

Controle Ambiental:

3. Geologia e Sedimentos

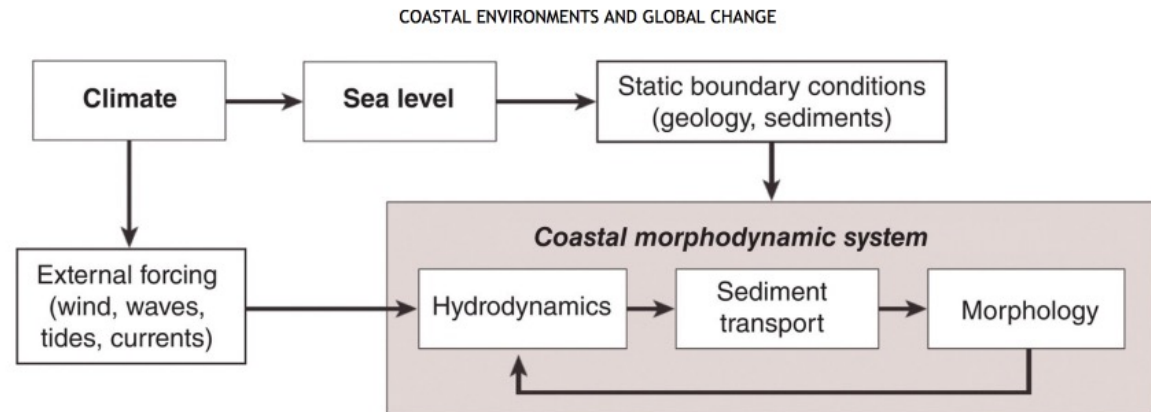


Fig. 1.5 Conceptual diagram illustrating the morphodynamic approach, showing the coastal morphodynamic systems and the environmental boundary conditions (sea level, climate, external forcing and static boundary conditions).

(Source: Masselink 2012. Reproduced with permission from Pearson Education Ltd.)

- 3.1.1 Diversidade costeira: uma herança da geologia e sedimentos
- 3.1.2. Escalas Espaciais e Temporais: a tectônica global ao controle local
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- 3.5 Mudanças Climáticas, geologia e sedimentos

3.1.1 Diversidade costeira: uma herança da geologia e sedimentos

- A diversidade dos ambientes costeiros é em grande parte explicada por sua morfologia e composição dos sedimentos
- A geologia determina a condição primária, no qual os processos irão operar
- A geologia envolve tectonismo e litologia

OUTROS:

- Espaço de acomodação de sedimentos
- Topografia
- Orientação da costa



Fig. 3.1 Illustration of the influence of geology on coastal geomorphology. The photograph shows sand and gravel beaches (the gravel has accumulated in the breaker zone) between headlands at Miraflores, Lima, Peru. These embayed beaches are backed by cliffs cut into alluvial deposits comprising ancient raised beaches ('rasa') on the tectonically active coastal margin of South America (see also [Fig. 3.4](#)).

- Embora o tipo de sedimento dependa da geologia, sofre grande influência do clima
- O clima afeta a taxa de intemperismo – erosão
- Atividades humanas também contribuem muito:
 - agricultura
 - Desflorestamento
 - Barragens
 - Obras de contenção etc..

3.1.2. Escalas Espaciais e Temporais: da tectônica global ao controle local

- O tectonismo global é o fator primário de formação e destruição da costa
- Reflete o movimento vertical em escala de milhões de anos
- Em menor escala atuam os movimentos tectônicos locais além da litologia

A largura da plataforma continental e o gradiente da plataforma interna são extremamente importante

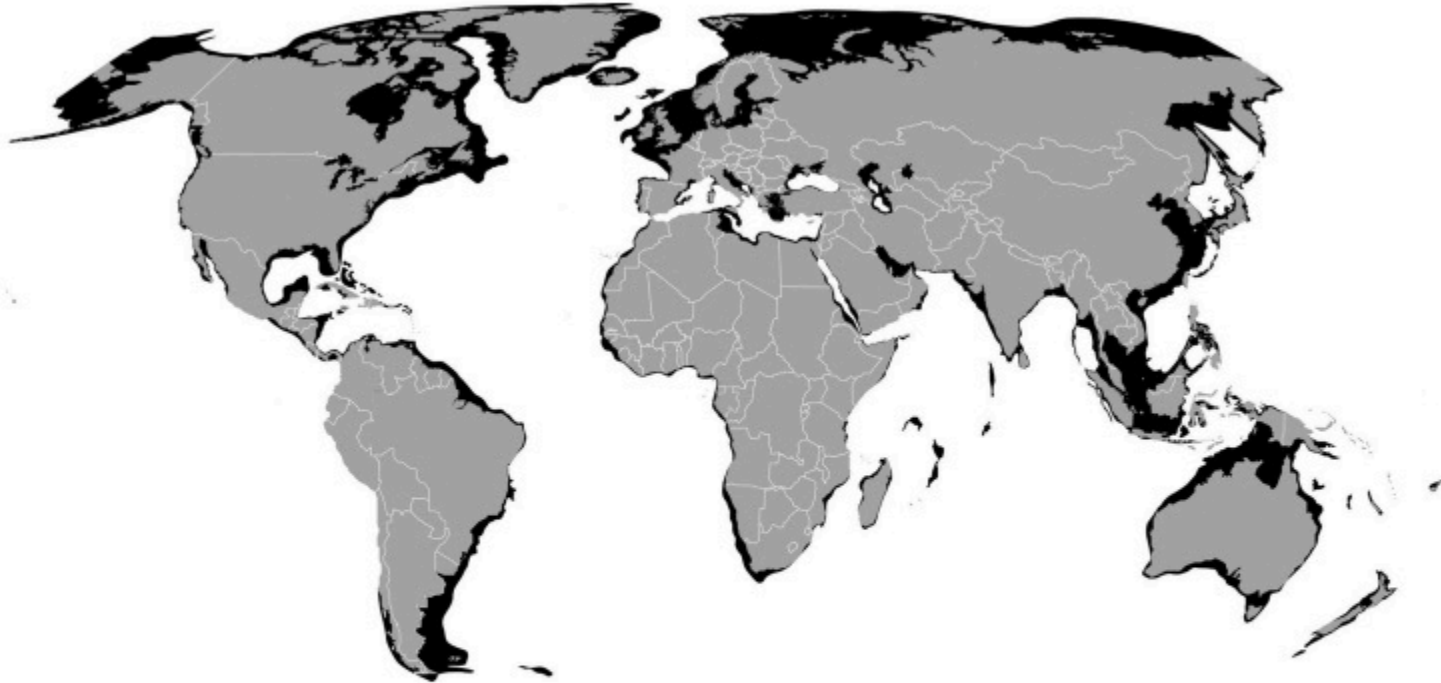
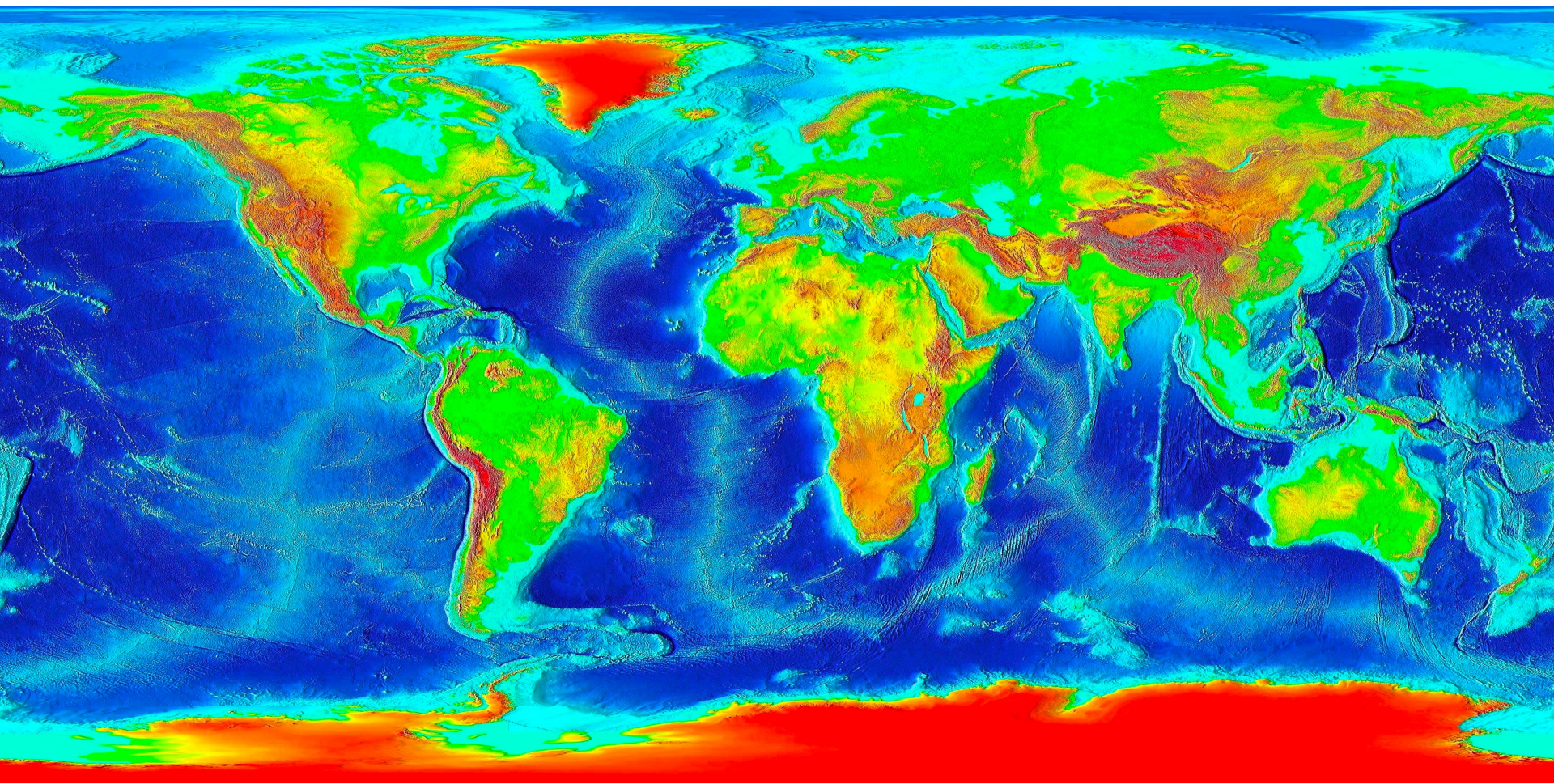
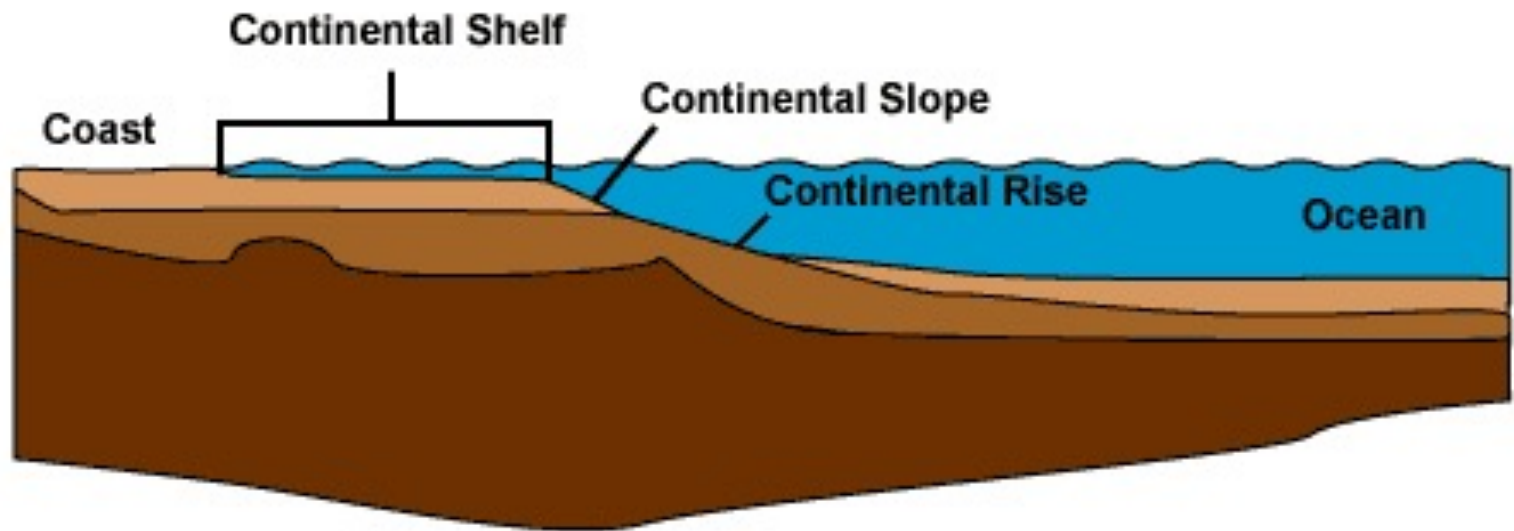


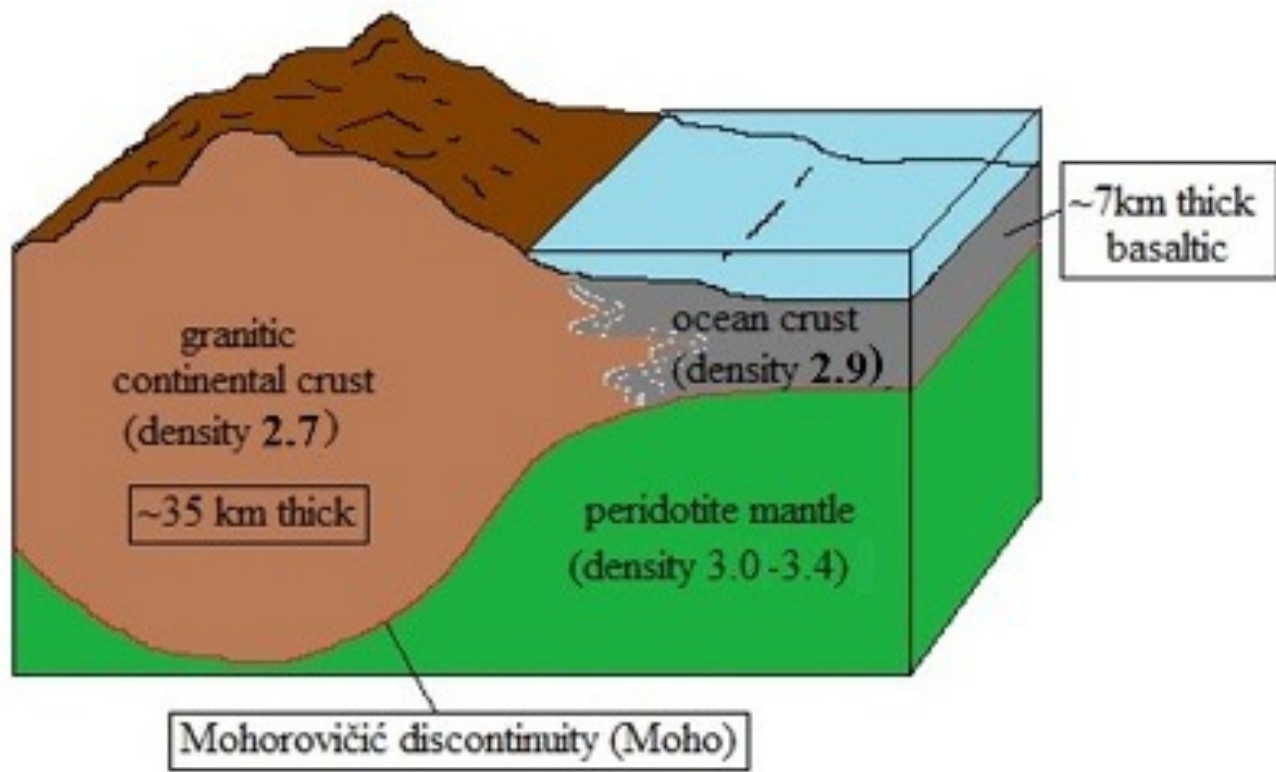
Fig. 3.2 World map showing variations in continental shelf width that are largely a product of the global tectonic regime and sediment trapping along plate margins.

A largura da plataforma e o regime de ondas caracterizam o tipo de ambiente

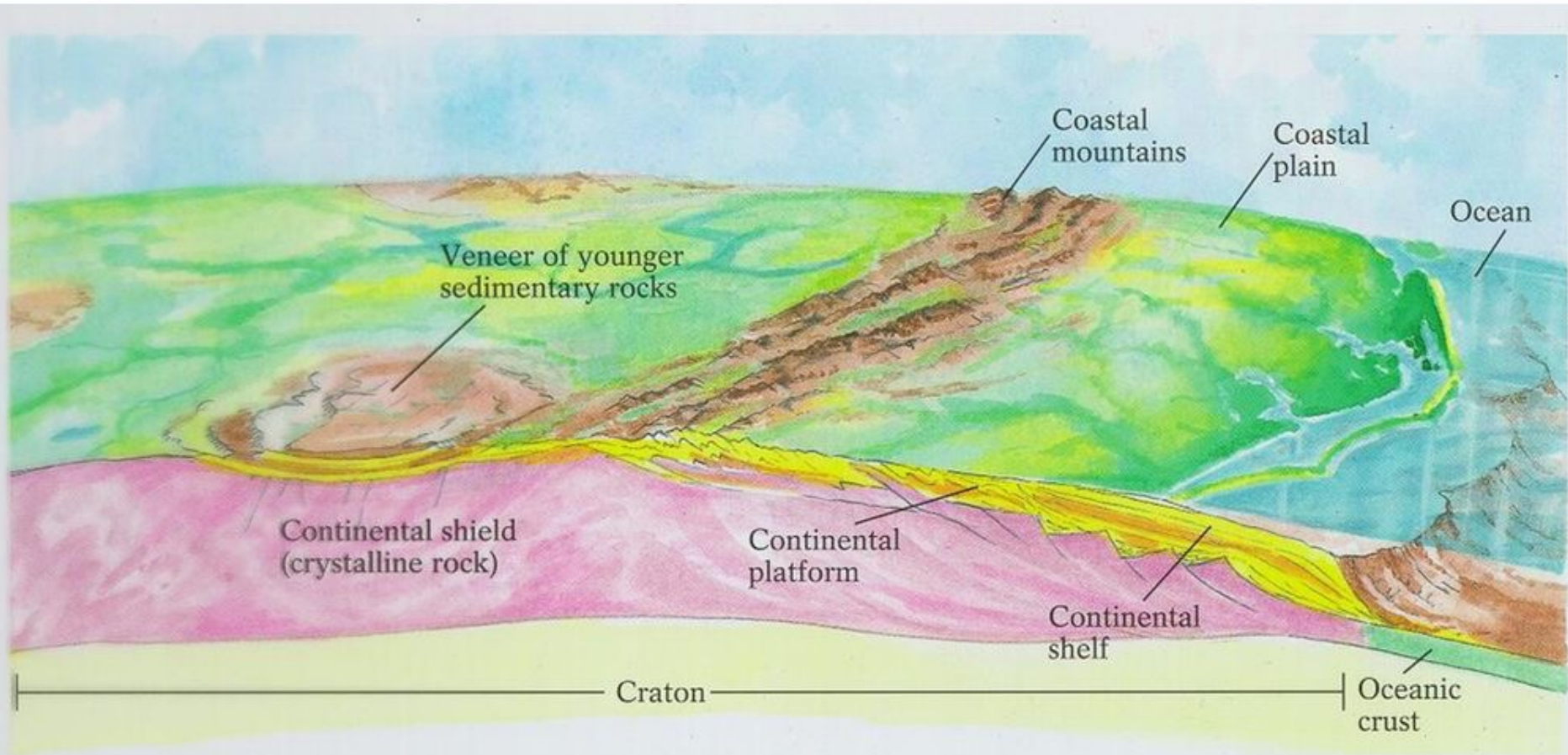


Margem continental – Crosta continental





<https://www.geolsoc.org.uk/>



Continental Crust Model of the Eastern United States

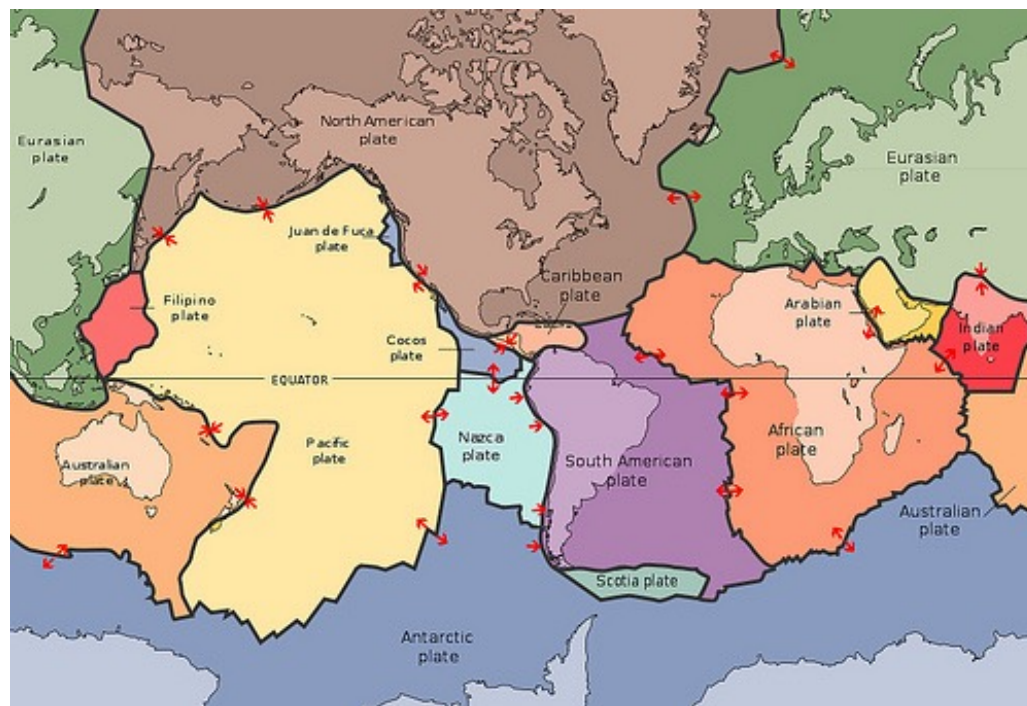
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3.2 Geologia e Costa

- O tectonismo esta na origem da linha de costa
- A costa se forma na quebra de placas e desaparece no choque
- O processo é extremamente complexo

- Antes do conceito da tectônica, Suess 1892, classificou os tipos de costa em:

- Tipo pacífica
- Tipo atlântica

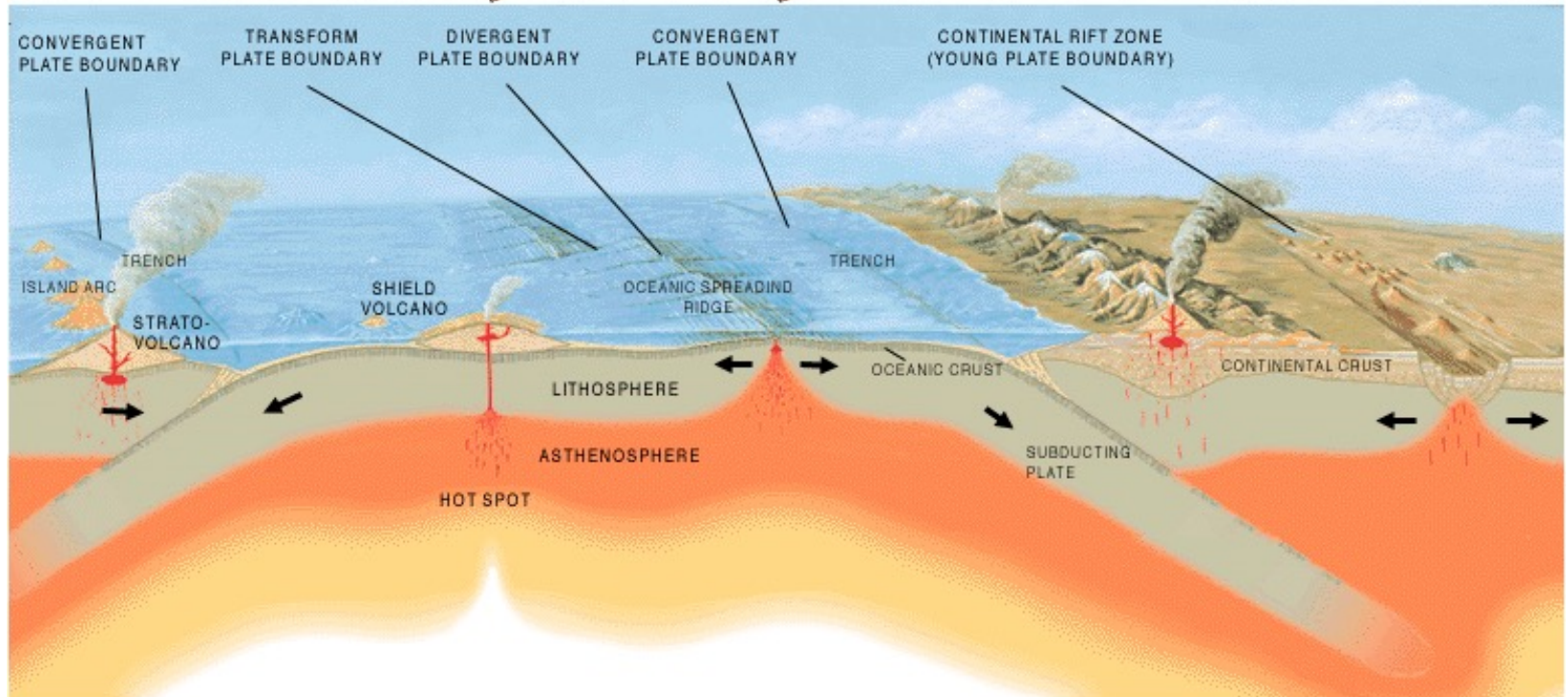
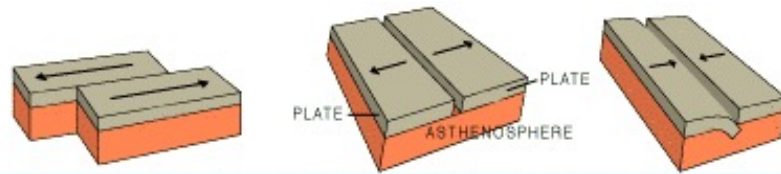


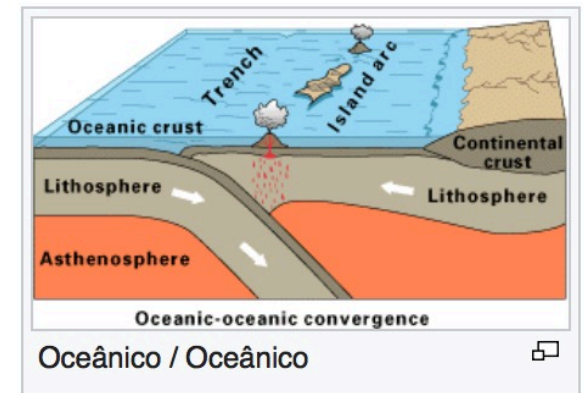
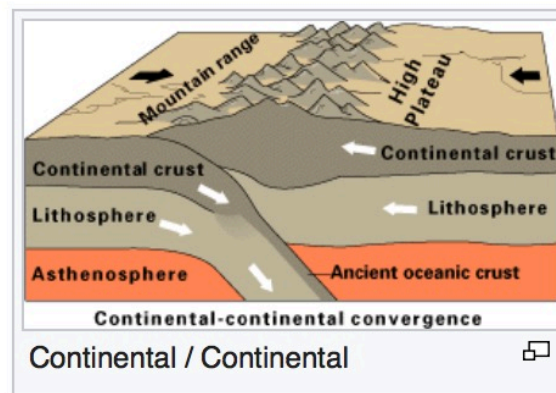
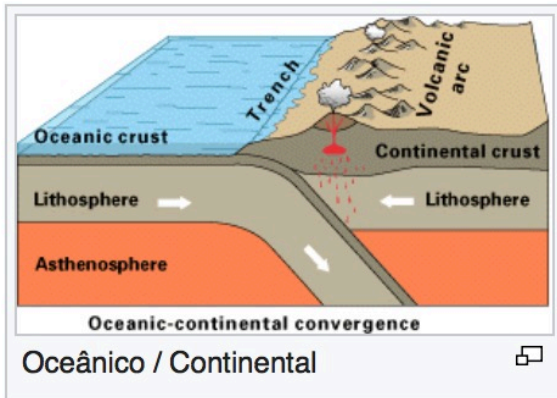
Animação:

<http://www.pnsn.org/outreach/about-earthquakes/plate-tectonics>

Os Limites das placas são classificados em 3 tipos (Inman & Nordstron, 1971)

- Limites transformantes ou conservativos
- Limites divergentes
- Limites convergentes





Mais comumente hoje margens ativas ou passivas

(a)

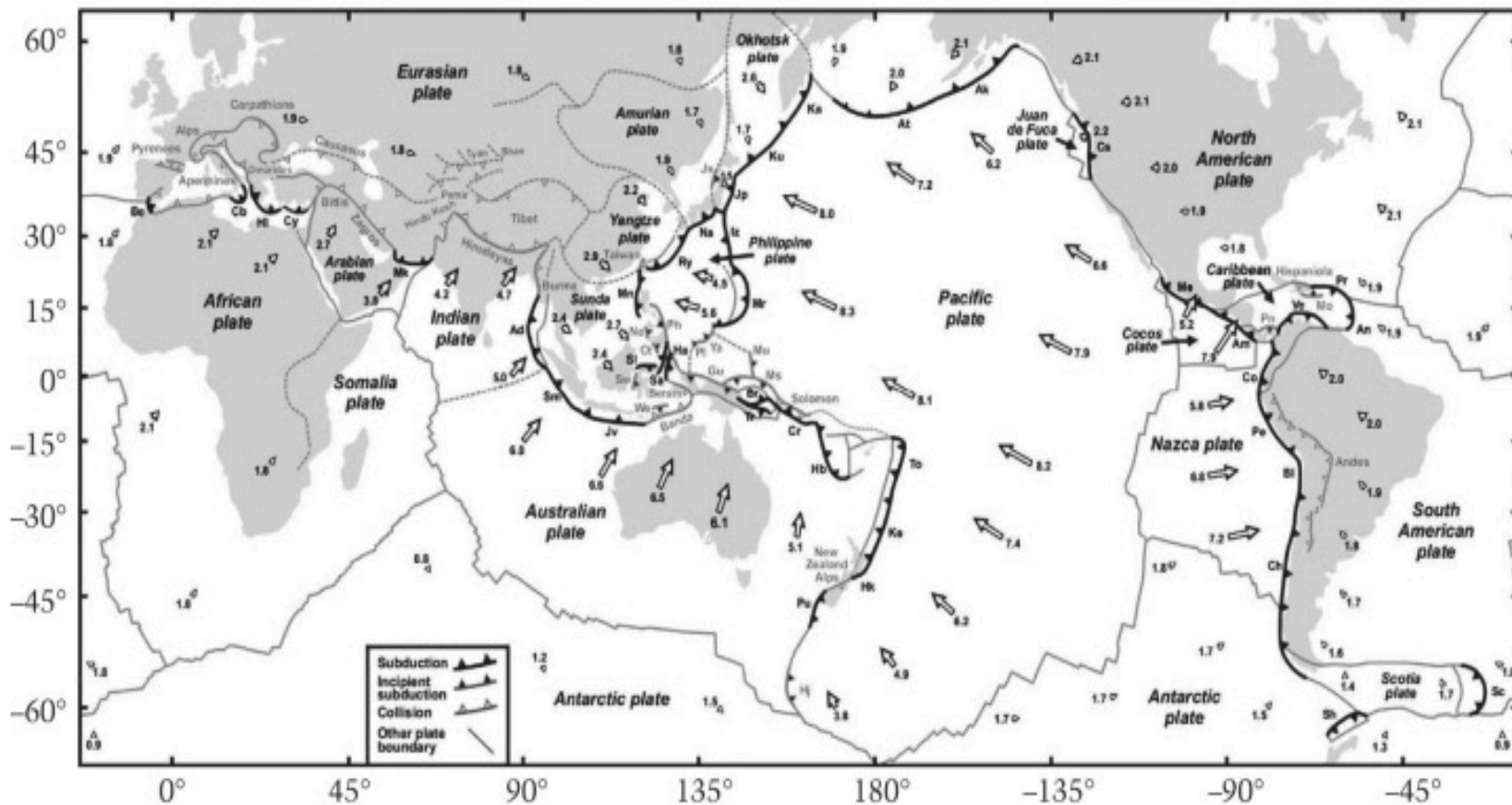


Fig. 3.3 Global tectonic maps showing: (a) active; and (b) passive plate margins. Each type of plate margin has a fundamental influence on coastal geomorphology. In (a), plates and all subduction zones on Earth (including incipient subduction zones), collision zones and the velocities of the major plates are shown (Source: Schellart and

Animação global

<https://www.youtube.com/watch?v=uLahVJNnoZ4>

Animação América do Sul

<https://www.youtube.com/watch?v=X0AqBCT8n4g>

(b)

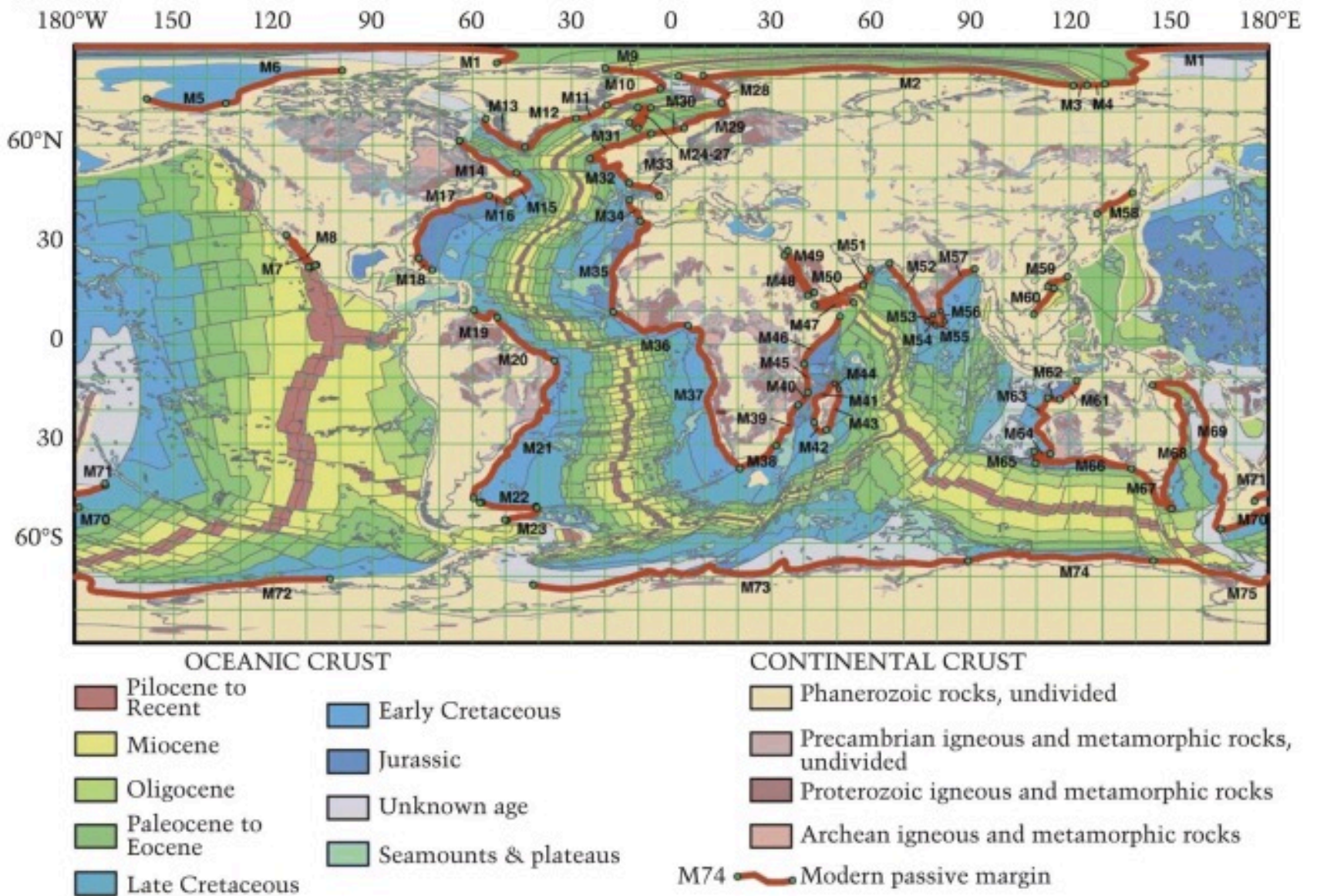
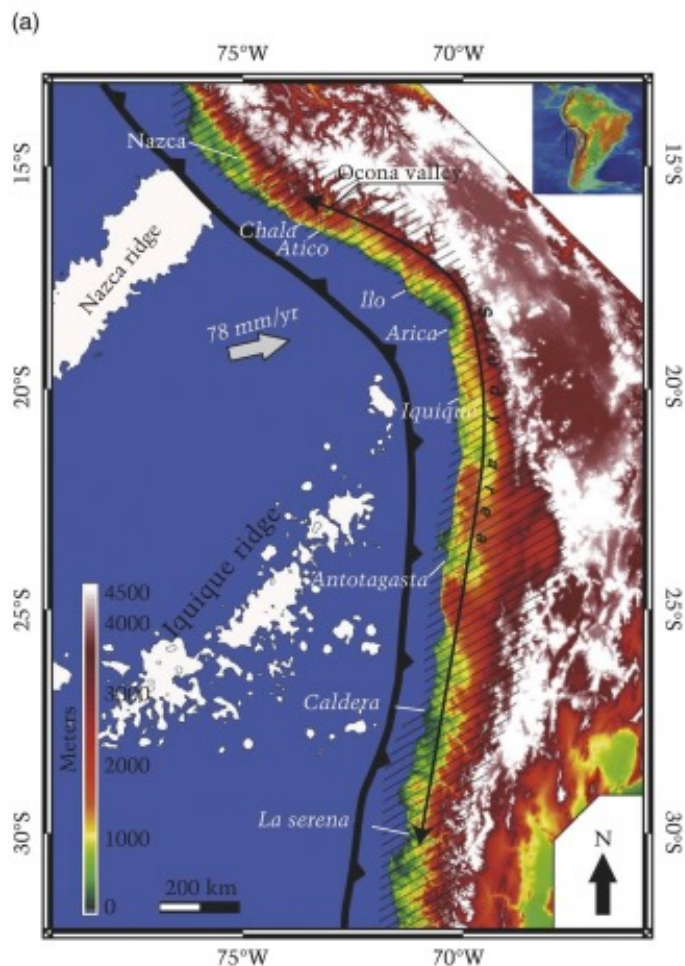


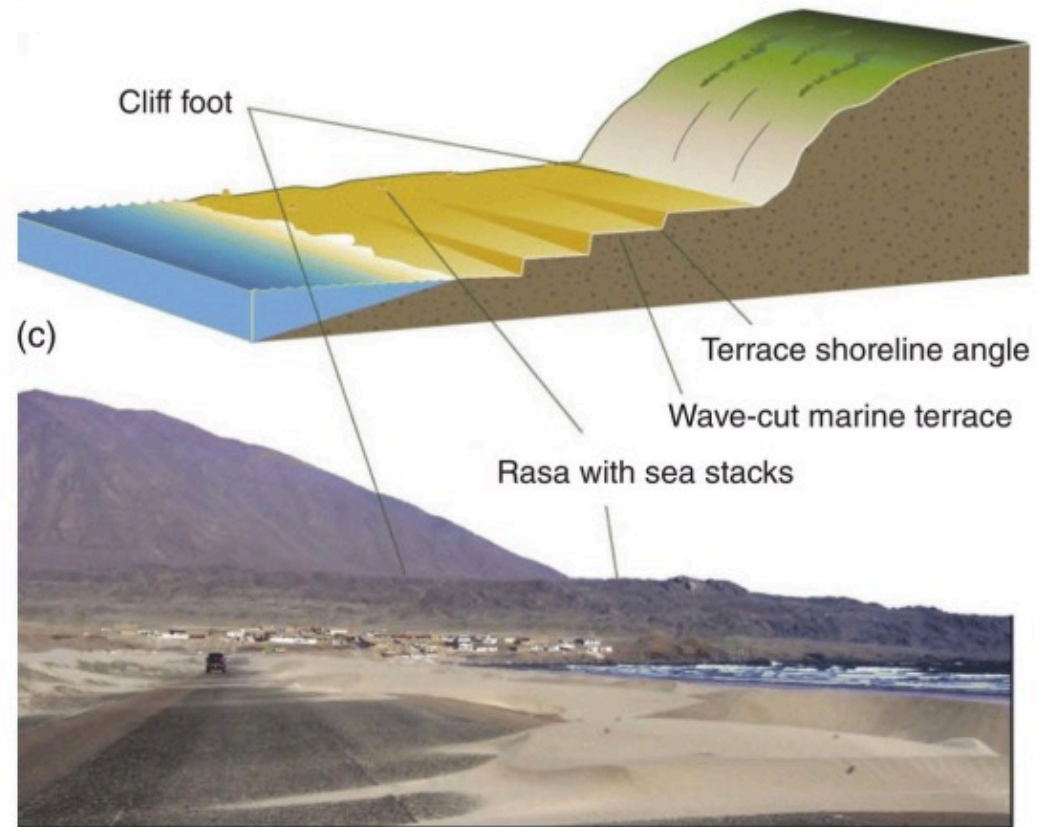
Table 3.1 General characteristics of coasts on active and passive plate margins.

(Source: Short 1999. Reproduced with permission of John Wiley & Sons.)

	Active margin	Passive margin
Age	Young (1 to 10s of millions of years)	Old (100 s of millions of years)
Relief	Steep, mountainous	Low-gradient plains
Landforms	High mountains and volcanoes Narrow continental shelf Deep-sea trough	Coastal aggradation plains Wide, low continental shelf Continental slope
Tectonics	Active, earthquakes	Quiescent, stable
Weathering	Physical, mass movements	Chemical, fluvial, rivers
Drainage	Short, steep streams	Long, meandering rivers
Sediments	Low	High
Quantity	Fine to coarse	Fine
Size	Poor	Well
Sorting	Dark	Light
Colour	Unstable minerals	Stable minerals
Composition		
Coastal landforms	Rocky, few beaches	Extensive barriers and deltas
Wave attenuation	Low	Moderate to high
Tide range	Minimal amplification	Enhanced
Examples	West coast of the Americas New Zealand Iceland Japan	East coast of the Americas Southern Africa North Alaska India



(b) Exemplo Costa margem ativa



ffects of neotectonic uplift on an active margin coast. The map (a) shows the topography of the Central Andes, the rate of migration of the Pacific plate and the subduction zone associated with tectonic uplift of this active margin. Most of the Pacific coast of the Central Andes, between 15°S and 30°S, displays a wide (a couple of kilometres) planar feature, gently dipping seawards and backed by a cliff. It is now widely accepted that the inner edges of these terrace features, called 'rasa', correspond to sea-level highstands. The presence of these rasa argues for a recent and spatially continuous uplift of the margin over this 1500 km long coast. A rasa is a wave-cut surface limited at its continental edge by a cliff foot. (b) General sketch of a rasa, which locally can be occupied by marine terraces. (c) Example of a rasa and cliff at Tanaka, southern Peru (15.75°S); the cliff foot is at ~300 m above mean sea level (MSL).

As margens passivas diferem devido a distância da porção ativa

Amero-trailing edge coast:

Com palnícei costeira extensa e deltas, plataformas largas.

No lado oposto, montanhas que proveem sedimentos



3.2.2. Papel das capas de gelo do Quaternário e processos isostáticos

- Ajustes regionais isostáticos também influenciam – Principalmente hemisfério norte
- São característicos ajustes rápidos Holocénicos
- A depressão devido ao gelo, pode causar elevação na borda
- Com isso, ao mesmo tempo que o nível do mar em uma área regride, outra, próxima, transgride

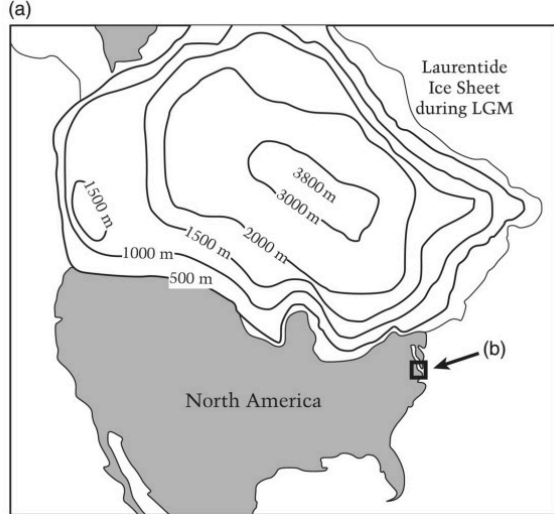
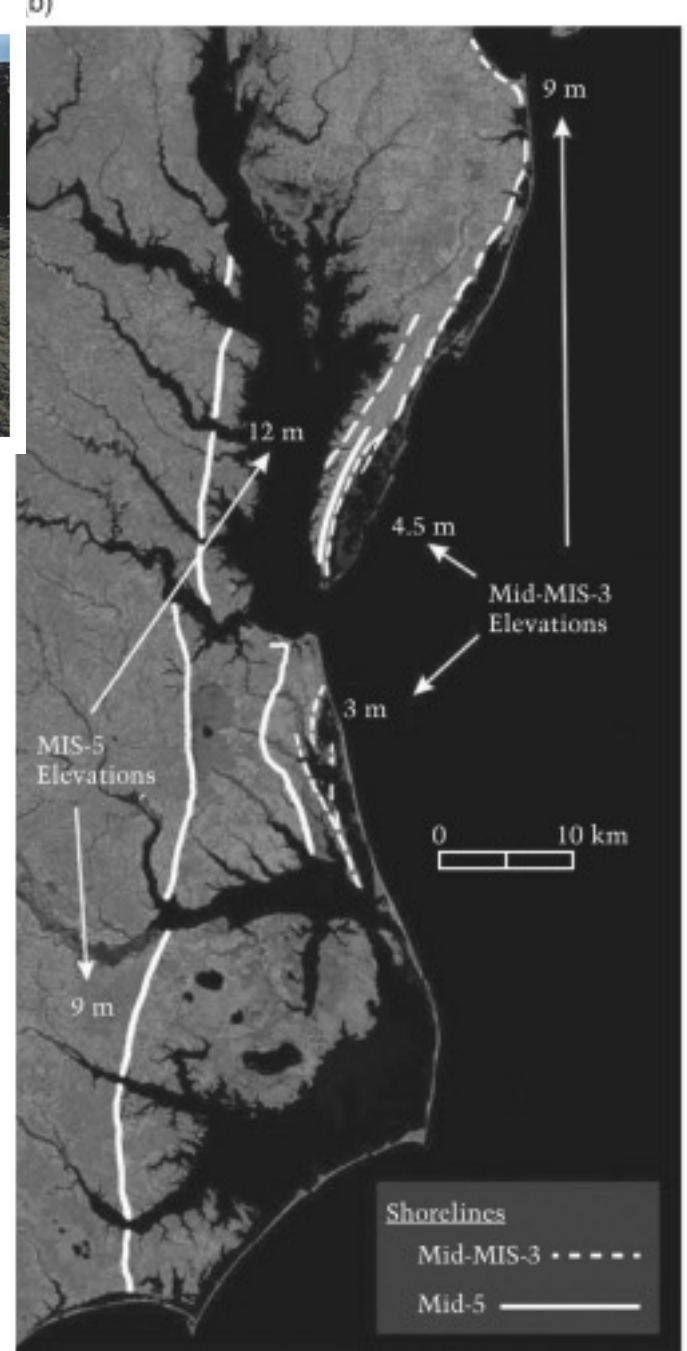
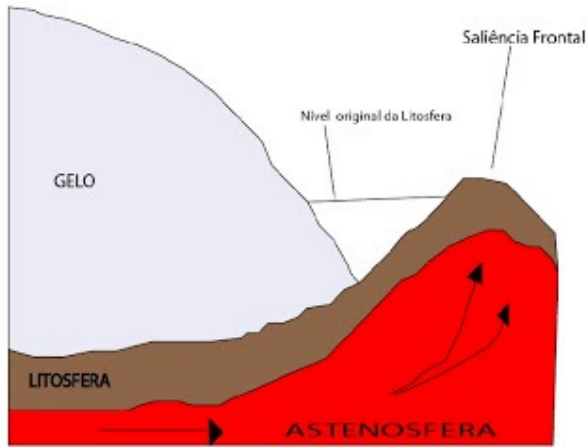


Fig. 3.5 Illustrations of glacio-isostatic effects on coasts. (a) Map of the Laurentide Ice Sheet in North America during the Last Glacial Maximum (LGM). (b) Aerial photograph of North Carolina, USA, showing approximate locations and alongshore variations in elevations of dated mid MIS-3 (Last Glacial) and MIS-5 (Last Interglacial) shorelines. The high elevations of the MIS-3 shorelines result from the effects of glacio-isostatic rebound of the Laurentide Ice Sheet. (Source: Scott et al. 2010. Reproduced with permission of Elsevier.) (c) Photo showing successive Holocene 'stair-case' raised beach ridges due to uplift resulting from glacio-isostatic rebound following ice removal at Kativik, Hudson Bay, Canada.



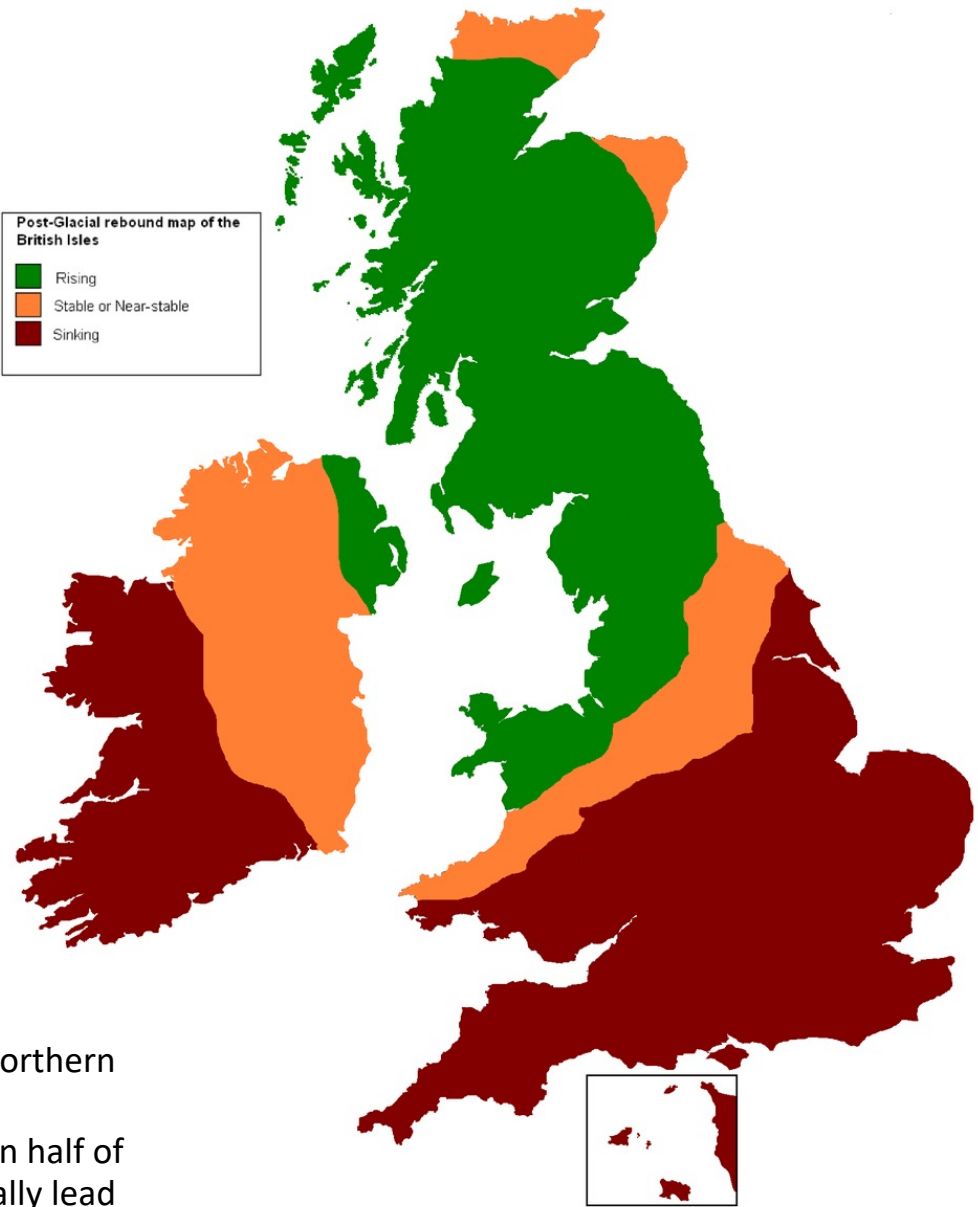


This layered beach at Bathurst Inlet, Nunavut is an example of post-glacial rebound after the last Ice Age. Little to no tide helped to form its layer-cake look. Isostatic rebound is still underway here. https://en.wikipedia.org/wiki/Post-glacial_rebound



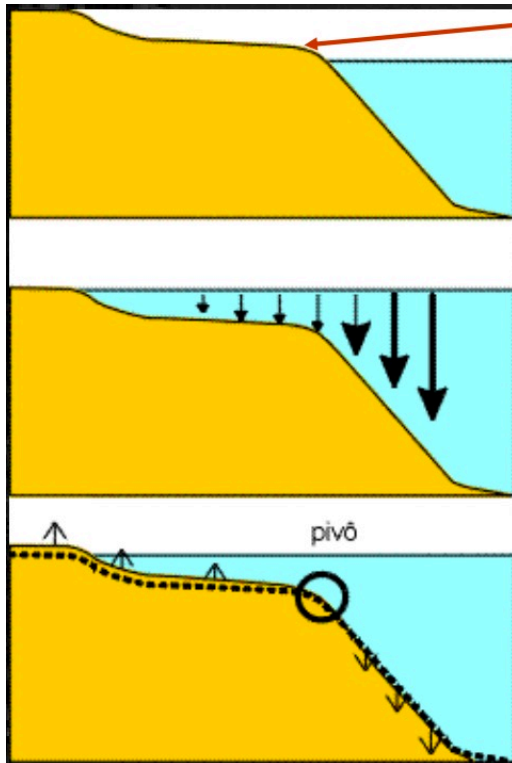
Post-Glacial rebound map of the British Isles

- Rising
- Stable or Near-stable
- Sinking



In Great Britain, glaciation affected Scotland but not southern England, and the post-glacial rebound of northern Great Britain (up to 10 cm per century) is causing a corresponding downward movement of the southern half of the island (up to 5 cm per century). This will eventually lead to an increased risk of floods in southern England and south-western Ireland.[10]

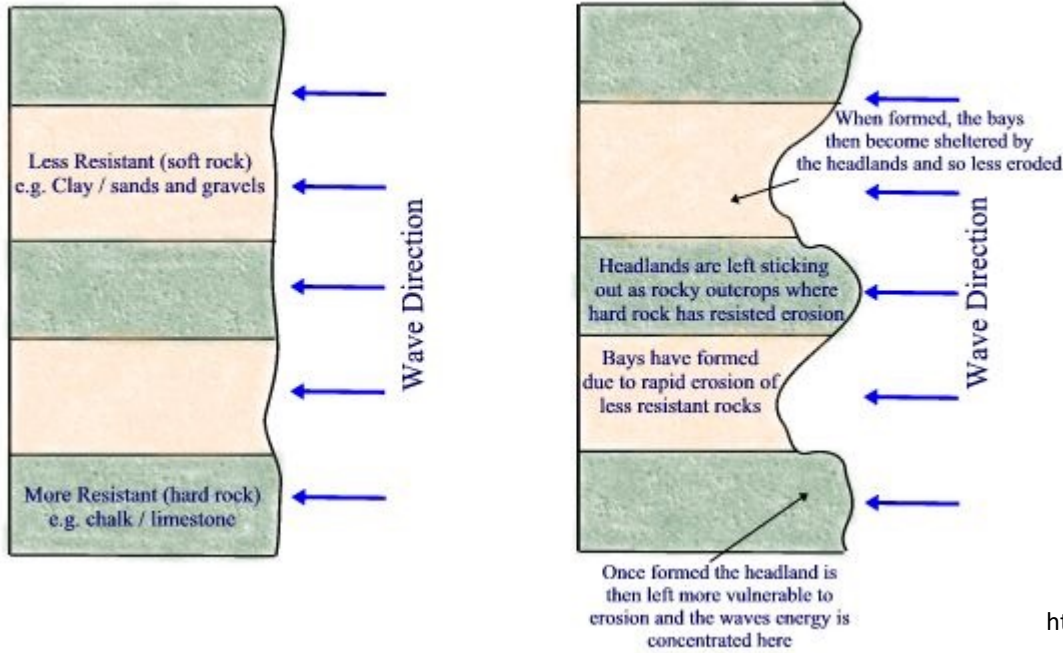
- Existe também a hidro-isostasia, porém menos significativa



3.2.4. Litologia, textura sedimentos e costas

- O desenvolvimento do relevo costeiro depende das características das rochas, condicionadas pelo clima – intemperismo
- A litologia pode variar no tempo e espaço rapidamente
- Outros fatores: topografia, ondas, espaçamento promontórios / baías, características das falésias e costões

The Formation of Headlands and Bays



<https://102coastsgroup2.wikispaces.com/3+HEADLANDS+AND+BAYS>



<https://theextendedigcsegeographyclass.wikispaces.com/Headlands+and+Bays>

A configuração depende do tipo de Embasamento

3.2.5 Outras condicinantes de entorno regionais ou locais

- Orientação da costa
- Gradiente
- Ambos influenciados pela geologia
- A maior parte das costas no mundo tem orientação de larga escala relacionada a borda da placa

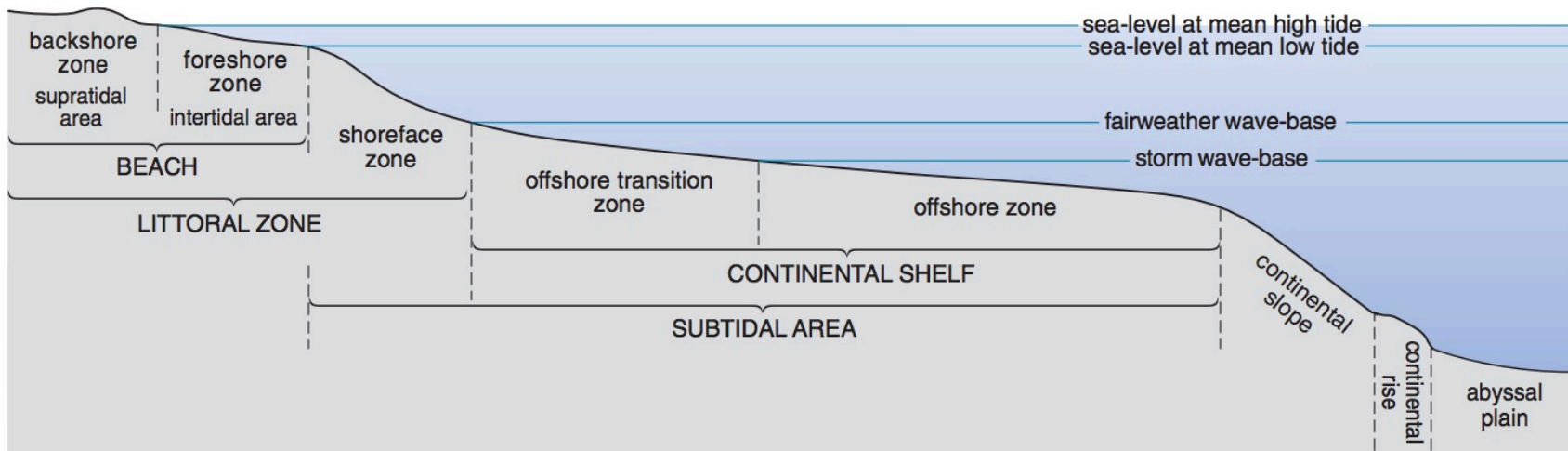
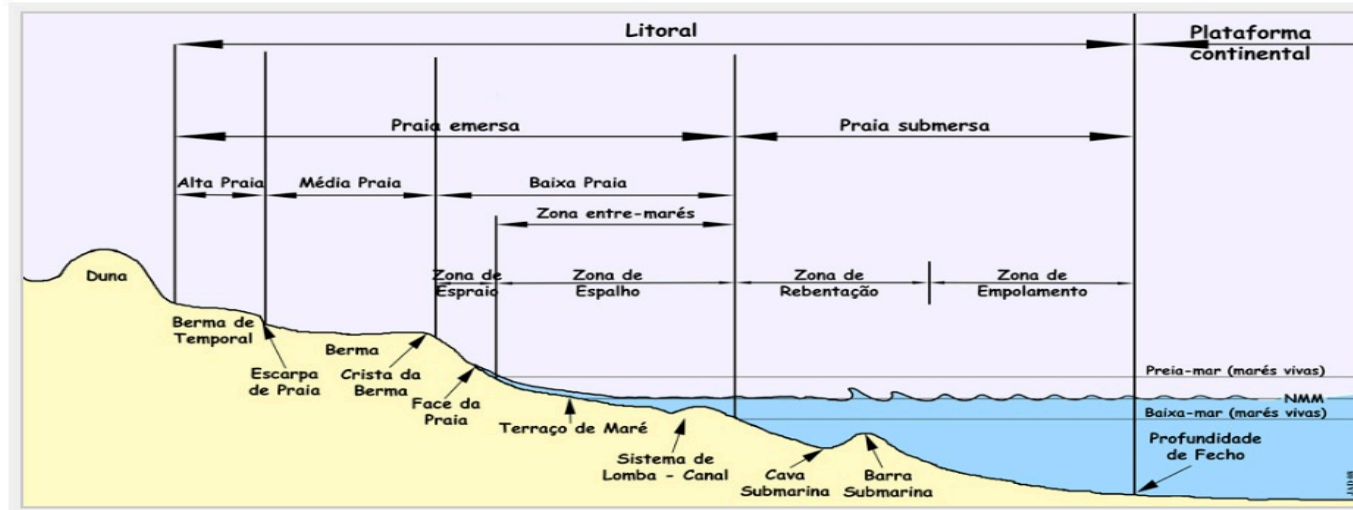


Figure 4.3 The shallow-marine equilibrium profile and various base levels discussed in the text; for simplicity, sea-level can be taken as the base-level in shallow-marine environments.

Equilibrium profiles in all environments ranging from alluvial to deep sea are perturbed by tectonic and climatic factors which also govern relative sea-level and sediment supply. Sea-level is thus particularly important in affecting deposition and erosion along both non-marine and marine equilibrium profiles. In the majority of circumstances, the amount of accommodation space above sea-level is generally less

from non-
a shallow-



Zonas em que normalmente se divide a praia. Refira-se que a nomenclatura da praia apresenta grande variabilidade, quer na literatura científica em português, como em inglês.

- Localmente podem independender da geologia de base e se orientar conforme a disponibilidade de sedimentos

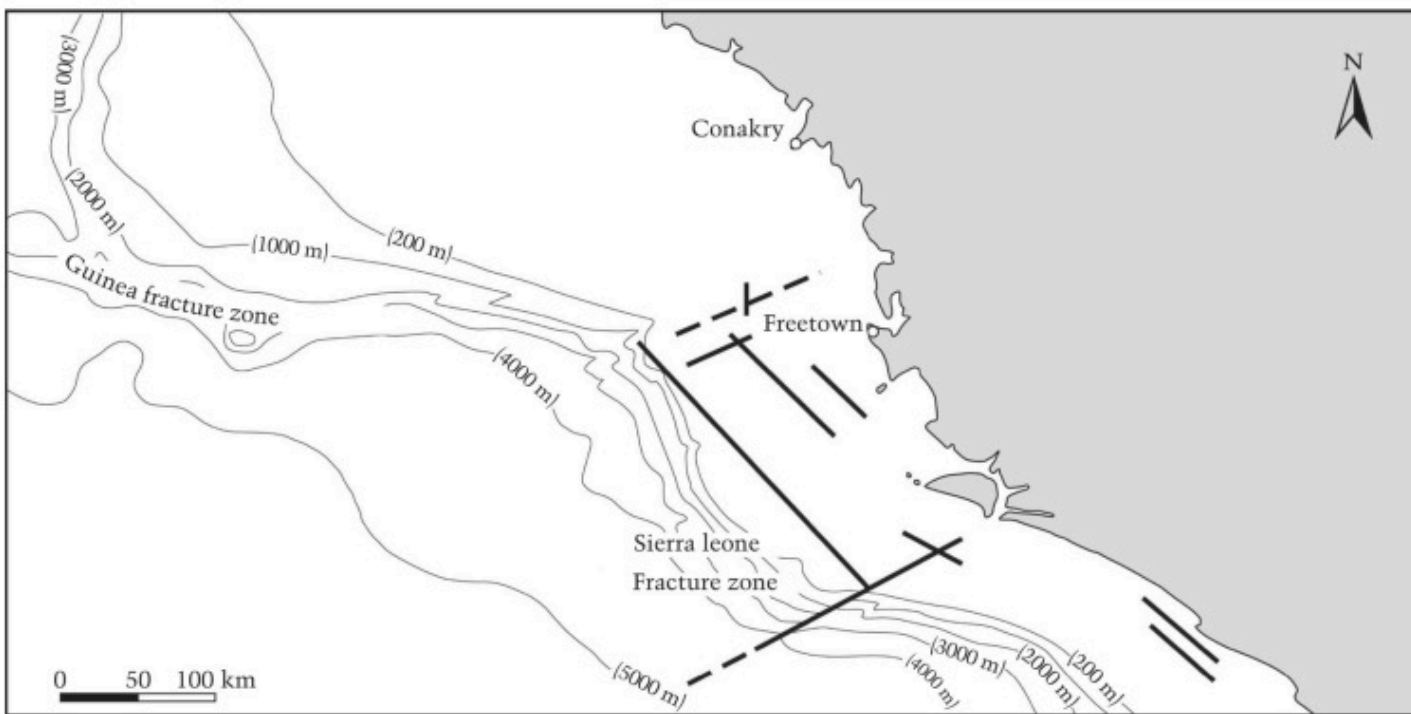


Fig. 3.6 Geological sketch of part of the West African continental margin showing the significant increases in continental shelf width related to offsetting by fracture zones. Fracture zones and their transform faults enable differential rates of ocean basin accretion associated with the Mid-Oceanic Ridge. These fracture zones show mild tectonic activity (occasional earthquakes) and their effect on the geomorphology of this coast has been fundamental. The narrow shelf south of the Sierra Leone Fracture Zone is a wave-dominated, low tide range coast with massive progradation (by several kilometres), shoreline advance and wave-formed sandy beach ridges. The broader shelf to the north shows transition between wave- and tide-domination up to the vicinity of Freetown, before becoming a tide-dominated shelf north of Freetown, associated with significant tide-range amplification and wave dissipation over the broad shallow shoreface. The coast in this tide-dominated zone comprises extensive open-coast mangroves and cheniers.

Outro fator importante o gradiente

- Maior o gradiente, menor espaço de acomodação
- Praias com gradiente elevado – pós praia curto

A diversidade também está relacionada ao suprimento de sedimentos

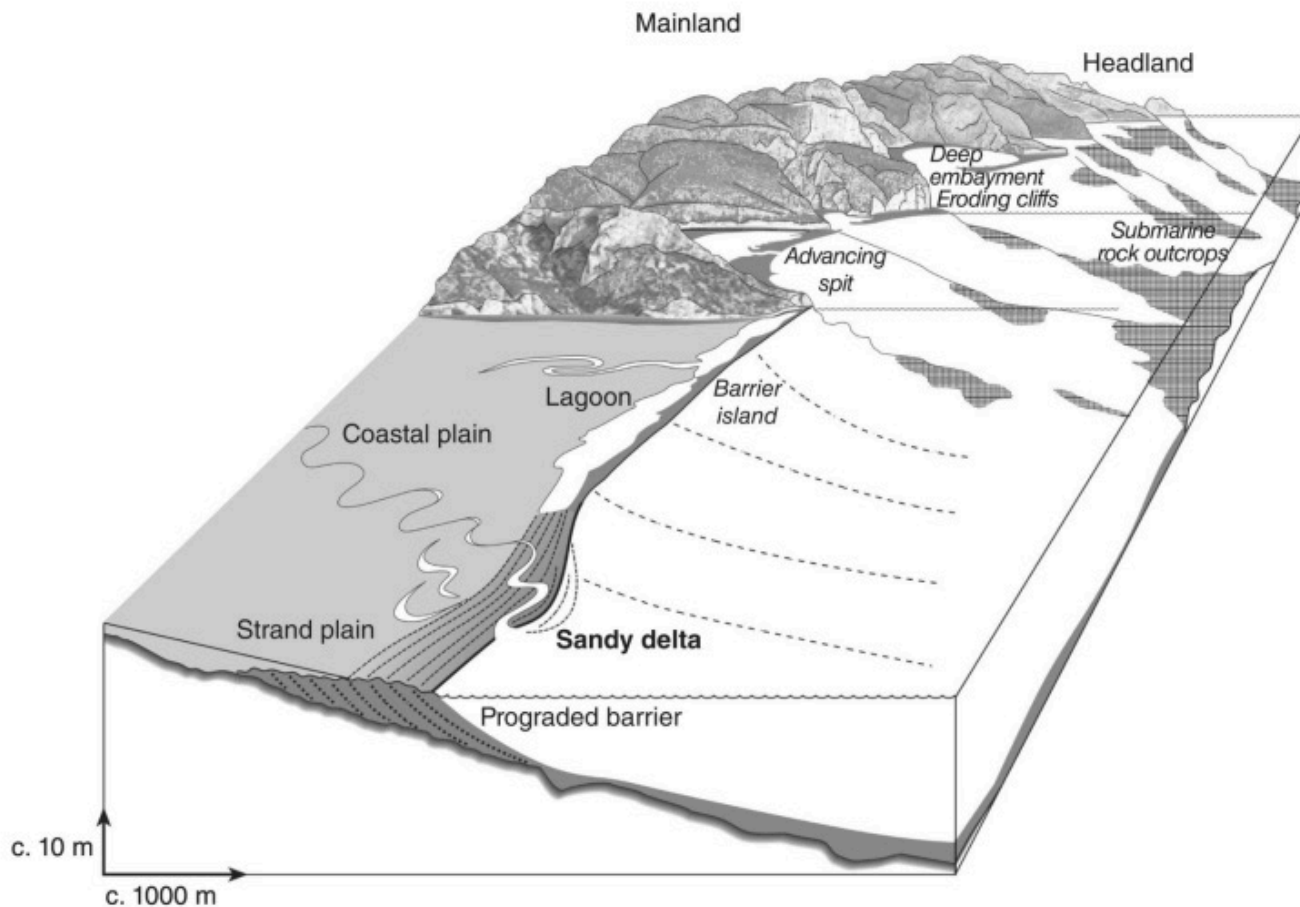


Fig. 3.7 Block diagram depicting the influence of variability in coastal lithology, substrate gradient and sediment supply on the development of coastal barriers, with a change from a sediment-starved bedrock-dominated coast with bold headlands, deep embayments and offshore rock reefs, to a sediment-rich coastal plain comprising a range of wave-formed barrier deposits.

3.3. Costas e Sedimentos

- Em geral, a maior parte dos sedimentos é de origem terrígena:
 - Lama
 - Areia
 - Cascalho
- Podem ser da plataforma interna
- Ou orgânicos

ϕ	Português	Inglês	mm
-9	Bloco	Boulder	512
-8			256
-7	Seixo	Cobble	128
-6			64
-5			32
-4			Cascalho muito grosseiro
-3	Cascalho grosseiro	Coarse gravel	8
-2	Cascalho médio	Medium gravel	4
-1	Cascalho fino	Fine gravel	2
0	Areia muito grosseira	Very coarse sand	1,000
1	Areia grosseira	Coarse sand	0,500
2	Areia média	Medium sand	0,250
3	Areia fina	Fine sand	0,125
4	Areia muito fina	Very fine sand	0,0625
5	Silte grosseiro	Coarse silt	31,25
6	Silte médio	Medium silt	15,63
7	Silte fino	Fine silt	7,81
8	Silte muito fino	Very fine silt	3,91
9	Argila grosseira	Coarse clay	1,95
10	Argila média	Medium clay	0,98
11	Argila fina	Fine clay	0,49
12	Argila muito fina	Very fine clay	0,24
13	Colóides	Colloid	0,12



<http://catarinabiogeo.blogspot.com.br/2012/4/processos-e-materiais-geologicos.html>

<http://www.aprh.pt/rgci/glossario/escala.html>

- Os sedimentos são organizados por ondas, correntes e vento
- Dependendo das condições hidrodinâmicas, tipo e abundância de sedimentos os depósitos são diferentes

- Depósitos dominados por maré::
 - Sistemas de bancos de areia em canais estuarinos
 - Planícies de maré lamosas (mudflats)
 - Planícies de maré arenosas
 - Pântanos com vegetação (marismas, mangue)
 - Deltas com canais

- Depósitos dominados ondas:
 - Deltas com barreiras
 - Bancos de lama e areia
 - Dunas e barreiras

3.3.2 A diversidade também está relacionada e ao espaço de acomodação

(landward shoreline shoreline).

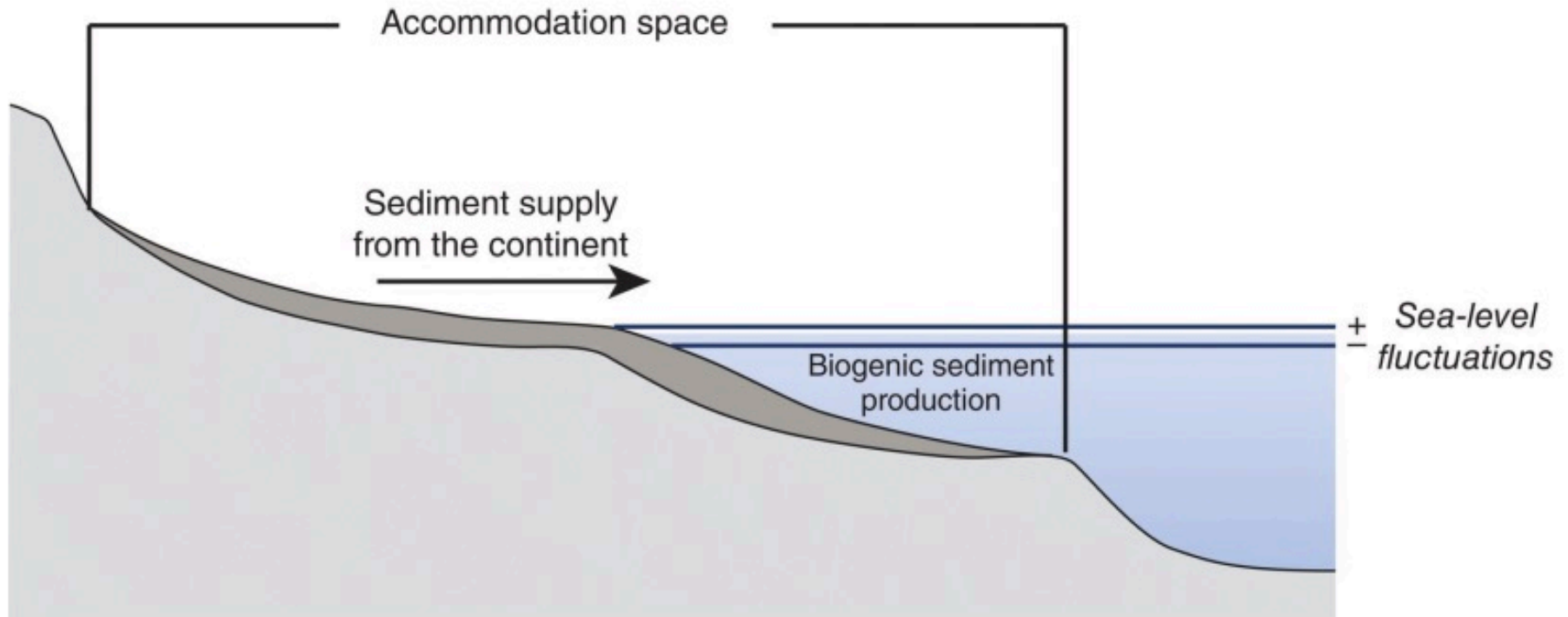


Fig. 3.9 A simple illustration of the concept of sediment accommodation space and its relationship to changes in sea level caused by eustasy or tectonics. The coastal sediment accommodation space can comprise both marine and non-marine space, and sediment supply from both the continent and the sea.

3.3.2 Espaço de acomodação dos sedimentos

- O espaço de acomodação representa a disponibilidade espacial para acomodar sedimentos terrígenos ou marinho
- Varia muito com o nível do mar
- Com a morfologia
- Onde não ha espaço o sedimento “passa”
- Areas negativas – sedimentos anteriores são erodidos

3.3.3 Suprimento de sedimentos terrígenos

- Os rios são as maiores fontes de sedimentos terrígenos: 90%
- 10-20 bilhões de tons/ano
- Um exemplo de como ver o processo: source-to-sink - fonte-sumidouro
- Nessa abordagem se juntam a gelologia e suprimento sedimentos e alguns processos

- O aporte ocorre em diversas escalas temporais, incluindo eventos extremos de curta duração:
 - Enchentes, tempestades, terremotos, vulcanismo, dependendo do contexto
- Grandes rios em margens tipo passivas
Amero-trialing ou Ativas com arcos de ilhas

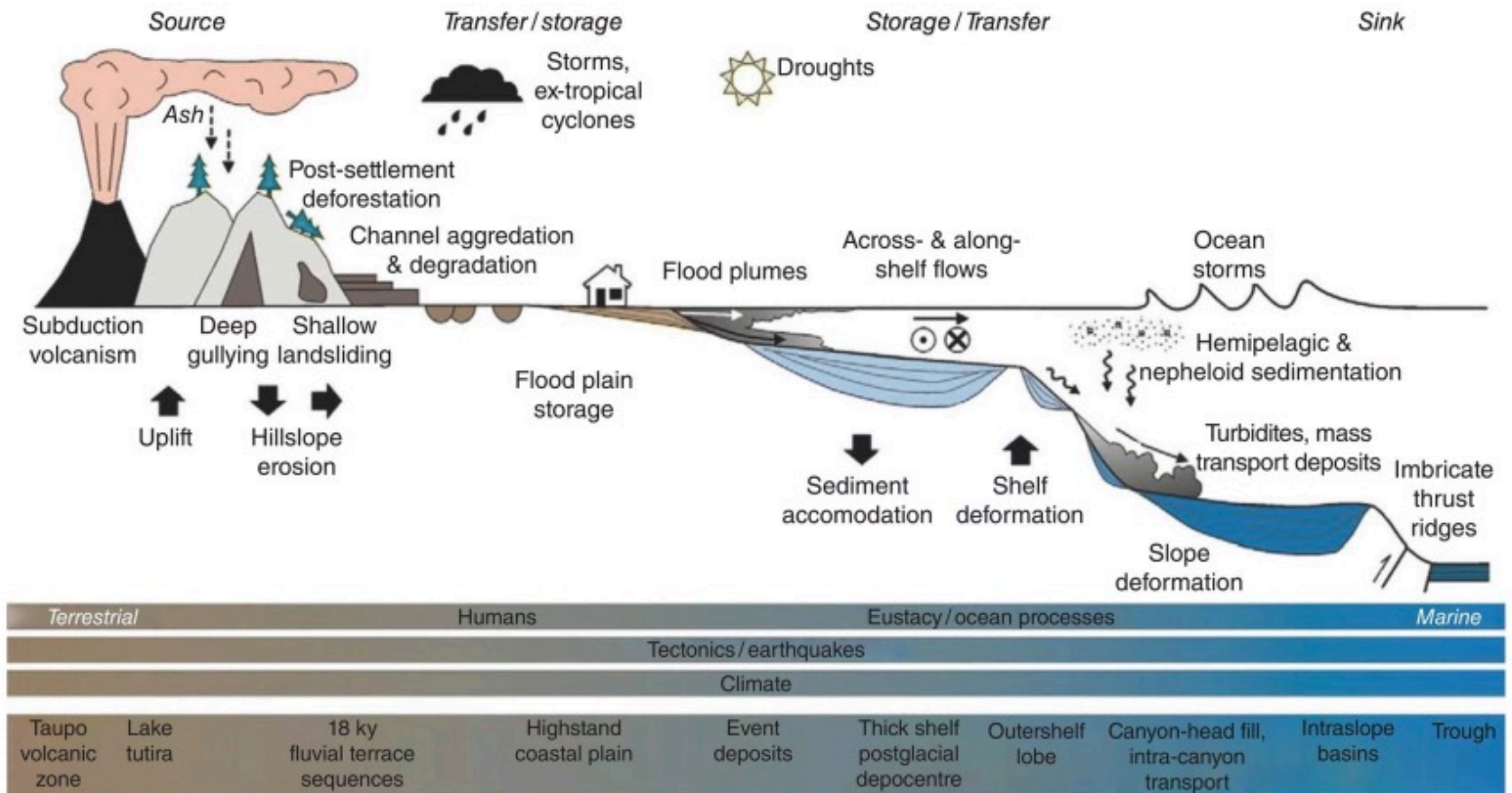
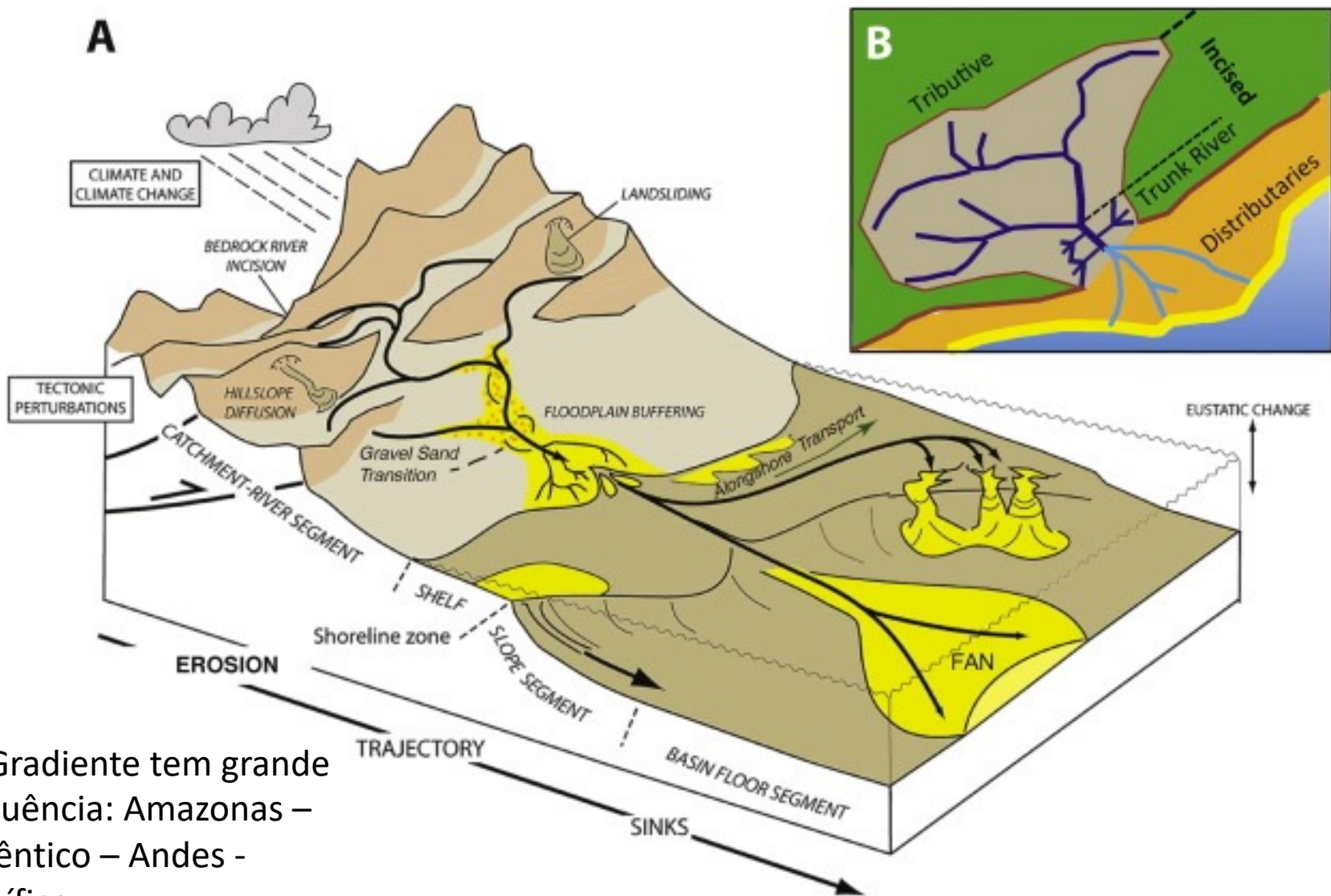


Fig. 3.10 Diagram illustrating the source-to-sink concept, using the Waipaoa Sedimentary System (WSS) in New Zealand as an example.



O Gradiente tem grande influência: Amazonas – Atlântico – Andes - Pacífico

Fig. 1. A. Source-to-sink components and processes. After Allen and Allen (2013) and Sømme et al. (2009). B. Channel networks in a typical S2S system. Tributary channels in the main upland catchment area converge to form a larger trunk river, with smaller side tributaries. The trunk channel feeds a distributive fluvial system that may also form part of the coastal or delta plain. These can also be linked to deep-water systems, as shown in Fig. 1A.

- Nesse contexto, qualquer variação no nível do mar afeta todo o processo.
- A atuação humana é também significativa: agricultura, desmatamento, urbanização....

3.3.4 Redistribuição de sedimentos do estuário para a costa

- Os estuários são zonas de transição
- Os processos de corrente perdem força para de ondas e marés

- Efeito da água salgada
- Geomorfologia
- Batimetria
- Transporte de sedimentos bidirecional
- Mais evidentes em estuários abertos e deltas

- Os sedimentos ficam entre deposição intra-estuário ou em deltas
- Gradiente de tamanho e propriedades das partículas
- Grande rios, como o Amazonas ou pequenos durante alta descarga, lançam sedimentos direto na plataforma interna formando depósitos ao longo da costa

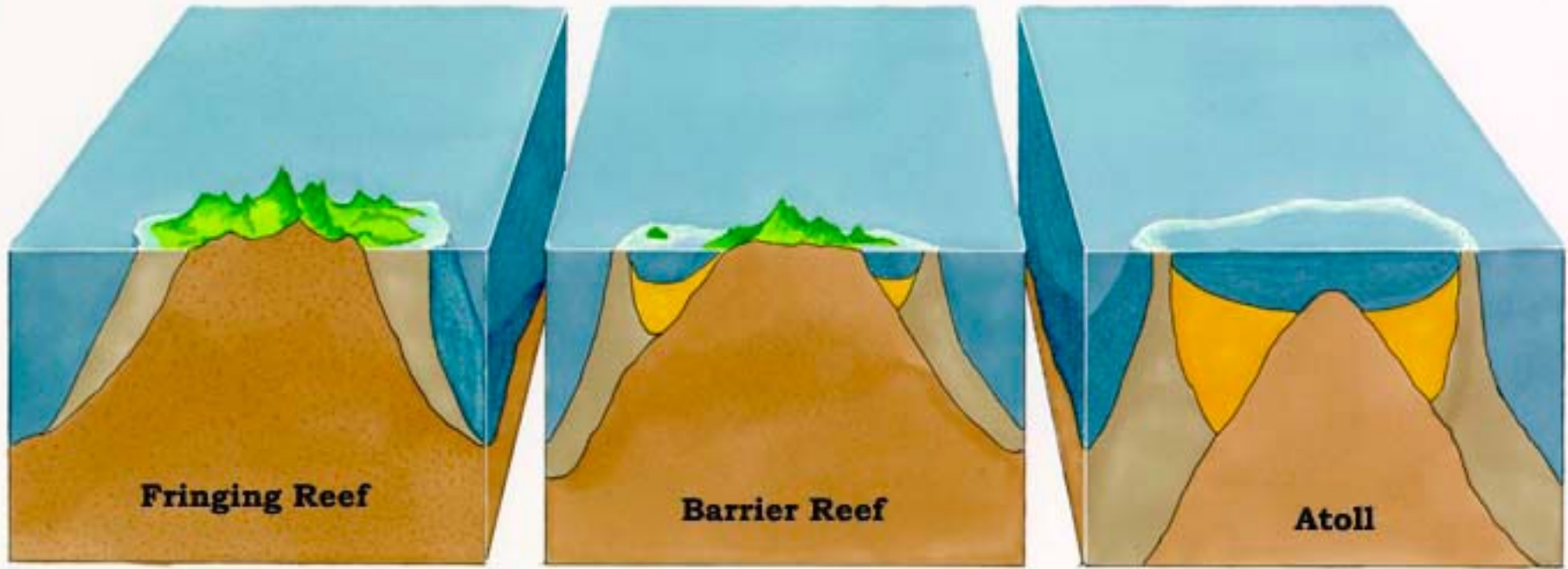


Fig. 3.11 Photograph of a mud bank on the coast of French Guiana, South America, showing stages of colonization by mangroves, comprising young individual plants in the foreground and denser and more mature stands in the background. The 1500-km long mangrove coast of South America between the Amazon and the Orinoco river-mouths is one of the world's muddiest coasts. The Amazon is the world's largest river system, with a drainage basin of 6.1 million km². The mean annual water discharge has been estimated at about 180,000 m³/s at Obidos, 900 km upstream of the mouth, leading to strong fluvial outflow onto the inner shelf. Part of the huge suspended sediment discharge of this river (about 750 million metric tons per year), composed essentially of clay-sized minerals derived from intense tropical weathering of rock debris from the Andes mountains, accumulates up to 150 km offshore, but feeds the formation of mud banks further inshore, which are conveyed alongshore from Brazil to Venezuela by waves and currents (Anthony et al., 2010). The mud banks, which may number more than 20 at any time, are each up to 5 m thick, 10–60 km long and 20–30 km wide, and each may contain one to several times the entire annual mud supply of the Amazon. As these banks migrate alongshore, they dissipate waves from the Atlantic, protecting the terrestrial shore. Temporary mud attachment to the shore leads to massive short-term (months to a years) coastal progradation (from hundreds of metres to over 1 km), followed by equally spectacular coastal erosion by waves a few years later as the bank continues its migration downdrift.

- Nos deltas o transporte por arrasto de fundo (bedload) é relevante
- Esse material eventualmente formará barras que serão ou não retrabalhadas por ondas

3.3.5 Sedimentos carbonáticos

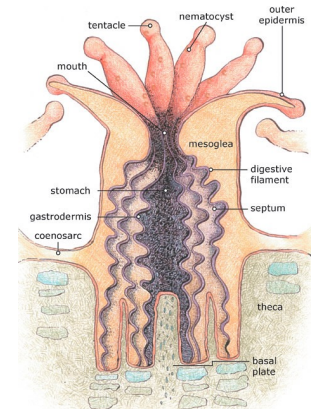
- Uma porção importante do registro sedimentar dos ambientes costeiros
- Rochas carbonáticas continentais podem eventualmente suprir sedimentos para a costa
- As plataformas carbonáticas e os recifes associados são as maiores feições biológicas costeiras
- Mesmo em costas onde corais não se desenvolvem, restos de conchas podem ser importantes



Close-up of a Coral Polyp

Credit: © osf.co.uk. All rights reserved.

The brownish-green specks seen in this coral polyp are the zooxanthellae that most shallow, warm-water corals depend on for much of their food. Like plants, zooxanthellae capture energy from the sun and turn it into food, some of which the coral eats in exchange for protection.



<https://www.youtube.com/watch?v=pRD8ZwdPYsY>

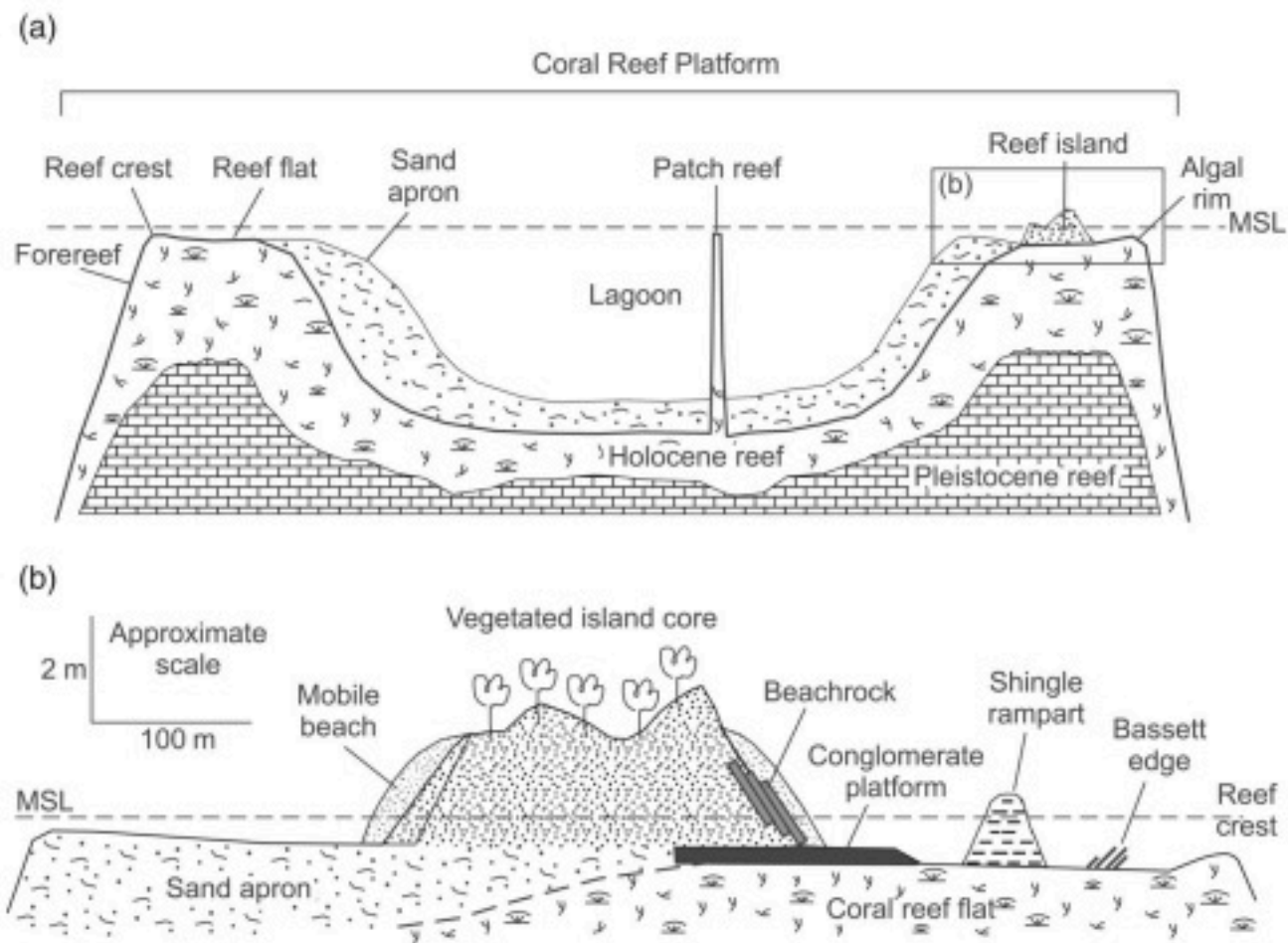


Fig. 16.1 Example of range of coral reef landforms: (a) cross-section of an atoll representing major elements of coral reef structure and large-scale reef geomorphic units typical of many reef settings; and (b) range of sedimentary landforms deposited on or adjacent to coral reefs. MSL, mean sea level.

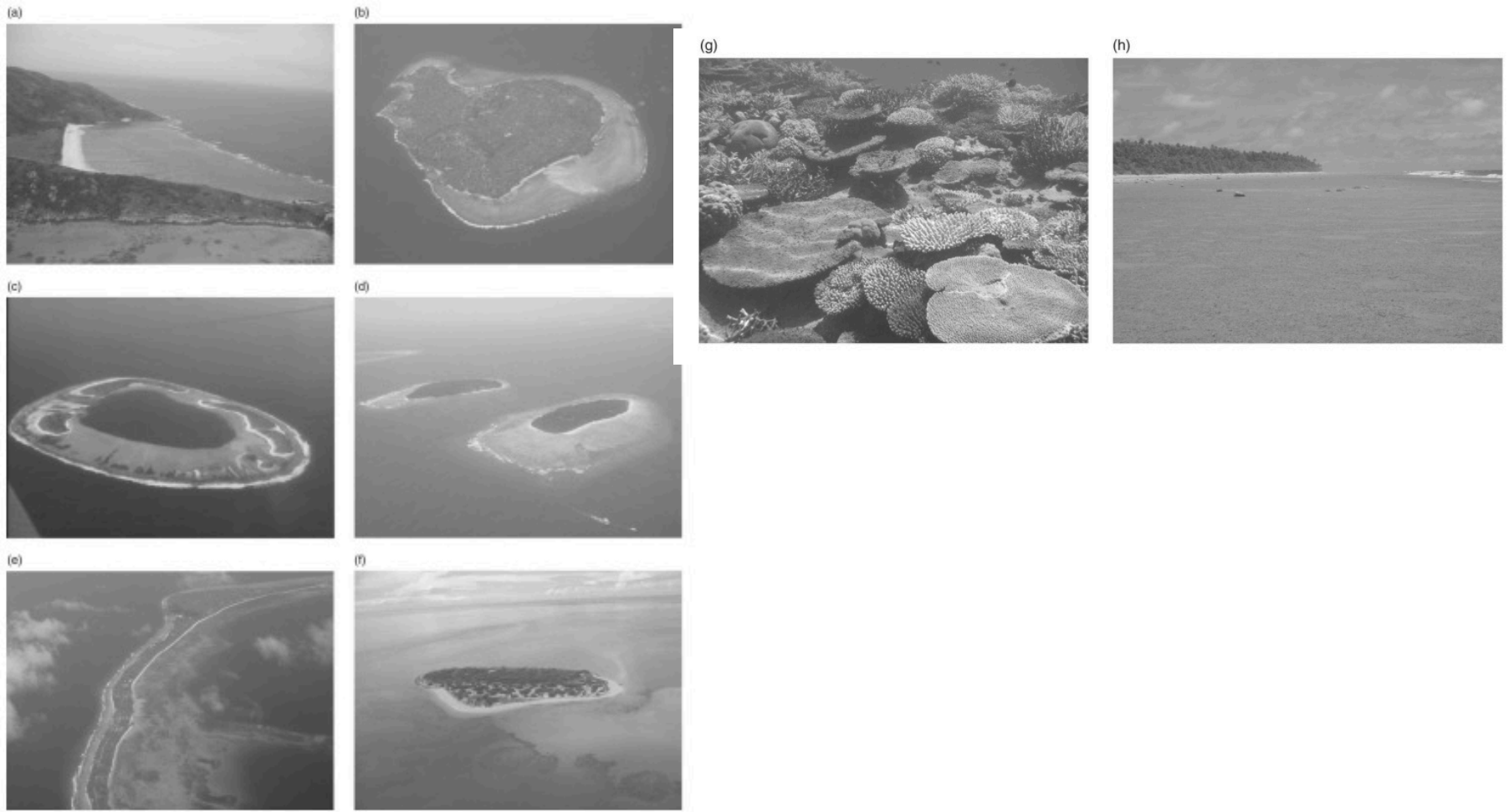


Fig. 16.2 Examples of coral reef landforms: (a) fringing reef, Great Barrier Reef (GBR), Australia; (b) fringing and barrier reefs around a high island in southern Japan; (c) mid-Pacific atoll; (d) reef platforms with platform islands, Maldives; (e) linear atoll island, Majuro atoll, Marshall Islands; (f) reef platform island, GBR, Australia; (g) productive forereef zone, Nadi Bay, Fiji; and (h) emergent reef flat, Jeh Island, Republic of Marshall Islands.

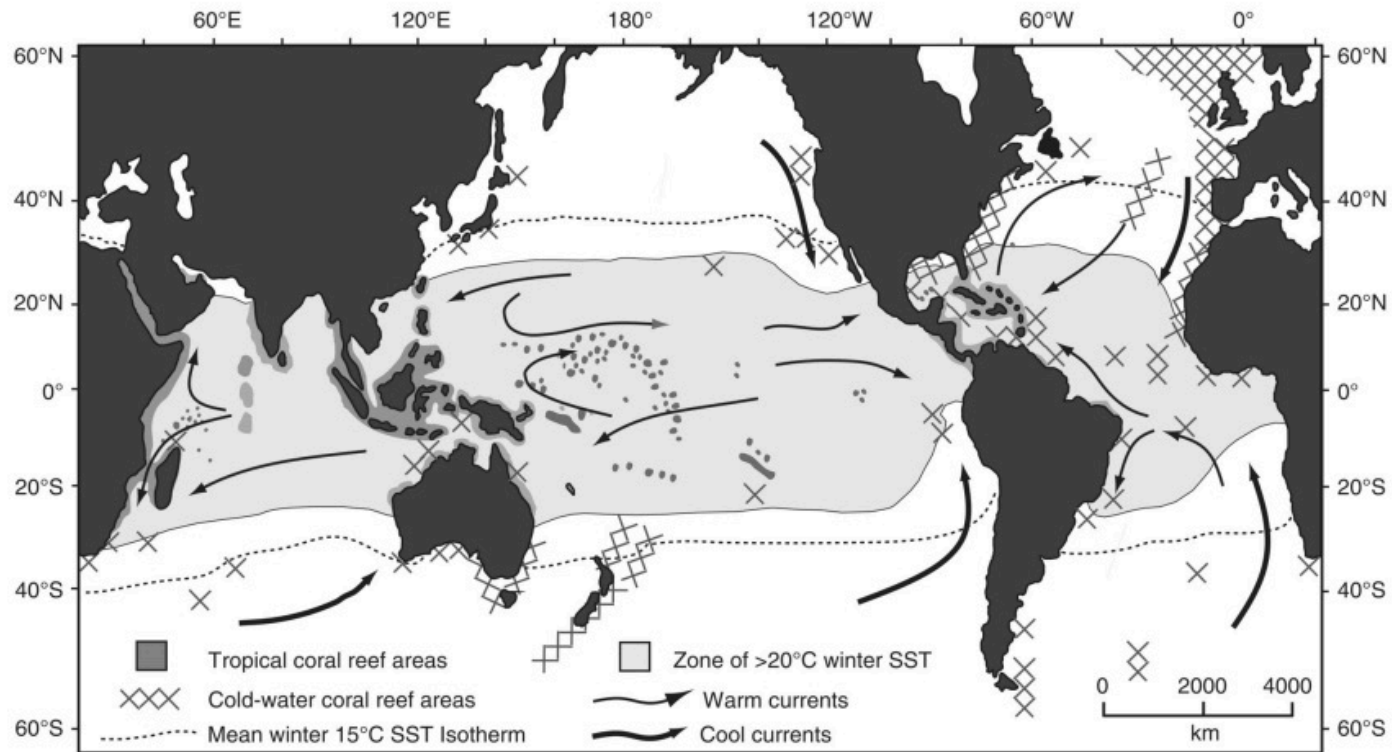
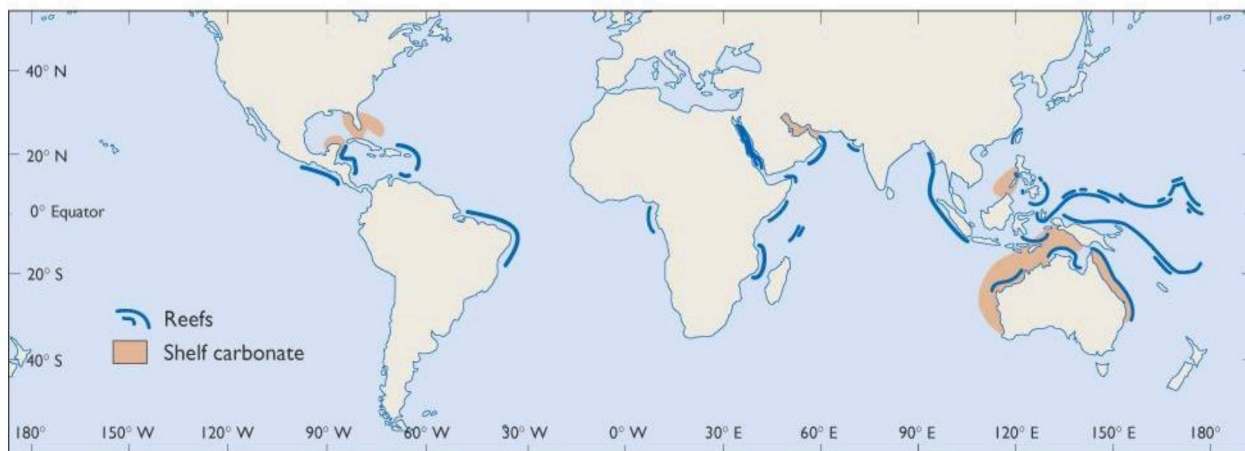


Fig. 16.4 Global distribution of coral reefs. Note the cool-water zones on the western margin of South America and Africa, which precludes coral reef development. SST, sea-surface temperature.



3.3.6. Suprimentos de sedimentos de falésias

- Erosão de falésias contam por 5% dos sedimentos para as costas (menor que rios)
- A erosão supri sedimentos para depósito junto as falésias ou para serem transportados
- O sedimento é transportado e depositado conforme suas características

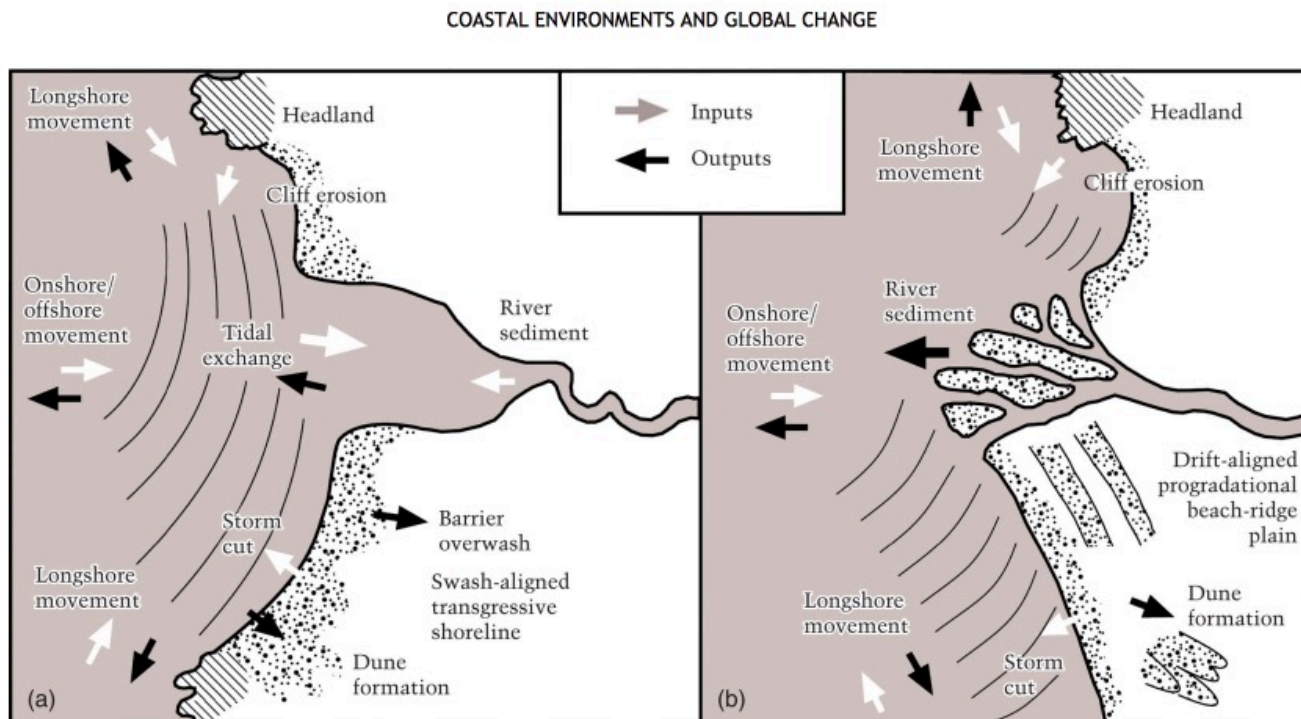


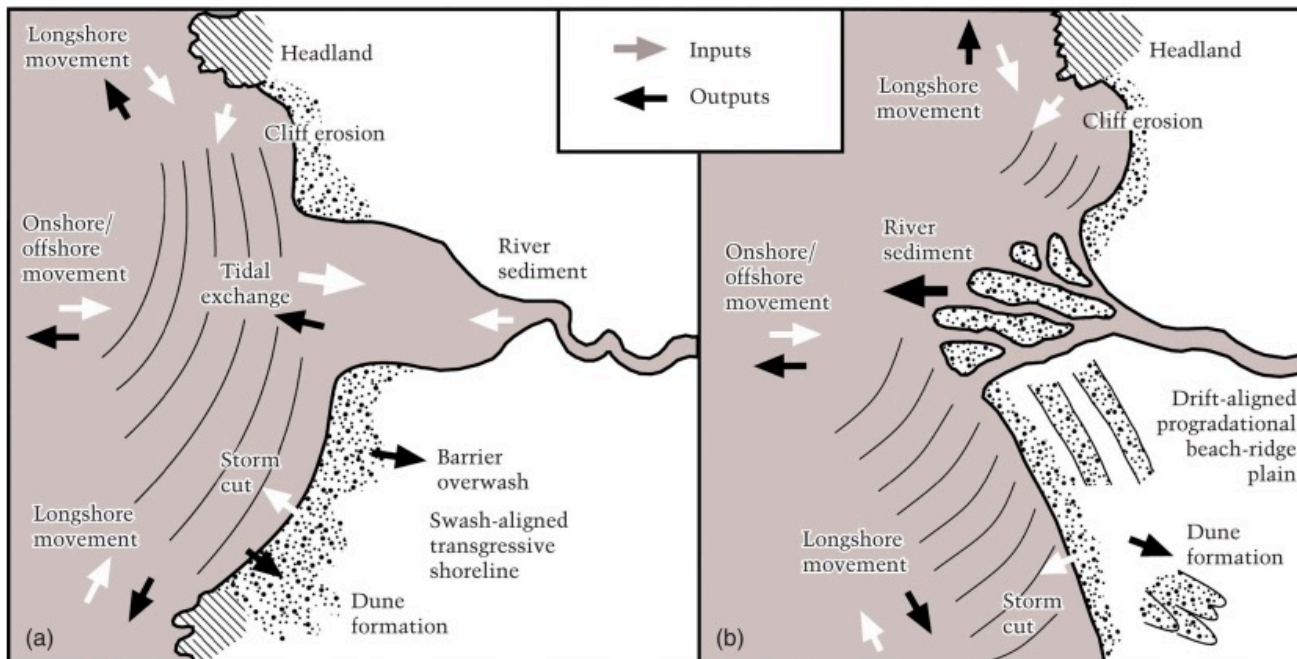
Fig. 3.12 'Soft' rock (chalk) cliffs, Three Sisters, Sussex, England. The gravel beach fronting the cliffs is composed of flint clasts liberated by cliff erosion. In the foreground on the left, the lower beach comprises a sandy apron. Both gravel and sand overlie a chalk platform that crops out in the middle background of the photograph.



3.3.7 Transporte de sedimentos ao longo da costa

- O transporte ao longo da costa redistribui os sedimentos ao longo das células sedimentares





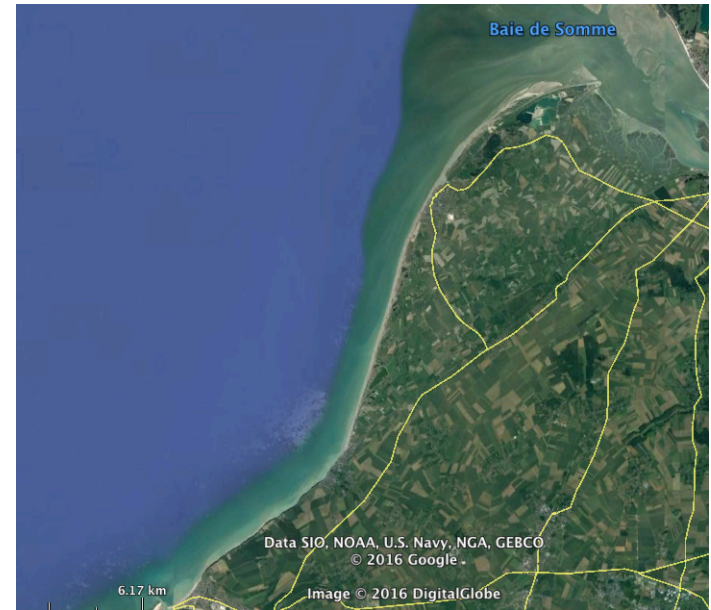
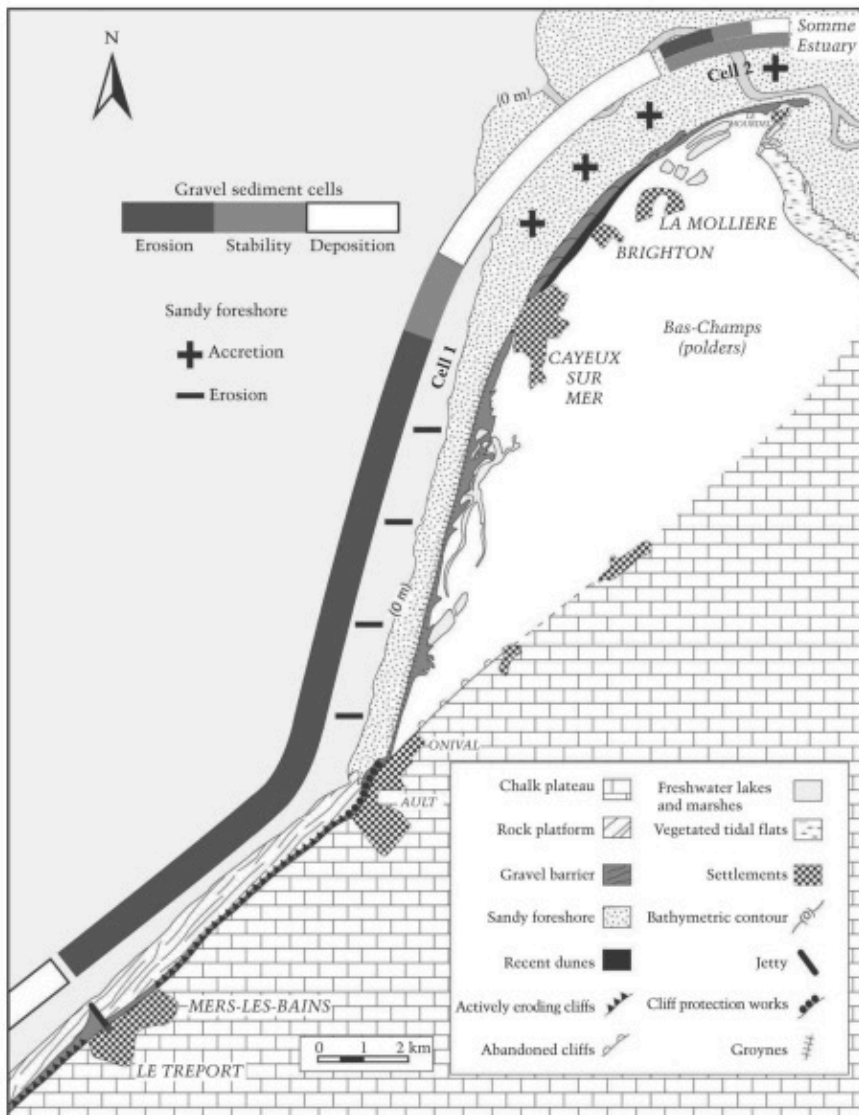


Fig. 3.13 Example of coastal sediment cells on a gravel beach on the Cayeux coast, Picardy, France. Here, the eroding cliffs to the south provide sediment for the gravel spit system. Sediment cells provide a conceptual (and shoreline management) tool for monitoring sediment transport continuities or discontinuities and sediment budgets along the coast. Each cell comprises an erosional, a transport, and a depositional sector, and is bound updrift and downdrift by cell boundaries that may be natural or artificial (engineering or port structures).

3.4 Impactos Antropogênicos sobre o suprimentos de sedimentos

- Histórico
- Alteração de áreas para agricultura e uso da terra
- Barragem
- Urbanização
- Intervenções de engenharia

<https://www.youtube.com/watch?v=ZvnPUlsTcJw>

https://www.youtube.com/watch?v=B7DrCMj_6IE

Megaconstruções - Barreira Contra o Mar

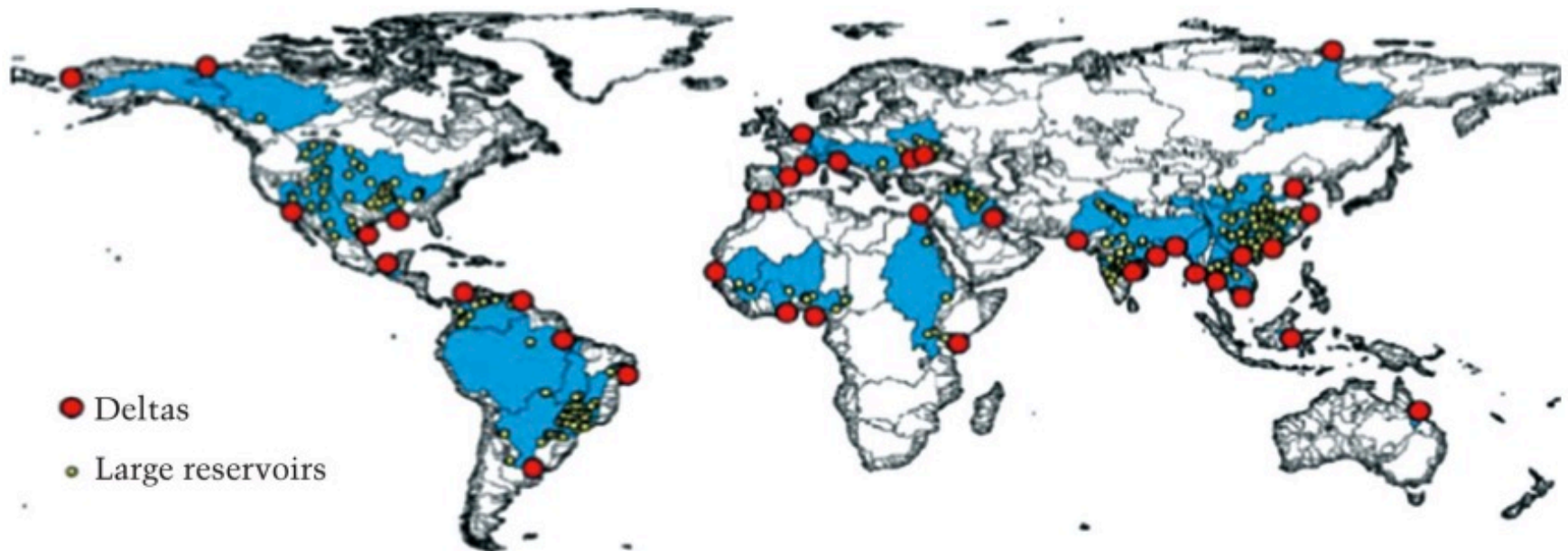


Fig. 3.17 Global distribution of 40 deltas in the world, showing the potentially contributing drainage basin area of each delta (grey) and the large reservoirs (>0.5 km³ maximum capacity) in each basin.

3.5 Mudanças Climáticas, geologia e sedimentos

- Na escala humana, a geologia não é afetada por mudanças climáticas a não ser o aporte de sedimentos
- Mudanças climáticas afetam as bacias hidrográficas, fontes de sedimentos
- De um lado mumento no deslissamento de encostas e transporte de sedimentos
- Com Alagamentos mais frequentes
- De outro diminuição por escassêz de chuvas

- Aumento de erosão e redistribuição de sedimentos
- Alteração nas células sedimentares costa – plataforma
- Em áreas baixas espera-se que o aumento no nível seja compensado pela intervenção humana

