

Lecture 14 - Oceans and coastlines



Crunch time on Most Important Project

- Remember that it is due tonight!

Outline

- Ocean origins, salinity, temperature, circulation, life
- Ocean sediment
- Coastline terminology
- Factors that control our coastline
- Features of different types of coasts
- Evolution of a coastline
- Humans and coasts

Oceans: Origin

Age of oceans:
4 billion years old (at least)

Origin of water:

Volume of the ocean:



Oceans: Origin

Age of oceans:

4 billion years old (at least)

Origin of water:

Water vapor from volcanoes

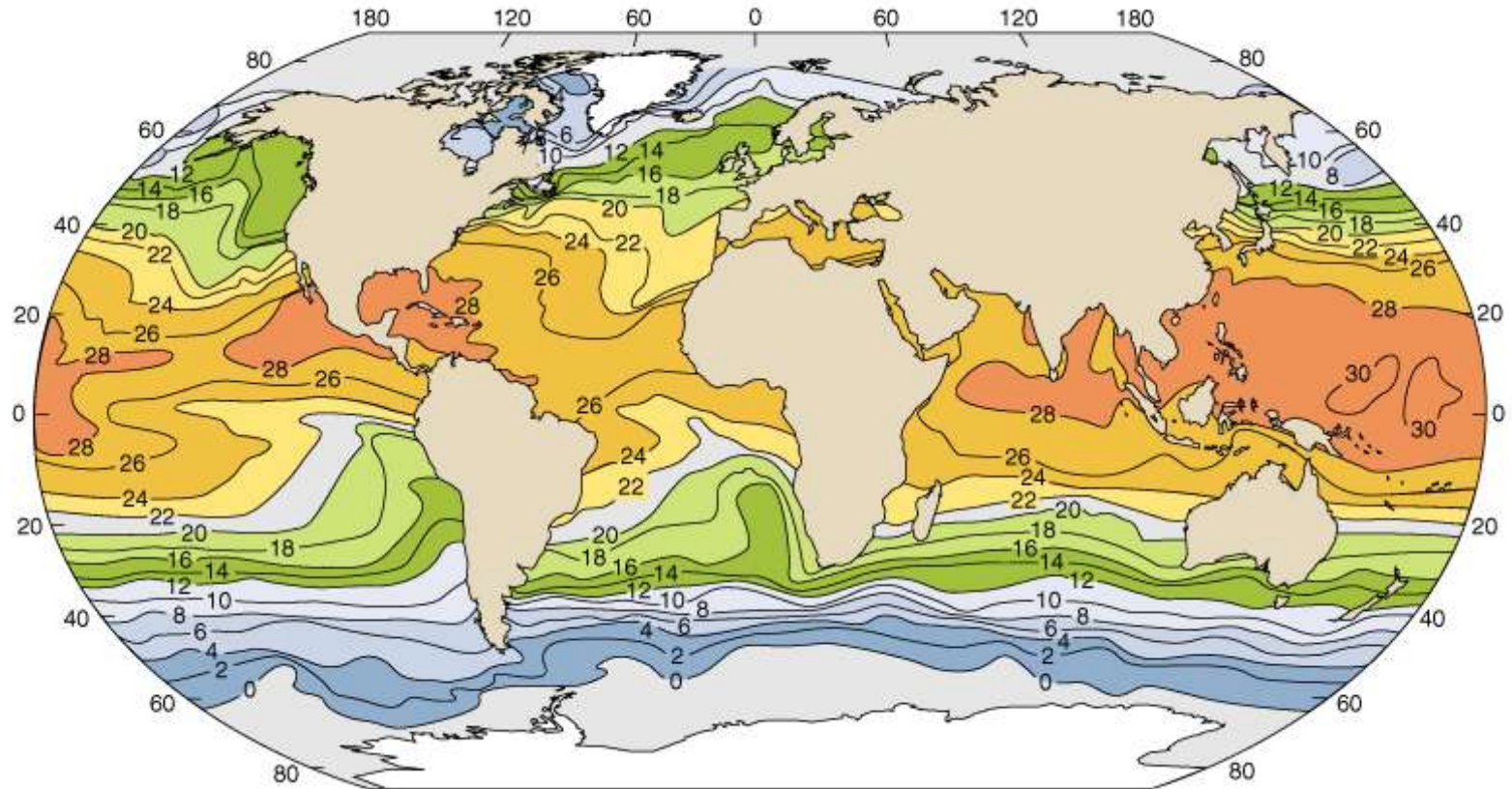
Water from comets

Volume of the ocean:

Increased through geologic time because of ongoing volcanic activity. Today = 1.35 billion km³



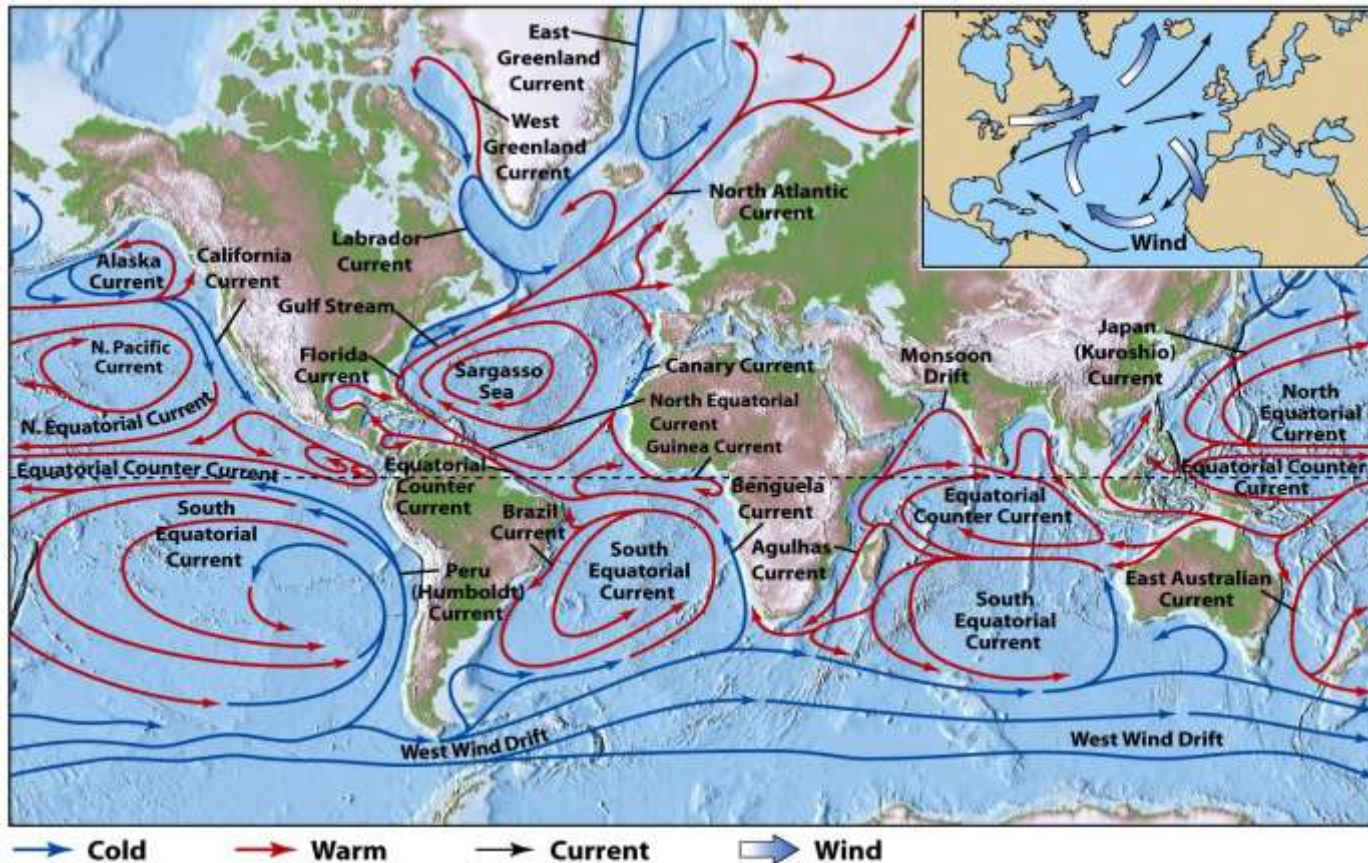
Oceans: Surface temperature



August temperatures

Surface ocean currents

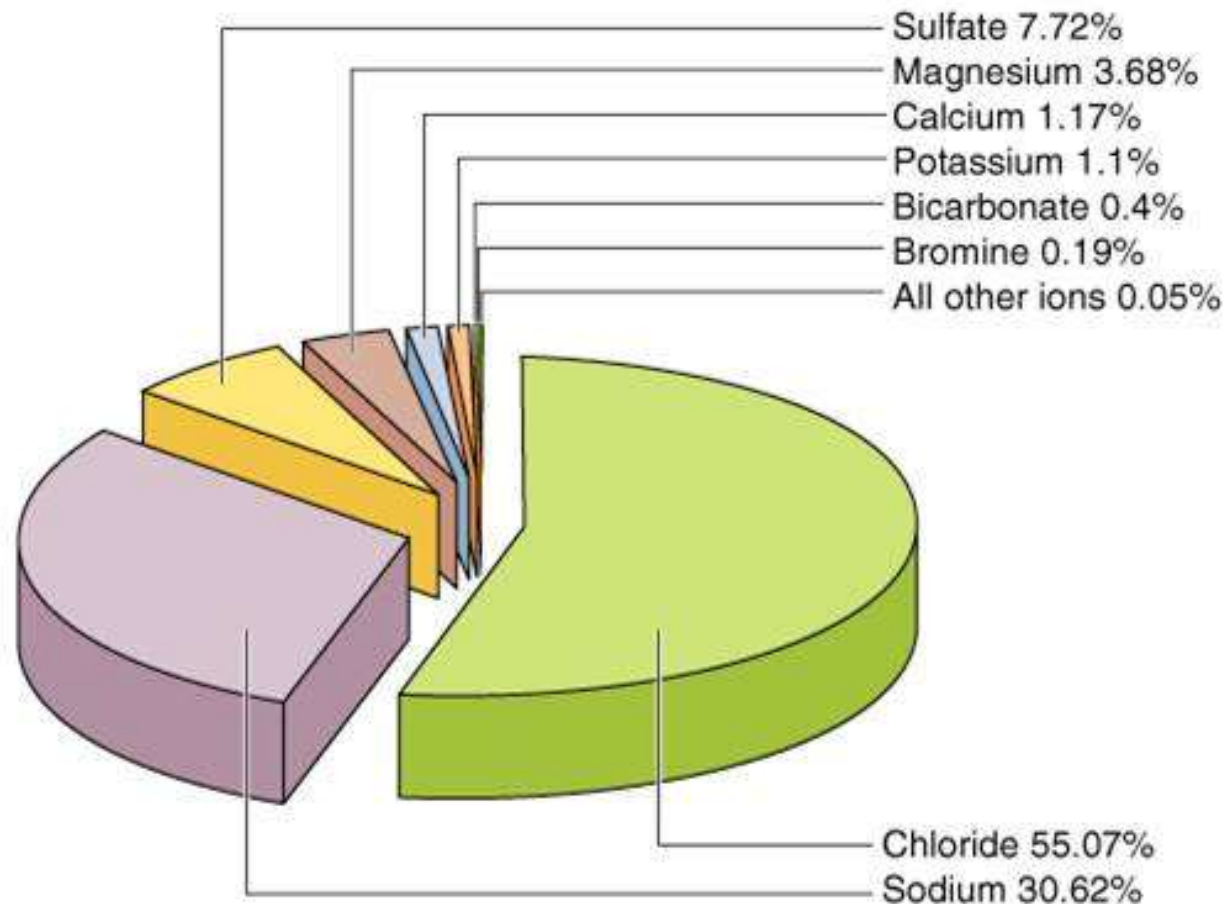
- Currents ceaselessly move ocean water
 - Surface currents (upper 100 m) move due to winds forming large ocean gyres



Oceans: Salinity

total mass of salts dissolved in a given mass of seawater,
expressed in practical salinity units

- range = 33 – 37 psu
i.e. in 1 kg of seawater
there is 33-37 g of
dissolved salts
- Primarily Sodium and
Chlorine
(NaCl = table salt)
- Only 8 ions responsible
for 99.9% of salinity

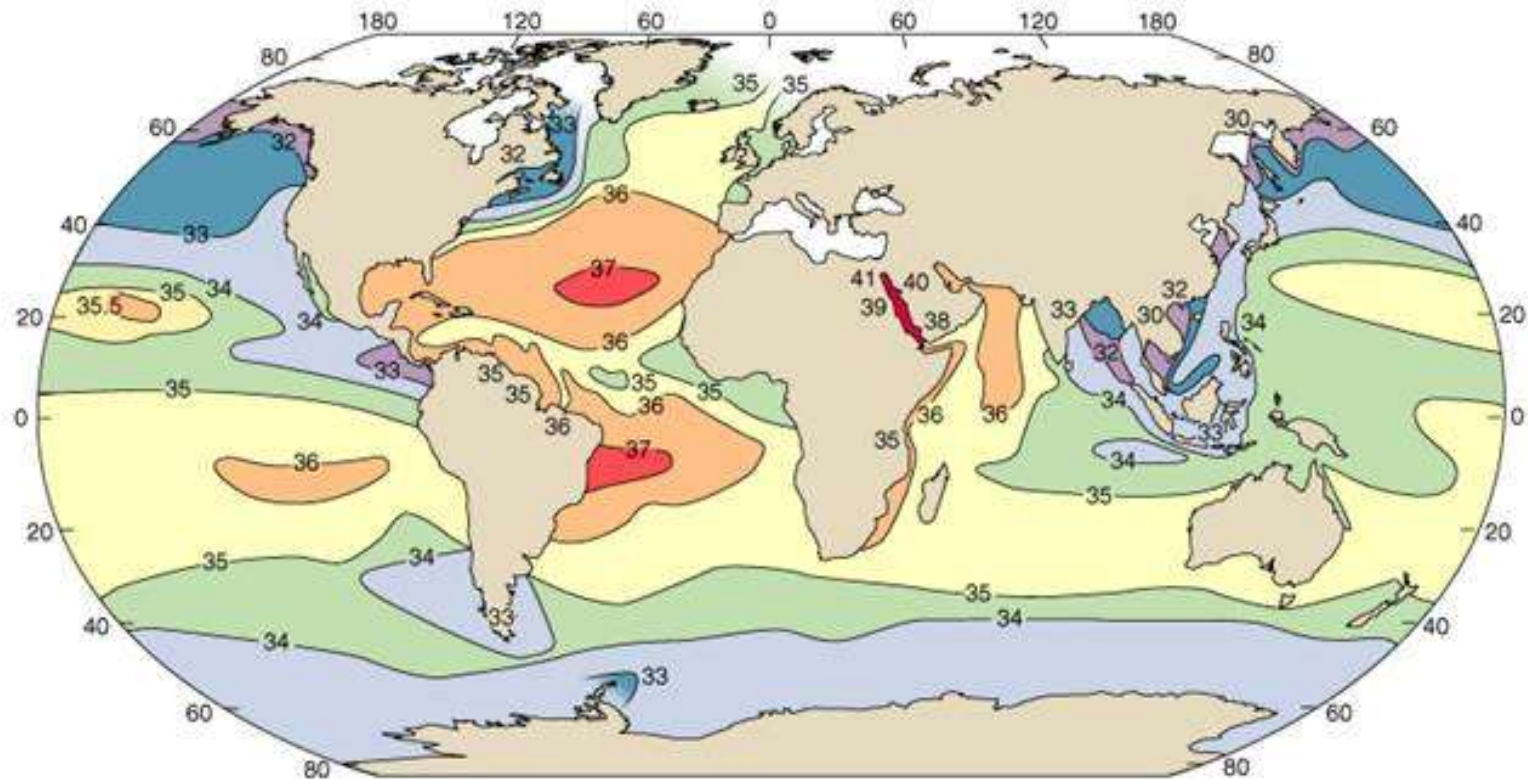


Ocean Salinity

- Salt remains behind during freezing or evaporation
- Desiccation yields evaporite mineral salts
 - Halite (NaCl)
 - Gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$)
 - Sylvite (KCl)



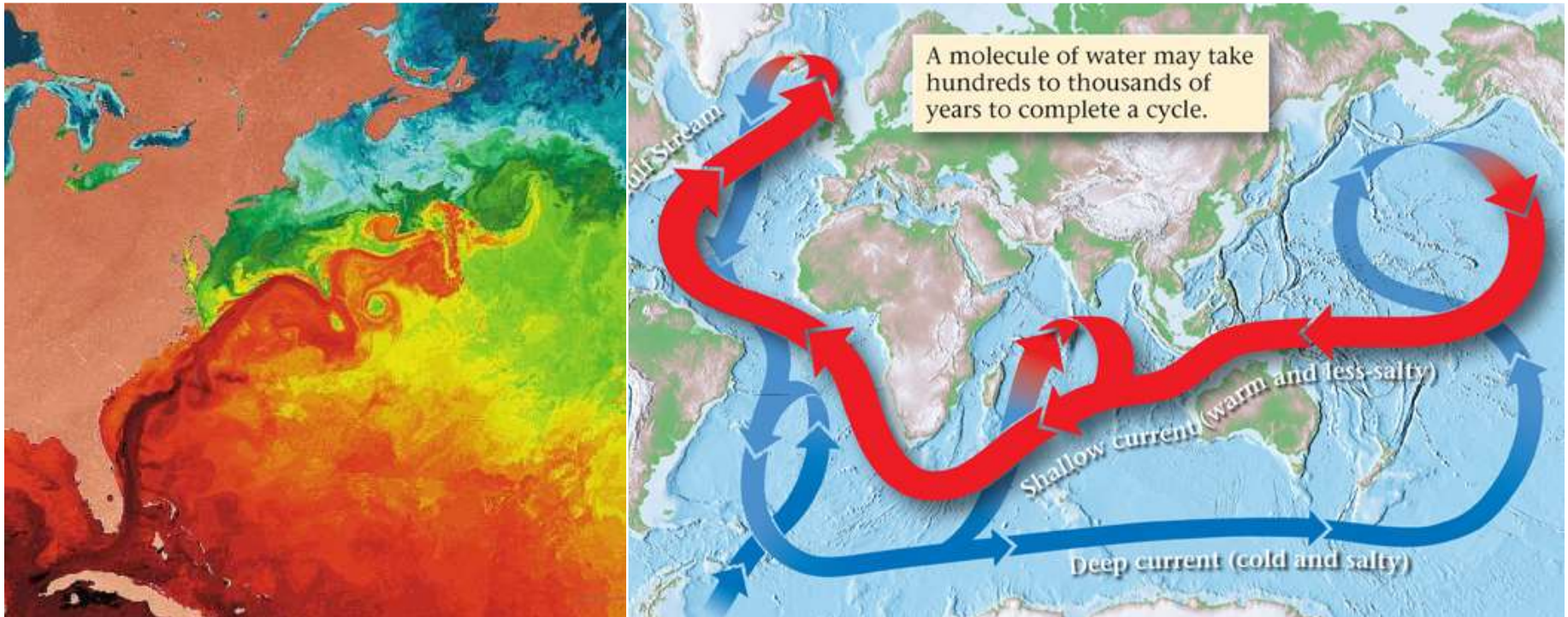
Oceans: Surface salinity



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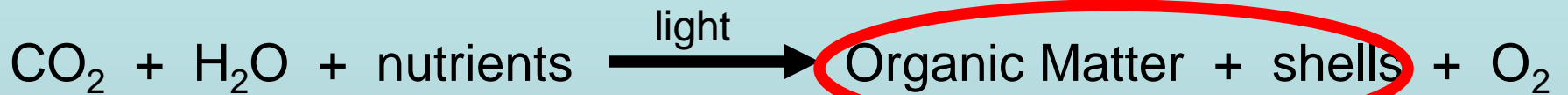
Thermohaline circulation

- Currents ceaselessly move ocean water
 - Deep ocean moves due to density differences forming a global “conveyor belt”



Oceans: Life

Photosynthesis: CO_2 and nutrients are consumed in the surface layer



Upwelling brings those nutrients back to surface

Respiration:



CO_2 and nutrients are regenerated in the deep ocean

~0.1 % of material is buried as sediment on the ocean floor

Vertical ocean currents

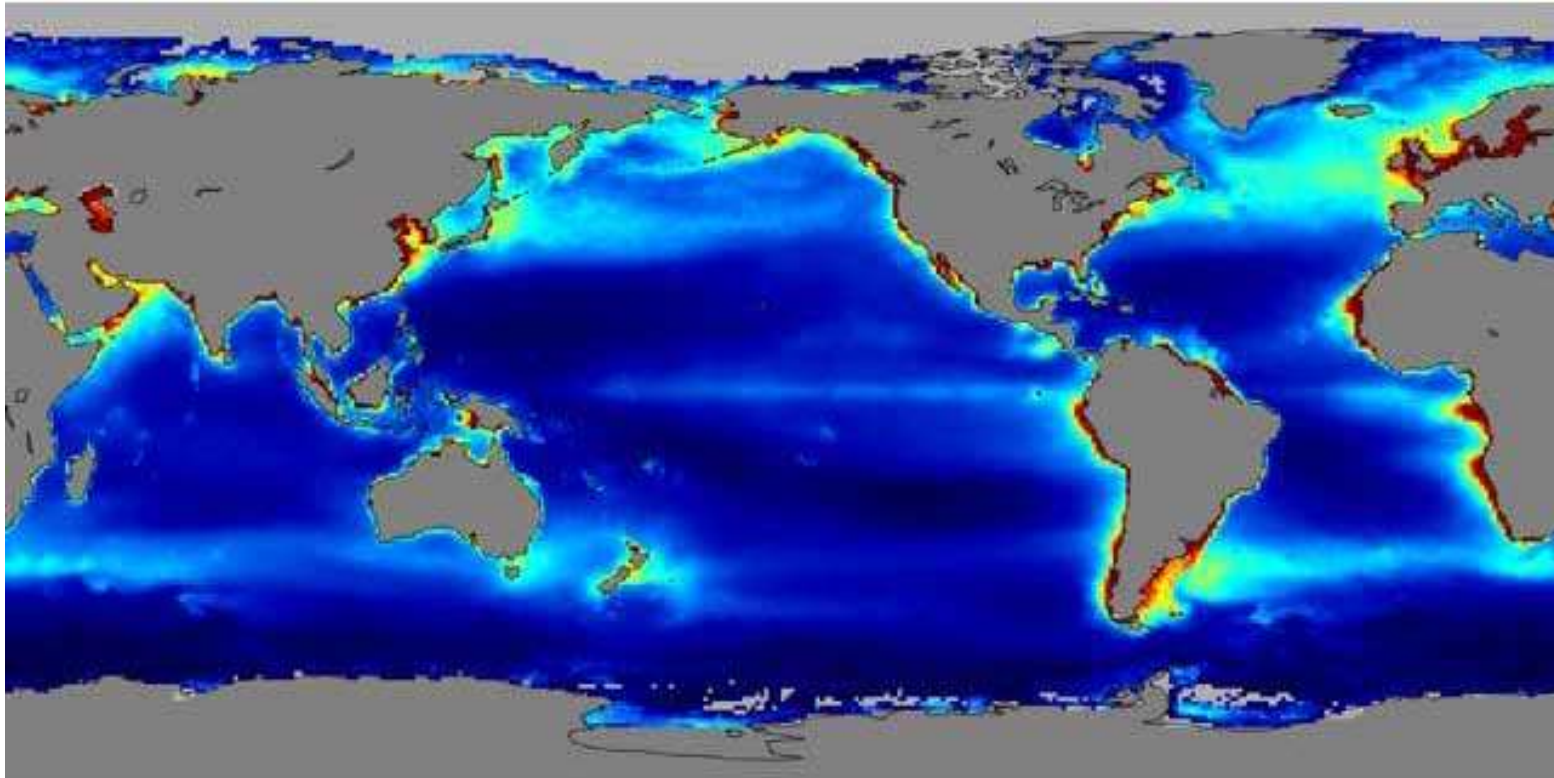
- Interaction of surface currents and continents:
 - Upwelling / downwelling (small scale)

What would be happening along the coast here?

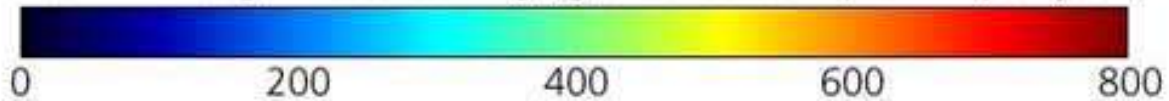
- a) Upwelling
- b) Downwelling



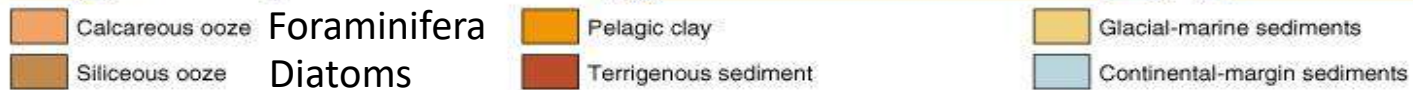
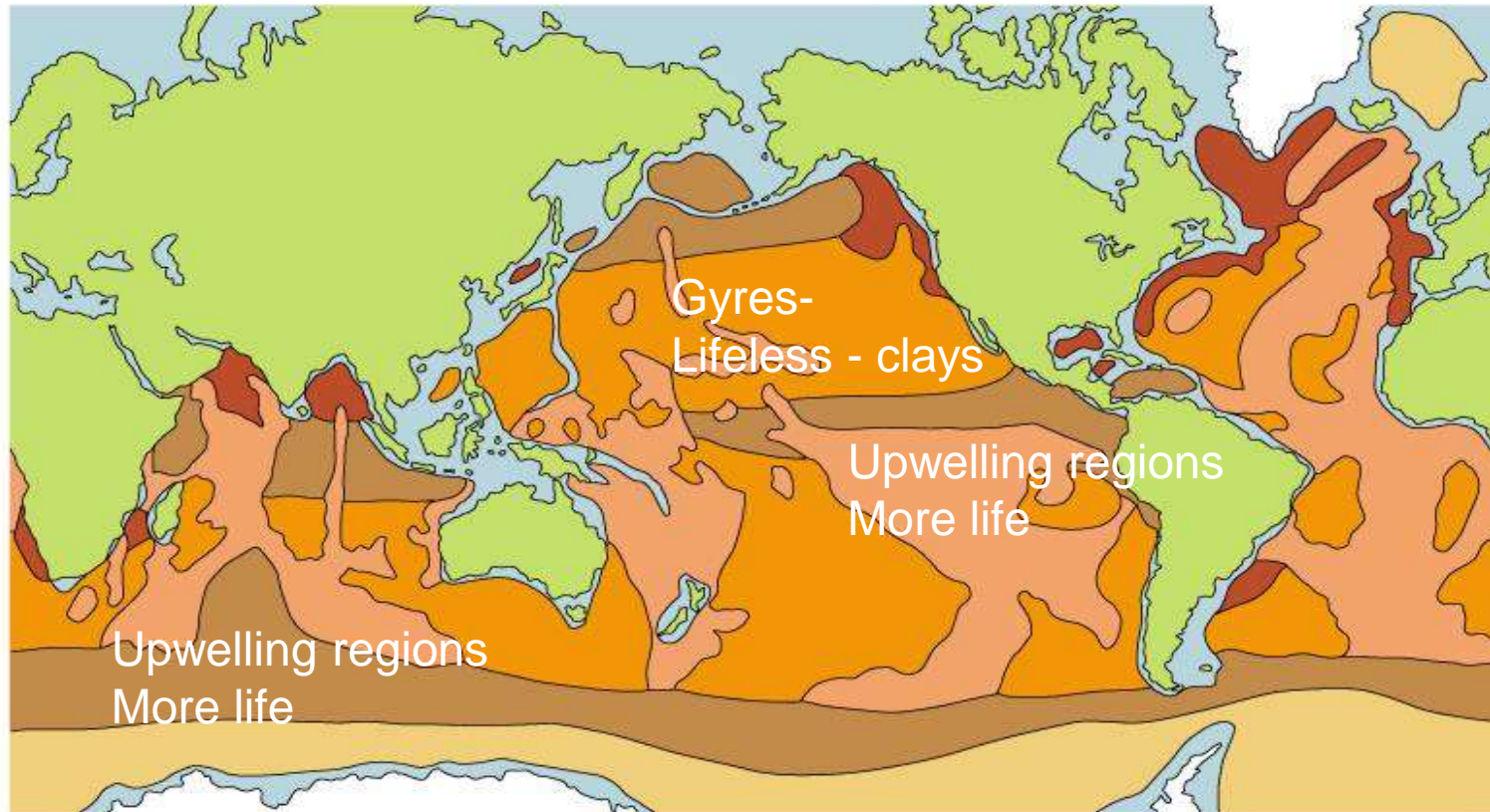
Oceans: Life



Net Primary Productivity (grams Carbon per m² per year)



Oceans: Sediments



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Washed from land,
not much life above

What affects what sediment we see?
How might this change in the next few thousand years?

Oceans: Sediments

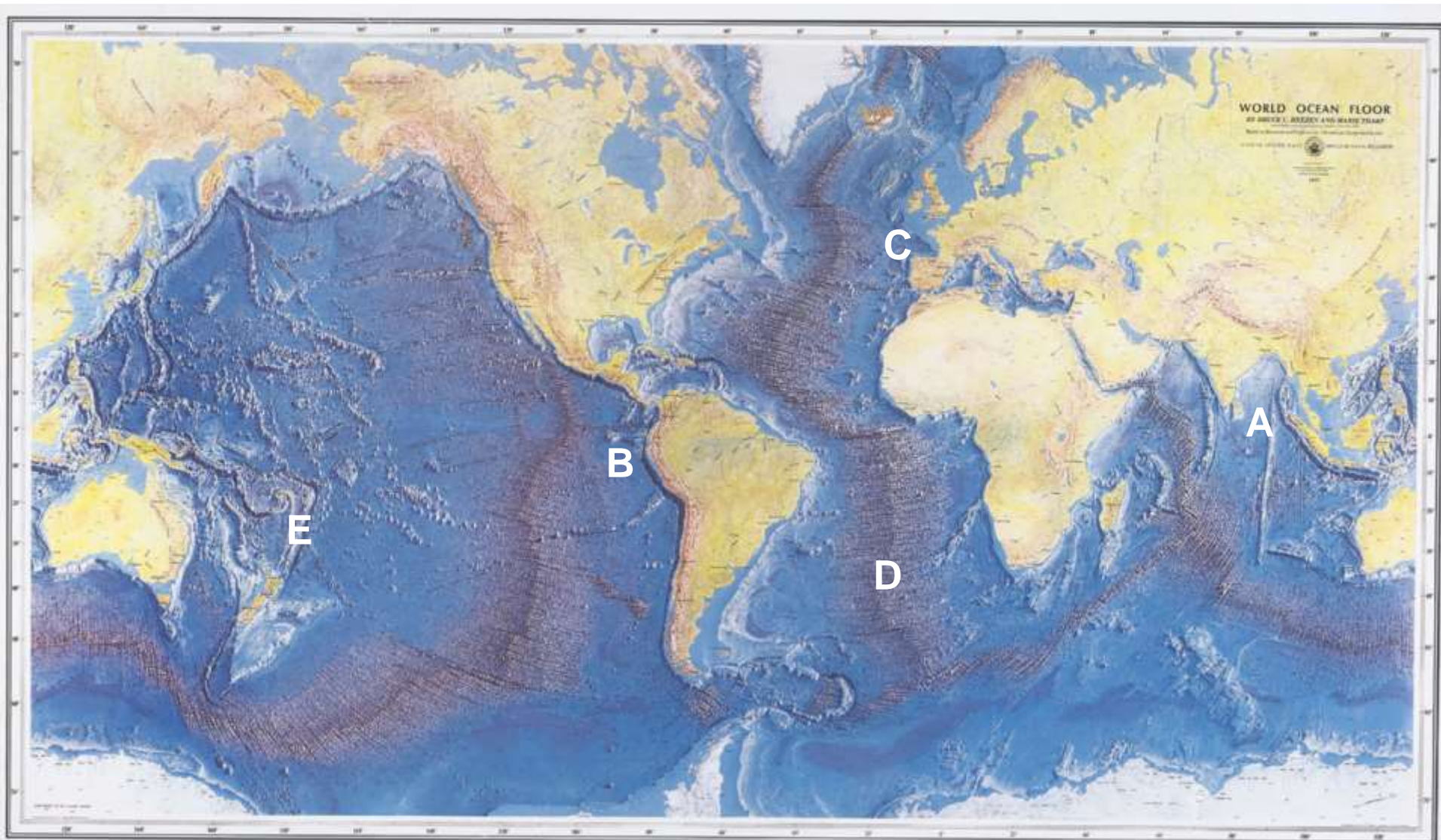
- Why are we interested in ocean sediments?

Oceans: Sediments

- Types of sediment, plankton, shells of foraminifera and diatoms can be used to reconstruct aspects of the climate system
- For example, Mg/Ca and oxygen isotopes of foraminifera allow us to reconstruct ocean temperature and salinity



Where would be the best place to take an ocean core?



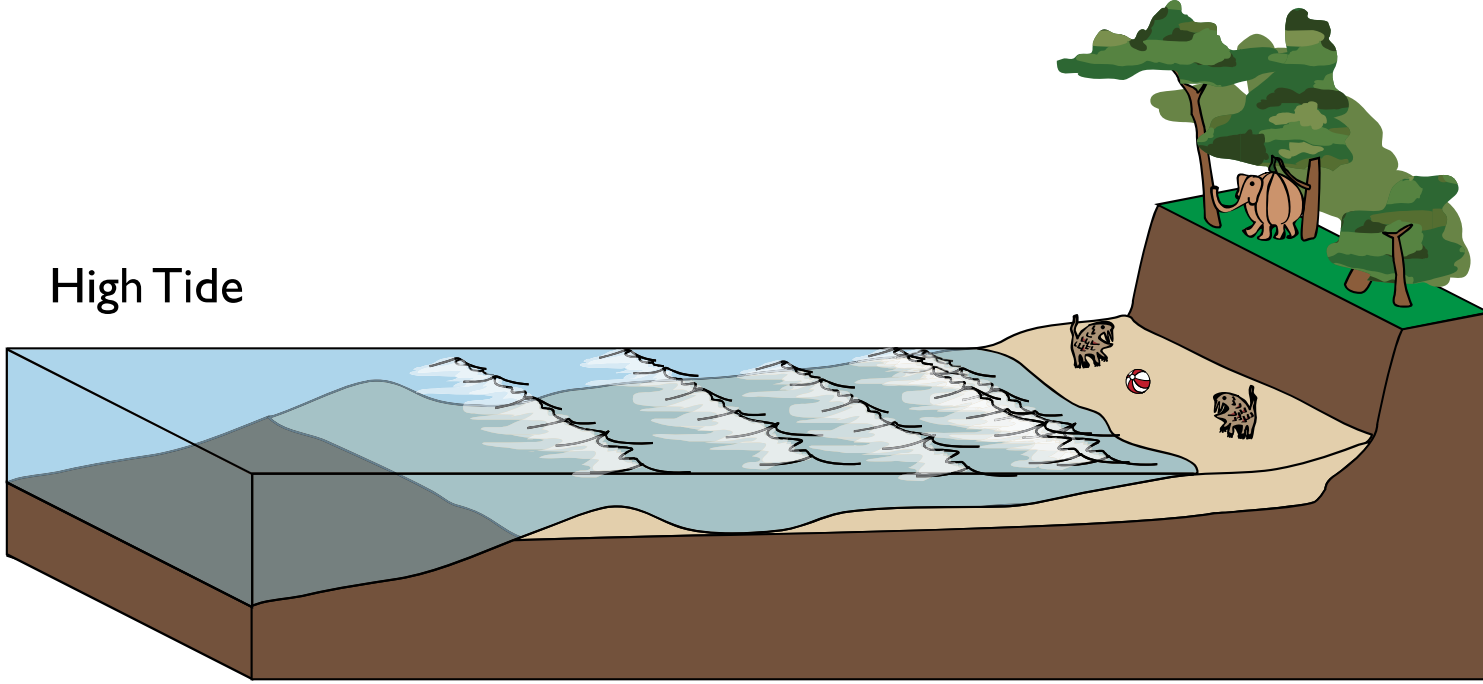
Coastlines



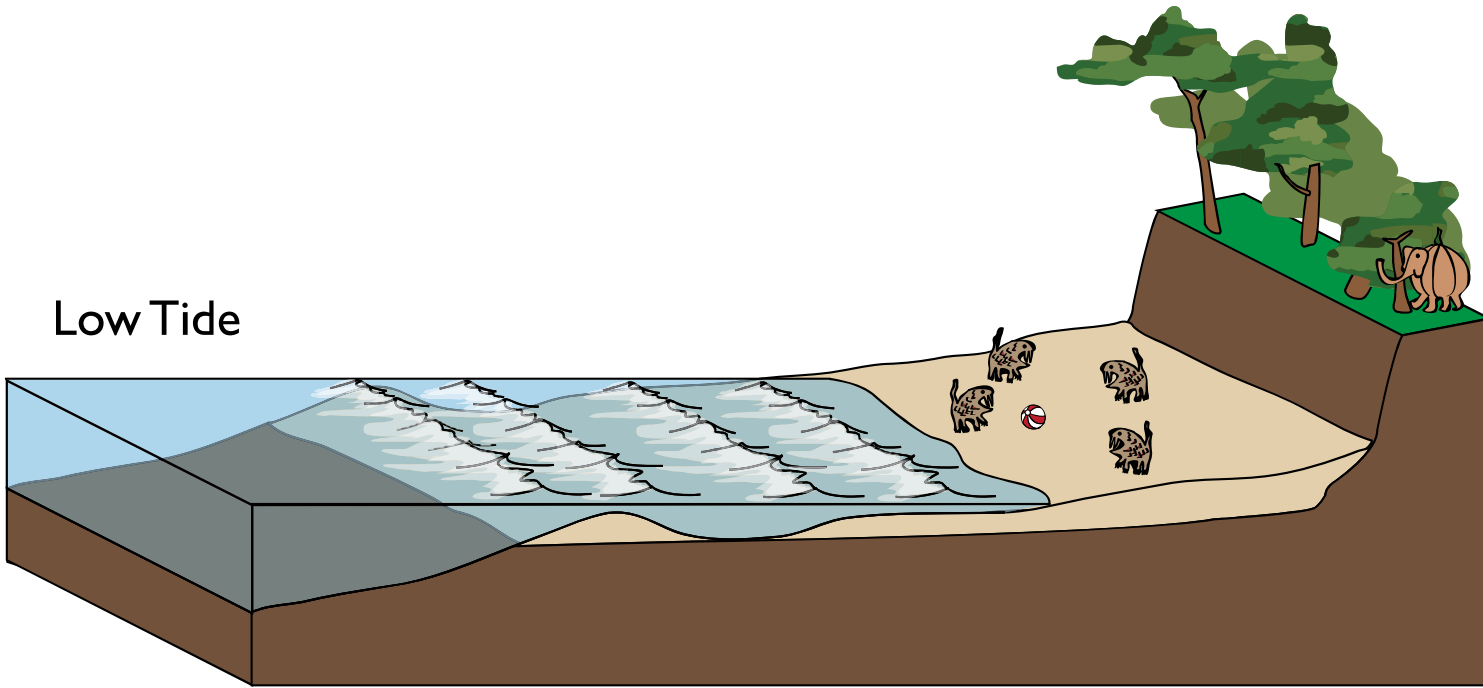
Coastlines

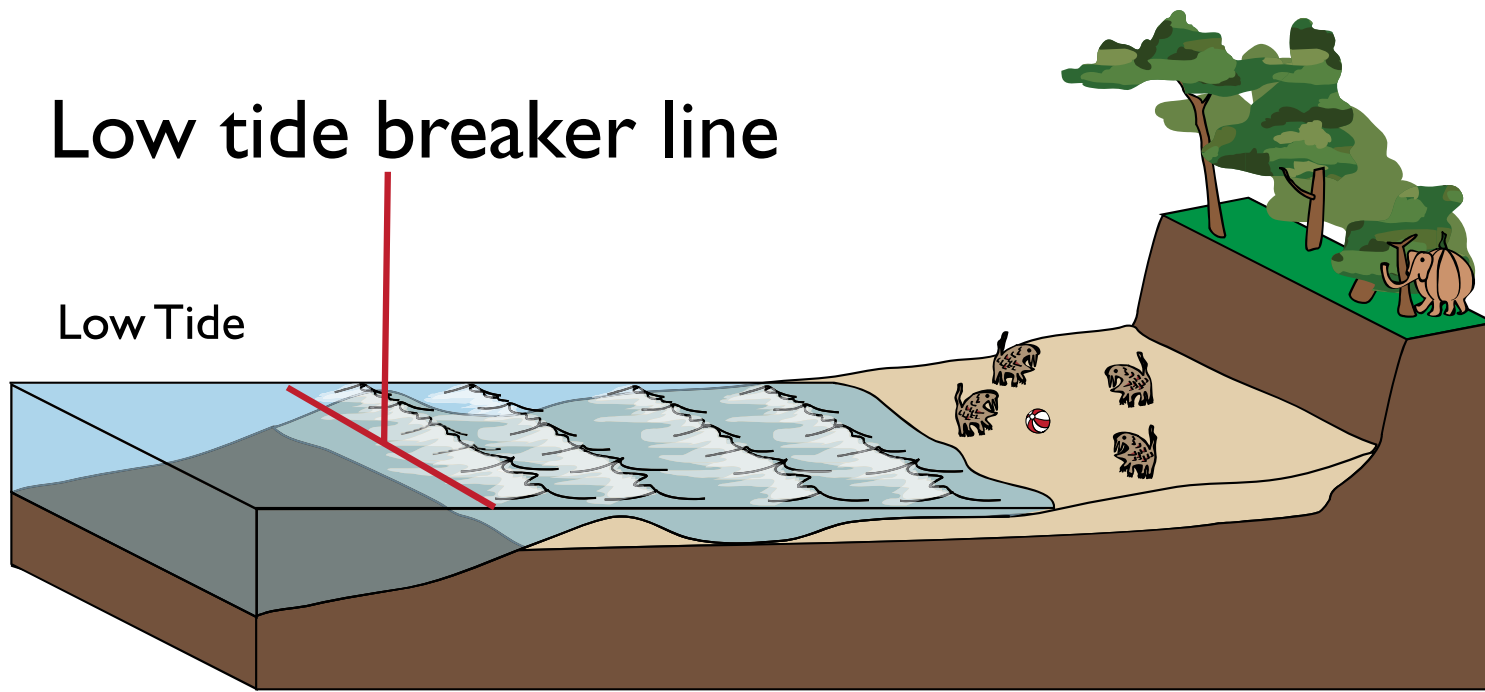
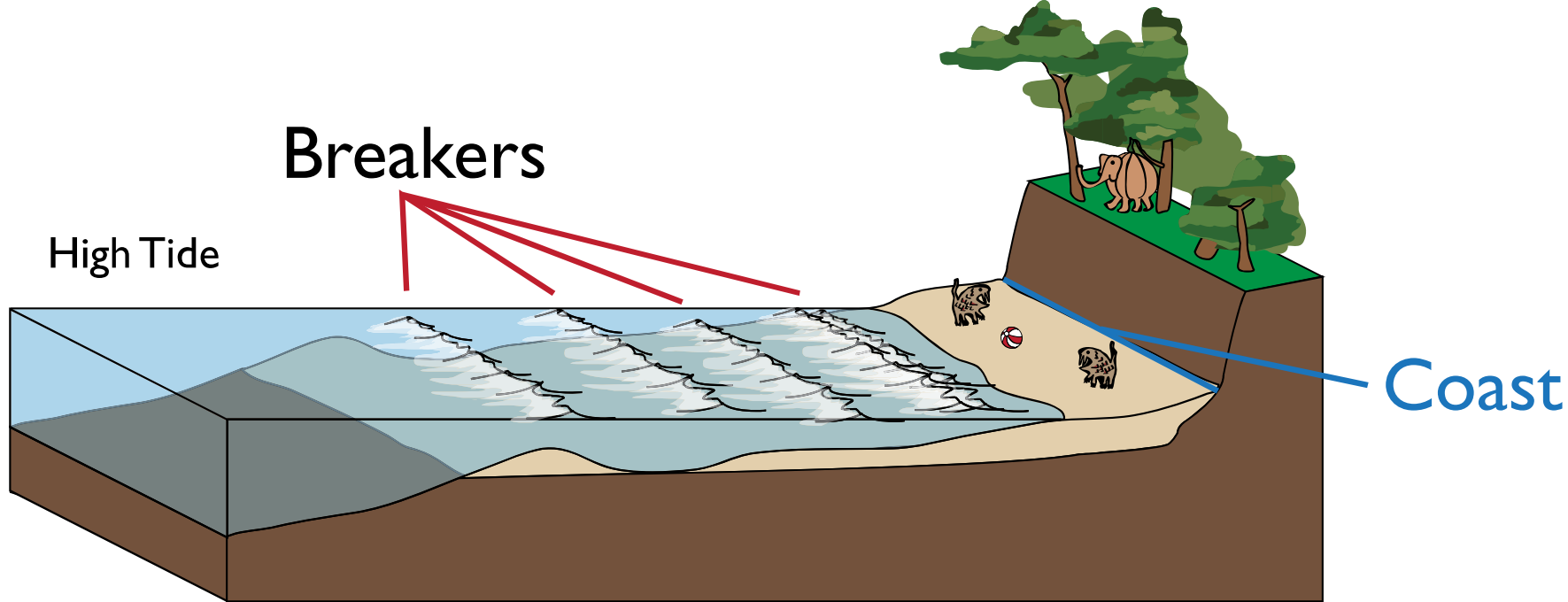


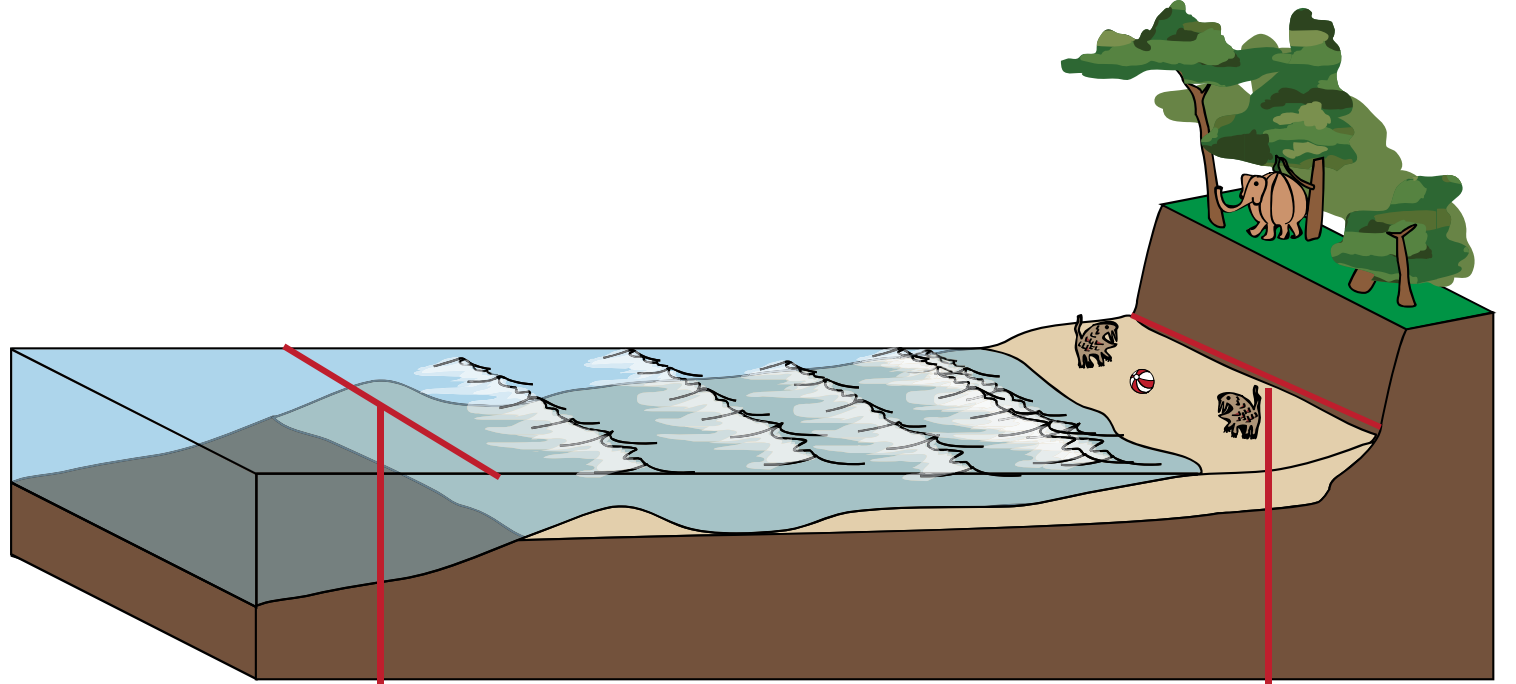
High Tide



Low Tide



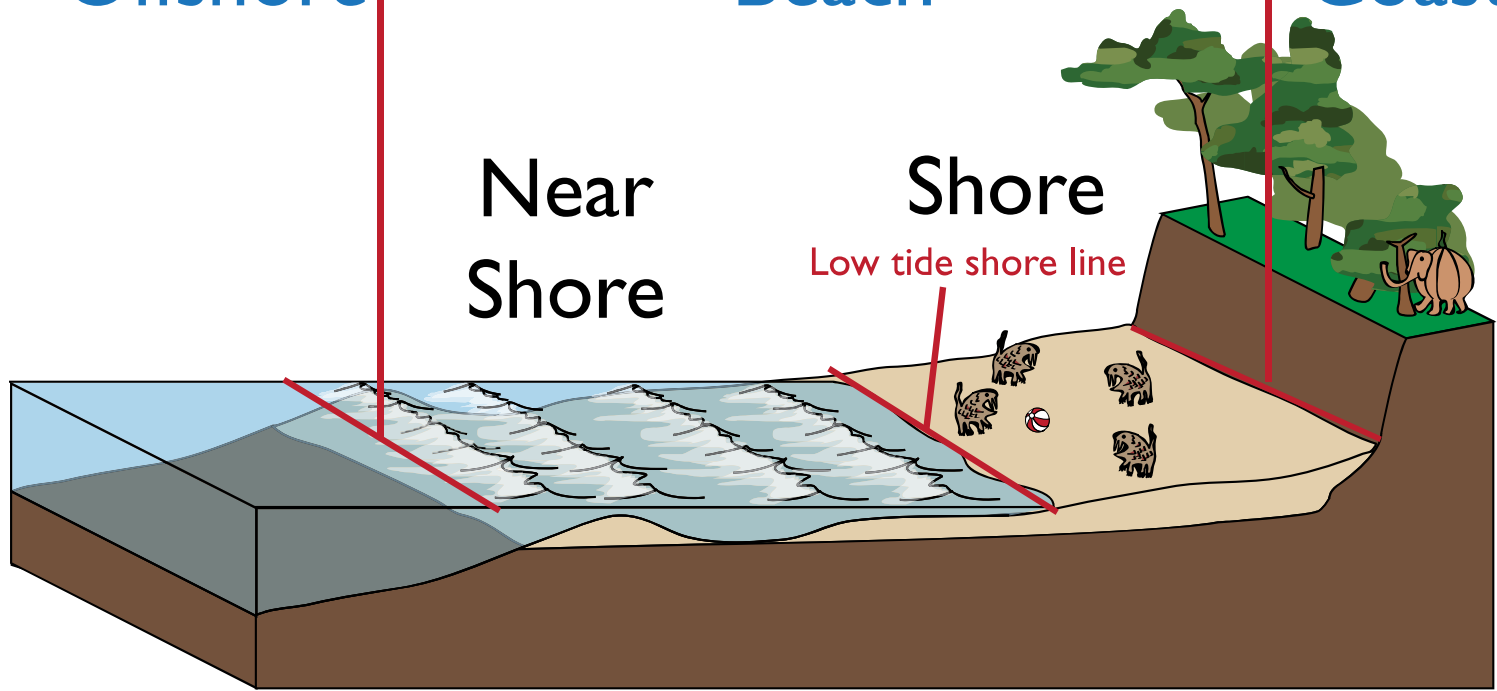




Offshore

Beach

Coast



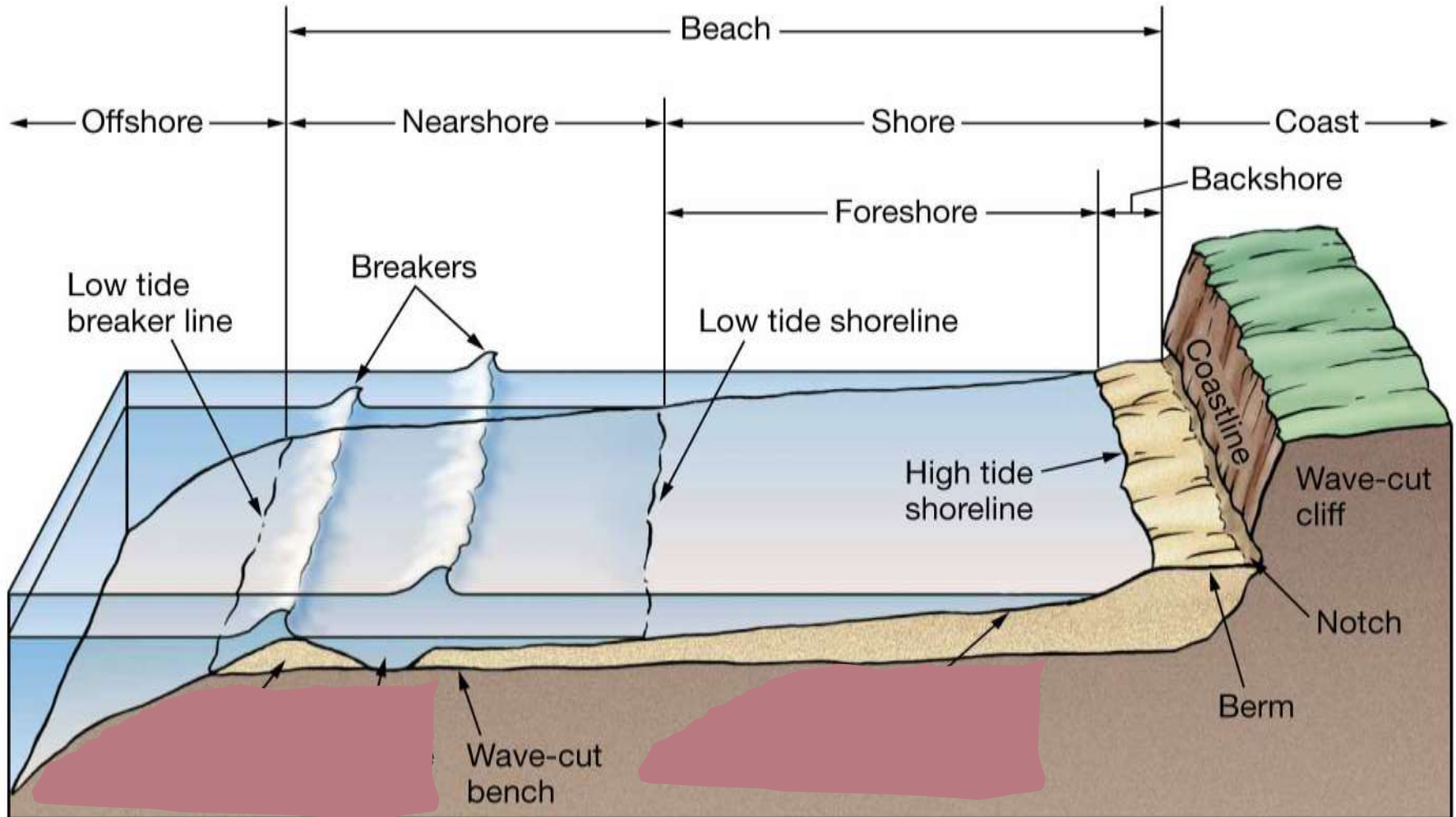
Near
Shore

Shore

Low tide shore line

Coast

Ridiculous amounts of terminology!



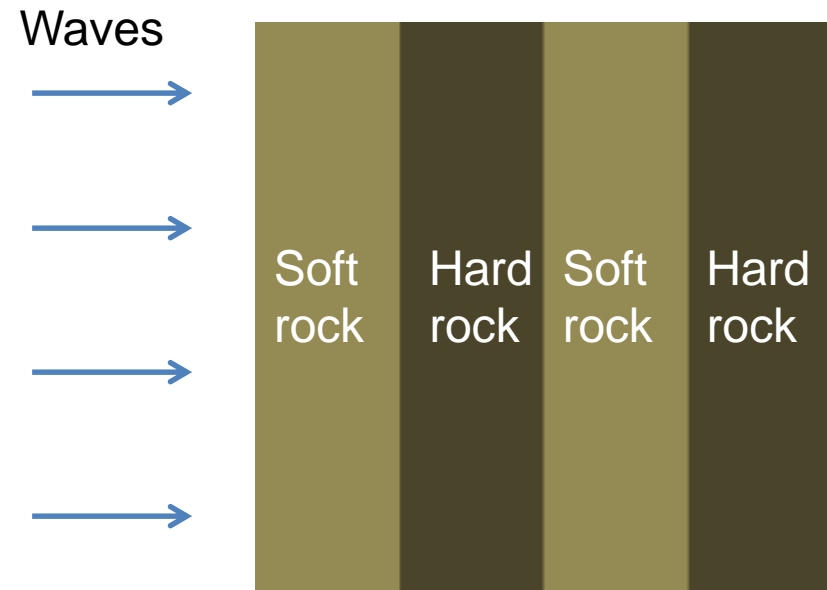
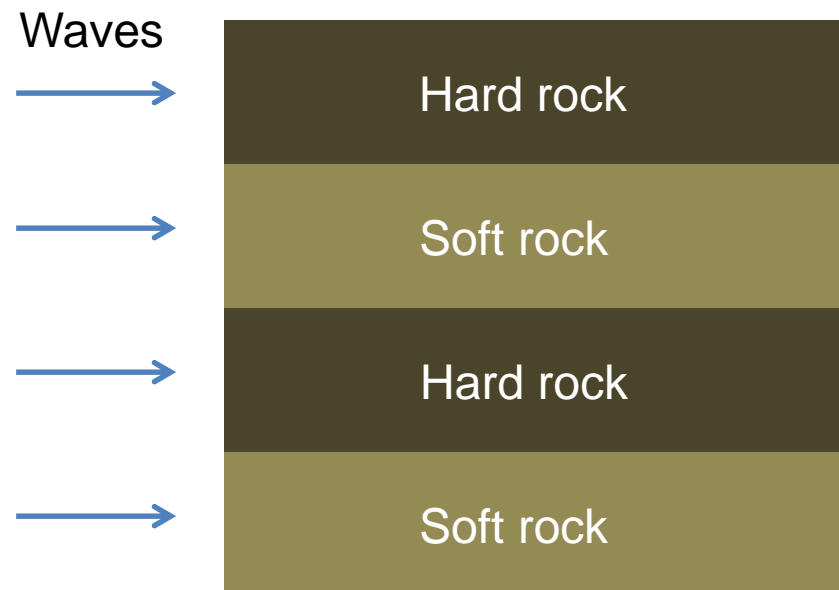
Our dynamic coastlines

Coastlines are constantly changing due to complex interactions between air, land, and the ocean:

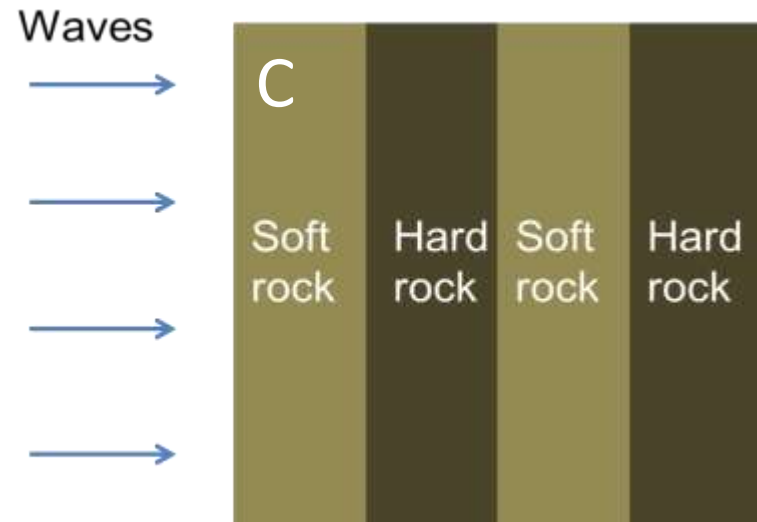
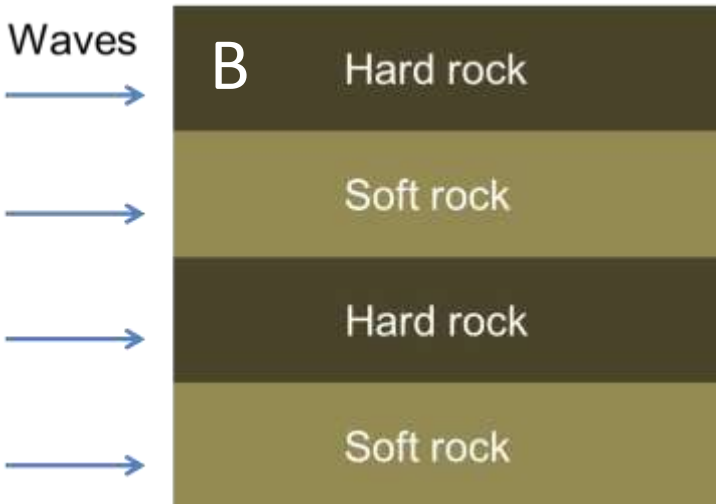
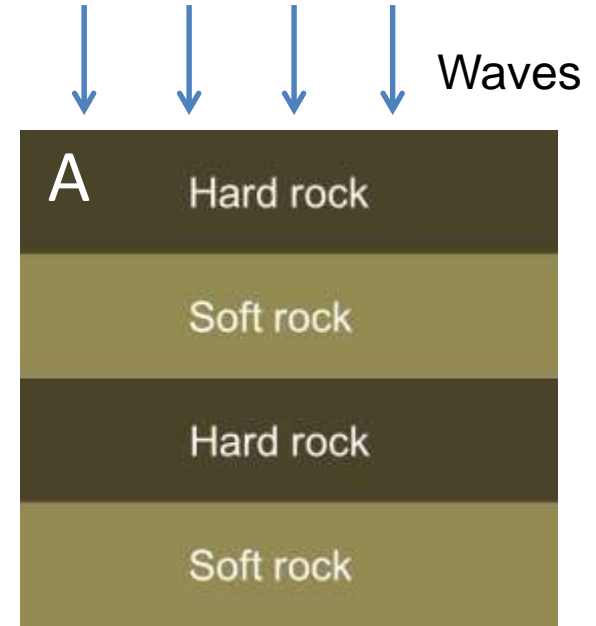
- Geology of area
- Sediment supply (from erosion and rivers)
- Ocean currents
- Tidal energy
- Wave energy
- Human activity

Coastlines: Geology

- Plate tectonics
- Resistance of rocks at the coast will affect:
 - how quickly they erode
 - how much sediment is supplied and what type of sediment



Which of the geological arrangements would cause the series of bays and headlands in the photo?





What causes the different colors here?

Coastlines: Sediment supply

Sediment provided by rivers or wave erosion and transport along coast



Coastlines: Currents, tides and waves

- Ocean currents transport sediment
- Tides affect the range of heights where sediment can be eroded and deposited
- Waves are main way that material is eroded, transported and deposited



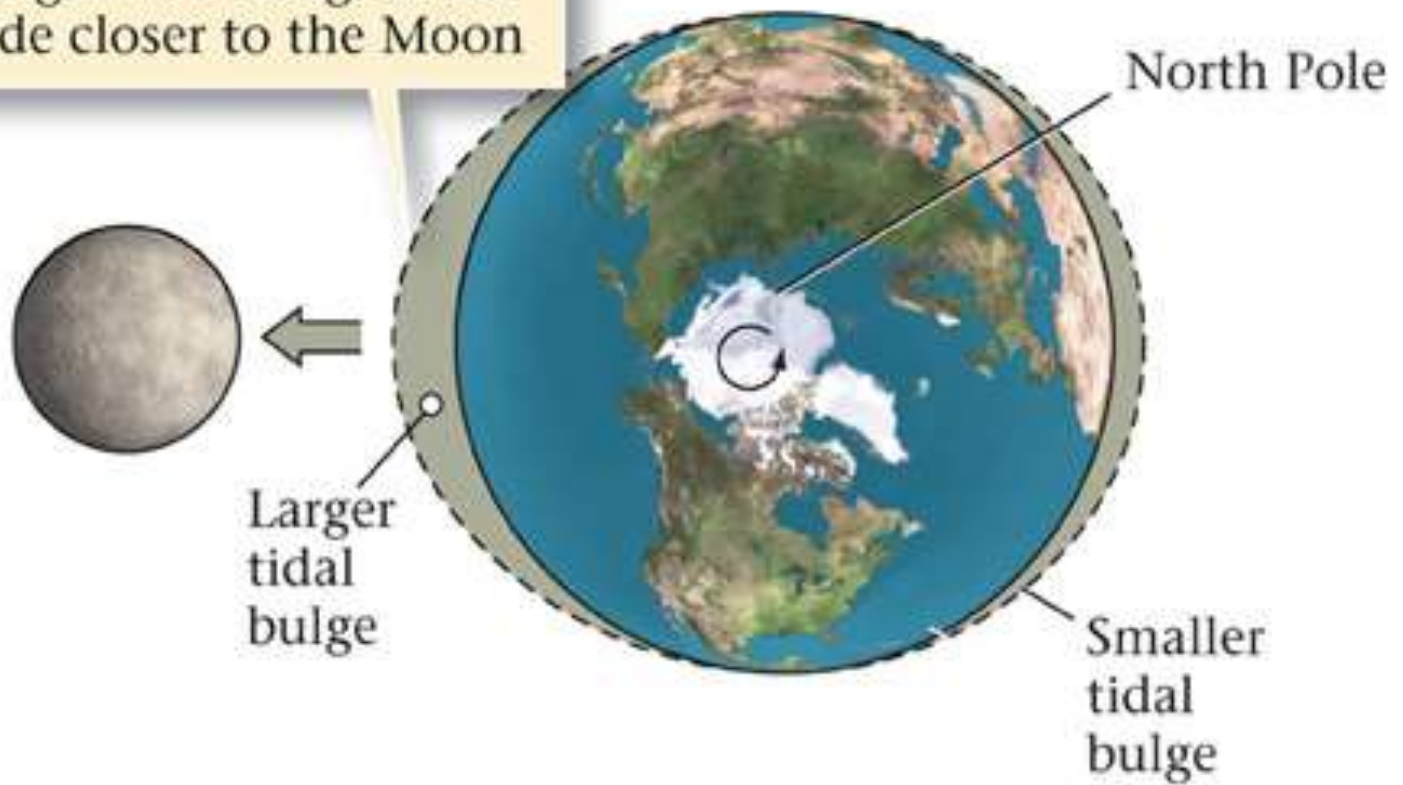
Tides

- Sea level rises and falls daily
 - High tide
 - Low tide
 - The intertidal zone lies between tides



Tides

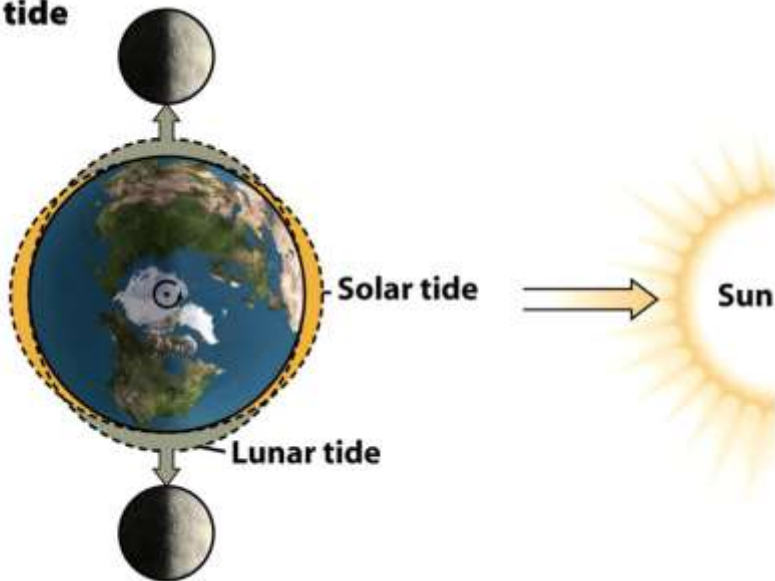
The larger tidal bulge is on the side closer to the Moon



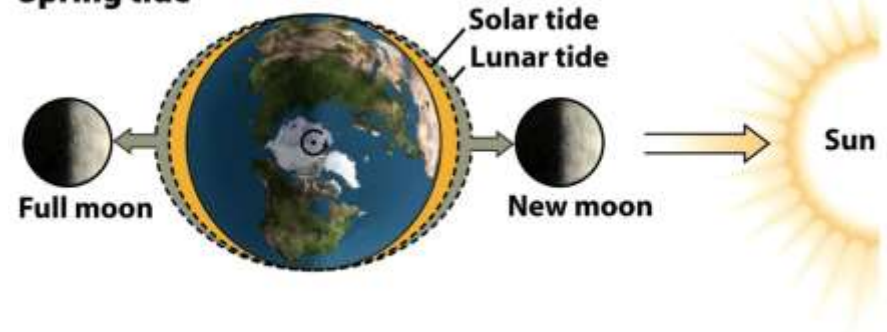
Tides

- Lunar and solar tidal effects interact
 - Positive alignment yields enhanced “spring” tides
 - Negative alignment results in dampened “neap” tides

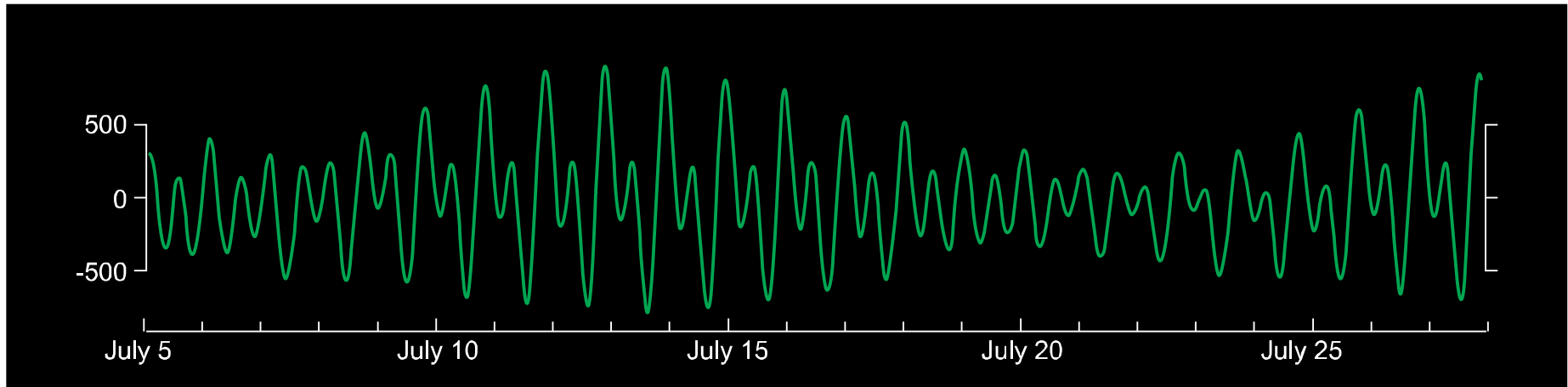
Neap tide



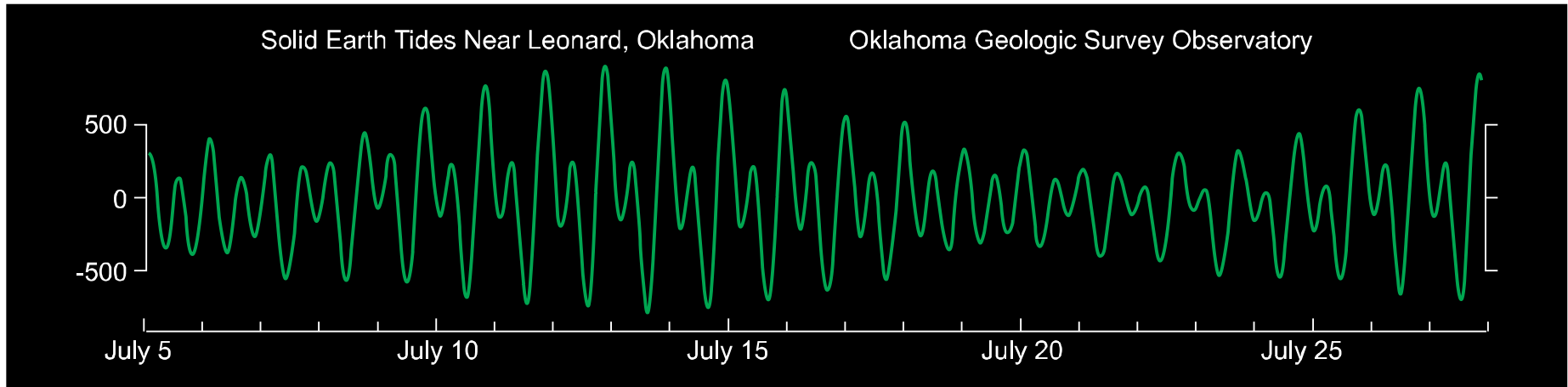
Spring tide



Tides



Tides

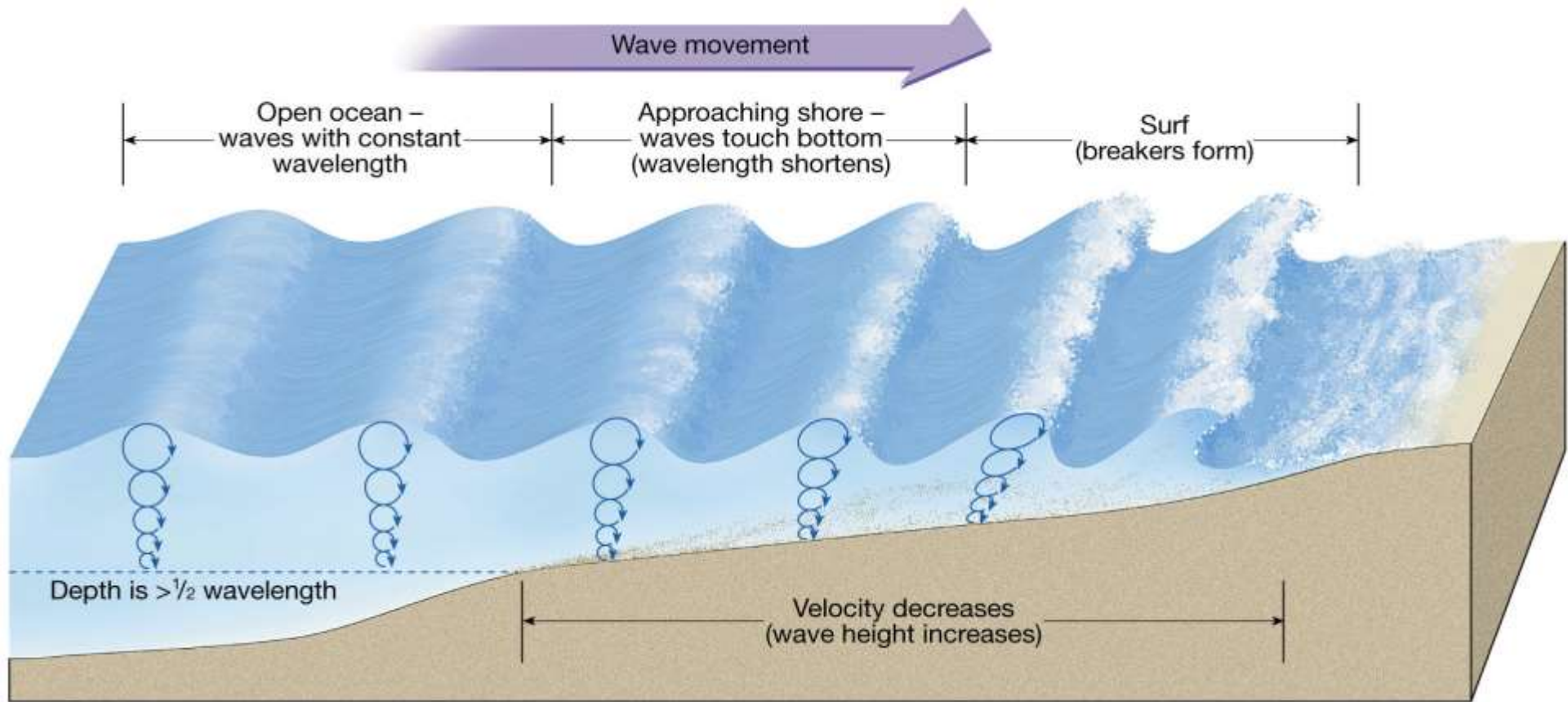


Waves

- Ocean waves are energy travelling along the ocean-atmosphere interface.
- Most ocean waves are wind-generated
- Waves can travel great distances across ocean basins!



Waves approaching shore



Wave erosion

- Breaking waves exert a great force on shorelines
- Wave erosion is caused by
 - Wave impact and pressure
 - Abrasion by rock fragments



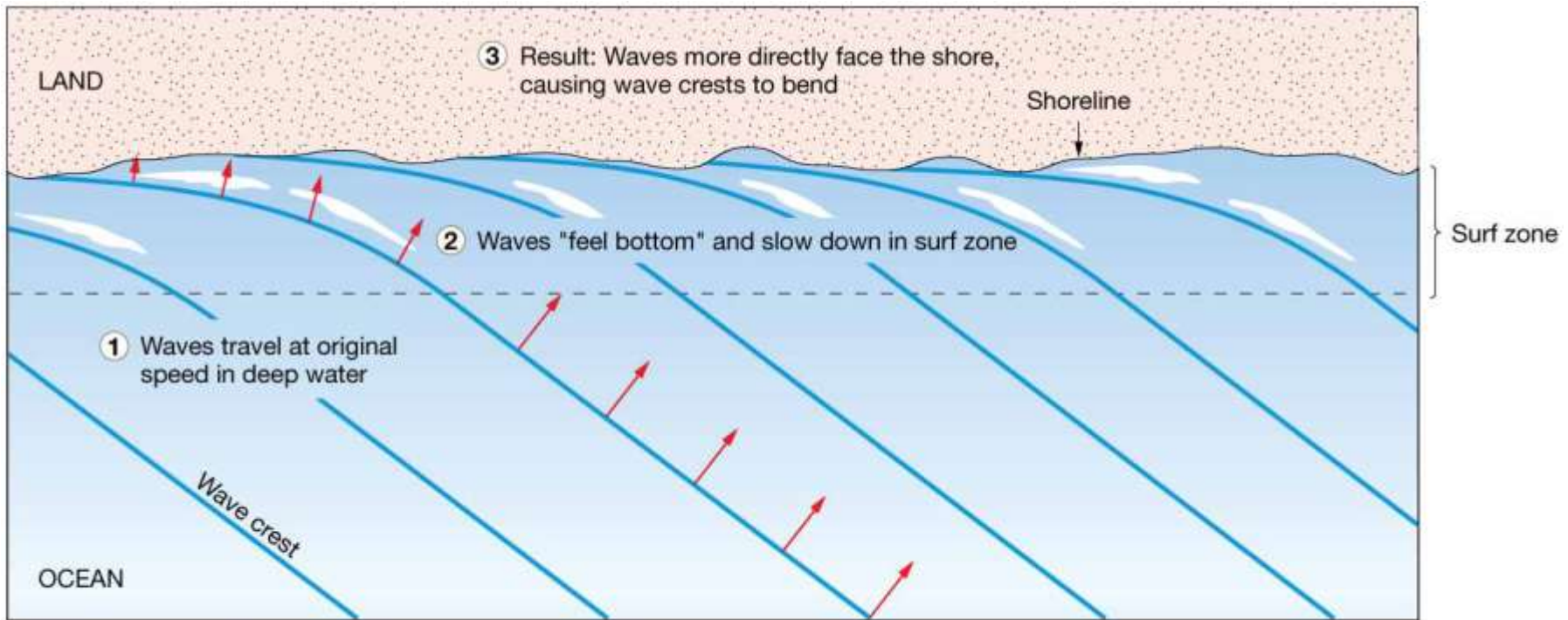
Wave refraction



- Waves often approach the shore at an angle but bend to align parallel to shore

Wave refraction: Straight shorelines

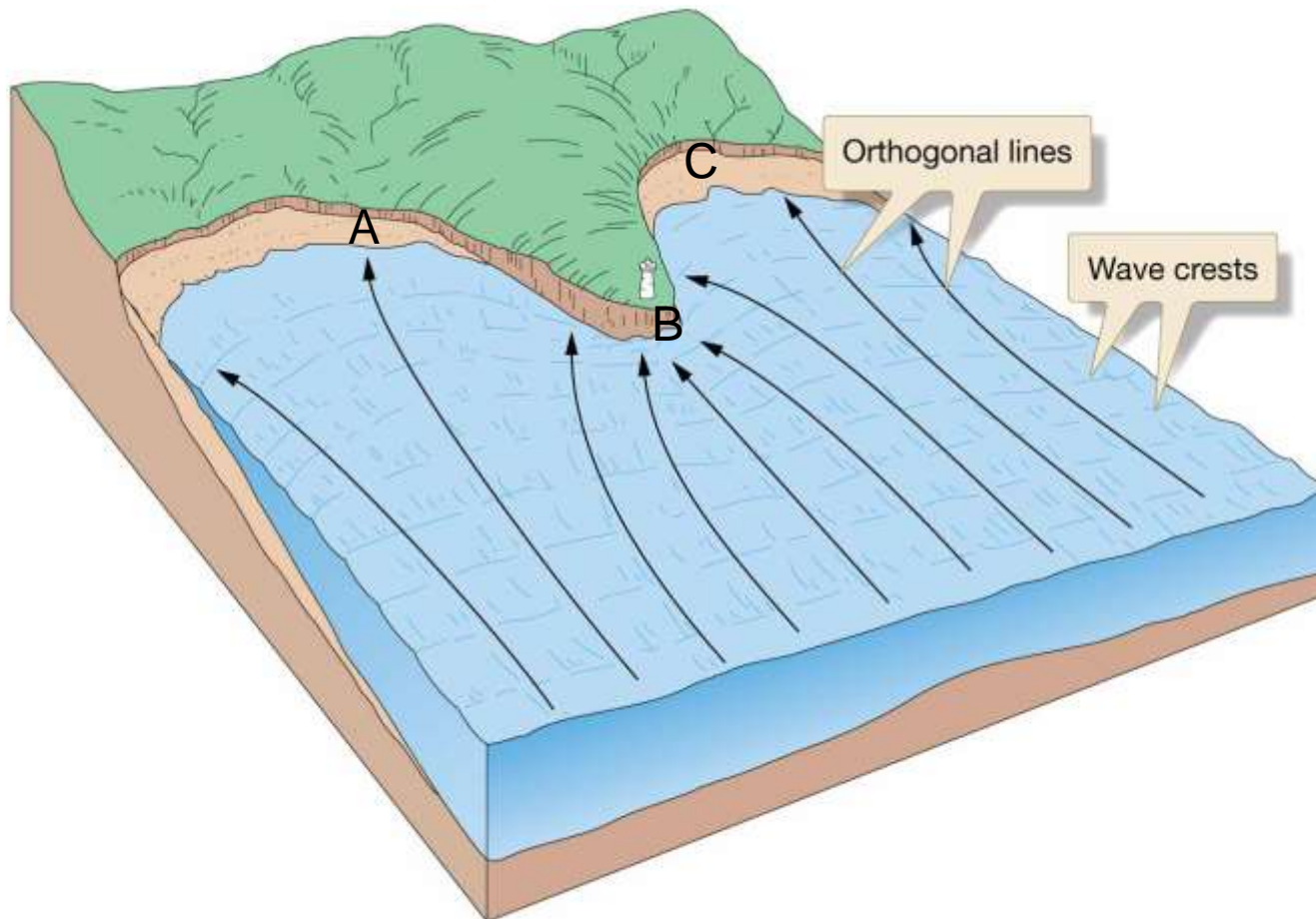
Waves are usually not completely parallel to the shoreline – results in movement of sand along the beach = longshore drift



(a) Wave refraction along a straight shoreline.

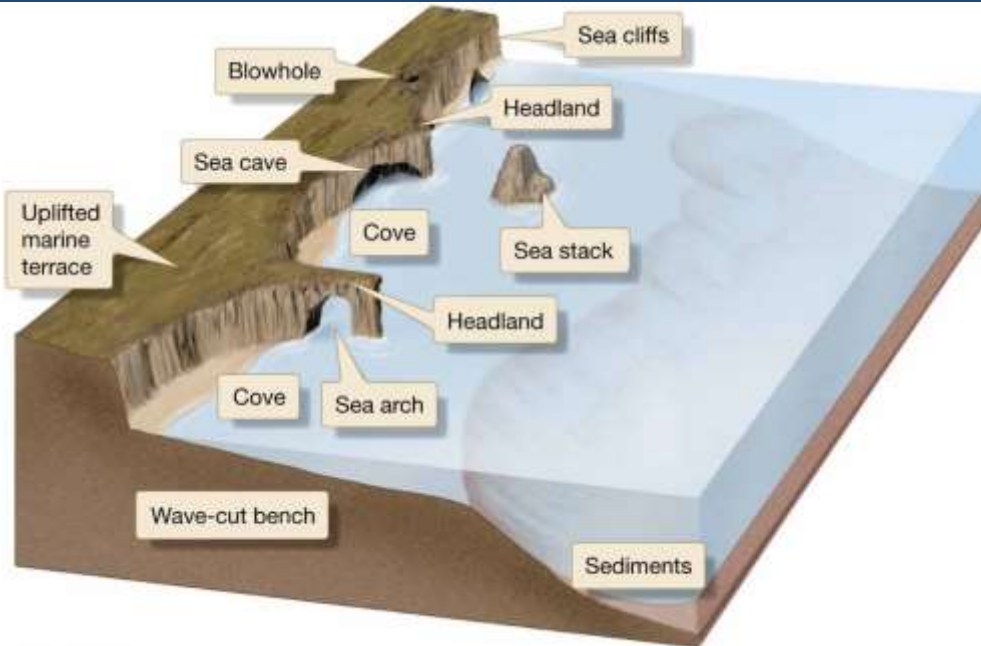
Wave refraction: Irregular shorelines

Where will most erosion occur due to ocean waves?

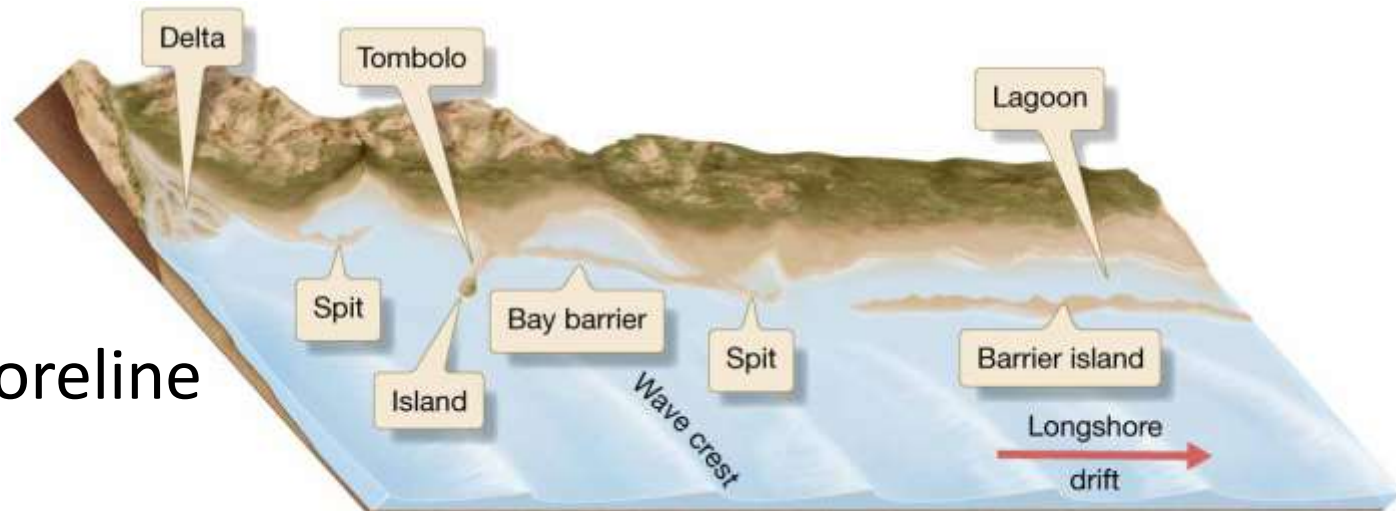


(b) Wave refraction along an irregular shoreline.

Erosional vs Depositional shores

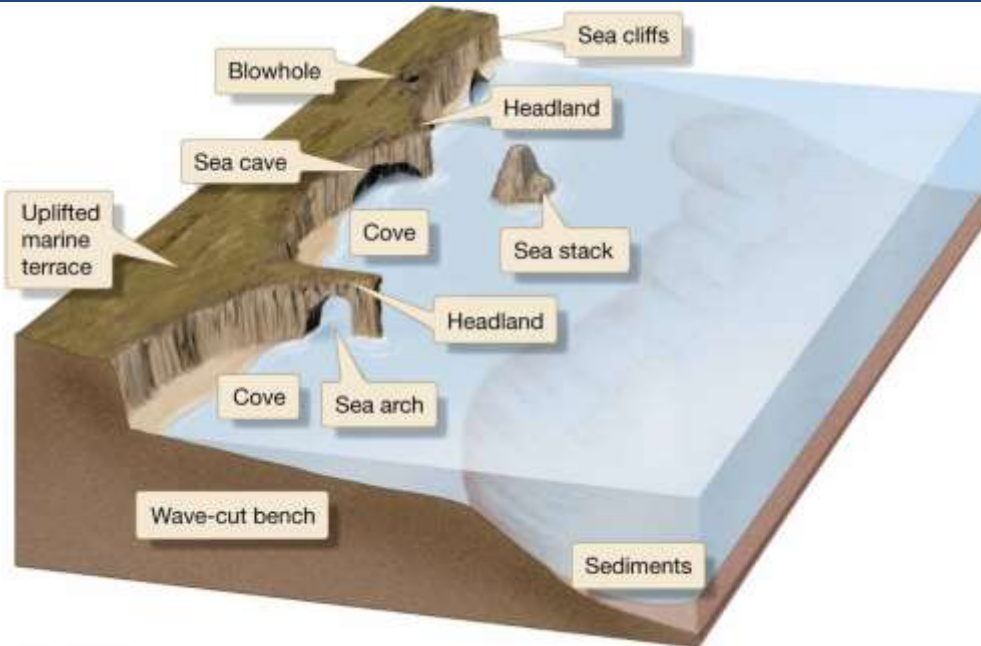


Erosional shoreline

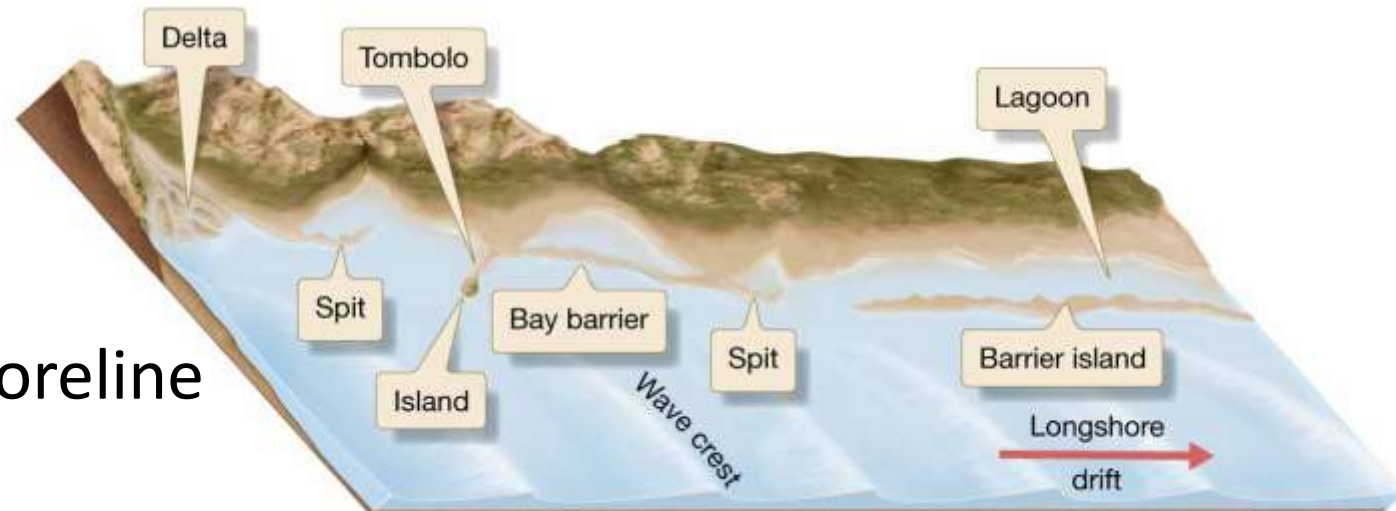


Depositional shoreline

In groups: What controls this process?

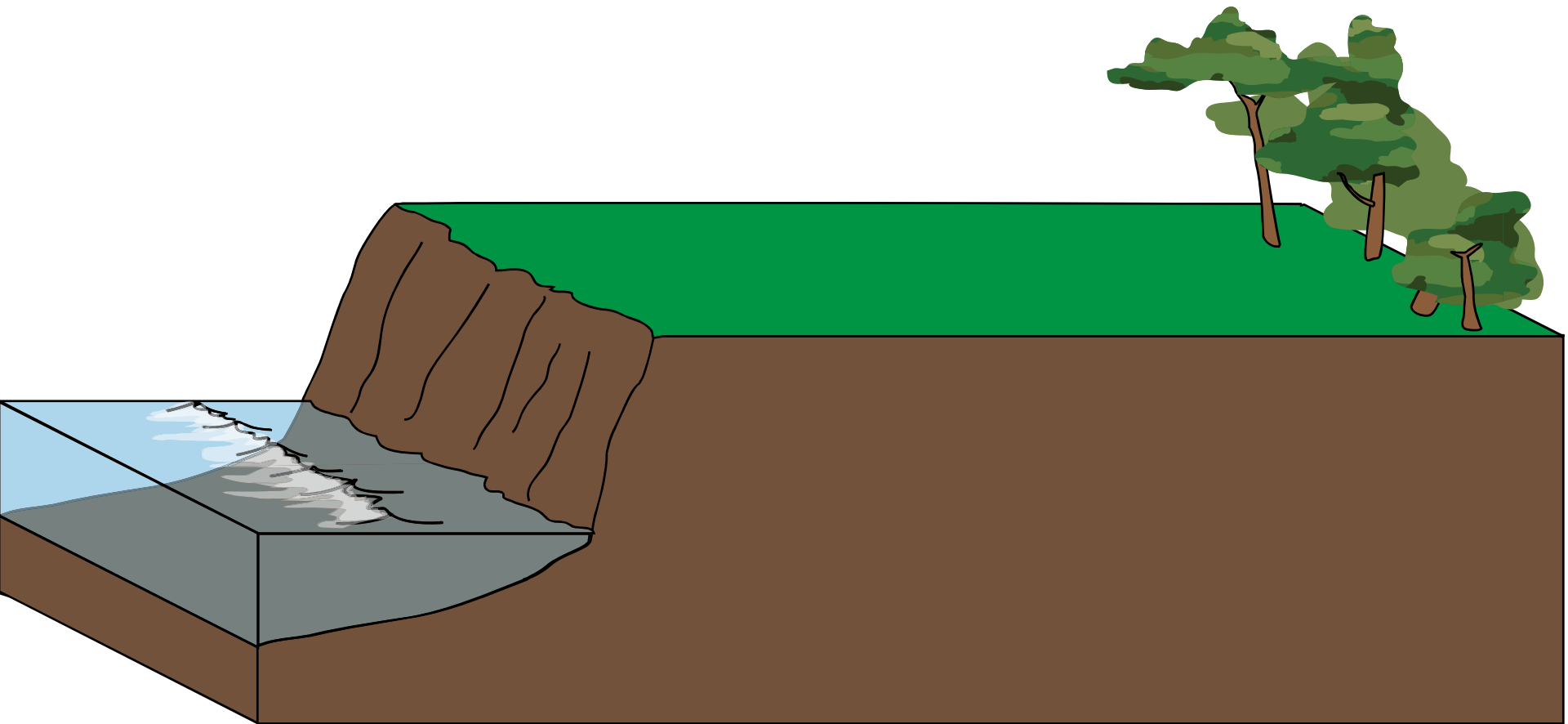


Erosional shoreline

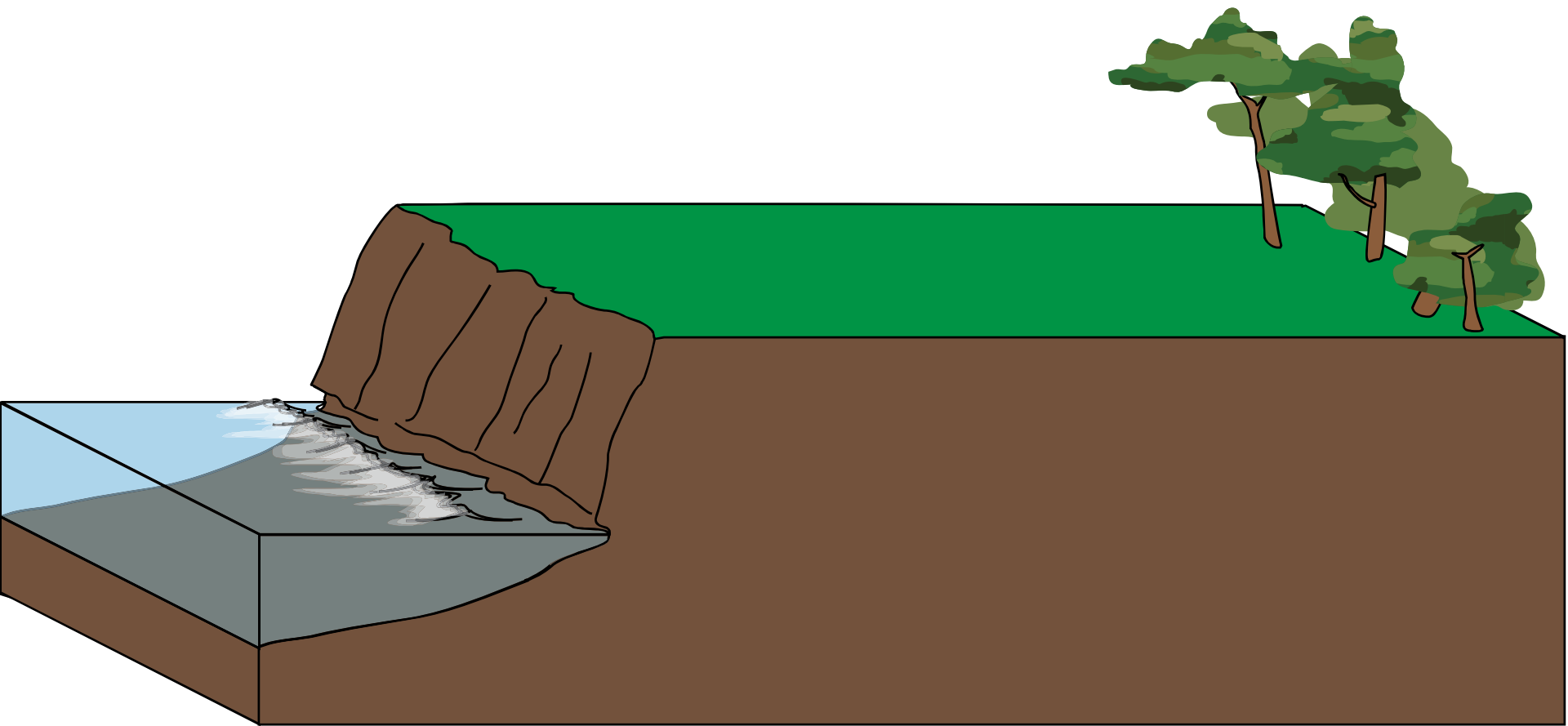


Depositional shoreline

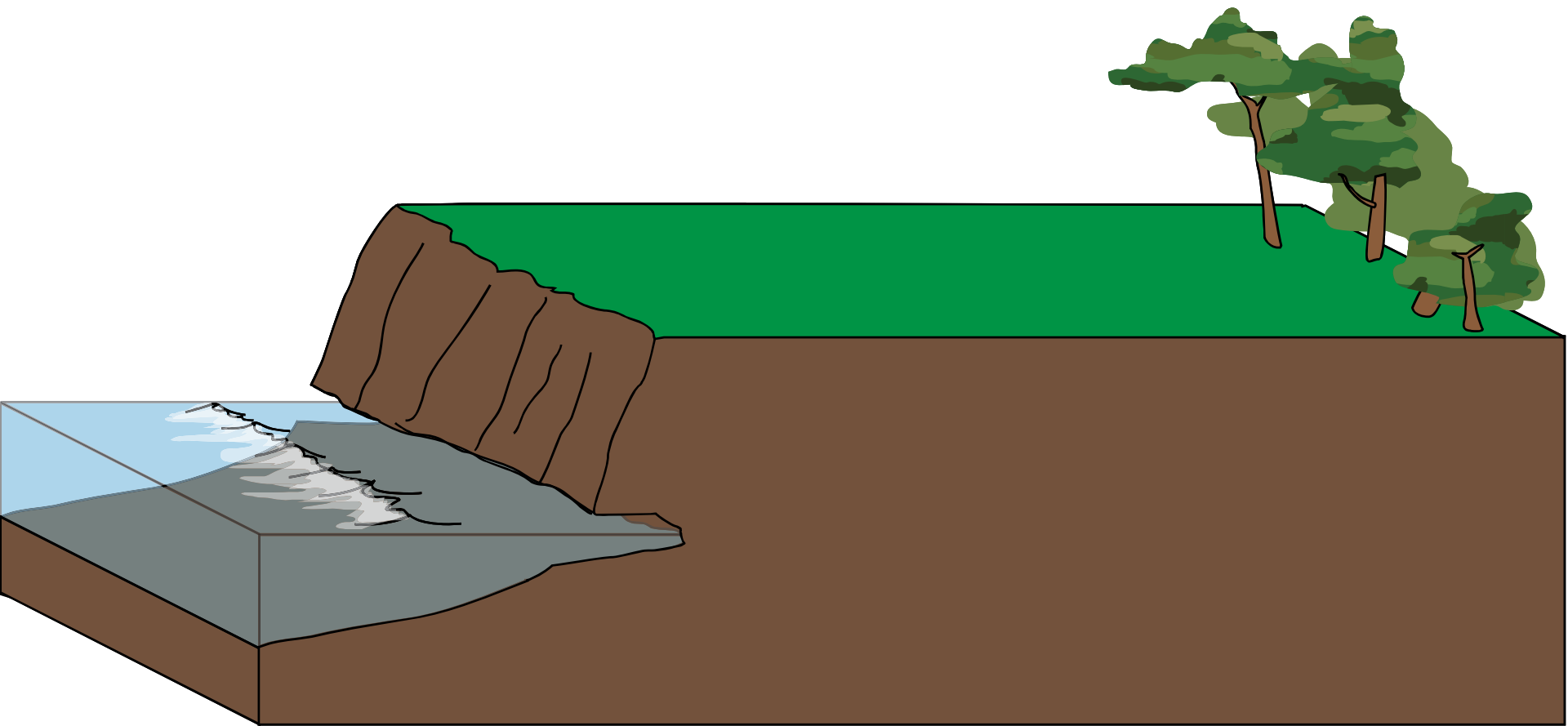
Erosional processes



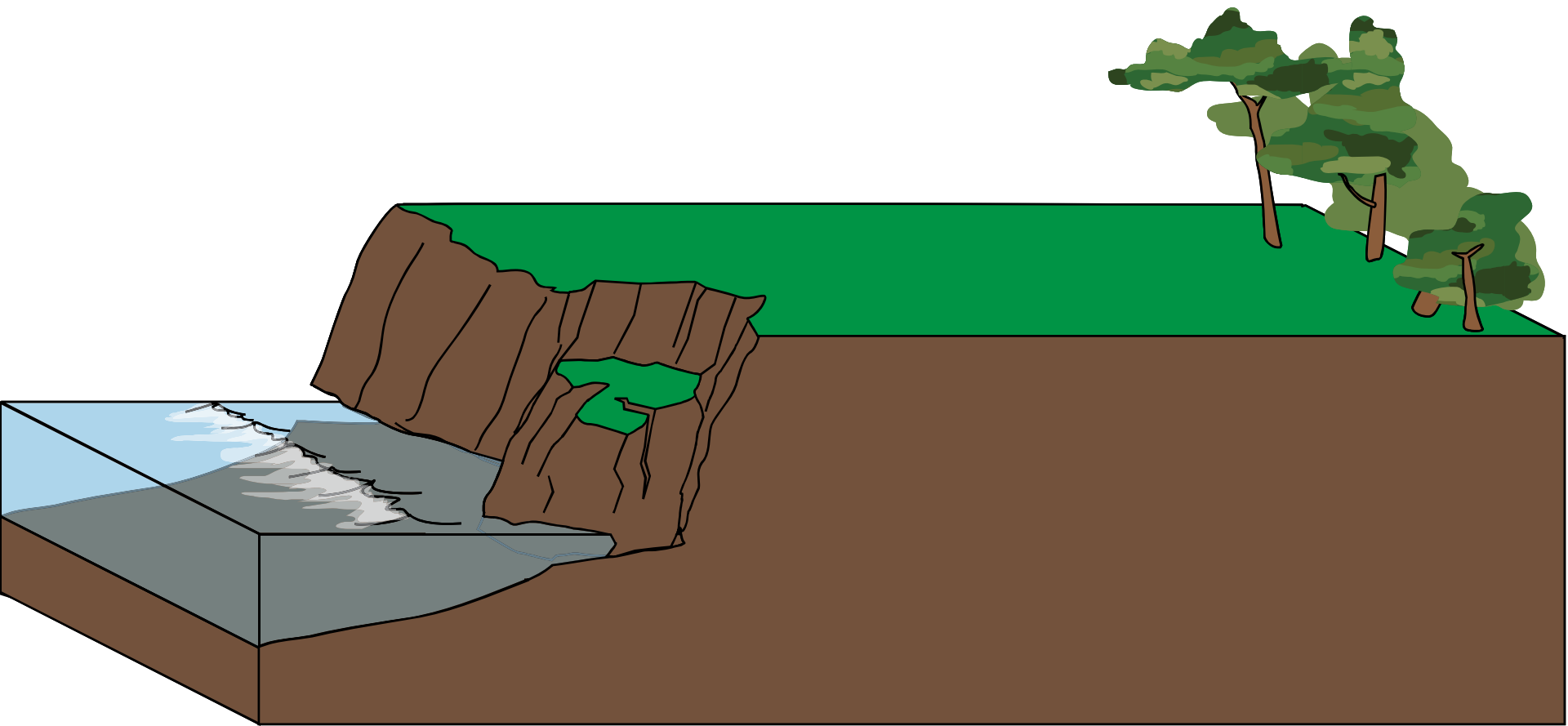
Erosional processes



Erosional processes

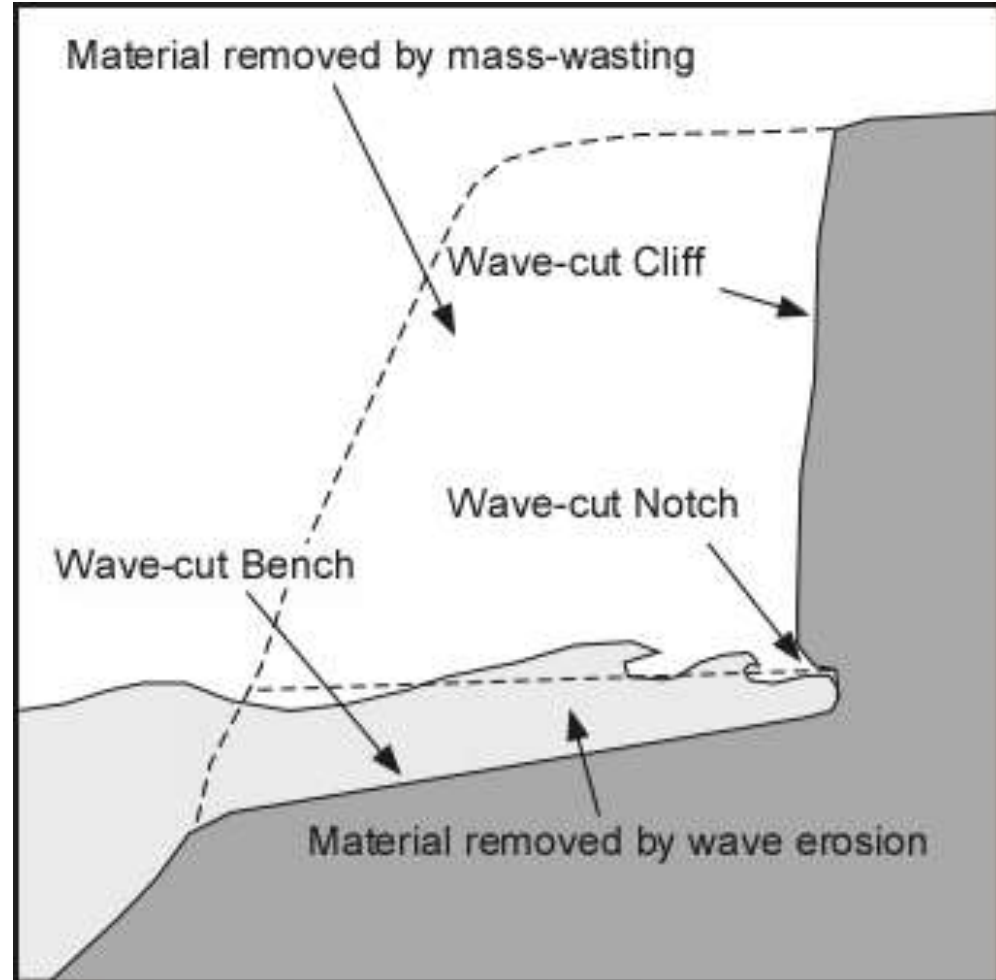


Erosional processes



Erosional shores: landforms

- Wave-cut cliffs
- Wave-cut platforms
- Sea arches and sea stacks



Erosional shores: landforms



Erosional shores: landforms



Erosional shores: landforms

Porthcothan Bay: Before



After: 6 January 2014



Erosional shores: landforms

Pom Pom rock: 29 December 2013



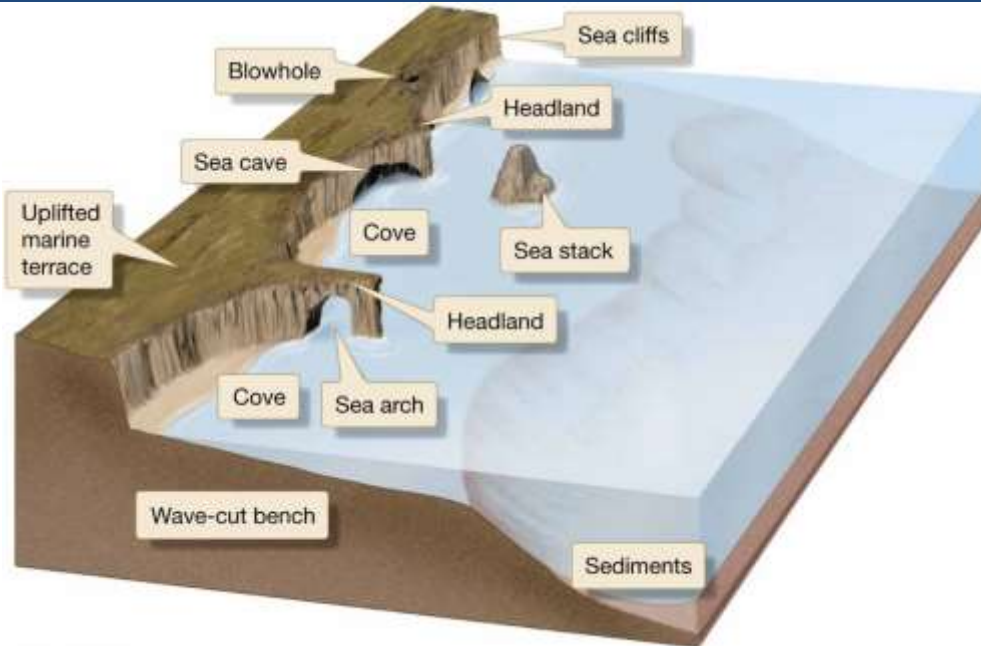
After: 6 January 2014



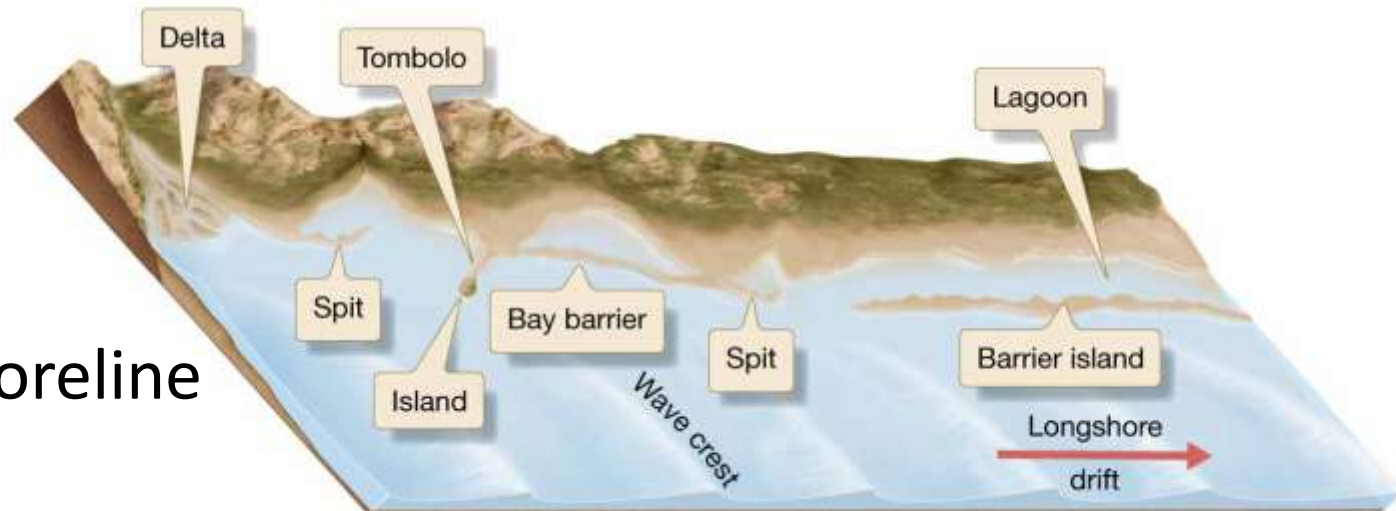
Erosional shores: landforms



Erosional vs Depositional shores



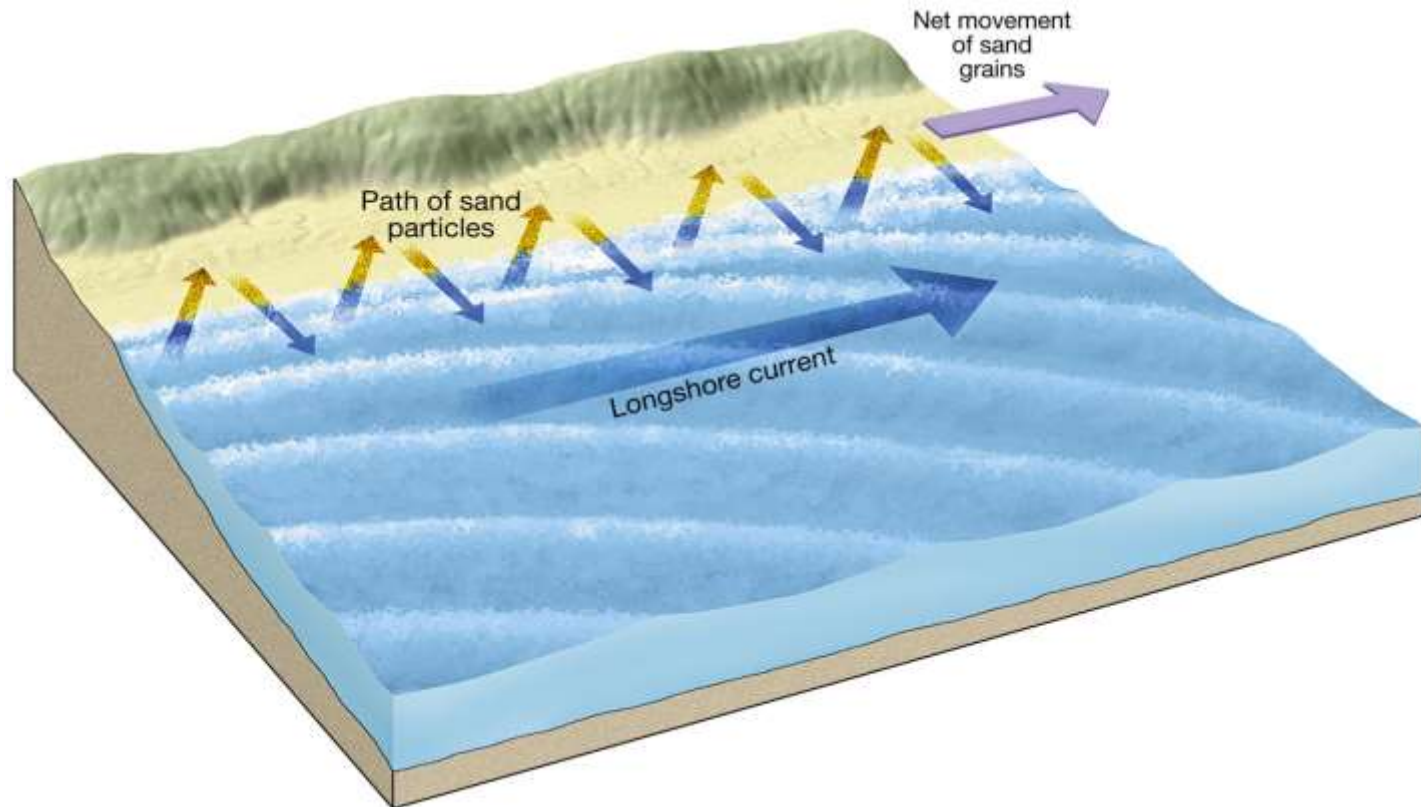
Erosional shoreline



Depositional shoreline

Transport of sediment

- Despite refraction, waves seldom approach the shore exactly straight on:
 - Oblique waves produce longshore currents
 - Sediment is moved down the coastline due to these currents



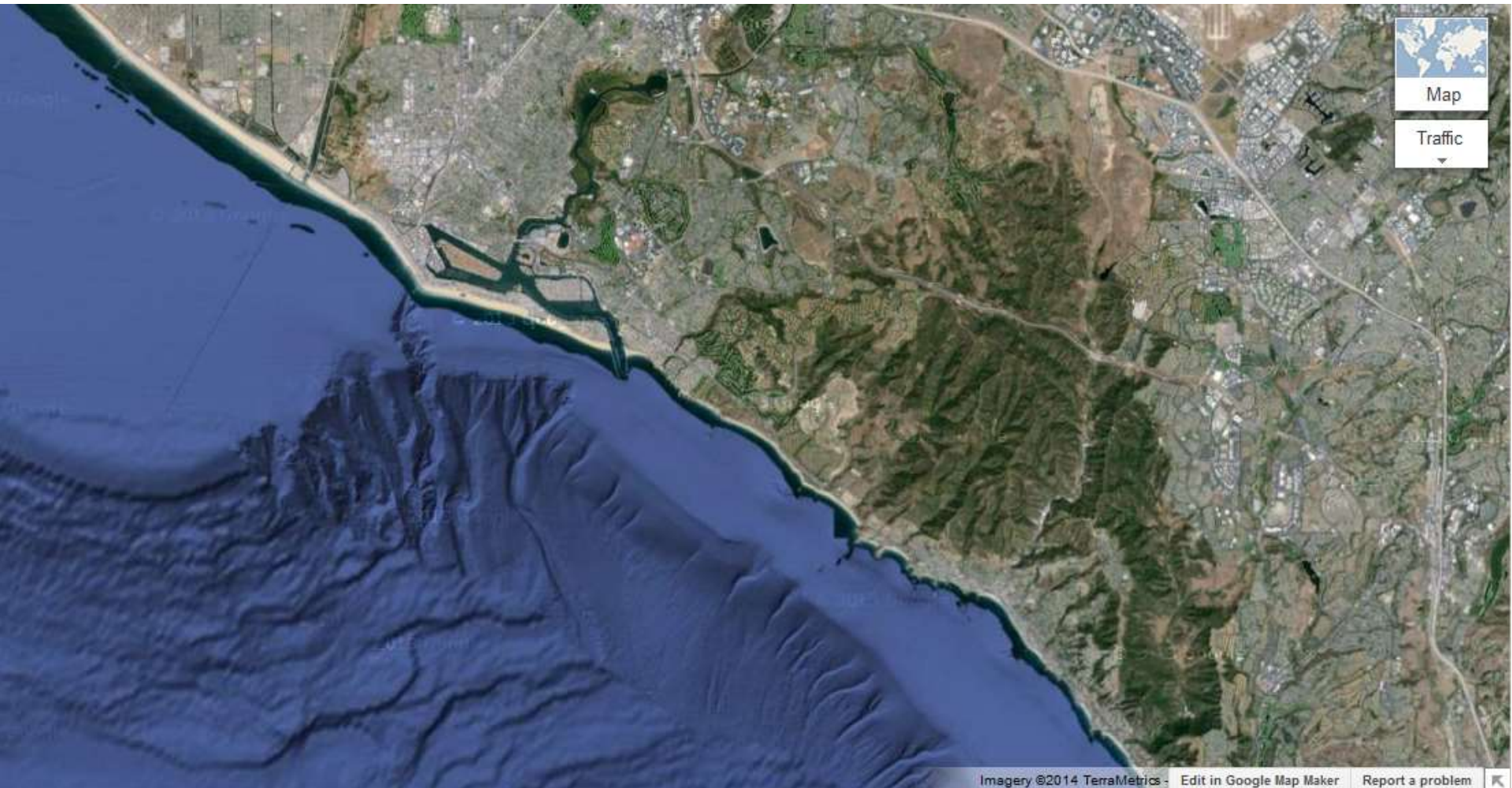
Depositional shores: Sediment transport

Beach compartment composed of:

- Rivers that supply sediment to beach
- Beach
- Offshore submarine canyon where sediment moves away



Our local coastline



<https://maps.google.com/>

Depositional shores: Spits and barrier islands

- Spit = linear ridge of sediment extends away from land due to deposition by longshore drift
- Barrier island = where spit extends all the way across a bay
- Rare along our coastline – much more common on east coast
- Popular places to live but very vulnerable

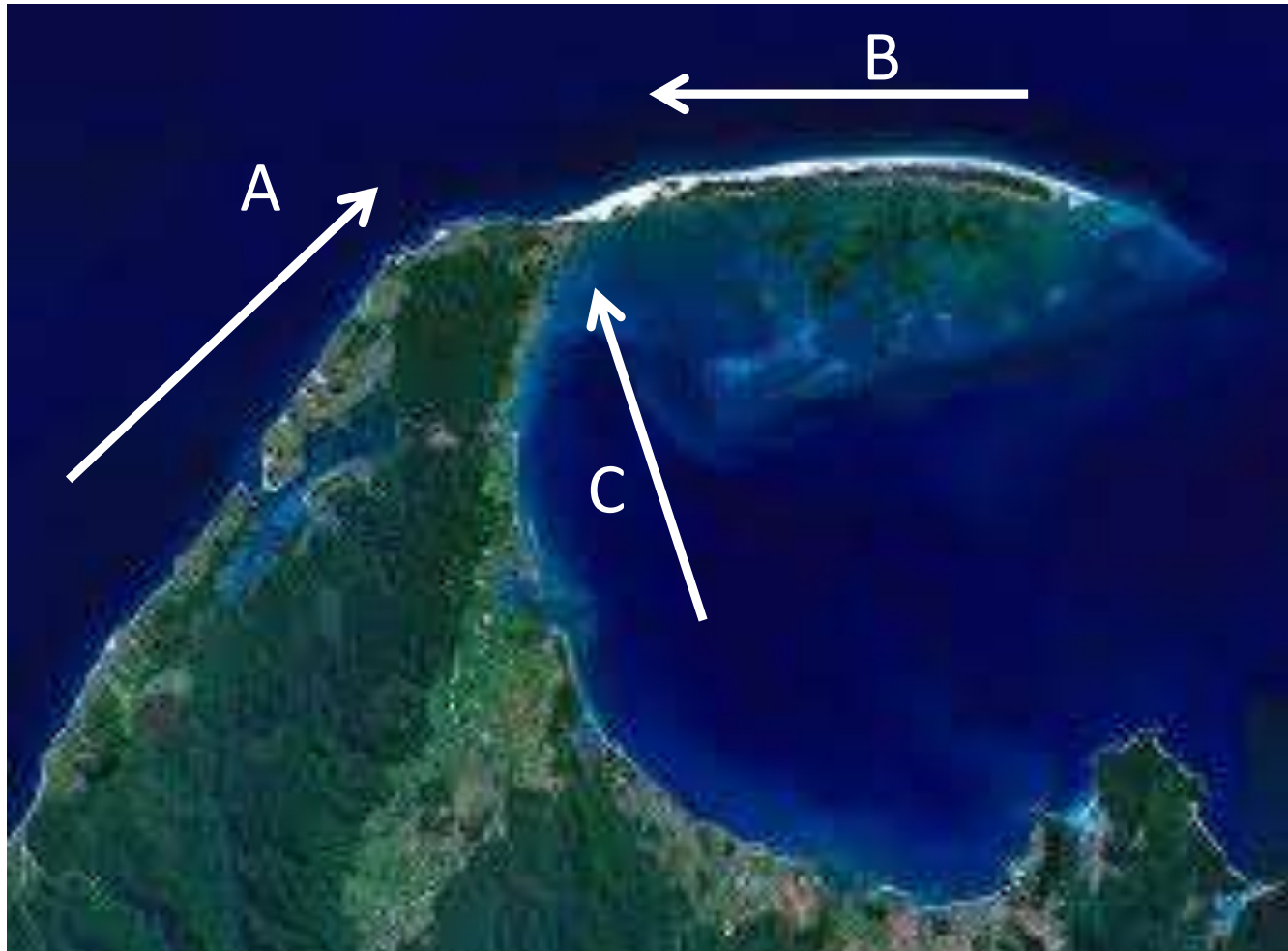


Storm Sandy: Before & After



Depositional shores: Spits and barrier islands

- Which direction is longshore drift in the image below?



Other types of coast: Estuaries and fjords



Estuary
Flooded river valley



Fjord
Flooded glacial valley

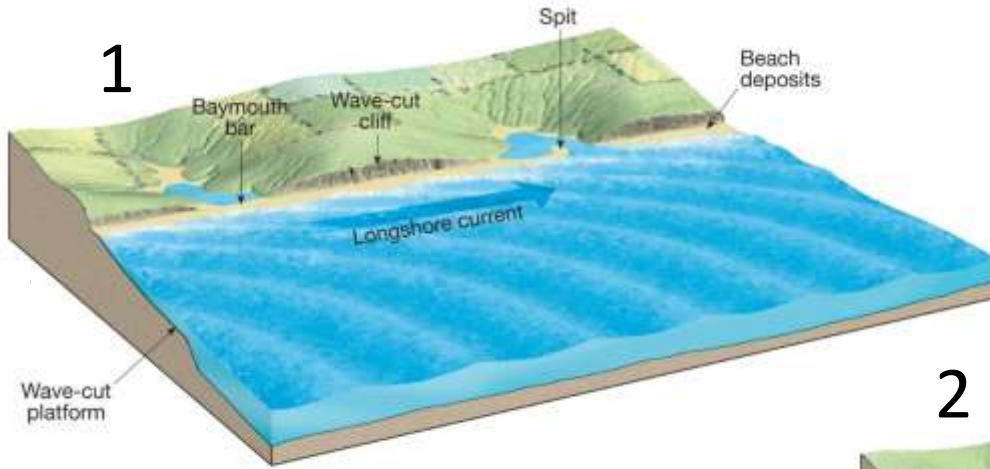
Other types of coast: Biological coasts

- Swamps, marshes in temperate climates
- Mangrove swamps in tropical or subtropical climates
- Coral reefs in tropical or subtropical climates

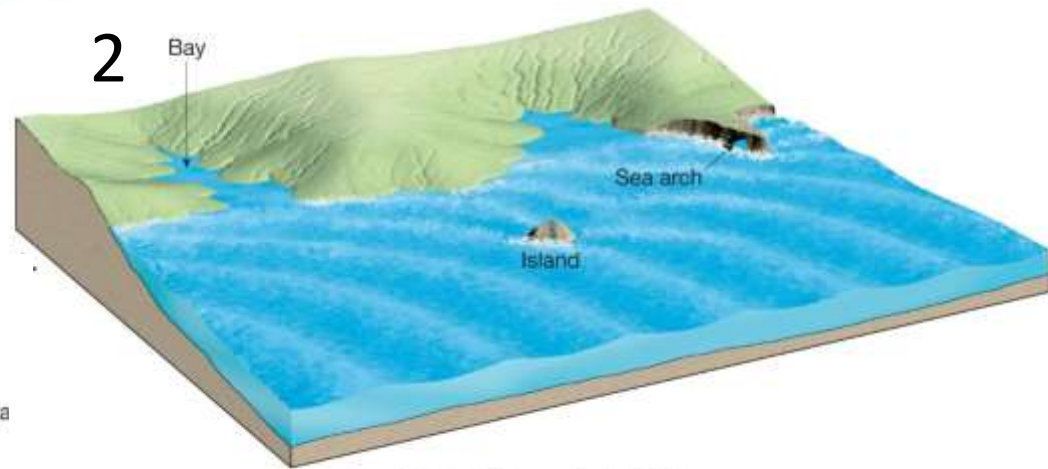


What is the correct order of the diagrams?

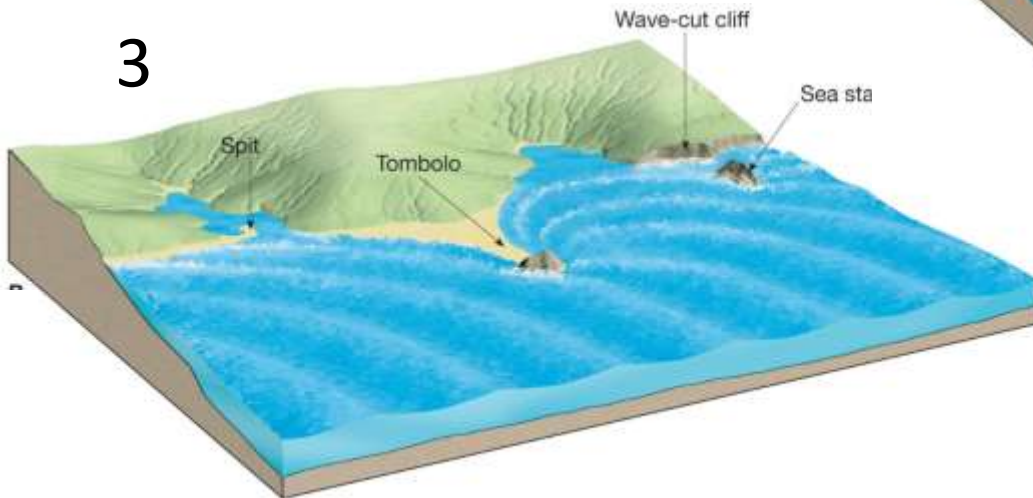
1



2



3



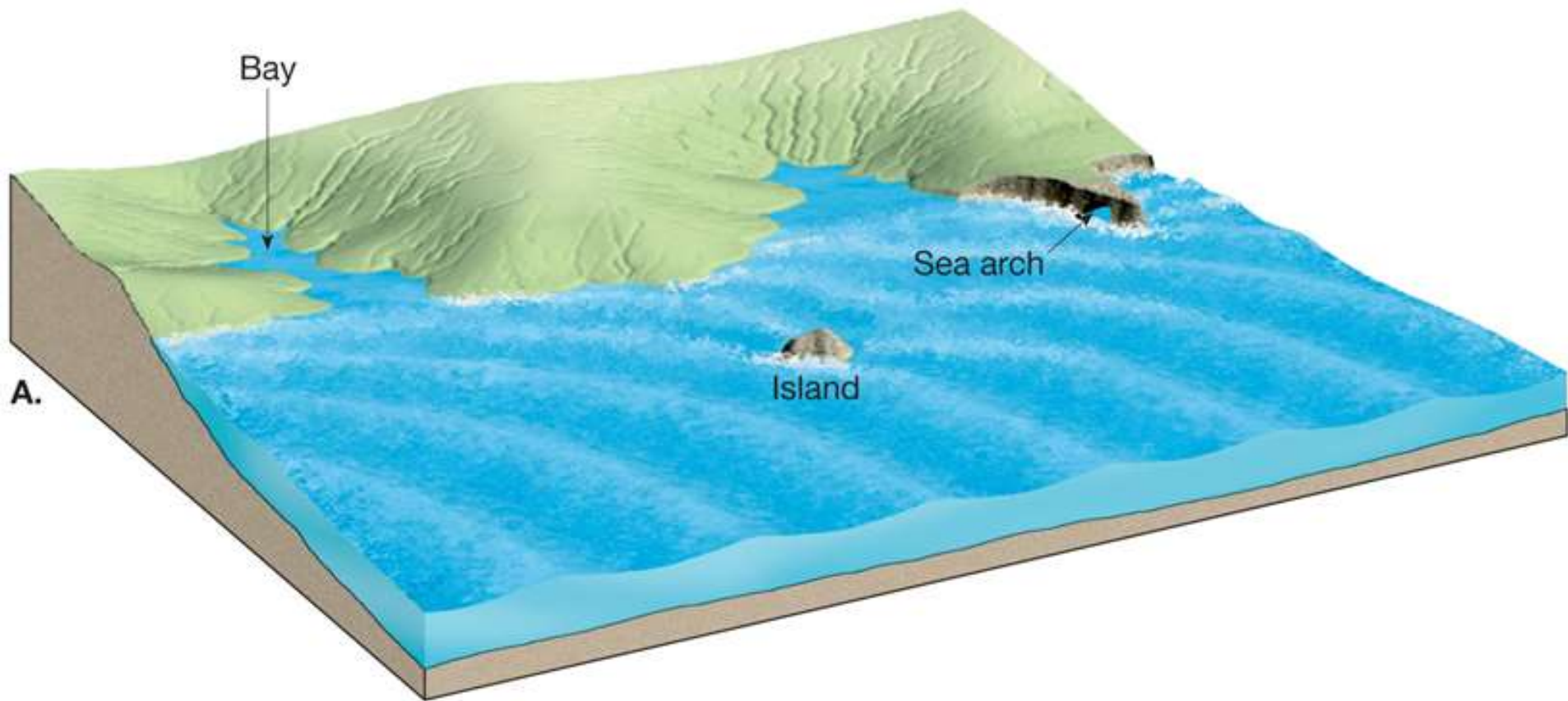
A) 1 - 2 - 3

B) 2 - 1 - 3

C) 2 - 3 - 1

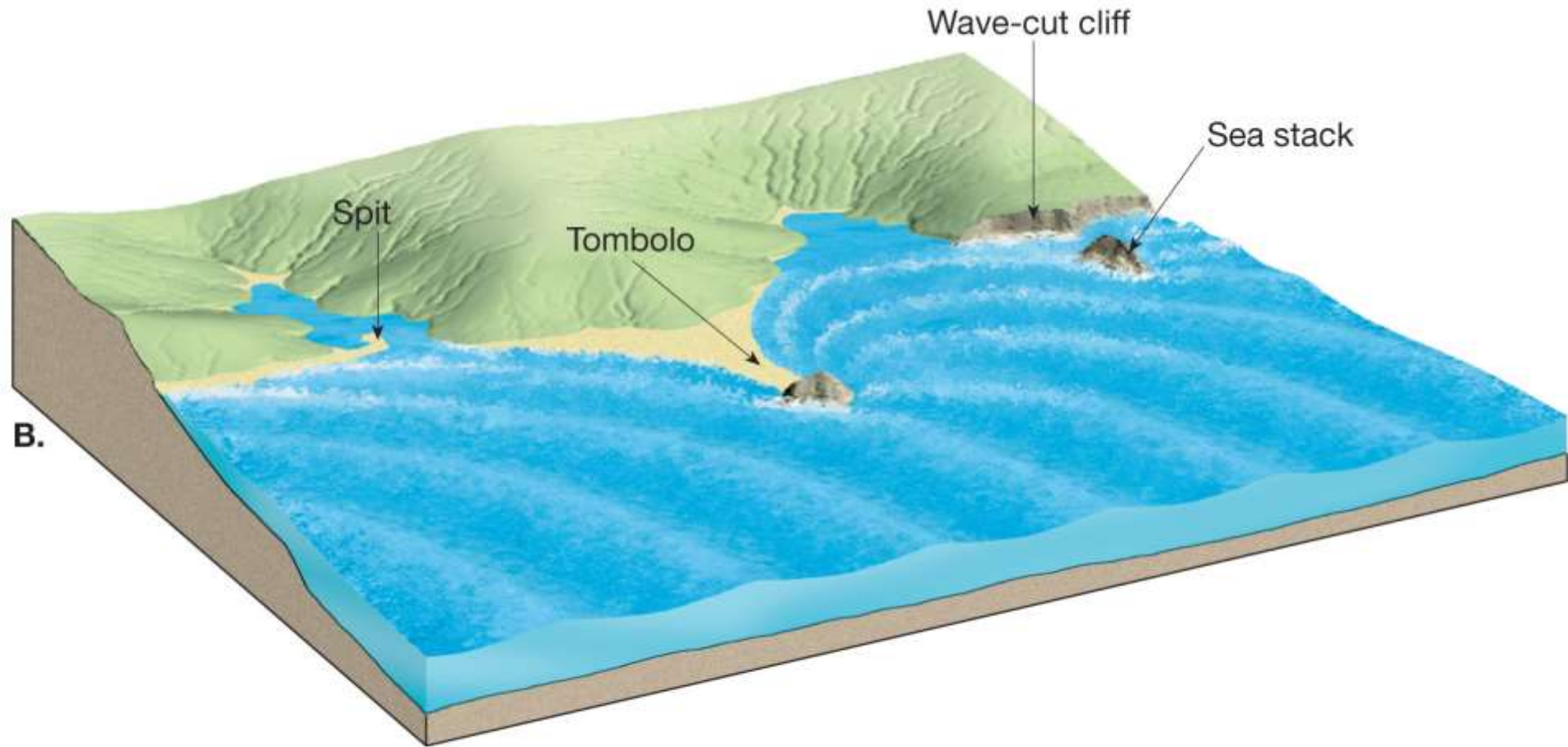
D) 3 - 2 - 1

Evolution of a coastline



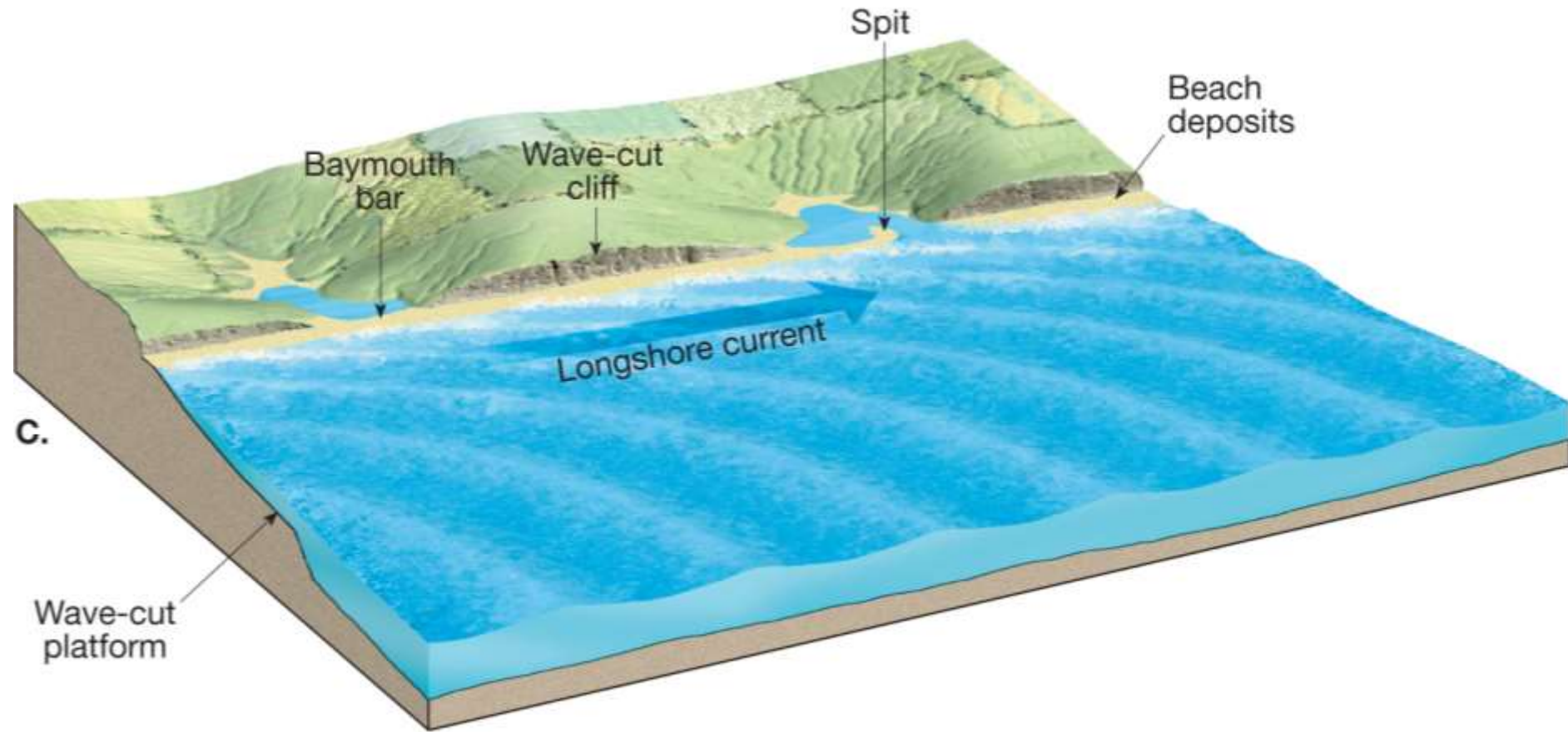
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Evolution of a coastline



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Evolution of a coastline

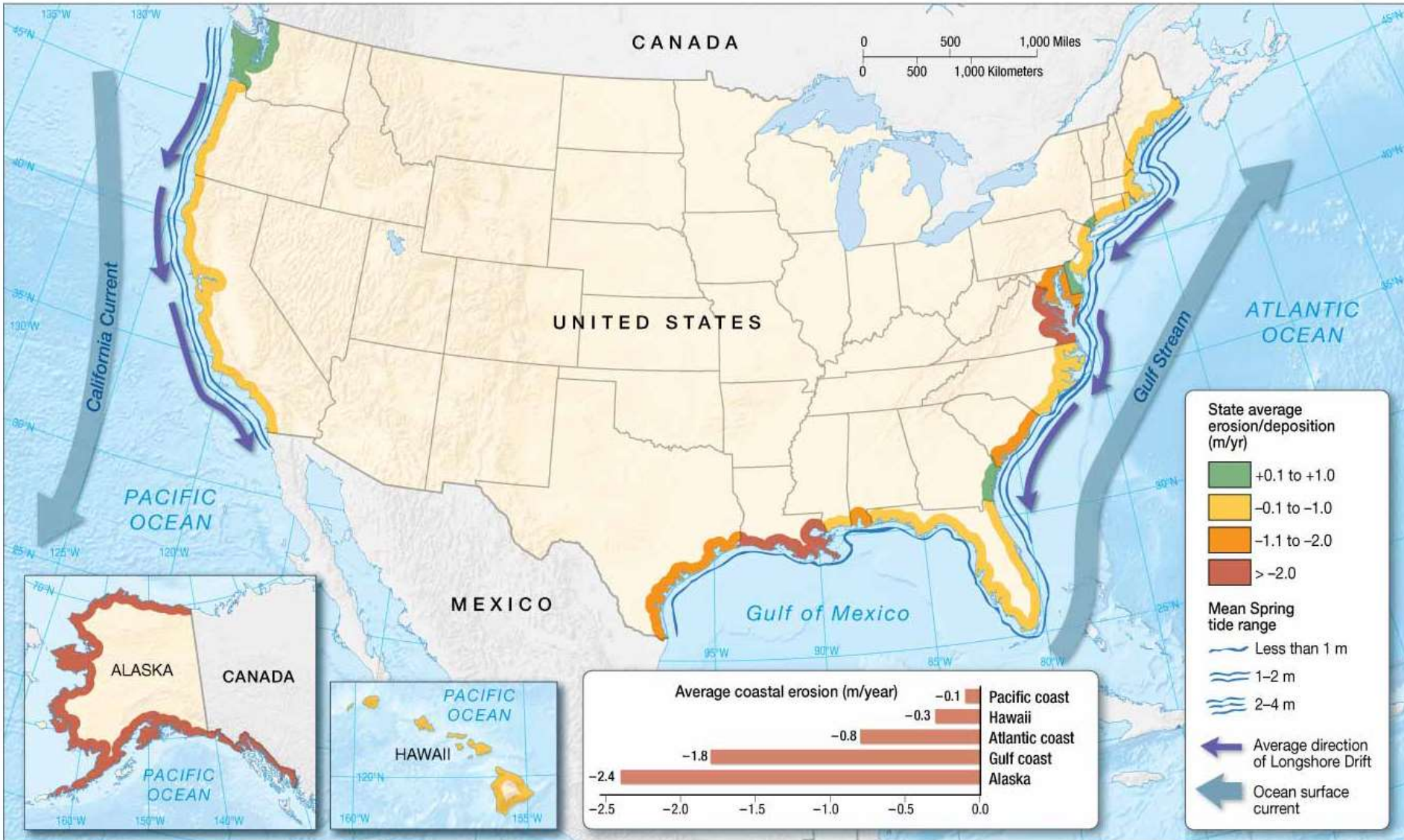


Coasts and Humans

- Coastal regions are subject to many natural hazards, especially as coastlines become increasingly developed:
 - Coastal erosion
 - Hurricanes
 - Tsunamis
 - Sea level rise

Humans therefore frequently try to control coastlines

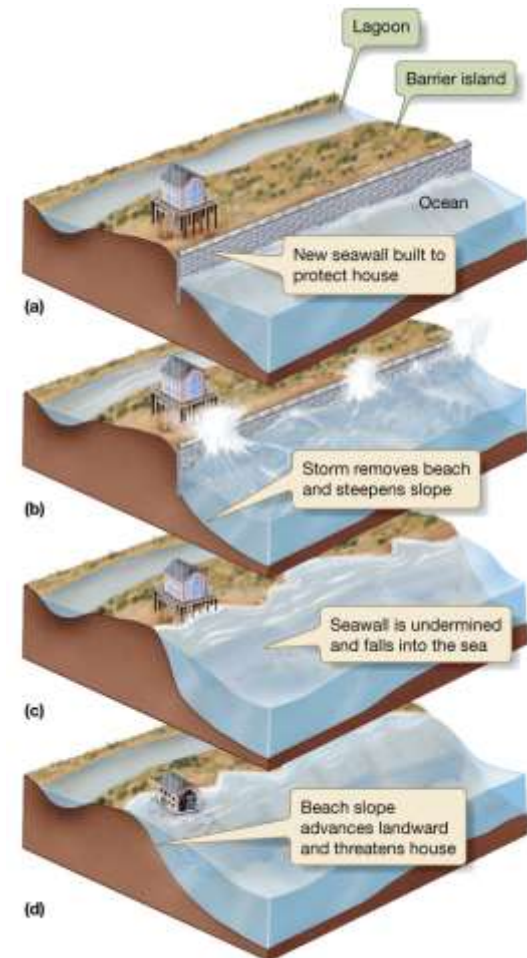
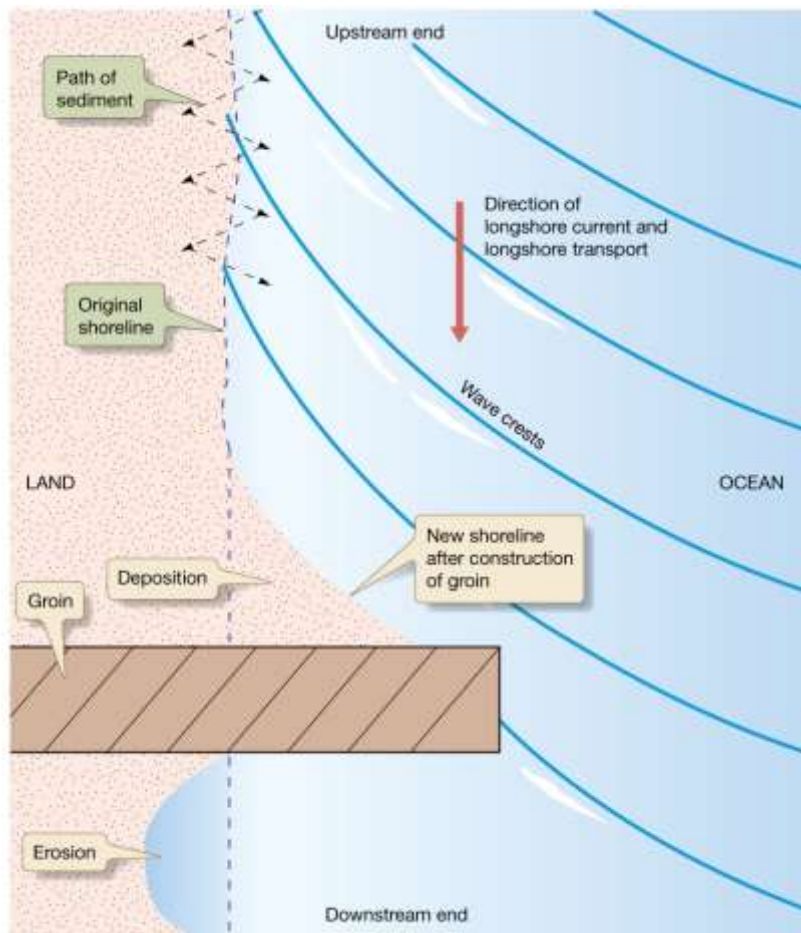
Coastal erosion



How to stabilize coastlines?

How to stabilize coastlines?

- Building structures e.g. groins, jetties, breakwaters and sea walls
- Prevents erosion in one place, but usually increases it elsewhere



How to stabilize coastlines?

Which direction is sediment travelling along this coastline?

- a) Left to right
- b) Right to left



How to stabilize coastlines?

- Alternatives to structures
 - Beach replenishment or ensuring adequate sediment supply



A.



B.

Would you buy this house?



Would you buy this house?



Would you buy this house?



How to stabilize coastlines?

- Alternatives to structures
 - Beach replenishment or ensuring adequate sediment supply
 - Restrictions on construction of new developments
 - Abandonment and relocation

