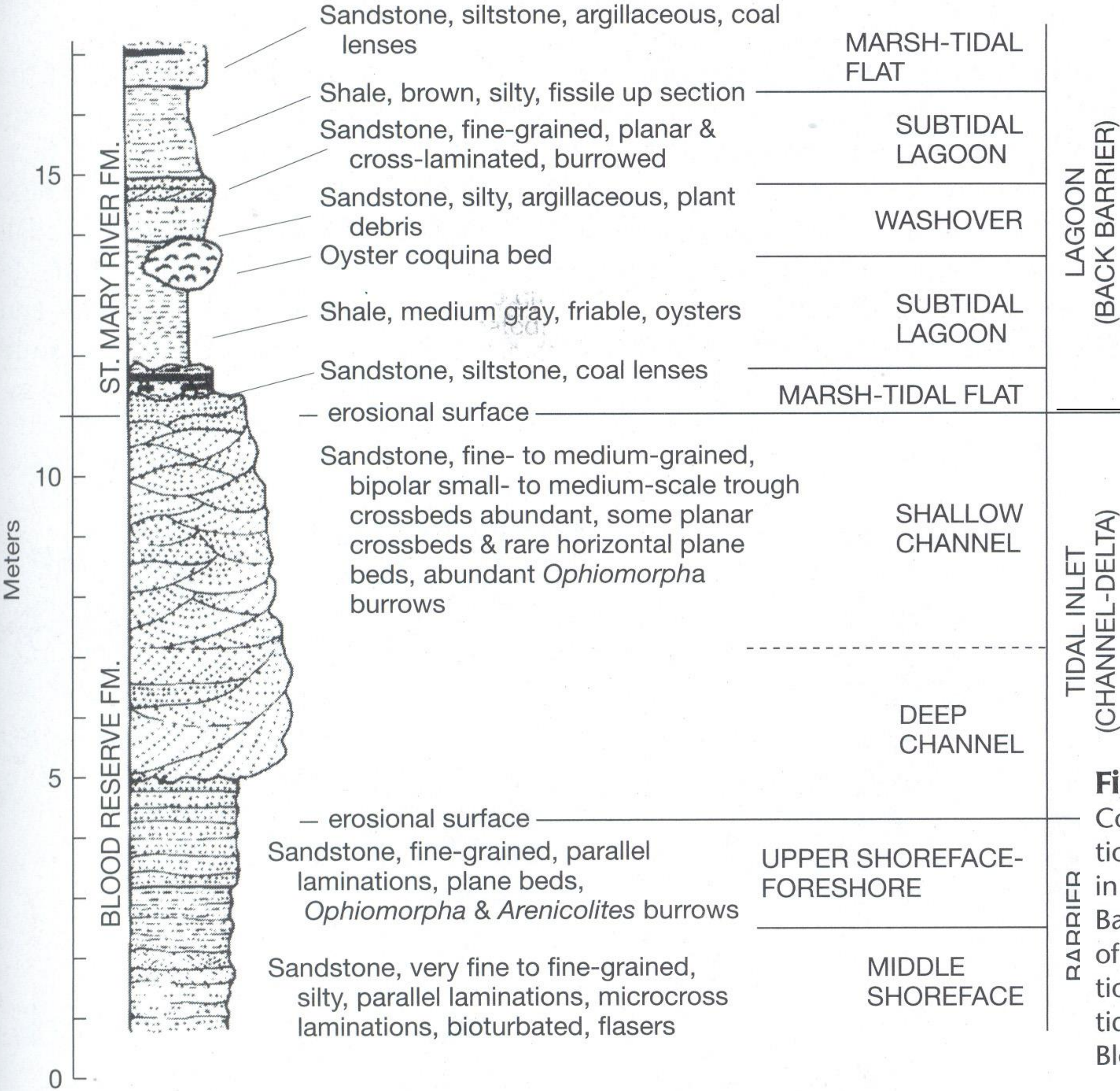
Tidal currents and wind-forced waves are dominant sedimentary agents in lagoons. Other agents may include freshwater runoff and episodic storms.

Except within tidal channels that extend into the lagoon, lagoons are predominantly areas of low water energy. Sedimentation in lagoons is dominated by deposition of silt and mud, although occasional high wave activity during storms can cause washover of sediment from the barriers.

In areas where little siliciclastic sediments is available and climatic conditions are favorable, sedimentation in lagoons is dominated by chemical and biochemical deposition. Under very arid conditions, lagoonal sedimentation may be characterized by deposition of evaporites (mainly gypsum, some halite and minor dolomite). Under less hypersaline conditions, carbonate deposition (e.g., carbonate muds and associated skeletal debris, ooids in more agitated environments) prevails particularly behind barrier reefs. Algal mats, commonly developed in the supratidal and shallow intertidal zone, may trap fine carbonate or siliciclastic mud to form stromatolites.

Criteria distinguishing ancient lagoonal deposits from estuarine and other deposits:

Evidence for restricted circulation: (a) presence of evaporites or anoxic facies, e.g., black shale; (b) lack of strong tidal influence; (c) slow rates of terrigenous sediment influx; (d) dominantly fine-grained sediments; (e) low faunal diversity; (f) extensive bioturbation.



Ancient Lagoonal Deposits

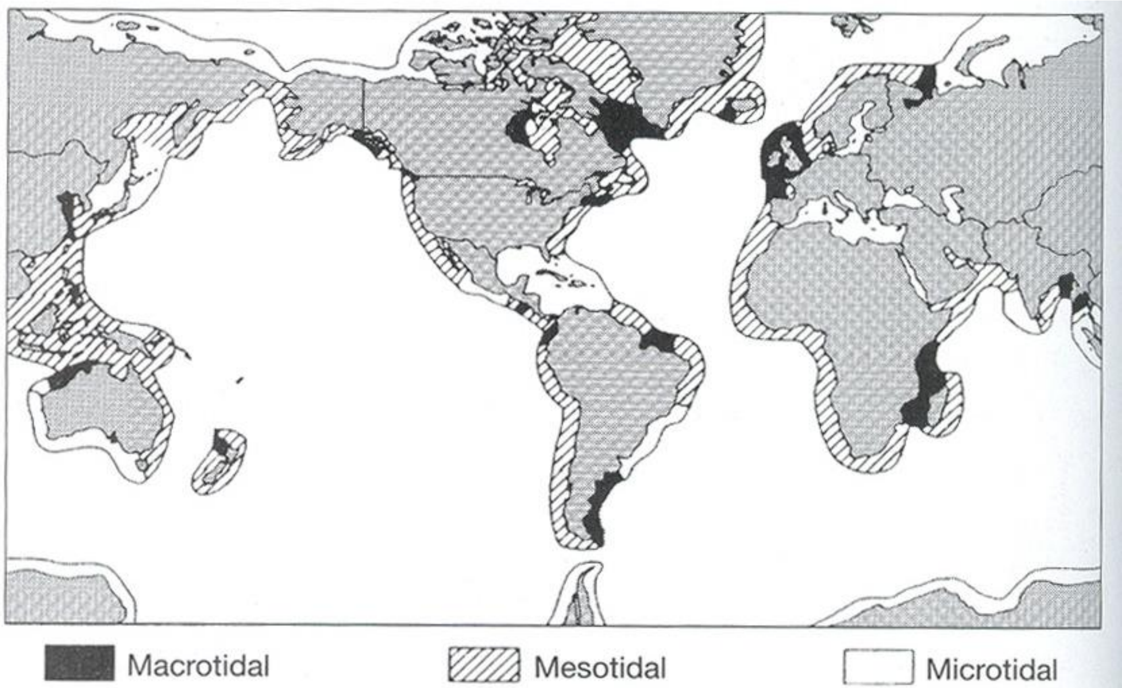
Progradational barrier-island complex

Figure 9.35
Composite stratigraphic section of Cretaceous formations in southern Alberta, Canada. Back-barrier lagoonal deposits of the St. Mary River Formation overlie tidal-inlet and tidal-delta deposits of the Blood Reserve Formation.

9.6 Tidal-flat Systems

Tidal flats form primarily on mesotidal and macrotidal coasts where strong wave activity is absent. They occur within estuaries, bays, the backshores of barrier-island complexes, and deltas, as well as along open coasts.

Figure 9.36
Global classification of coastlines by tidal range (microtidal 0–2 m; mesotidal 2–4 m; macrotidal >4 m). [From Klein, G. deV., 1985, Intertidal flats and intertidal sand bodies, *in* Davis, R. A. Jr. (ed.), Coastal sedimentary environments, 2nd ed.: Springer-Verlag, New York, Fig. 3.1, p. 189, Redrawn from Davies, J. L., 1964, Zeitschrift für Geomorphologie, v. 8, Fig. 4, p. 136.]

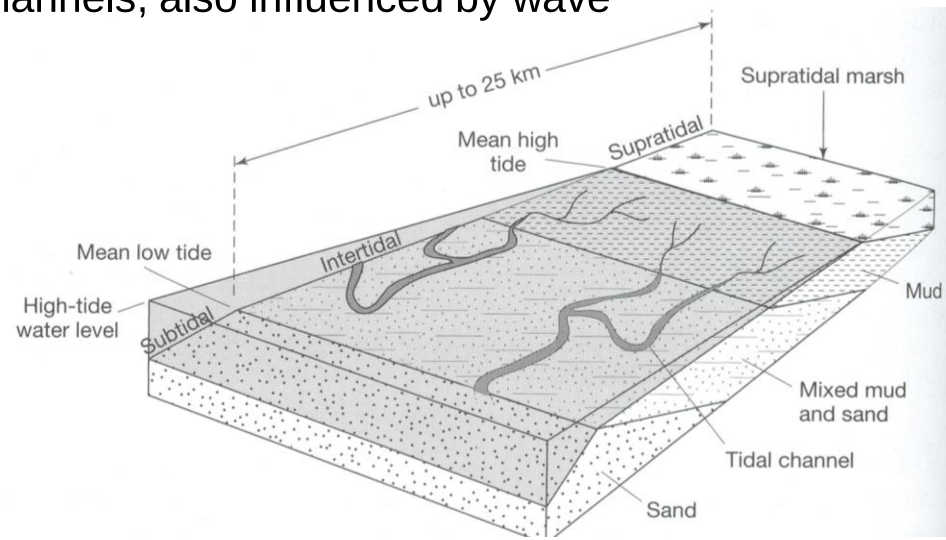


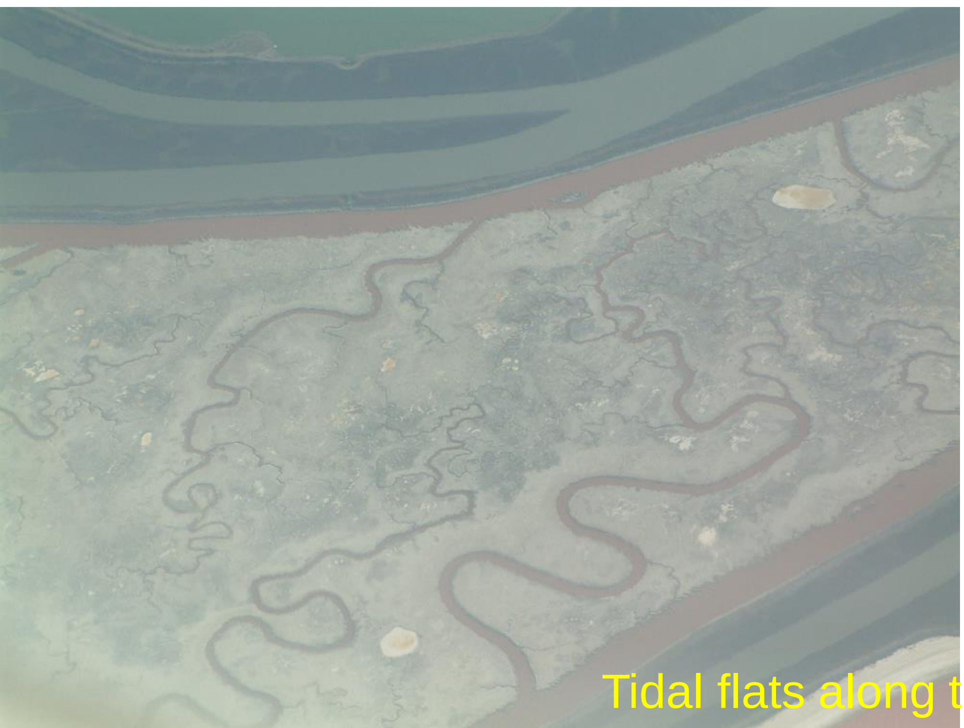
Tidal flats are marshy and muddy to sandy areas dissected by a network of tidal channels and creeks that are largely exposed ruing low tide. As tide level rises, flood-tide waters move into the channels until at high tide the channels are overtopped and water spreads over and inundates the adjacent shallow flats.

Figure 9.37
Tidal flat in the Ashe Island area, about 70 km (45 mi) south of Charleston, South Carolina, exposed at low tide. Note tidal channels and areas covered by shallow water (dark patches) on the flats. National Oceanographic and Atmospheric Administration (NOAA) photograph. Downloaded from the Internet 4/23/04.

Tidal flat is divided into three zones: subtidal, intertidal and supratidal. Subtidal zone (lying below mean low tide level): subjected to the highest tidal-current velocities especially in the tidal channels, also influenced by wave proecesses.

Figure 9.38
Schematic diagram showing the relationship of subtidal, intertidal, and supratidal zones in the tidal-flat environment. Note that mud is the dominant deposit in the upper part of the intertidal zone, mixed mud and sand predominate in the lower intertidal zone, and sand is deposited in the subtidal zone and in tidal channels. Muddy marsh deposits characterize the supratidal zone.





Tidal flats along the San Francisco bay

Sedimentary Processes and Sediment Characteristics of Tidal-flats

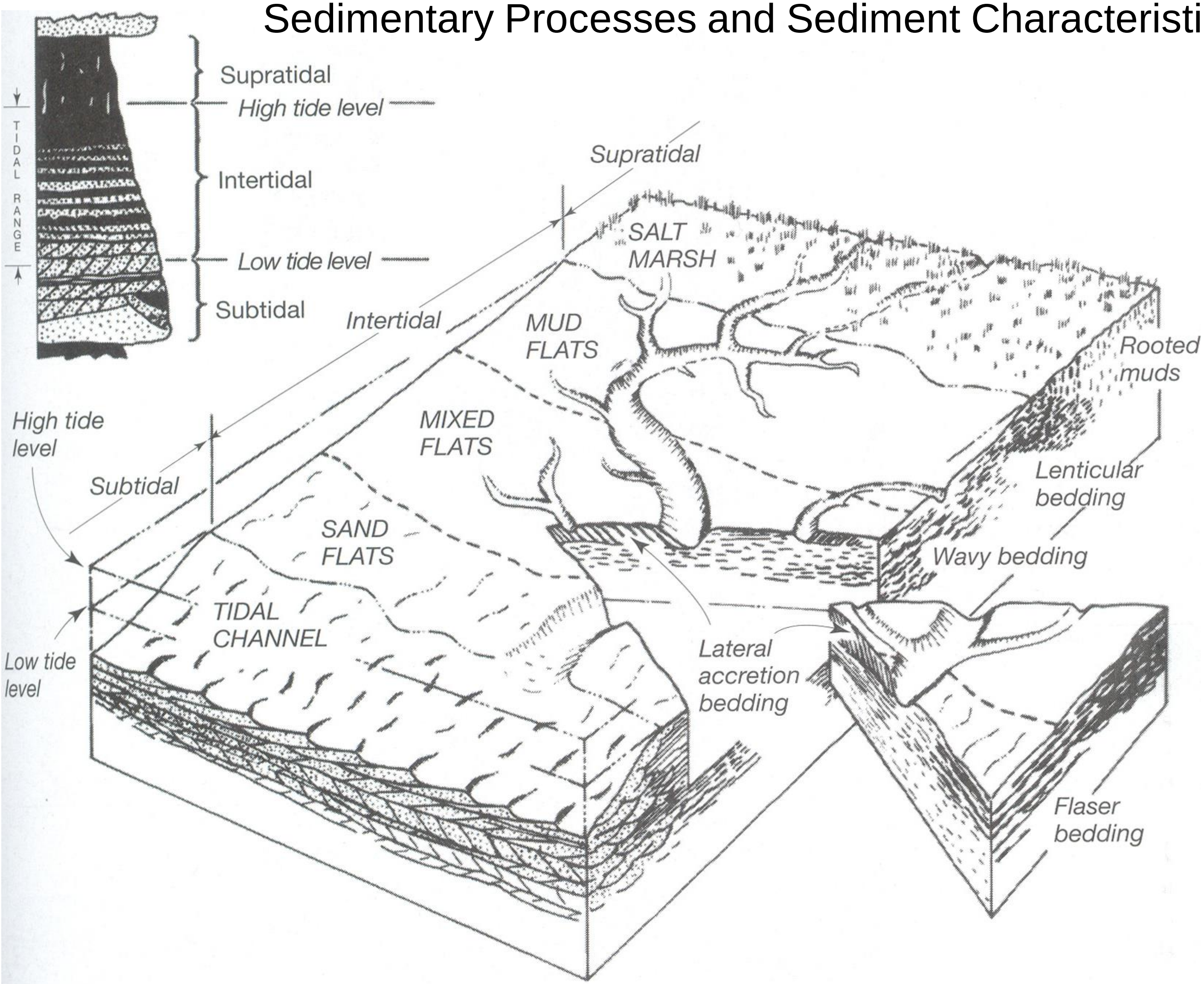


Figure 9.39
Schematic diagram of a typical siliciclastic tidal flat. The tidal flat fines toward the high-tide level, passing gradationally from sandflats, though mixed flats, to mudflats and salt marshes. An example of the upward-fining succession produced by tidal-flat progradation is shown in the upper-left cor-

Ancient Tidal flat sediments

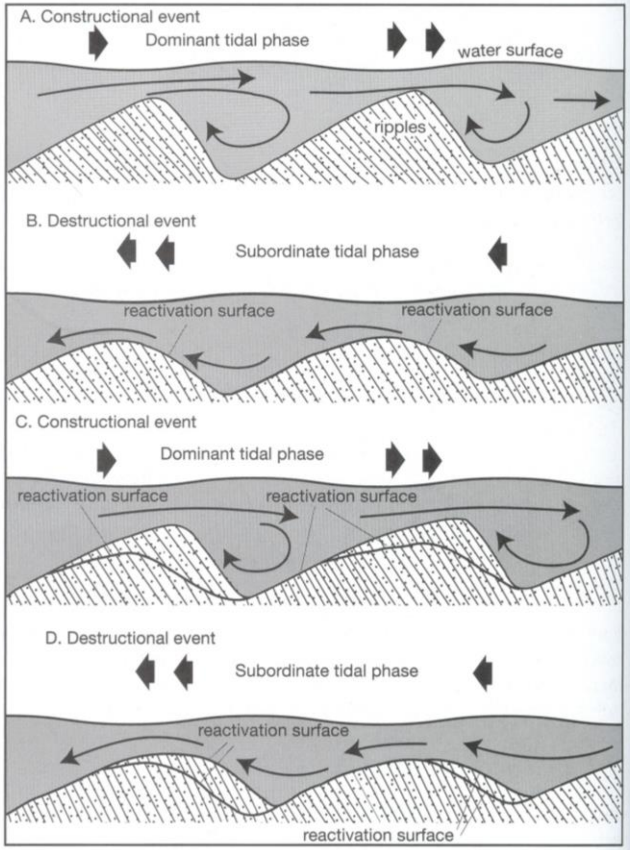


Figure 9.41
Schematic representation of reactivation surface developed owing to alternation of a dominant tidal phase (constructional event) with a subordinate phase (destructional event). [After Klein, G. deV., 1970, Depositional and dispersal dynamics of intertidal sand bars: Jour. Sed. Petrology, v. 40, Fig. 28, p. 1118, reproduced by permission of SEPM (Society for Sedimentary Geology), Tulsa, Okla.]

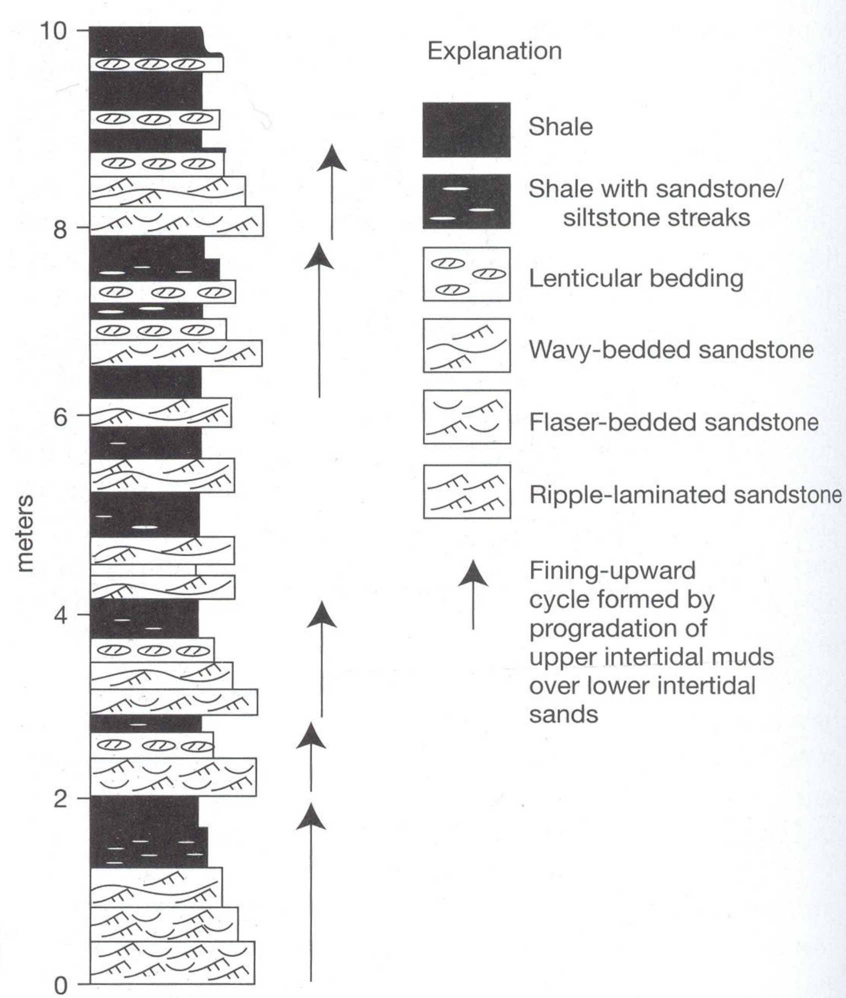


Figure 9.42
Representative lithostratigraphic column of the upper member of the Baraichari Shale Formation (late Miocene-Pliocene), Bengal Basin, Bangladesh, interpreted as a cyclic succession of progradational tidal-flat deposits. [After Alam, M. M., 1995, Tide-


立霧溪扇洲
N
W
E
S
Image © 2006 TerraMetrics
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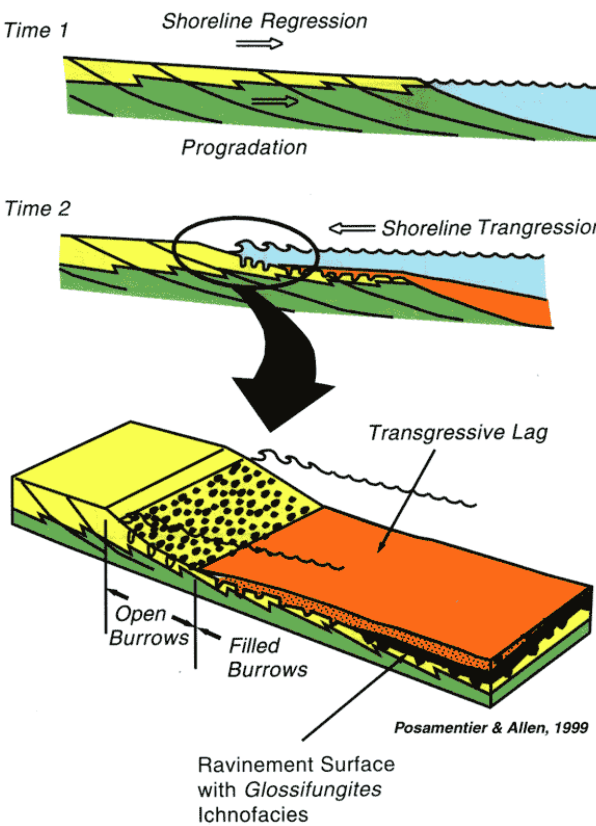
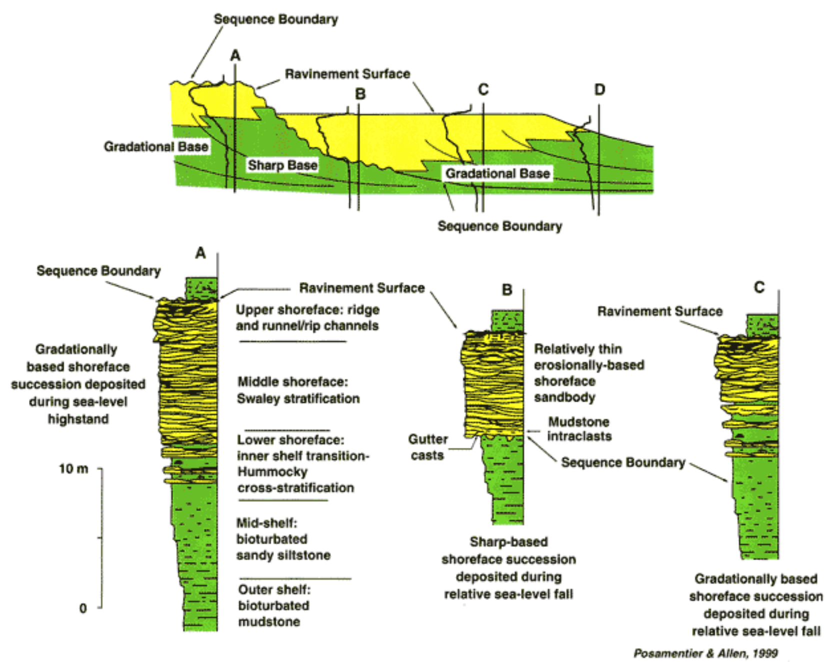
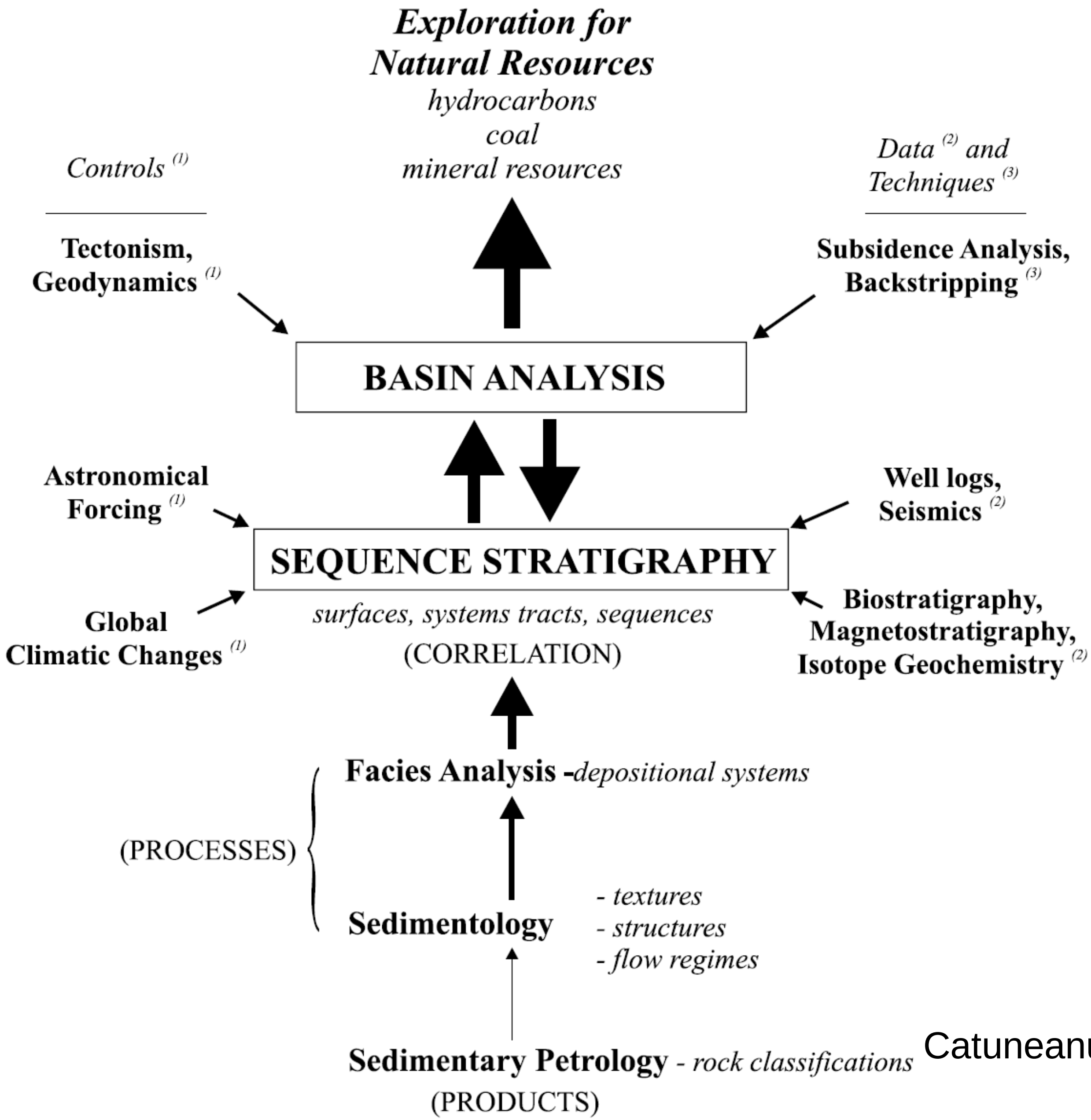
A time transgressive or diachronous subaqueous erosional surface resulting from nearshore marine and shoreline erosion associated with a sea-level rise. This erosional surface parallels the migration of the shoreface "razor" across previously deposited coastal deposits. Burrows in this surface are often filled by sediments deposited during a sea-level rise.



Ravinement surfaces are commonly ascribed to the transgressive movement of the landward margin of the Transgressive Systems Tract. However, as the attached movie shows, these erosional surfaces will tend to occur wherever the landward edge of the sea rises over an underlying sedimentary surface. Thus if the Late Lowstand Systems Tract has a subaerial landward margin it will have an updip ravinement surface associated with it.





Catuneanu (2002) J. African Ear. Sci.

Sequence stratigraphy in the context of interdisciplinary research

Ravinement surfaces (transgressive surface of erosion)

Regressive surface of erosion

Transgressive surface

Marine flooding surface

Onlap surface

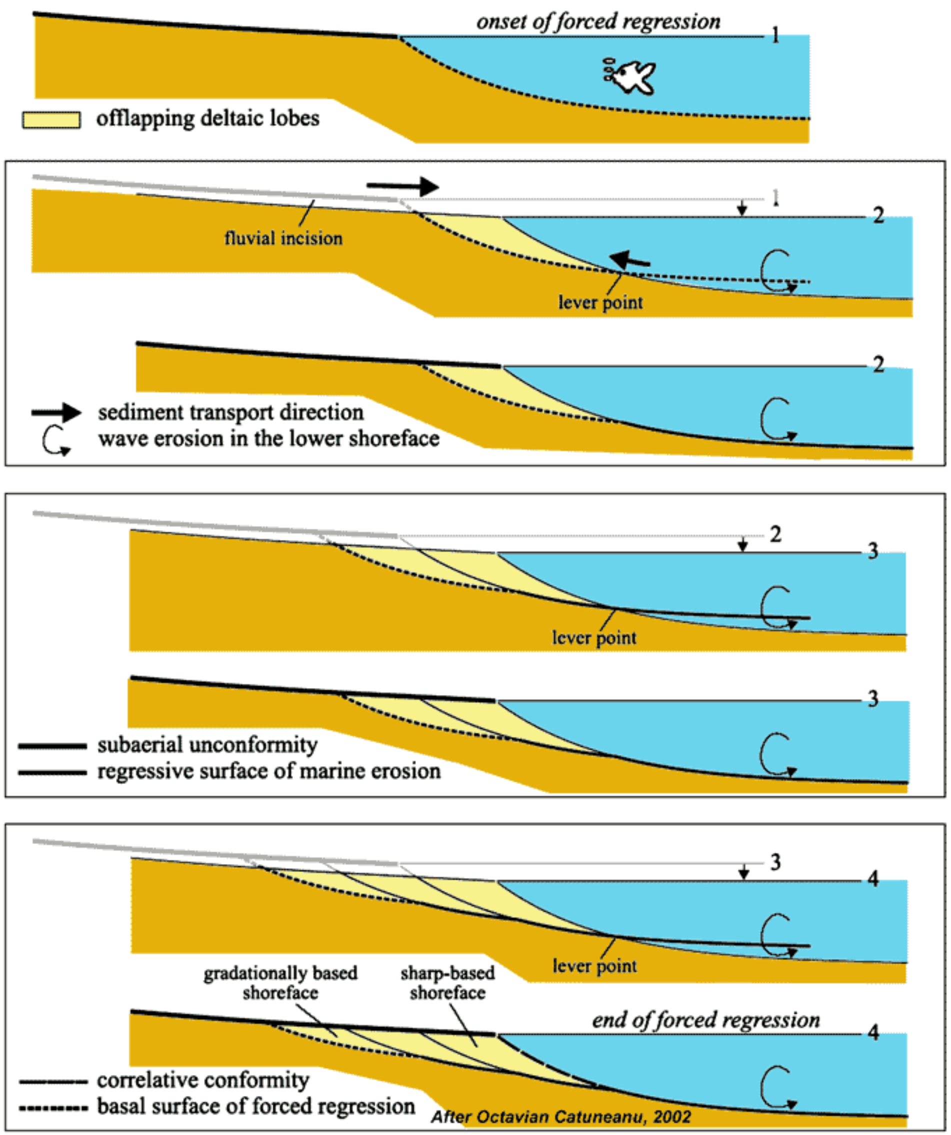
Downlap surface

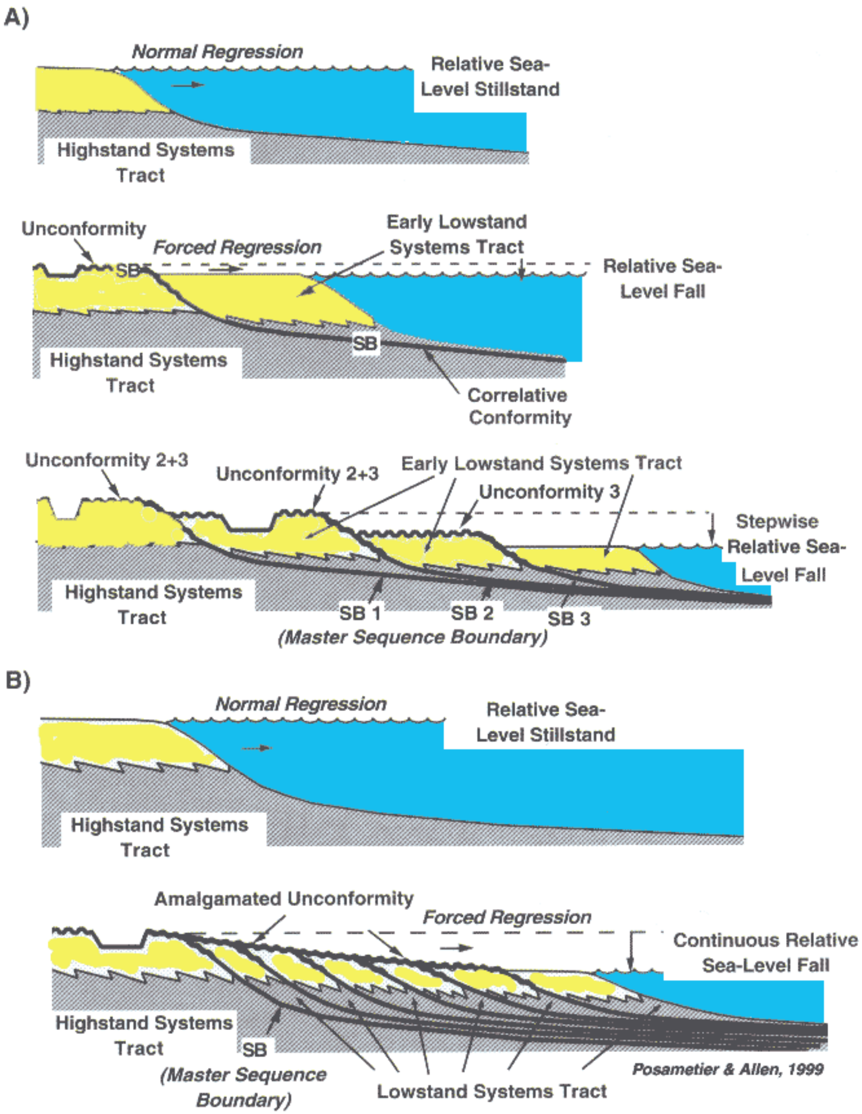
Regressive surface of marine erosion

Subaqueous surface of marine erosion formed during a relative sea-level fall. As sea level falls, wave base and the upper shoreface zone of current transport drops, too, and planes off the seafloor sediments that formerly lay below wave base and the upper shoreface currents. Such a fall usually is followed by the superposition of coarser-grained upper shoreface deposits sharply overlying finer-grained lower shoreface or shelf deposits.

During a forced regression of the shore the shoreface maintains its equilibrium with the wave energy with its concave-up shape. This leads to scouring of the lower shoreface by waves and the formation of a regressive surface of marine erosion. The formation of the regressive surface of marine erosion requires a shallow gradient of the sea floor, smaller than the average gradient of the shoreface profile. This is often the case in shelf settings, where the average gradient of the sea floor is about 0:03. In contrast, slope settings have a steeper sea floor topography relative to what is required by the shoreface to be in equilibrium with the wave energy, and hence no scouring is generated in the lower shoreface during forced regressions. These steep sea floor slopes are progaded by Gilbert-type deltas whose delta front facies are not sharp-based.

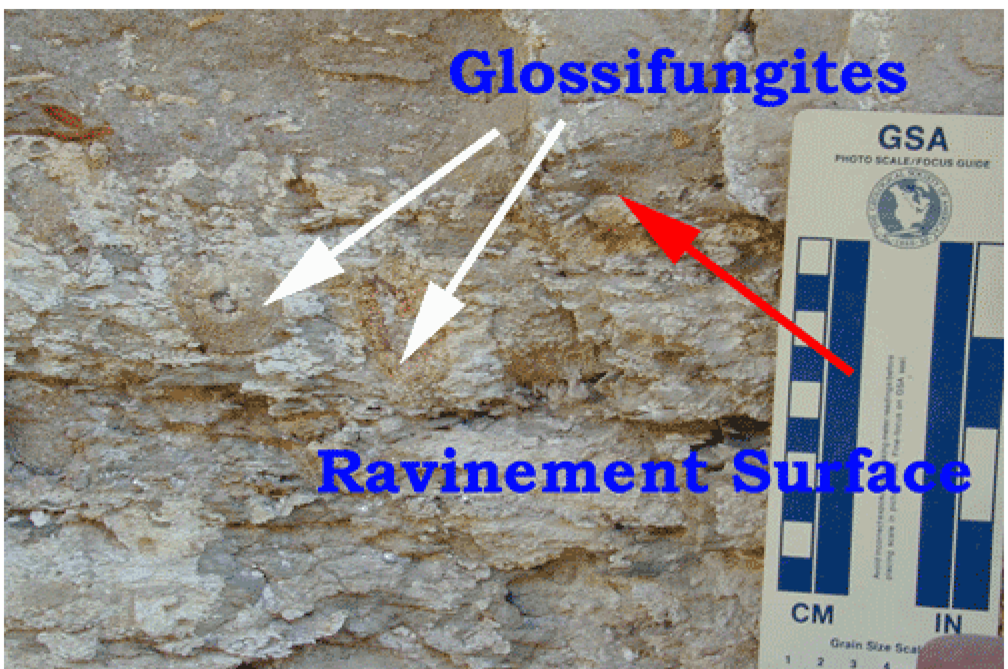
The Glossifungites ichnofacies may be present within this surface associated with material deposited or reworked during fall or during the following transgression. Burrowers excavate open burrows in the firm muds and leave behind traces such as Rhizocorallium, Diplocraterion, Thalassinoides, Skolithos, etc. The burrows commonly remain open and are subsequently filled with coarser-grained shallow water sediments related to the downward shift in sea level, or the shallow water sediments of the subsequent sea level rise.


onset of forced regression
1
offlapping deltaic lobes
fluvial incision
1
2
lever point
2
sediment transport direction
wave erosion in the lower shoreface
2
3
lever point
3
subaerial unconformity
regressive surface of marine erosion
3
4
gradationally based shoreface
sharp-based shoreface
lever point
end of forced regression
4
correlative conformity
basal surface of forced regression
After Octavian Catuneanu, 2002


A)
Normal Regression
Relative Sea-Level Stillstand
Highstand Systems Tract
Unconformity
Forced Regression
Early Lowstand Systems Tract
Relative Sea-Level Fall
SB
SB
Highstand Systems Tract
Correlative Conformity
Unconformity 2+3
Unconformity 2+3
Early Lowstand Systems Tract
Unconformity 3
Stepwise Relative Sea-Level Fall
Highstand Systems Tract
SB 1
SB 2
SB 3
(Master Sequence Boundary)
B)
Normal Regression
Relative Sea-Level Stillstand
Highstand Systems Tract
Amalgamated Unconformity
Forced Regression
Continuous Relative Sea-Level Fall
Highstand Systems Tract
SB
(Master Sequence Boundary)
Lowstand Systems Tract
Posametier & Allen, 1999

Glossifungites are an Ichnofacies which represents an assemblage of burrows (vertical, U-shaped, or
sparsely branched) that occur in firm, but not lithified siliciclastic and/or carbonate muds and silts of th
intertidal and shallow marine where scouring has often removed the unconsolidated layers at the sed
surface. The surfaces on which Glossifungites occur are interpreted to have formed following a regres
and sea level fall and just after the inital transgressive phase immediately following sea level lowstand
these discontinuity surfaces sedimentation appears to have temporally ceased, and erosion has occu
Examples of these surface include the transgressive surfaces formed just below the maximum floodin
surfaces of parasequence boundaries.

http://strata.geol.sc.edu/terminology/glossifungites.html

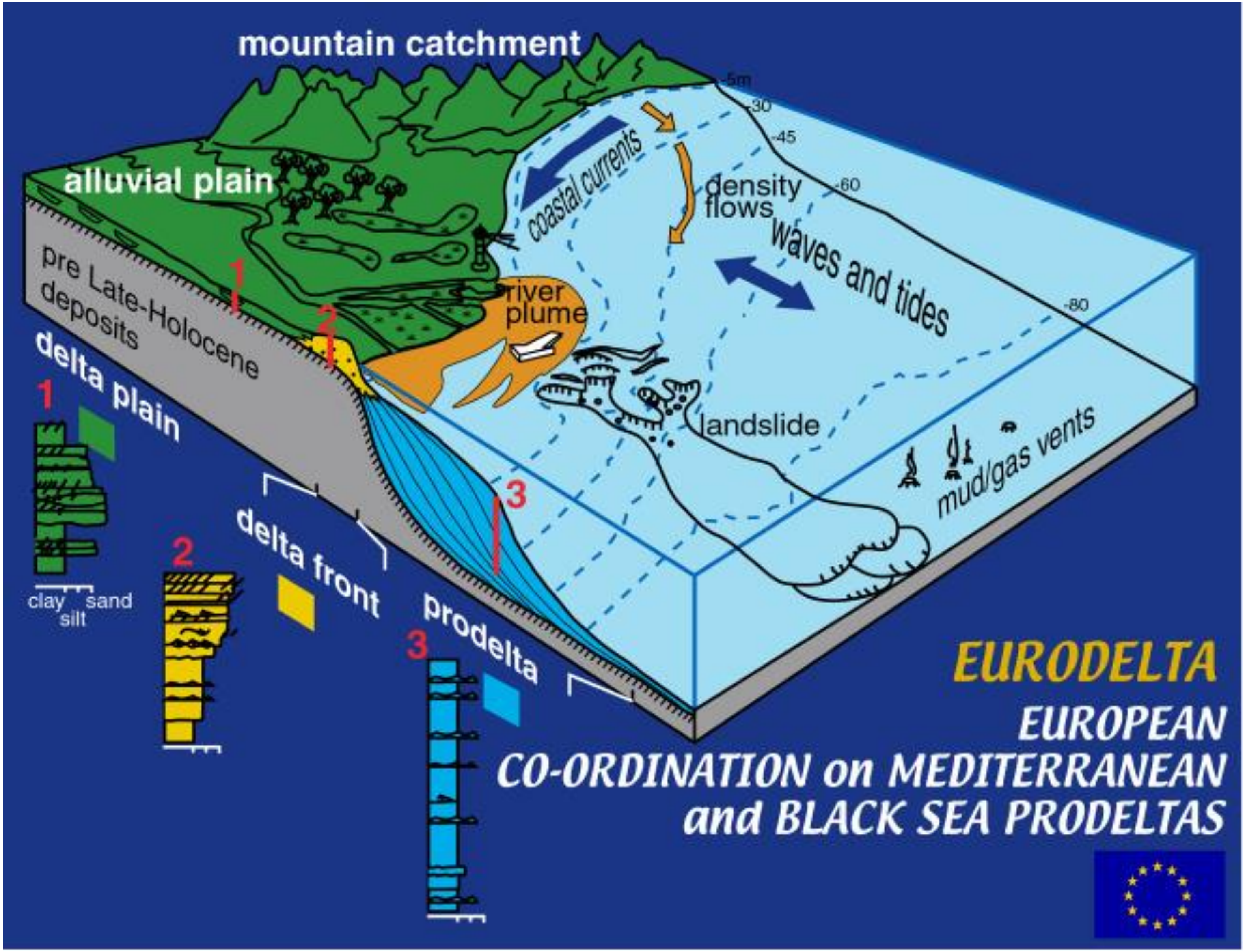


Transgressive Surface

This is a marine-flooding surface that forms the first significant flooding surface in a sequence. The TS, in most siliciclastic and some carbonate successions, marks the onset of the period when the rate of creation of accommodation space is greater that the rate of sediment supply. It forms the base of the retrogradational parasequence stacking patterns of the Transgressive Systems Tract. In areas of high sediment supply, e.g. on rimmed carbonate platforms, the rate of sediment supply may keep pace with the rate of relative sea-level rise and thus the TS will mark a change from a progradational to an aggradational parasequence stacking patterns. The TS often marks the base of the most prominent onlap.

If no lowstand or falling stage systems tract facies are preserved above the sequence boundary, the TS may coincide with this boundary. A TS is often characterized by the presence of a surface marked by consolidated muds of firmgrounds or hardgrounds that are cemented by carbonates. Both surfaces are often penetrated by either burrowing or boring organisms. For instance Glossifungites burrows are found penetrating the firm grounds and are often filled by an overlying widespread winnowed, sorted and often conglomeratic ravinement sediment, or lag. Cemented surfaces may be colonized and bored by a Trypanites ichnofacies and infilled by the sediments associated with the base of the transgressive system tract and are often wave winnowed.

If the rate of sediment supply is low over the transgressive surface this may merge landward with the maximum flooding surface. When a TS extends over LST valley fill, the response on the resistivity log curve may show a small local increase resistivity followed by a low. This increase in resitivity is in response to the carbonate cementation of the hardground, while the low is associated with deposition of trangressive shales.



http://www.pangaea.de/Projects/EURODELTA/