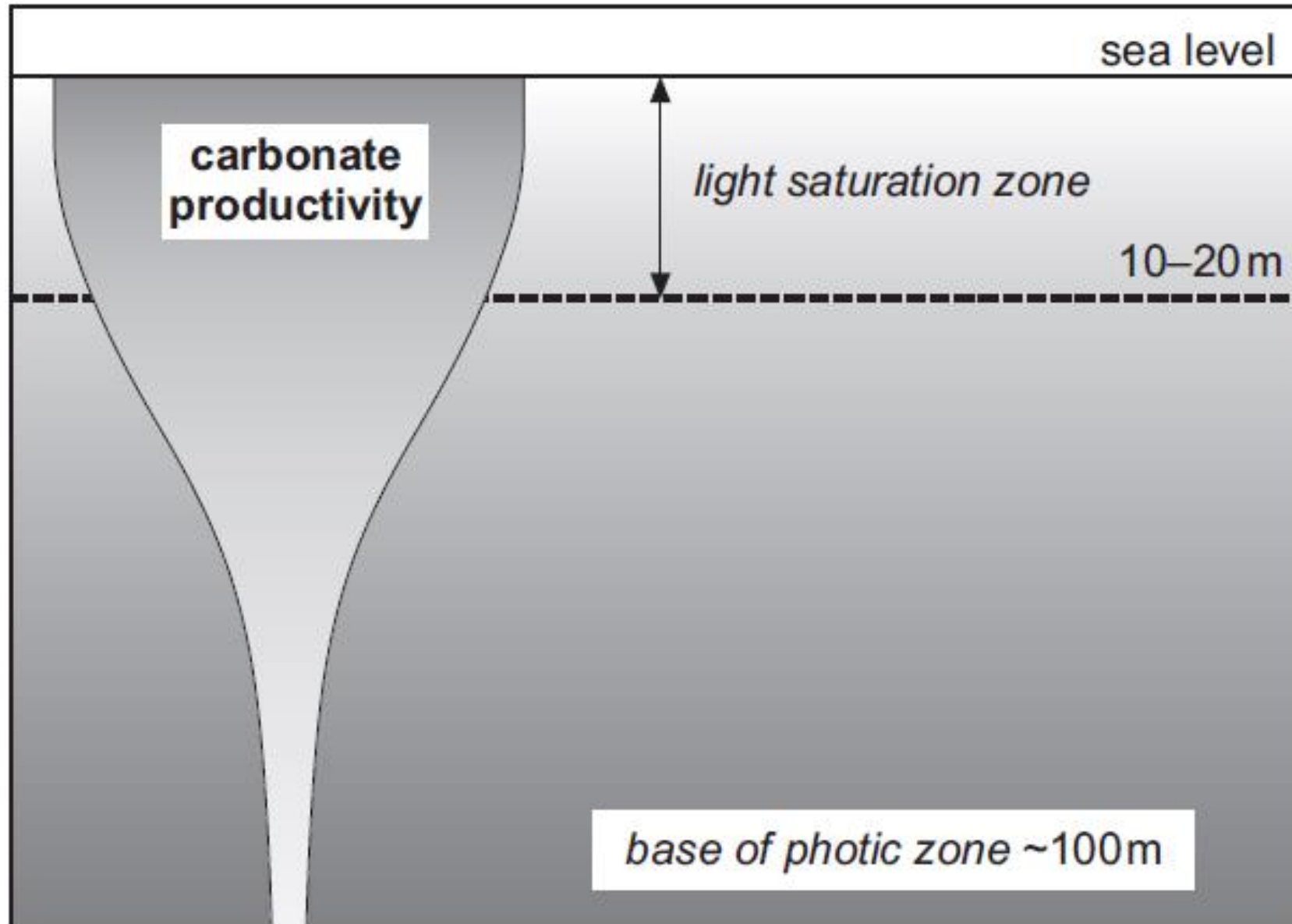
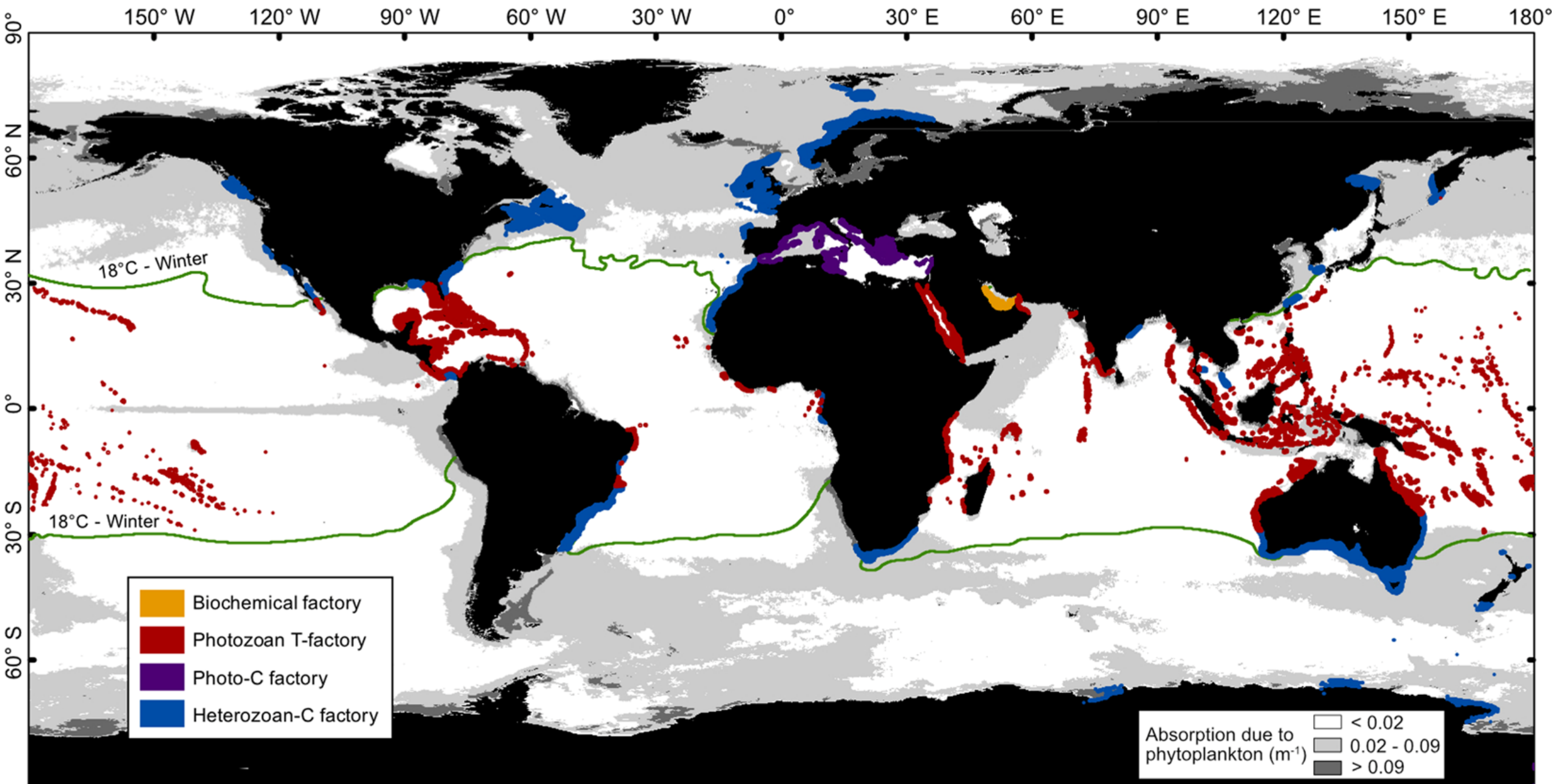


Rochas carbonáticas: sedimentação e modelos de fácies

GSA0252-Sedimentologia

“Fábrica” carbonática





- *Biochemical Factory*: água rasa, plataforma epicontinental, temperatura e salinidade elevadas, micrita, estromatólitos, evaporitos, bioclastos como componentes secundários, *bindstone/mudstone*, rampa homoclinal.
- *Photozan T-Factory*: água rasa, mar aberto, temperatura elevada, ecossistema oligotrófico, biota fototrófica, corais, foraminíferos bentônicos, bioclastos diversos como componentes secundários, *framestone/bafflestone*, recife.
- *Photo-C-Factory*: mares restritos, subtropical/temperado, ecossistema oligo-mesotrófico, algas vermelhas, foraminíferos bentônicos, *sea-grass*, bioclastos diversos e corais como componentes secundários, *grainstone/rudstone/packstone/wackstone*, rampa íngreme.
- *Heterozoan C-Factory*: mar aberto sob influência de ressurgência, ecossistema eutrófico, biota heterotrófica, bioclastos diversos como componentes secundários, *grainstone/packstone/wackstone*, coquinas, plataforma continental.

Chemical energy

External flux

Fluid-related factory

Continental & seeps



Continental

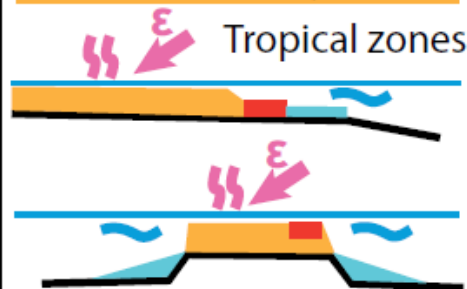
sedimentary behavior

Inorganic &
organo-
mineralization

Evaporation

Marine biochemical T-factory

Tropical zones



T-factory

sedimentary behavior (cf. Schlager, 2005)

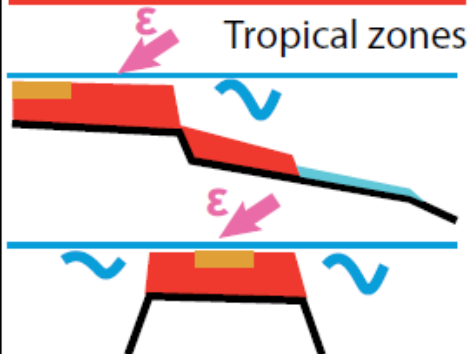
Organo-
mineralization

Light energy

Tropical temperature

Photozoan T-factory

Tropical zones

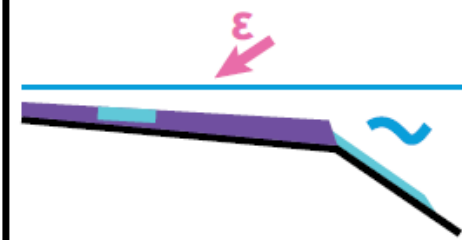


Photosynthetically-
controlled
biomineralization

Mid-latitude temperature

Photo-C-factory

Warm-temperate zones



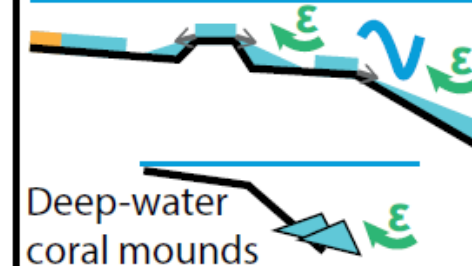
Photosynthetically-
controlled
biomineralization

Trophic energy

Organic-rich

Heterozoan C-factory

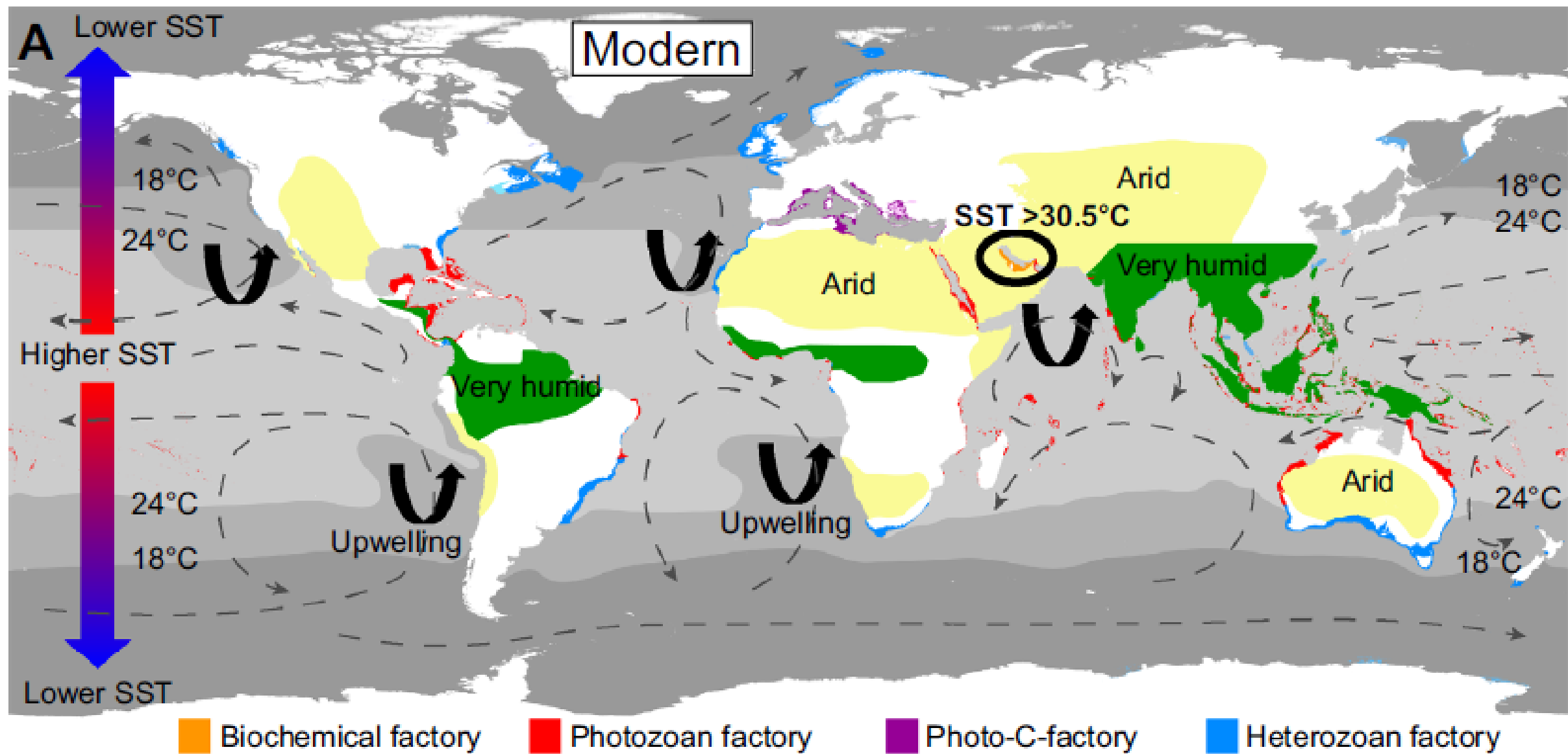
Tropical to polar zones

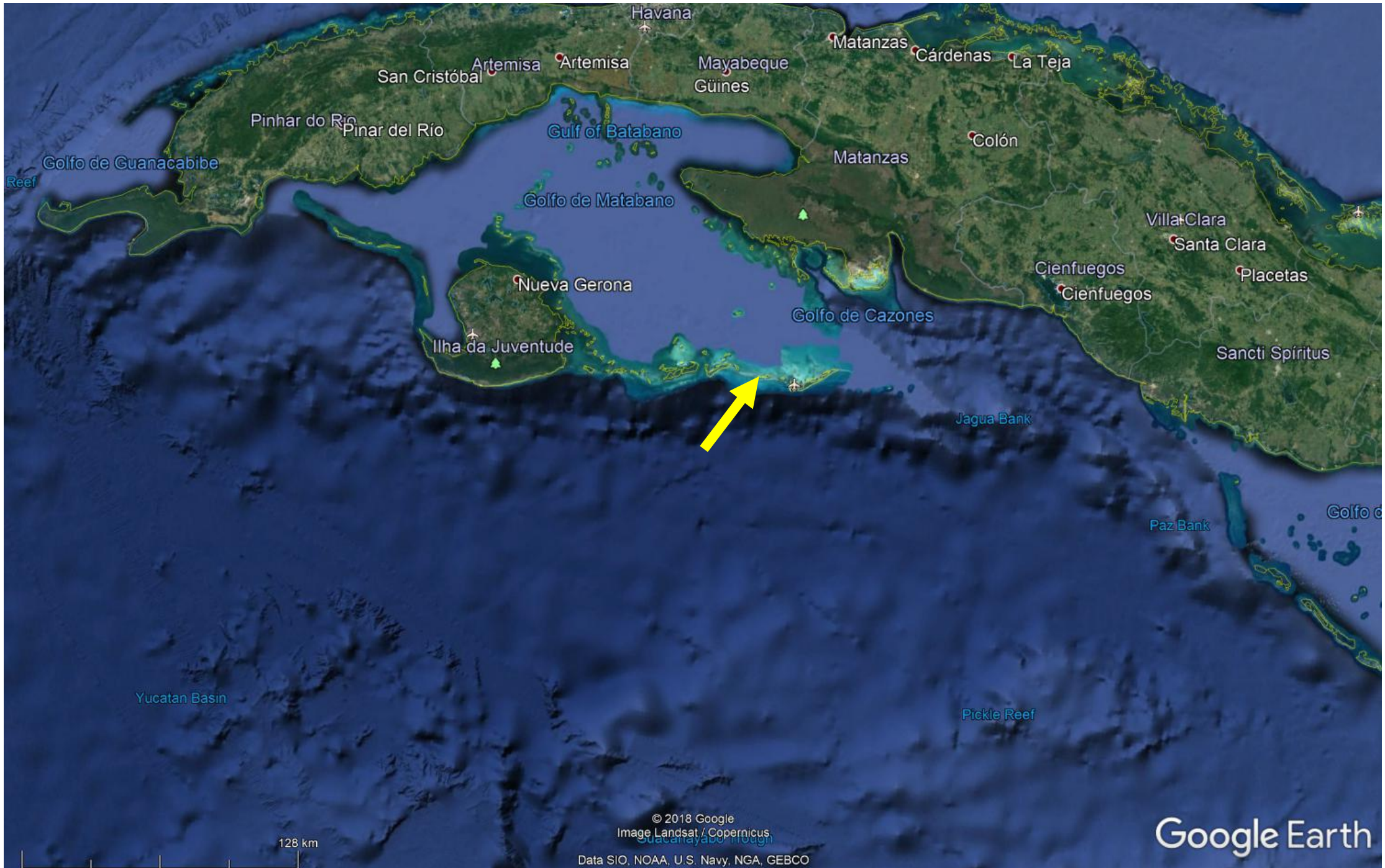


C-factory

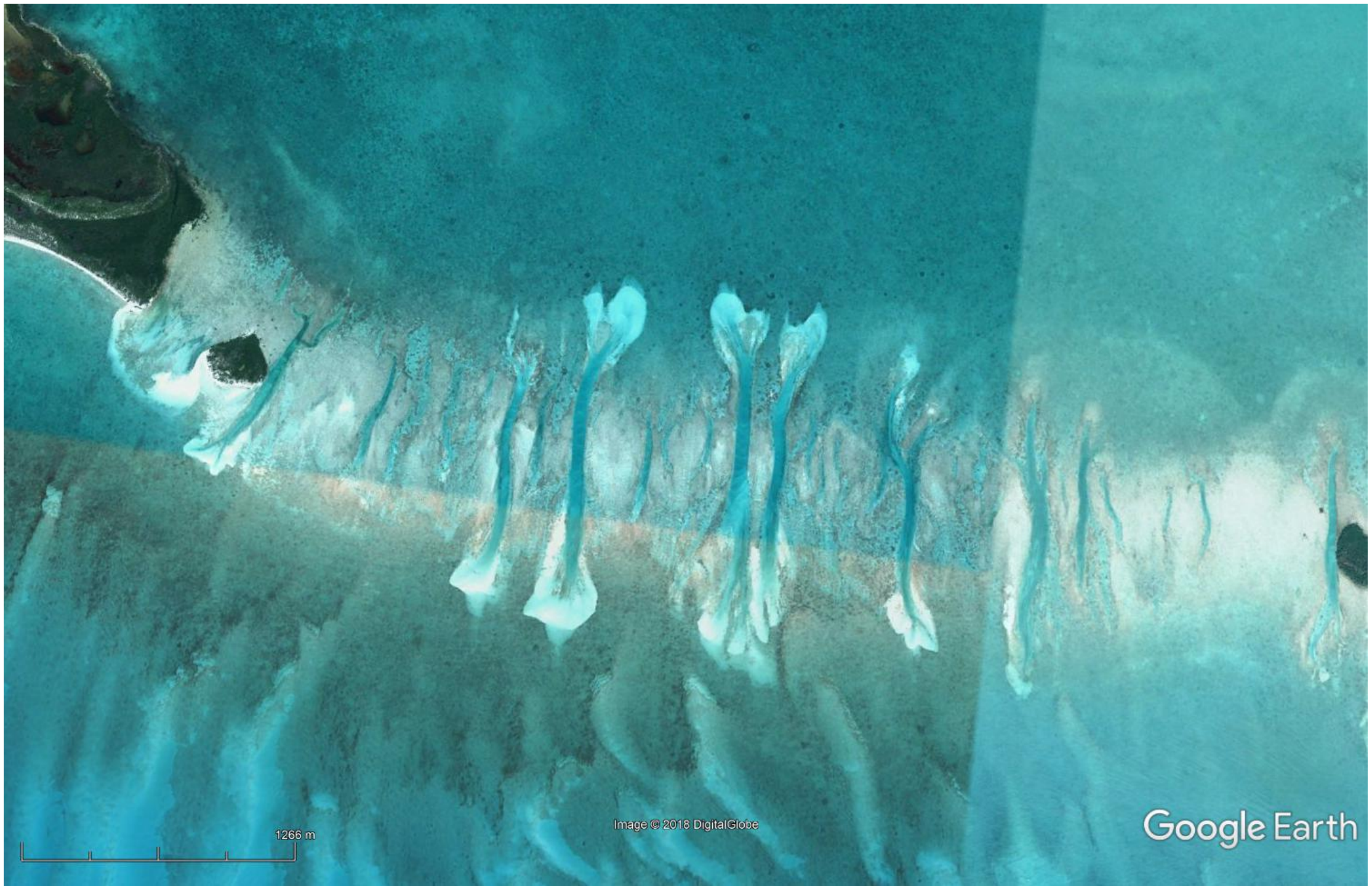
sedimentary behavior (cf. Schlager, 2005)

Biologically-
controlled
biomineralization





Google Earth

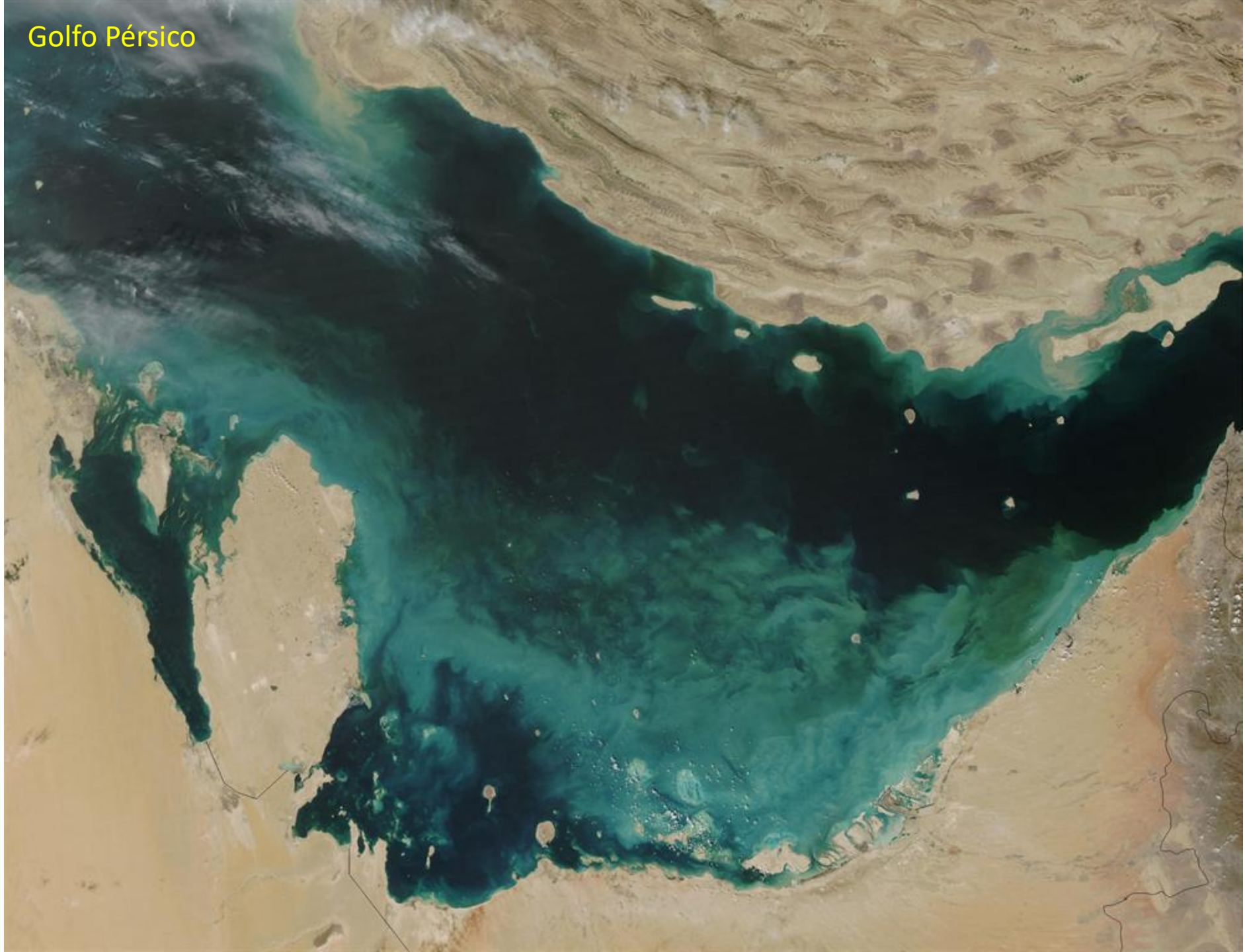


1266 m

Image © 2018 DigitalGlobe

Google Earth

Golfo Pérsico



Recifes



A satellite image showing a river, Rio Mimoso (MS), flowing through a dense, green forest. The river is a dark, winding line that cuts through the textured canopy of the trees. The forest appears to be a tropical rainforest, with varying shades of green indicating different types of vegetation and possibly some cleared areas or roads visible as lighter patches.

Rio Mimoso (MS)

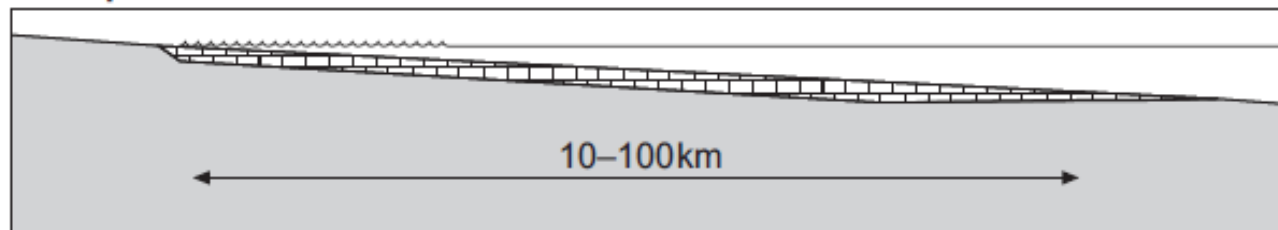
Image © 2015 CNES / Astrium



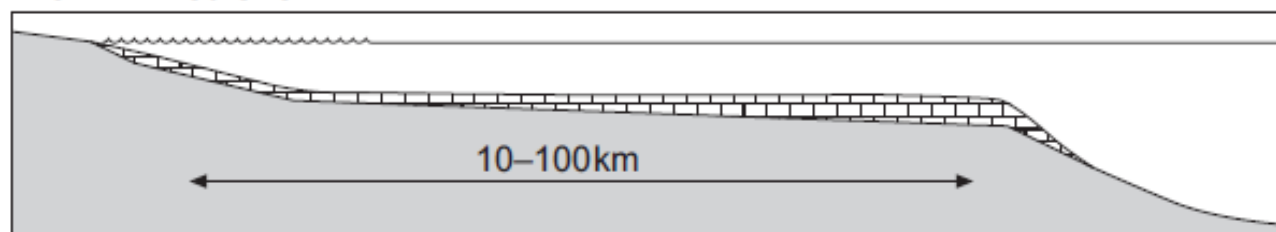
Ribeiro (2014)



Ramp

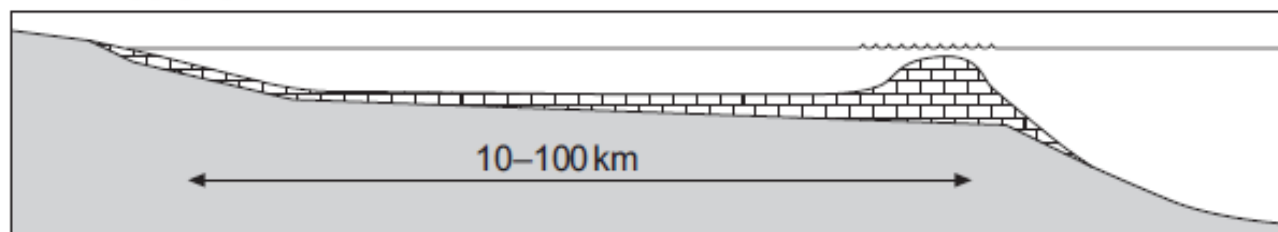


Non-rimmed shelf



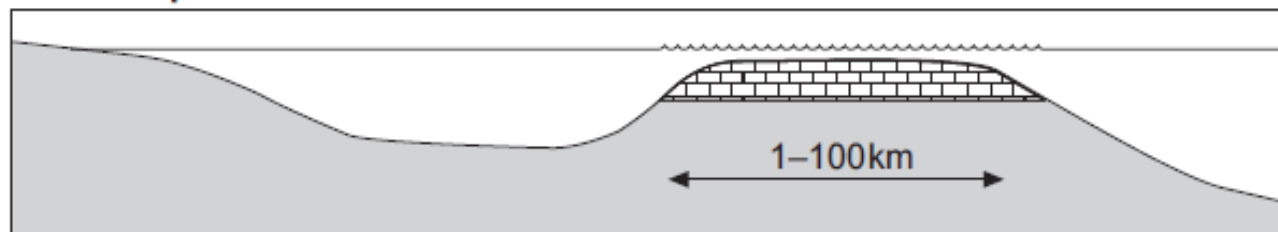
Rimmed shelf

Barreira

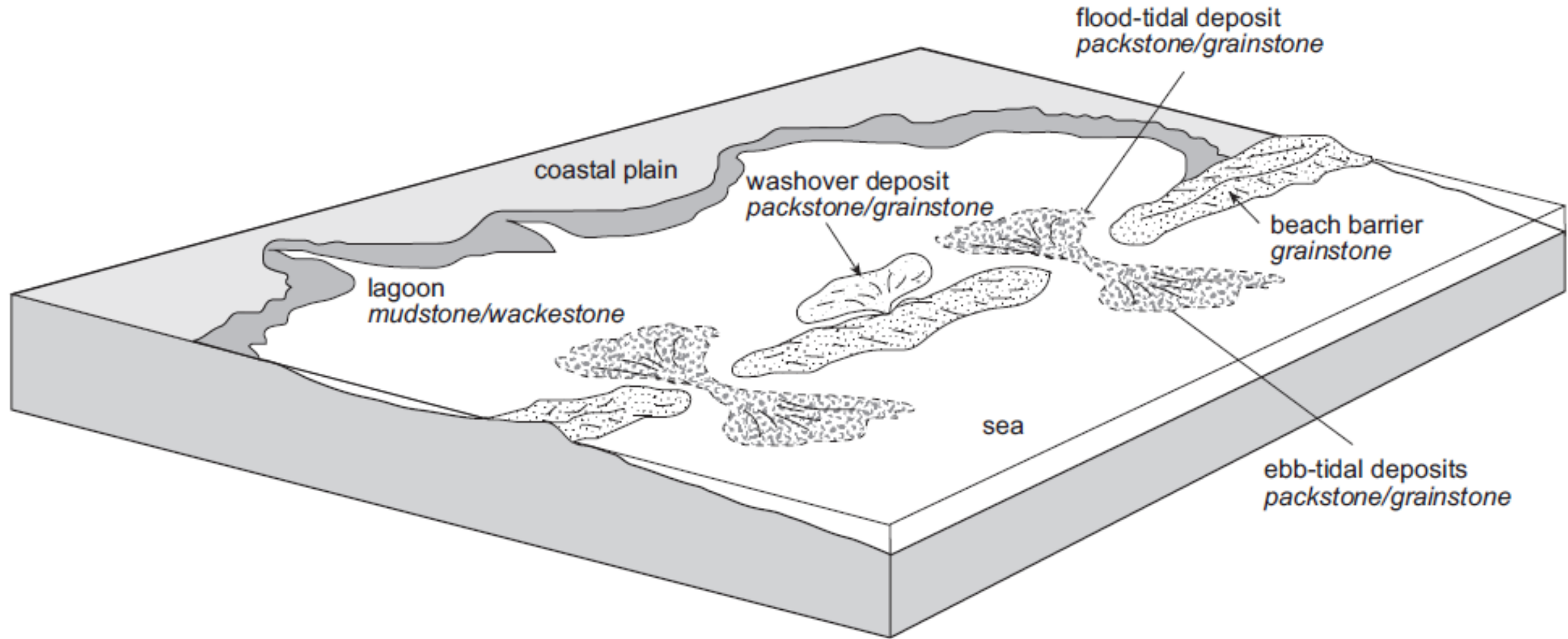


Isolated platform

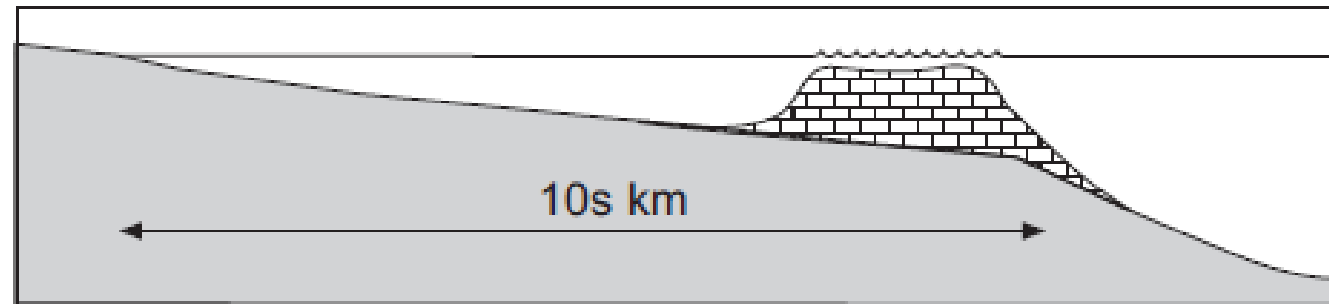
Barreira



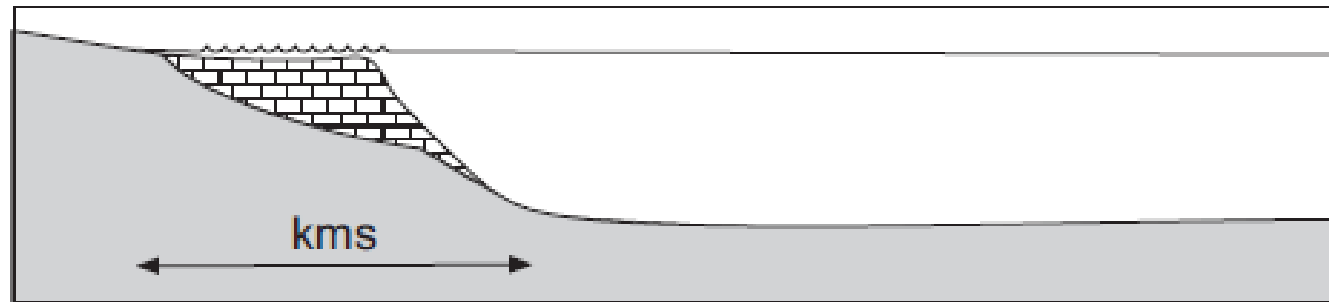
Sistemas Barreira-Laguna carbonática



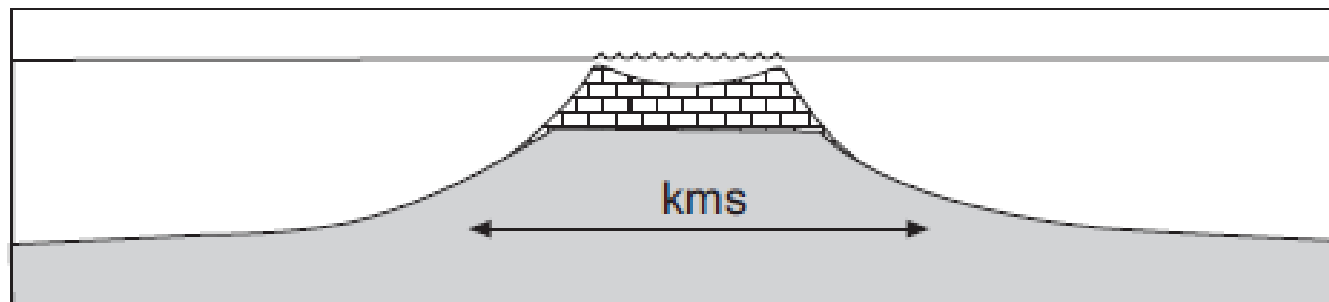
Barrier reef

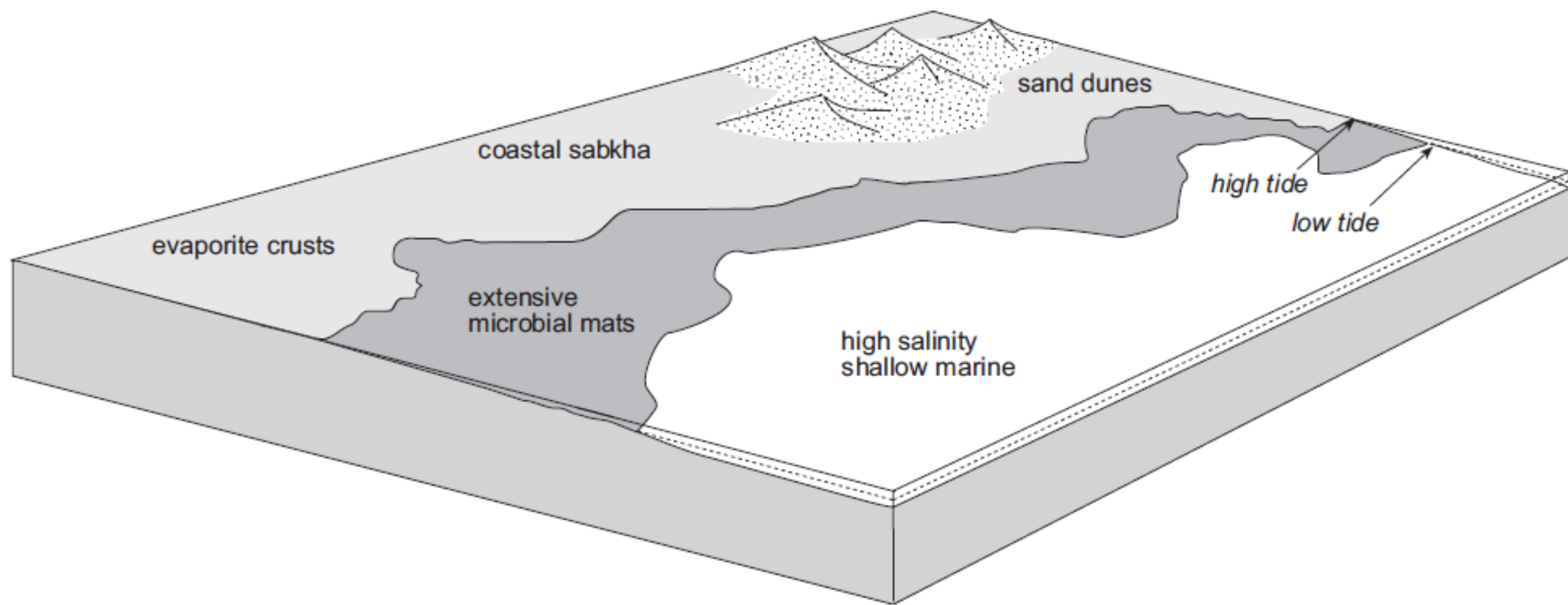


Fringing reef

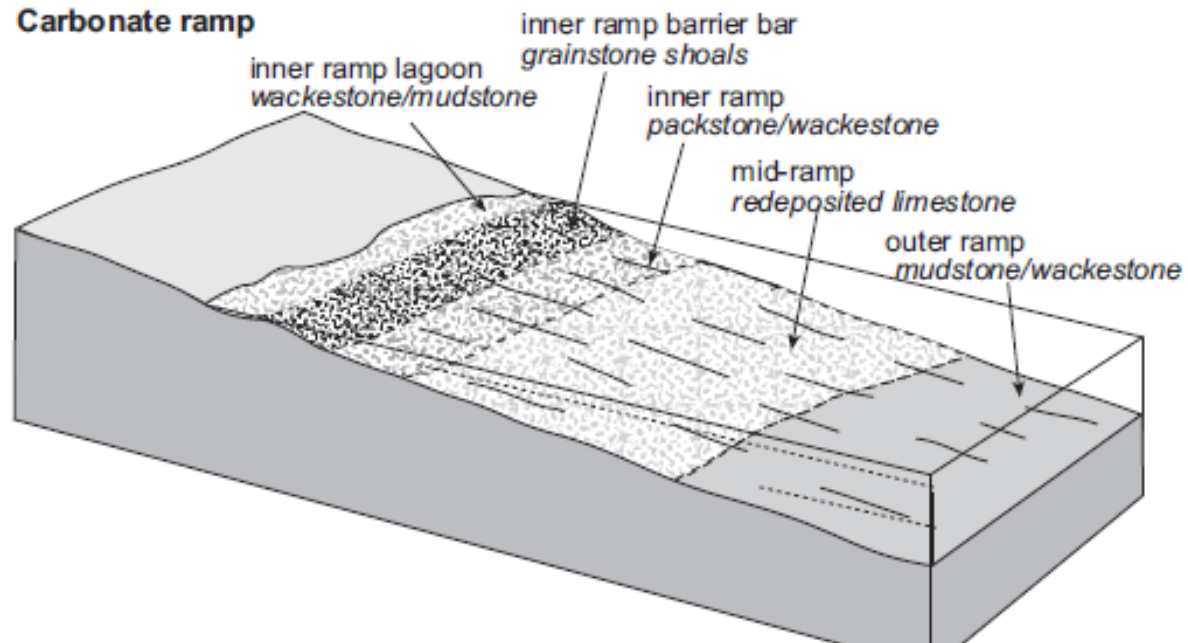


Patch reef

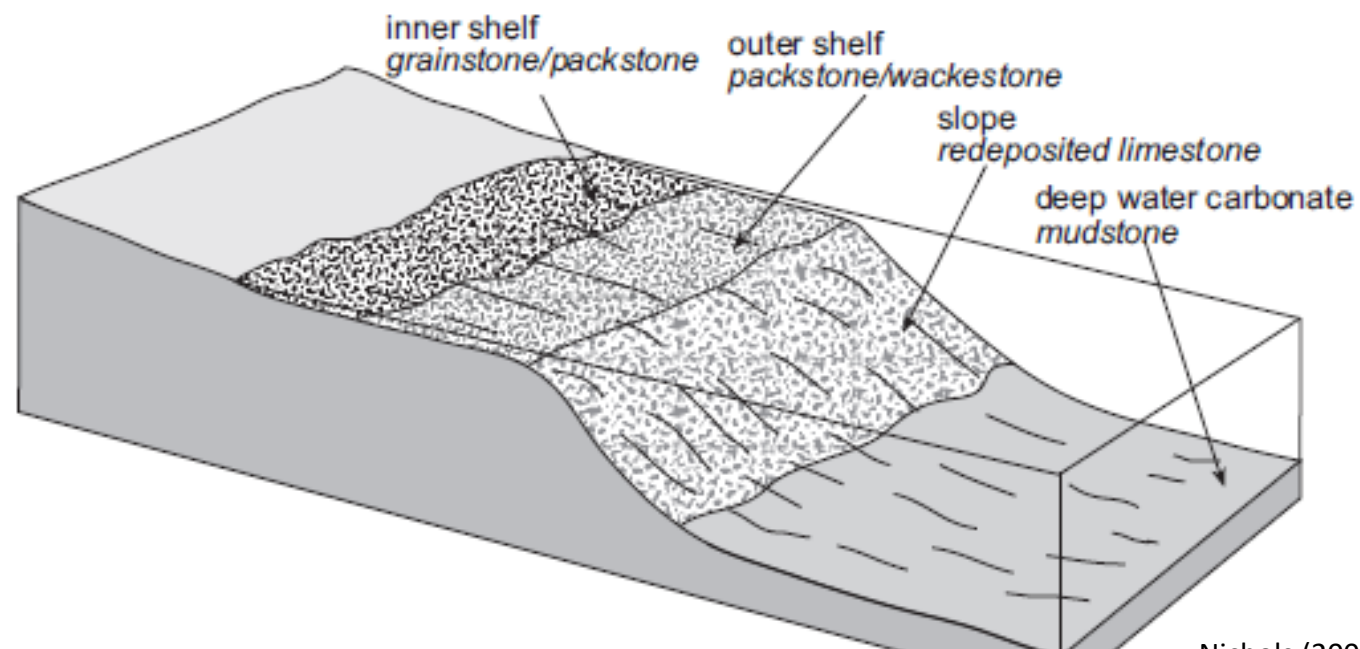


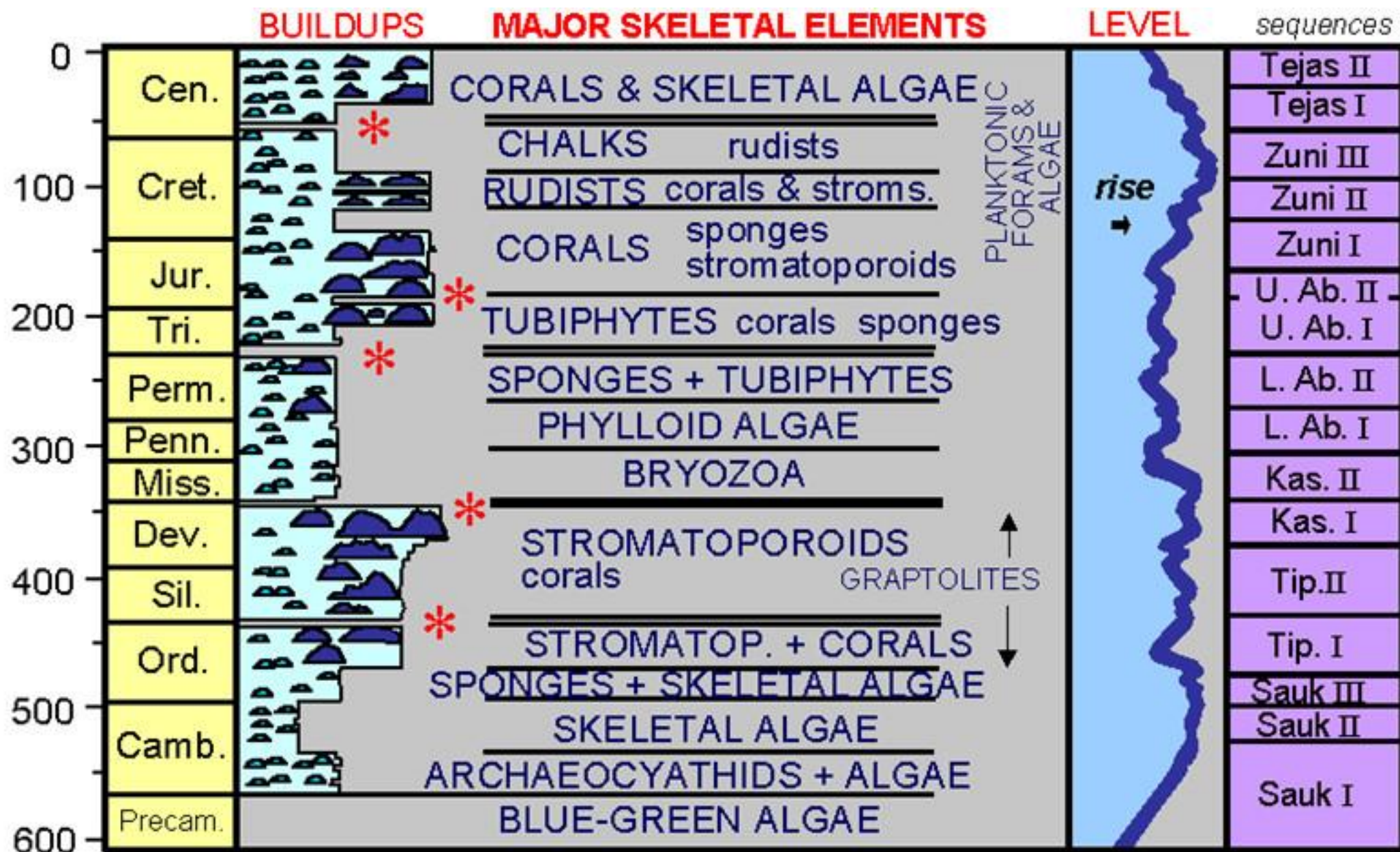


Carbonate ramp



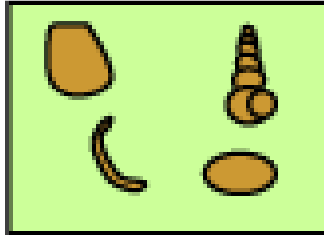
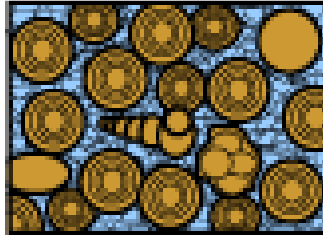
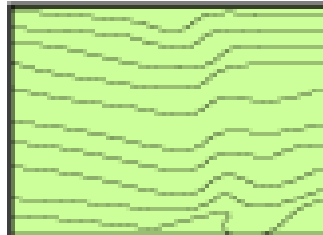
Non-rimmed carbonate shelf



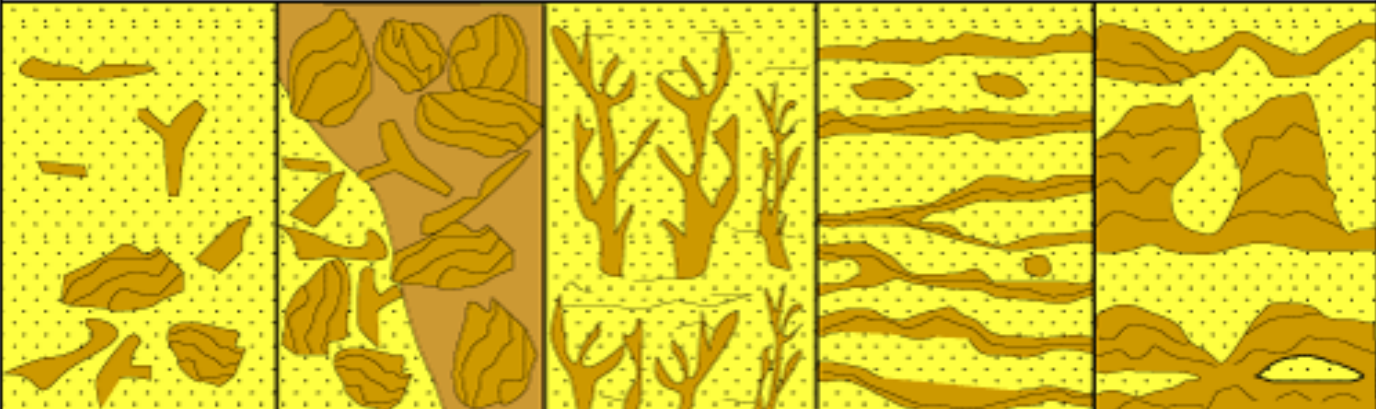


reefs mounds * mass extinction

Drafted by Waite 99, after James 1984)

Original components not bound together at deposition				Original components bound together at deposition. Intergrown skeletal material, lamination contrary to gravity, or cavities floored by sediment, roofed over by organic material but too large to be interstices
Contains mud (particles of clay and fine silt size)		Lacks Mud		
Mud-supported		Grain-supported		
Less than 10% Grains	More than 10% Grains			
Mudstone	Wackestone	Packstone	Grainstone	Boundstone
				

C. G. St. C. Kendall, 2005 (after Dunham, 1962, AAPG Memoir 1)

Allochthonous		Autochthonous		
Original components not bound organically at deposition		Original components bound organically at deposition		
>10% grains > 2mm				
Matrix supported	Supported by >2mm component			
Floatstone	Rudstone	By organisms that act as baffles	By organisms that encrust and bind	By organisms that build a rigid framework
		Bafflestone	Bindstone	Framestone
				

Textural classification of reef limestones after Embry & Klovan (1971) and James (1984)

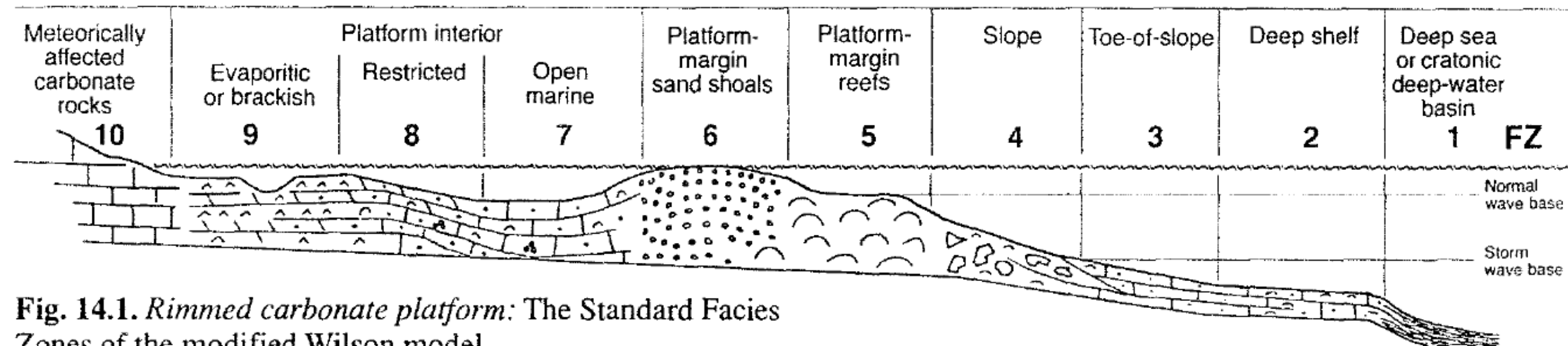
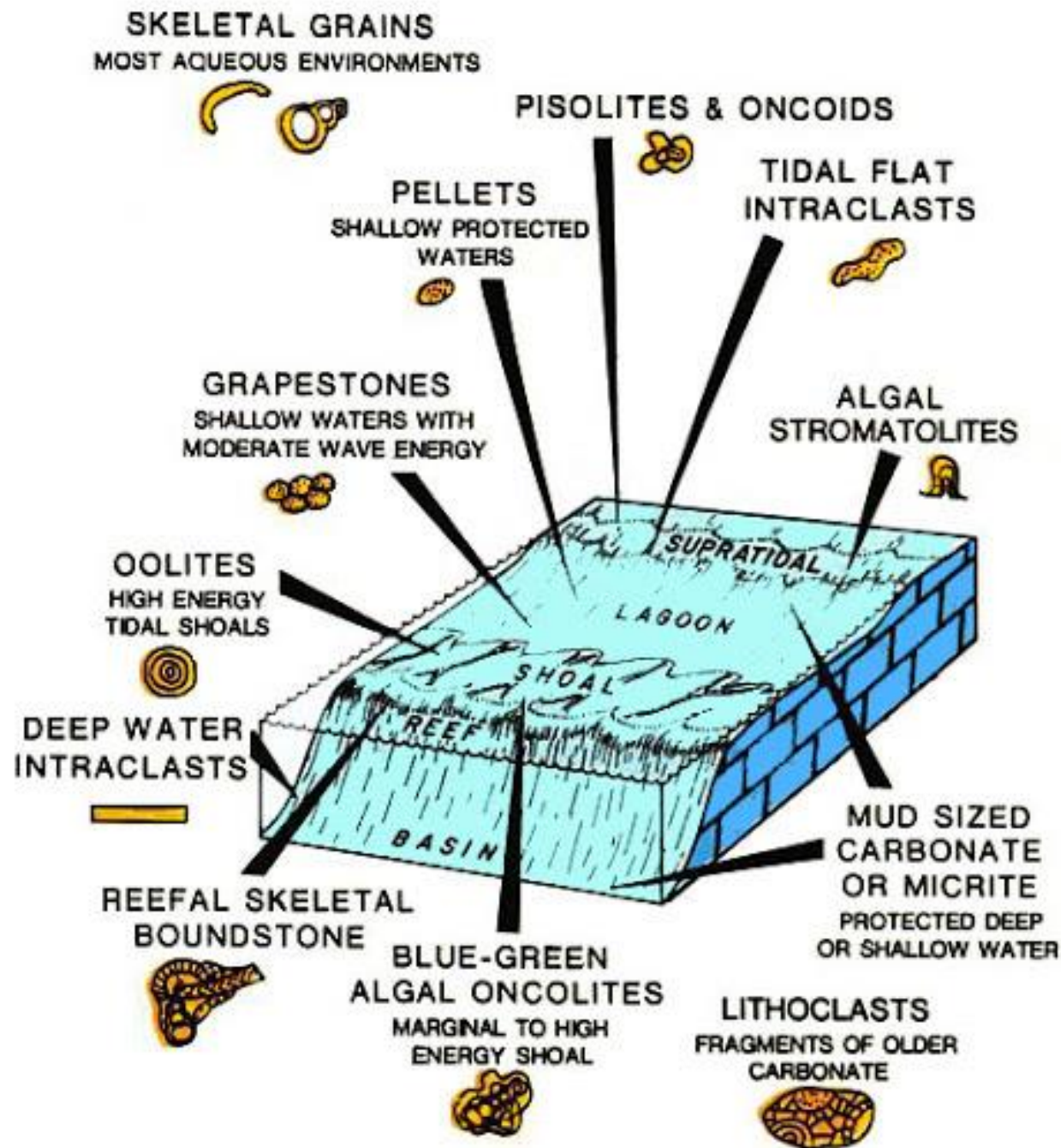


Fig. 14.1. *Rimmed carbonate platform: The Standard Facies Zones of the modified Wilson model.*



Sumário

- Controles sobre a fábrica carbonática
- Plataformas carbonáticas (rampas e plataformas com recife)
- Zoneamento faciológico de uma plataforma carbonática com recife

Box 14.1. Standard Facies Zones (FZ) of the modified Wilson model describing a rimmed carbonate platform.

Basin and deep shelf

FZ 1A Deep Sea

Setting: Below wave base and below the euphotic zone in oceanic deep water. Water depth several hundreds to several thousands of meters. Wide facies belt.

Sediments: Entire suite of deep-sea sediments including pelagic clay, siliceous and carbonate ooze, hemipelagic muds, turbidites. Adjacent to platforms mixtures of pelagic and platform-derived material (peri-platform oozes and muds). Bedding highly variable, often thin-bedded. Rock color: dark, reddish or light depending on differences in oxidizing and reducing conditions.

Biota: Predominantly plankton, typical oceanic assemblages, sometimes associated with autochthonous benthic fossils. In peri-platform sediments up to 75% shallow-water benthos.

Common lithofacies: Pelagic mudstone and wackestone; marls; allochthonous packstone, grainstone, breccia.

FZ 1B Cratonic deep-water basin

Setting: Below wave base, below the euphotic zone. Water depth about 30 m to several 100s m. Wide facies belt.

Sediments: Similar to 1A. Hemipelagic muds very common. Occasionally anhydrite. Sometimes common cherts. Anoxic conditions fairly common (high organic content; lack of bioturbation). Dark thin limestone beds and dark shale beds. Lime mudstones, calcisiltites. Rock color: dark brown and black (due to organic matter) and reddish (due to slow sedimentation).

Biota: Predominantly nekton (e.g. ammonites) and plankton (radiolarians, pelagic foraminifera, calpionellids, coquinas of thin-shelled bivalves). Occasionally benthos (abundant sponge spicules).

Common lithofacies: Lime mudstone, wackestone, packstones. Marls. Anhydrite.

FZ 2 Deep shelf

Setting: Below fair-weather wave base but within the reach of extreme storm waves. Within or just below the euphotic zone. Forming plateaus between active platforms and deeper basins. The plateaus are commonly established on top of drowned platforms. Water depth tens of meters to hundreds of meters. Normal salinity, oxygenated waters with good current circulation. Wide facies belt.

Sediments: Mostly carbonate (highly fossiliferous limestone) interbedded with marl beds. Skeletal wackestone and whole fossil wackestone; some grainstone and coquinas. Matrix commonly pelmicrite. Some silica. Well bioturbated. Well bedded. Bedding thin to medium, wavy to nodular. Rock color: gray, green, red and brown depending on variable oxidizing and reducing conditions.

Biota: Diverse shelly fauna indicating normal marine conditions. Infauna and epifauna. Minor plankton. Stenohaline biota conspicuous (e.g. brachiopods, echinoderms).

Common lithofacies: Wackestone. Occasional grainstones. Marls and shales.

Toe-of-slope and slope

FZ 3 Toe-of-slope apron (deep shelf margin)

Setting: Below wave base and barely at oxygen level. Moderately inclined sea floor (over 1.5°) basinward of steeper slopes. Water depths similar to FZ 2 and perhaps 200 to 300 m. Narrow facies belt.

Sediments: Mostly pure fine-grained carbonates, in some places cherty, rare intercalations of terrigenous muds. Pelagic material admixed with fine-grained detritus moved off from adjacent shallow shelves. Grain size highly variable. Typical are well-defined graded beds or breccia layers (turbidites, debris-flow deposits) intercalated in fine-grained background sediment. Rock color: dark to light.

Biota: Mostly redeposited shallow-water benthos; some deep-water benthos and plankton.

Common lithofacies: Lime mudstones; allochthonous packstones and grainstones. Shale partings.

FZ 4 Slope

Setting: Distinctly inclined sea floor (commonly 5° to nearly vertical) seaward of platform margins. Very narrow facies belt.

Sediments: Predominantly reworked platform material and pelagic admixtures. Highly variable grain size. End members are gentle muddy slopes with much slumping, and sandy or rubbly slopes with steep foresets. Rock color: dark to light.

Biota: Mostly redeposited shallow-water benthos, encrusting slope benthos and some deep-water benthos and plankton. The facies may be very fossiliferous.

Common lithofacies: Mudstone; allochthonous packstone and grainstone; rudstone and floatstone. Breccia.

Upper slope reefs and platform-margin reefs

FZ 5 Platform-margin reefs

Setting: (a) Organically stabilized mud mounds on upper slope; (b) ramps with knoll reefs and sand shoals; (c) wave-resistant barrier reefs rimming the platform (see Sect. 16.1.2). Water depths generally some meters, but some hundred meters for mud mounds. Very narrow facies belt.

Sediments: Almost pure carbonates of very variable grain size. Massive limestones and dolomites. Masses or patches of various types of boundstones. Reef cavities filled with internal sediment or carbonate cements; multiple generations of construction, encrustation, boring and destruction. Rock color: light.

Box 14.1. Definitions of Standard Facies Zones (continued).

Biota: Almost exclusively benthos. Colonies of frame-builders, encrusters, and bafflers along with large volumes of loose skeletal rubble and sand containing benthic microfossils (e.g. foraminifera, algae).

Common lithofacies: Framestone, bafflement, bindstone, wackestone and floatstone, grainstone and rudstone.

Platform-edge and platform sand shoals

FZ 6 Platform-margin sand shoals

Setting: Elongate shoals, tidal bars and beaches, sometimes with eolianite islands. Above fair-weather wave base and within the euphotic zone, strongly influenced by tidal currents. Very narrow facies belt.

Sediments: Clean calcareous, often rounded, coated and well-sorted sands, occasionally with quartz. Sand grains are skeletal grains, or ooids and peloids. Partly with well-preserved cross-bedding, sometimes bioturbated. Susceptible to subaerial exposure. Rock color: light.

Biota: Worm and abraded biota from reefs and associated environments. Low-diversity infauna adjusted to mobile substrate. Common biota are large bivalves and gastropods and special types of foraminifera and dasyclads.

Common lithofacies: Grainstone, packstone.

Open-marine platform

FZ 7 Platform interior - normal marine (open marine)

Setting: Flat platform top within euphotic zone, normally above fair-weather wave base. Called lagoon when protected by sand shoals, islands or reefs of the platform margin. Sufficiently connected with the open sea to maintain salinity and temperature close to that of the adjacent ocean. Moderate circulation. Water depths a few meters to tens of meters. Wide facies belt.

Sediment: Lime mud, muddy sand and clean sands, depending on the grain size of local sediment production and the efficiency of winnowing by waves and tidal currents. Medium to coarse bedded. Locally patch reefs or organic banks. Terrigenous sand and mud may be common in attached platforms, but are generally absent in detached platforms such as oceanic atolls. Rock color: light and dark.

Biota: Shallow-water benthos with algae, foraminifera, and bivalves; gastropods, particularly common. Areas with marine grasses and with patch reefs.

Common lithofacies: Lime mudstone, wackestone and floatstone, packstone, grainstone.

Restricted-marine platform

FZ 8 Platform interior - restricted

Setting: As for Facies Zone 7, but less well connected with the open ocean, causing large variations in salinities and temperatures. Within the euphotic zone. Typically strongly differentiated tidal zones with freshwater, salt-water and hypersaline conditions as well as subaerially exposed areas. Shallow, cut-off ponds and lagoons with restricted circulation and hypersaline water. Lagoons behind barrier reefs, within atolls or behind coastal splits. Water depths below one meter and a few meters to a few tens of meters. Wide facies belts.

Sediments: Mostly lime mud and muddy sand; some clean sand. Terrigenous influx common. Early diagenetic cementation common. Limestones and dolomites. Rock color: light.

Biota: Shallow-water biota of reduced diversity, but commonly with high number of individuals. Typical are miliolid foraminifera, ostracods, gastropods, algae and cyanobacteria. Marine and freshwater vegetation.

Common lithofacies: Lime mudstone and dolomite mudstone, wackestone, grainstone, bindstone. Sedimentary breccia.

Arid near-coast evaporitic platforms

FZ 9A Arid platform interior - evaporitic

Setting: As in Facies Zone 7 and 8, yet with only episodic influx of normal marine waters and arid climate so that gypsum, anhydrite or halite may be deposited beside carbonates. Supratidal. Sabkhas, salt marshes, salt ponds. Wide facies belt.

Sediments: Calcareous or dolomitic mud or sands, with nodular, wavy or coarse-crystalline gypsum or anhydrite. Intercalations of red beds and terrigenous eolianites in land-attached platforms. Rock color: highly variable; light, yellow, brown, red.

Biota: Little indigenous biota except cyanobacteria; ostracods, mollusks, brine shrimps adapted to high salinities.

Common lithofacies: Laminated lime and dolomitic mudstones and bindstones alternating layers with layers of gypsum or anhydrite.

Humid near-coast brackish regions

FZ 9B Humid platform interior - brackish (humid)

Setting: Poor connection with the open sea as in FZ 9A but with a humid climate so that water runoff dilutes small bodies of ponded seawater and marsh vegetation spreads in the supratidal flats. Narrow facies belt.

Sediments: Calcareous marine muds or sand with occasional freshwater lime mud and peat layers. Rock color: gray, light, brown, dark.

Biota: Shallow-water marine organisms washed in with storms plus organisms adapted to brackish-water and freshwater (ostracods; freshwater snails; charophycean algae).

Paleokarst, caliche and other terrestrial and terrestrial-marine settings

FZ 10 Humid and arid often subaerially exposed, meteorically influenced limestones

Setting: Subaerial or subaqueous, formed under meteoric-vadose and marine-vadose conditions. Abundant in karst settings and pedogenic carbonates (continental and near-coast areas), and supratidal and intertidal environments.

Sediments: Limestones affected by early diagenetic meteoric dissolution predominantly during phases of subaerial exposure (e.g. paleokarst). Common in caliche crusts. Typically occurring in limestones rich in carbonate cement crusts, but also occurring in micritic caliche or as reworked grains in restricted environments (e.g. coastal ponds or lagoons).

Biota: Indigenous biota lacking except cyanobacteria and microbes.

