

Coastal Landscapes

Waves, Wind & Shorelines...



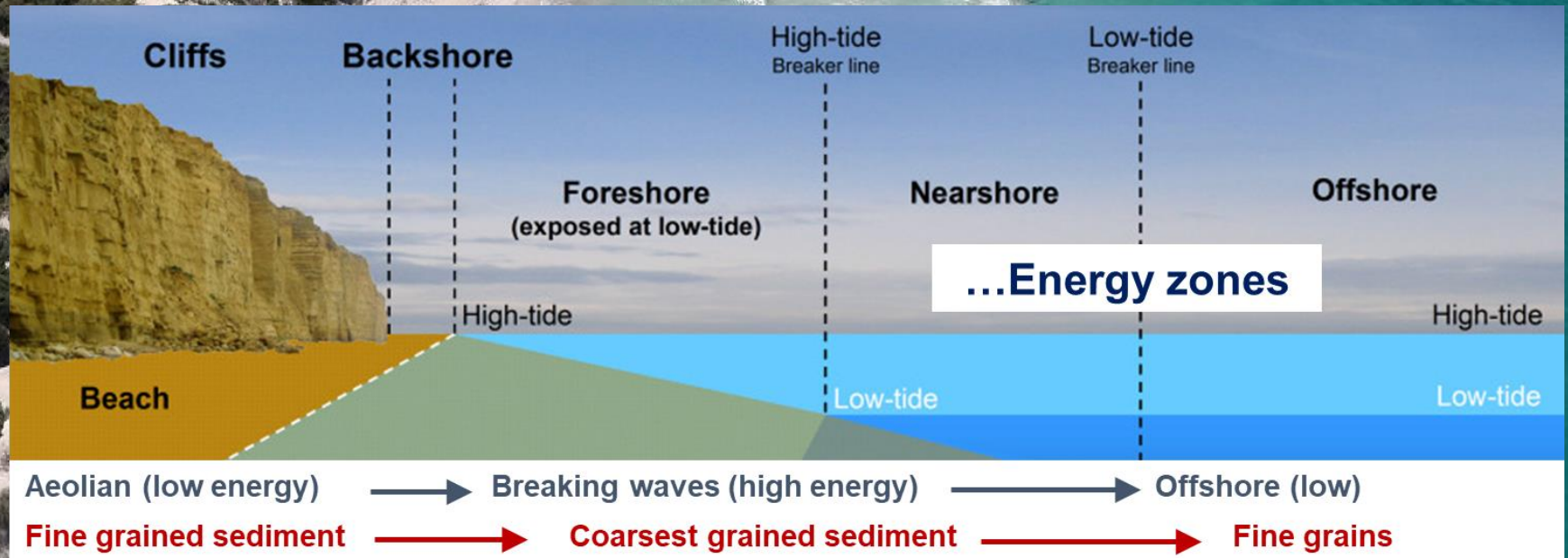
Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Dr Alissa Flatley

The Coastal Zone...

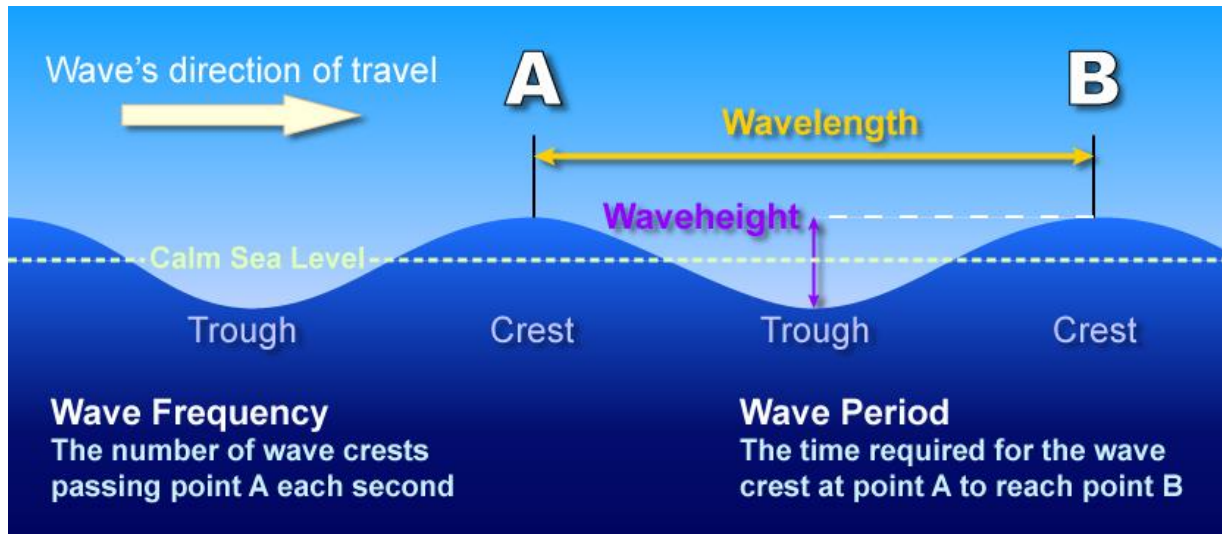
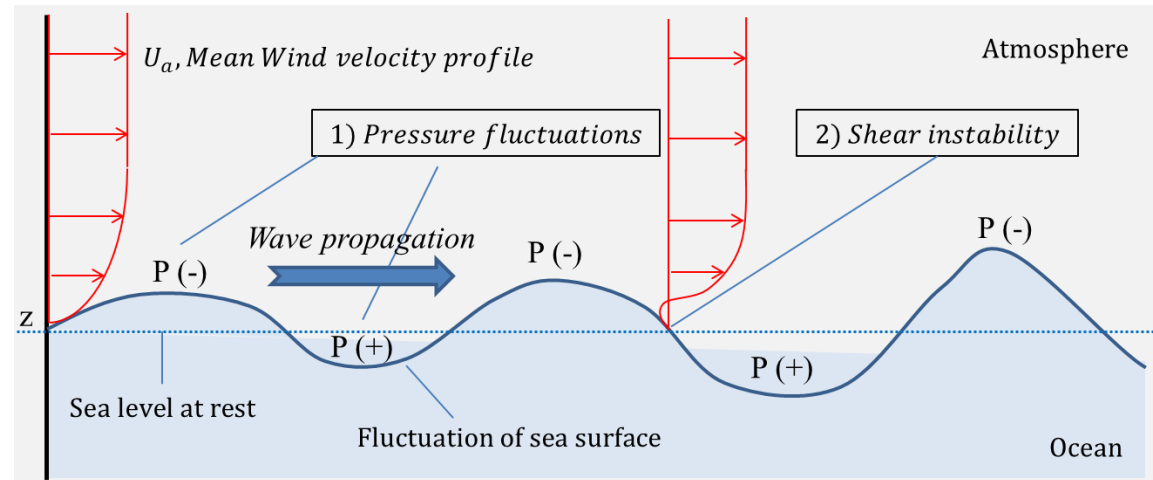
- Transition from terrestrial to marine environments, but marine processes are generally more important for their evolution

Wave base to the hinterland:
decreased marine influence landward



Ocean wind waves

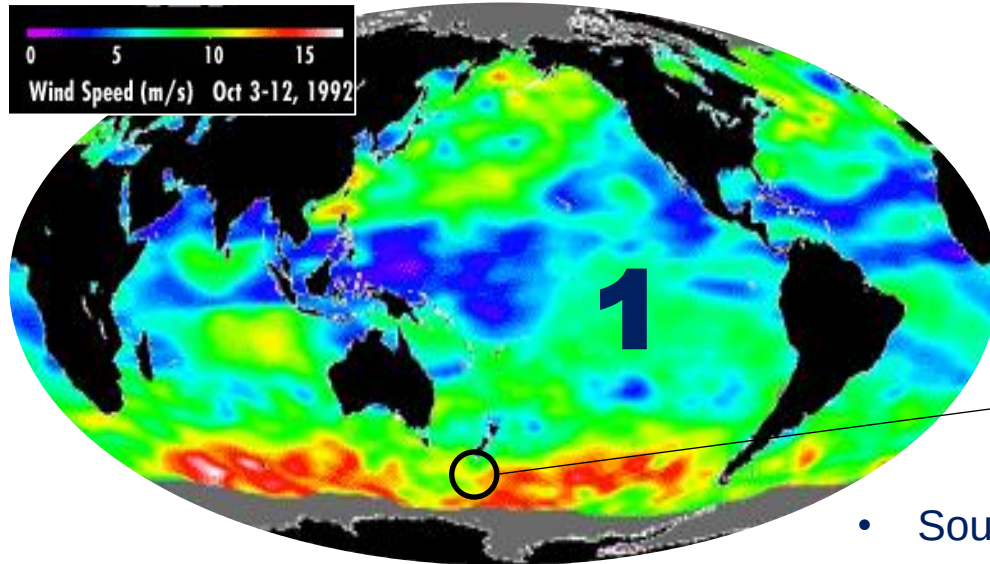
- Wind blowing on the surface of the sea - pressure fluctuations drive displacement of the water



- Significant wave height (H_s): The average height of the highest third of all waves.
- Represents waves that can erode or accrete at shorelines.

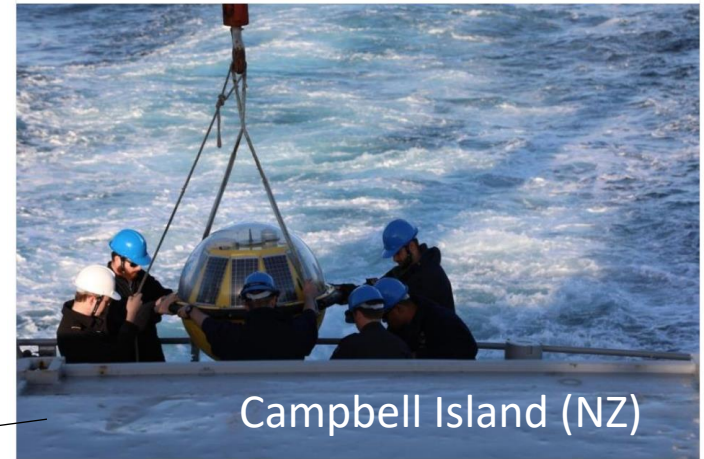
- Height depends on... ??

What drives waves?



Monster 23.8m-wave is largest ever recorded in southern hemisphere

Posted 11 May 2018, updated 12 May 2018

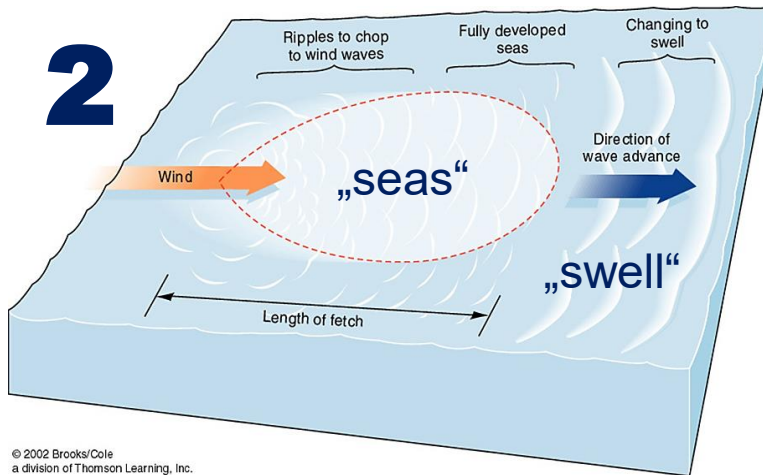


The solar-powered buoy is moored near New Zealand's Campbell Island. (MetOcean Solutions: Dean Whaanga)

- Southern Ocean has the largest waves globally

- **Fetch:** the distance the wind moves across the ocean in a constant direction to generate waves.

- Longer duration = higher waves (low-pressure systems)

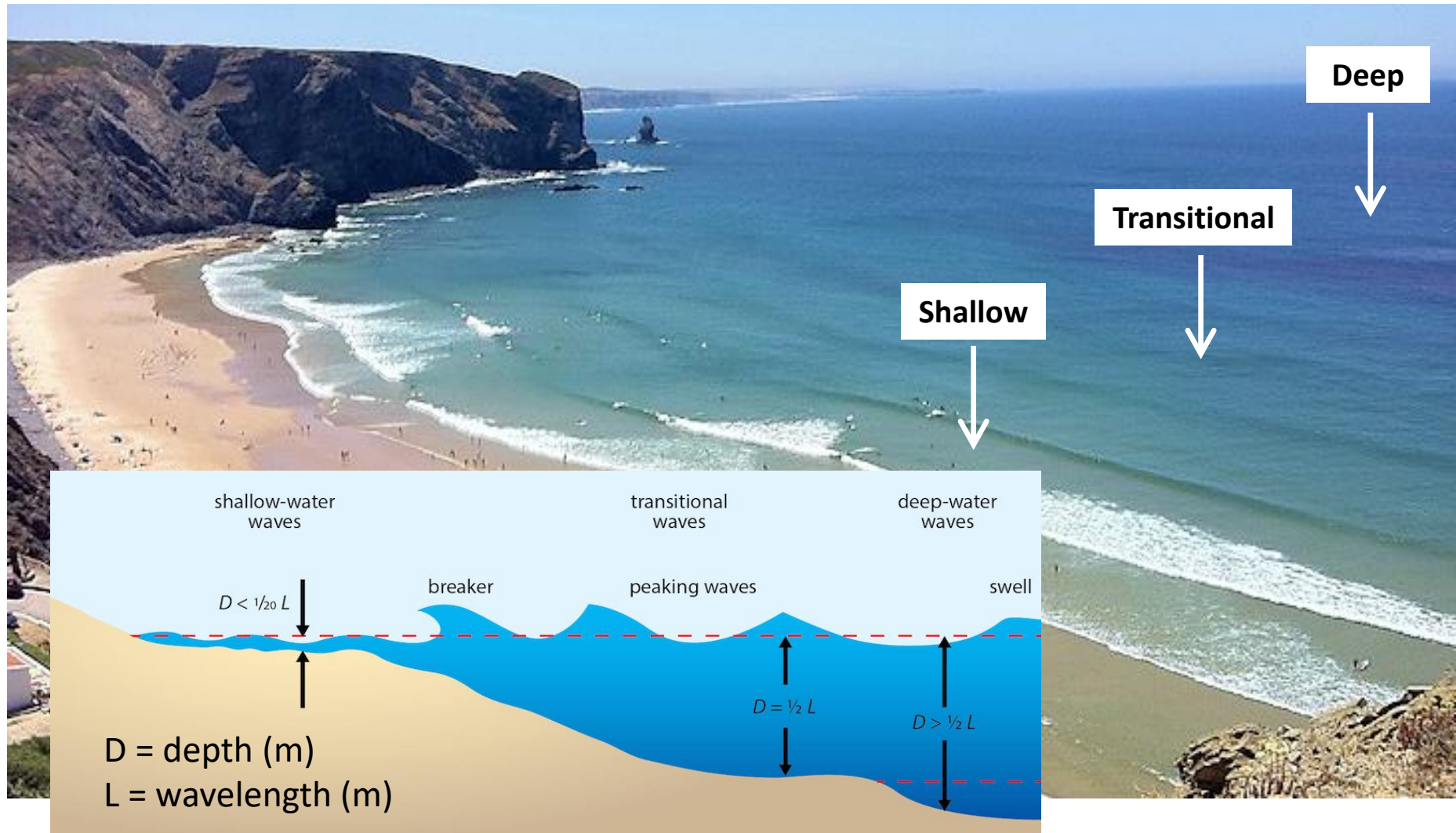


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- Wind also drags surface water down to 100 m in general direction of wind

What drives waves?

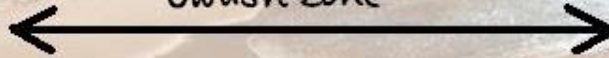
- Waves in transitional and shallow waters are affected by bottom friction - they steepen, slow down, and orbits become compressed



What drives waves?

A) Cross-shore transport
(normal to shore)

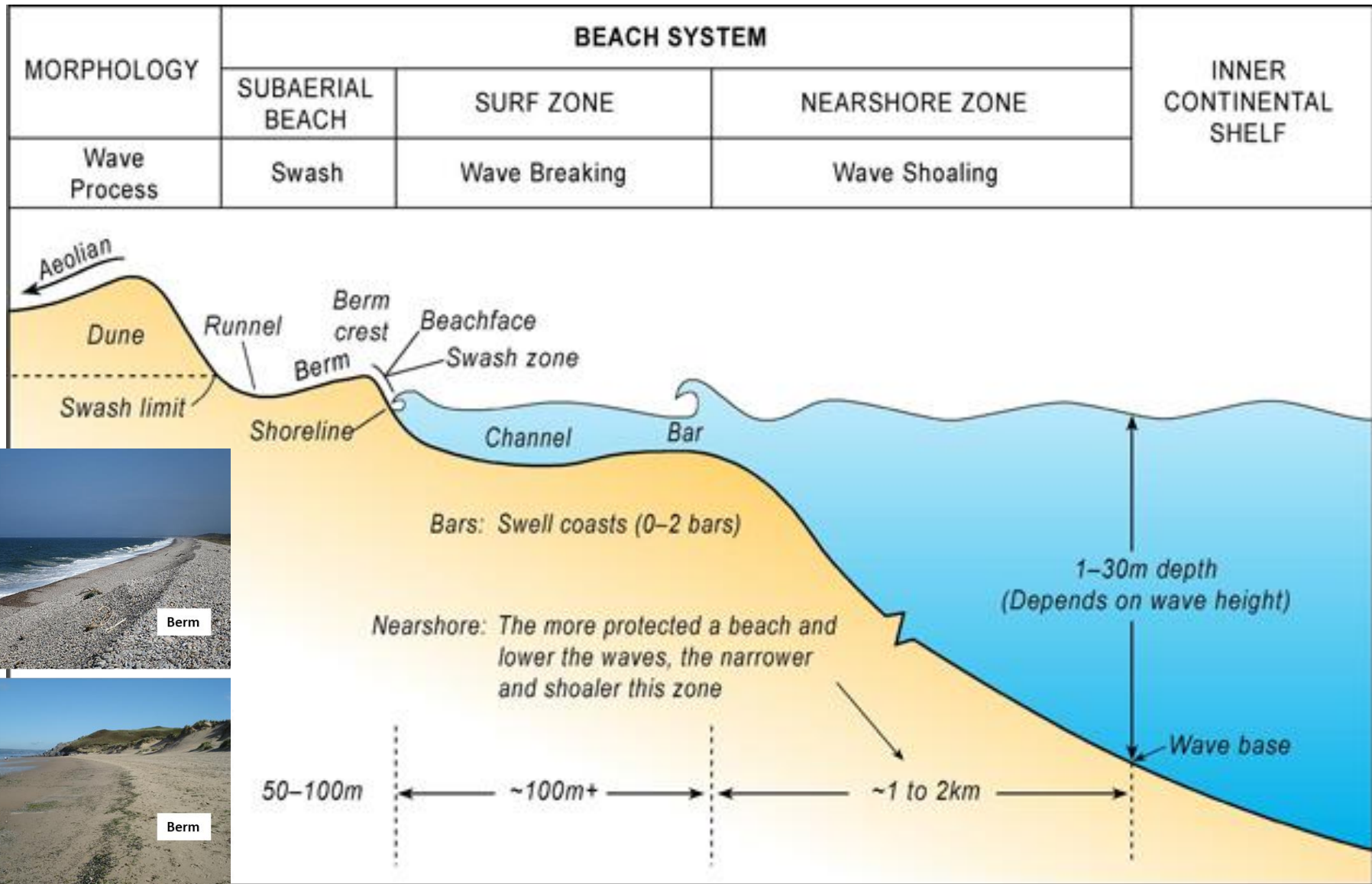
Swash zone



- Swash zone:
- Uprush - moves up beach
- Backwash - moves down beach

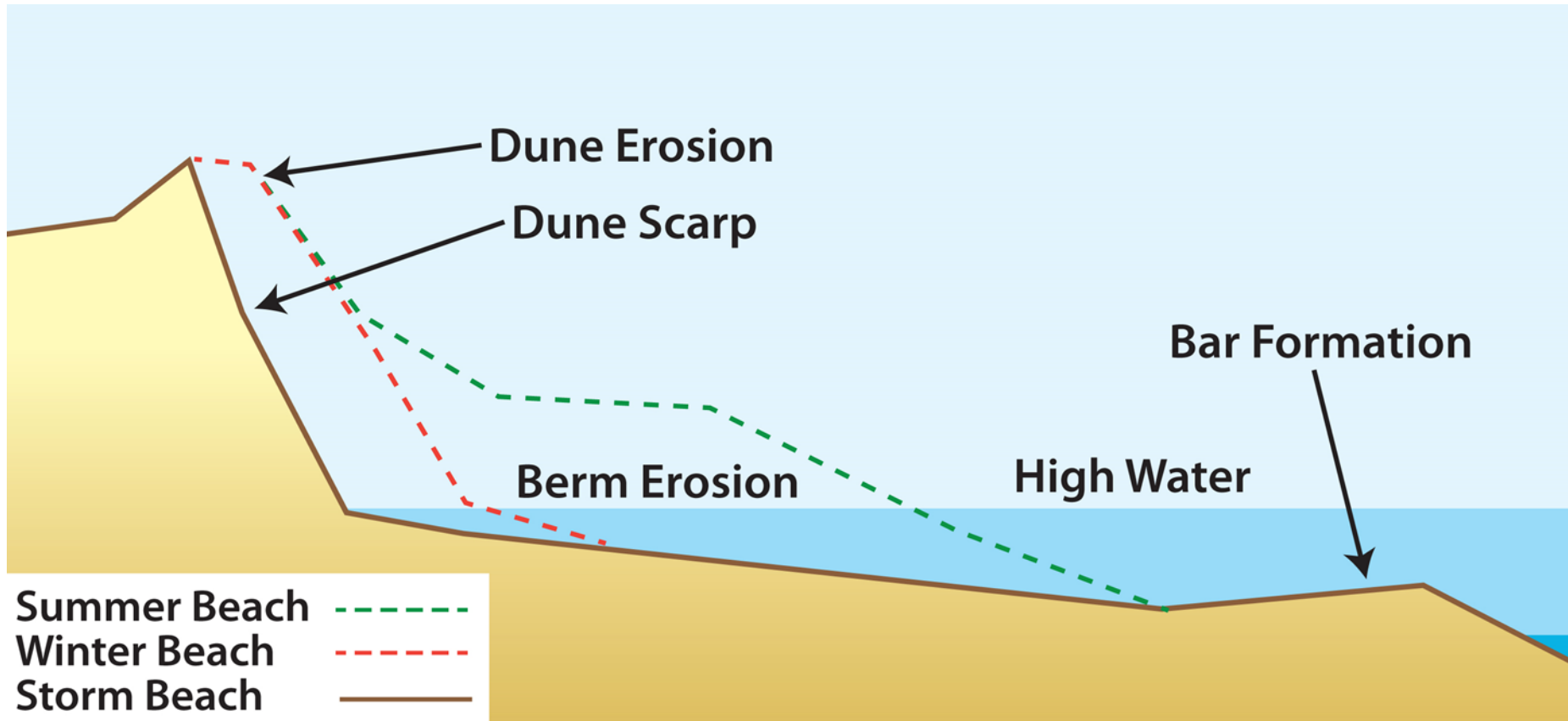
Wave dominated coasts

- Wave-dominated Beach Profile



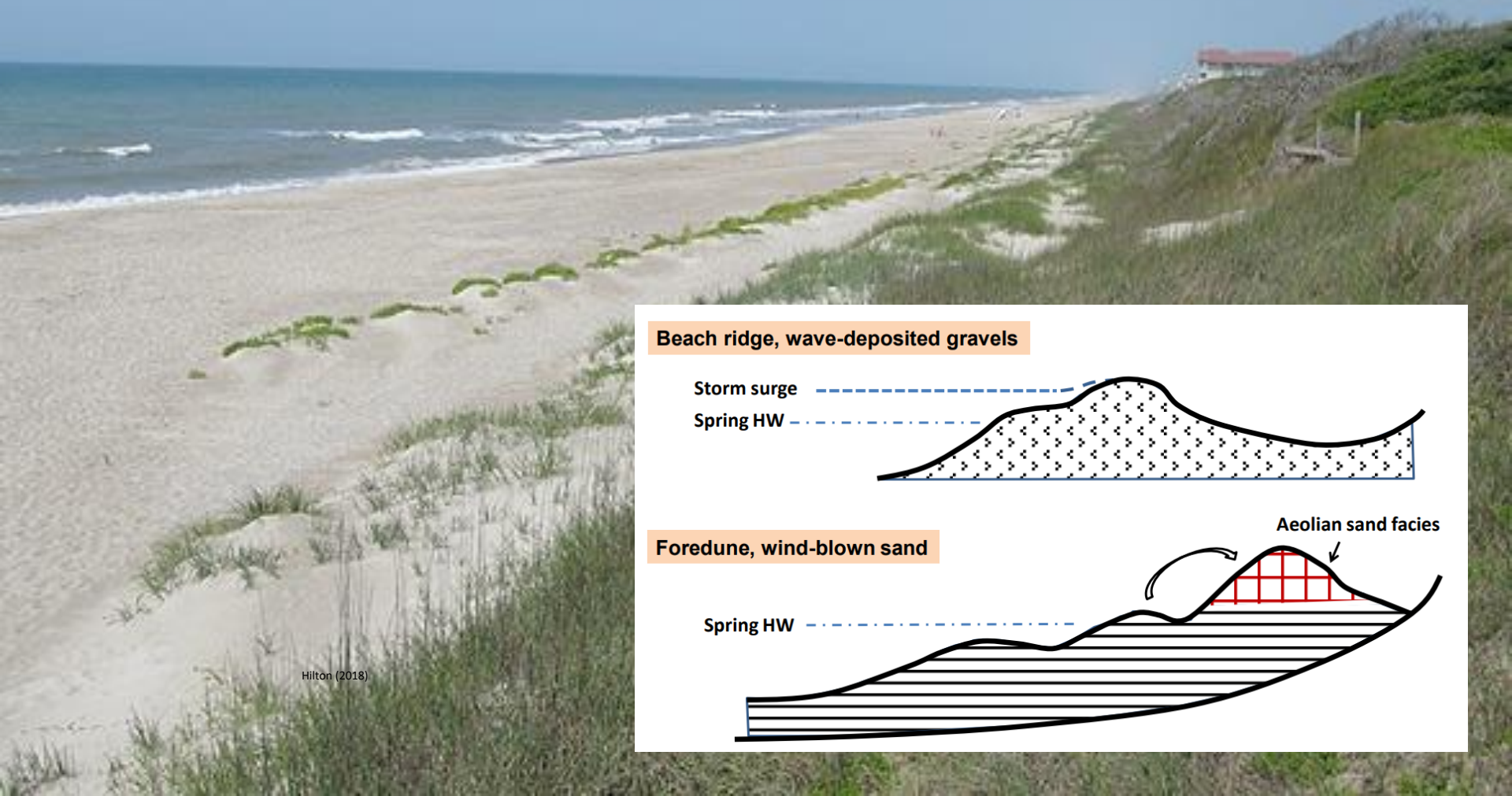
Wave dominated coasts

- Seasonal beach profile change
- Summer (depositional) vs winter (erosional) beach profiles
- Sand eroded from beach - returns in summer under low waves



Wave dominated coasts

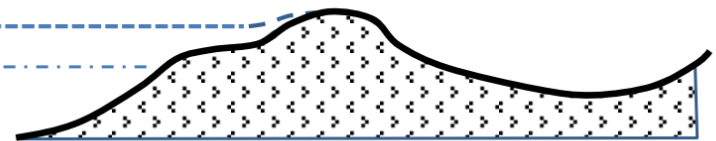
- **Beach ridges:** no aeolian sediment (marine); elevation close to storm surge level; and coarser sediment (containing gravels and shell).
- **Dunes:** aeolian over marine; no close relationship to SL; vegetation.



Beach ridge, wave-deposited gravels

Storm surge

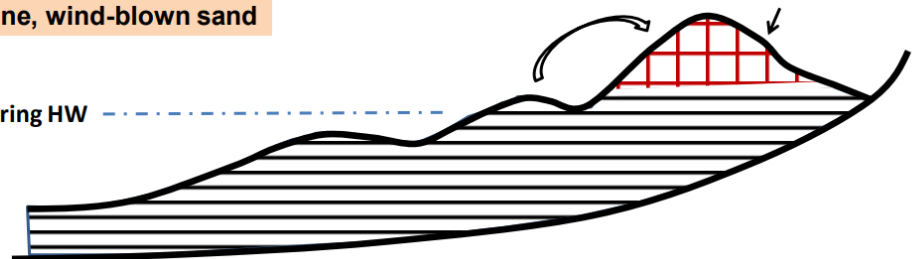
Spring HW



Foredune, wind-blown sand

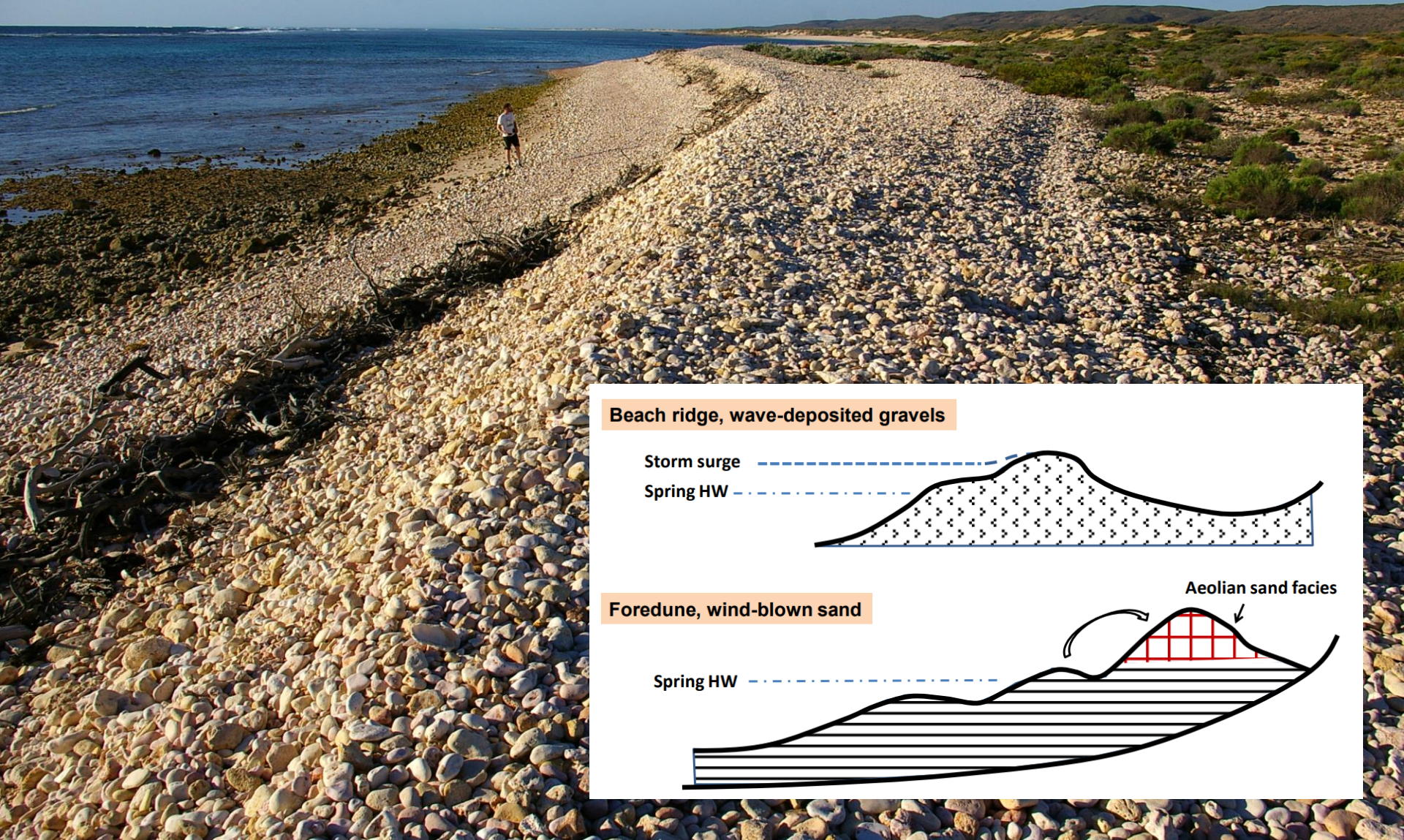
Spring HW

Aeolian sand facies



Wave dominated coasts

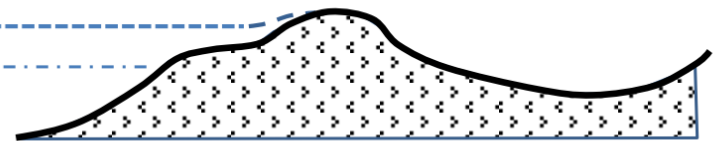
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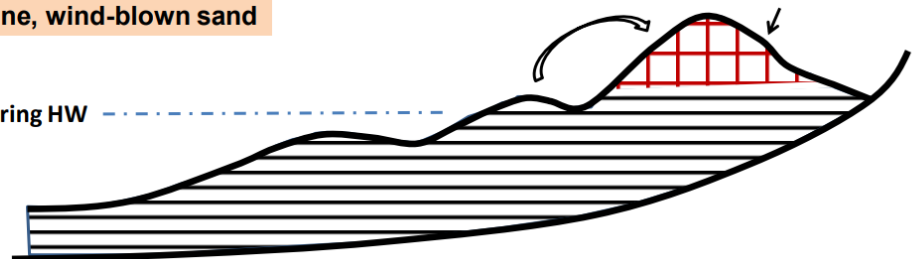
Spring HW



Foredune, wind-blown sand

Spring HW

Aeolian sand facies



Wave dominated coasts

- (1) **Sand:** surplus supply;
- (2) **Wind:** threshold of motion around 8m/s for fine - med sands
- (3) **Vegetation:** to hold it in place.



Wave dominated coasts

- Transgressive dunes and dune fields
- Dune encroachment into river and estuary



Thurra River (VIC)

Wave dominated coasts

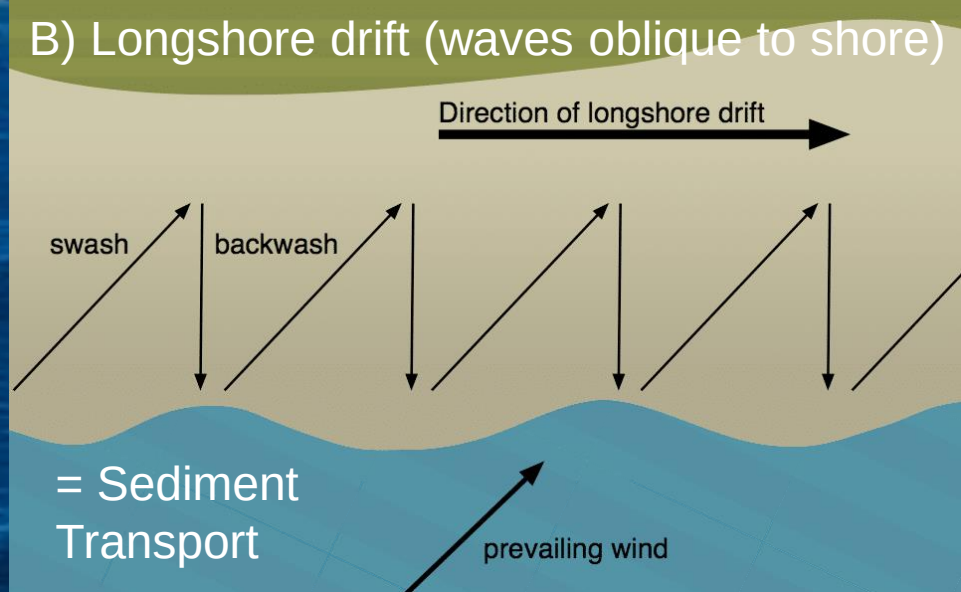
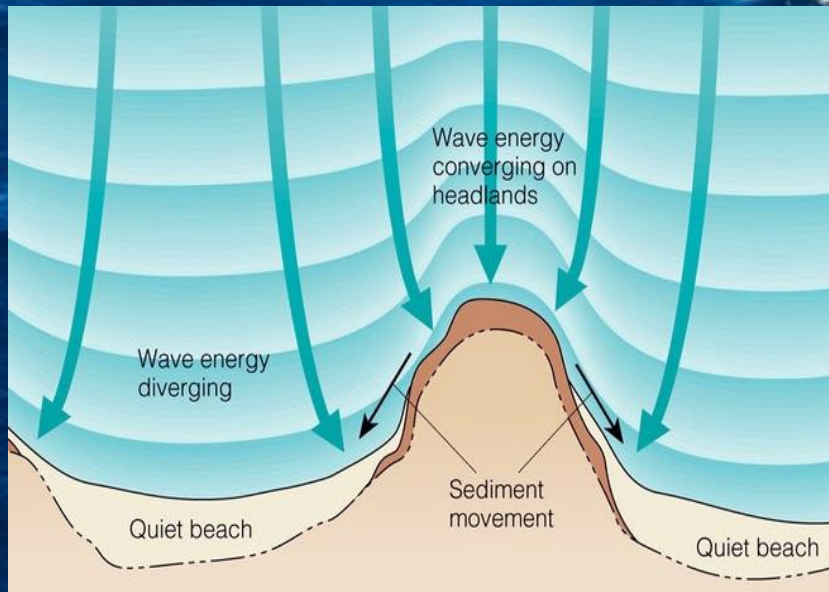
Cooloola Sand Mass (Queensland) - one of the largest, oldest and most complex dune field systems on Earth



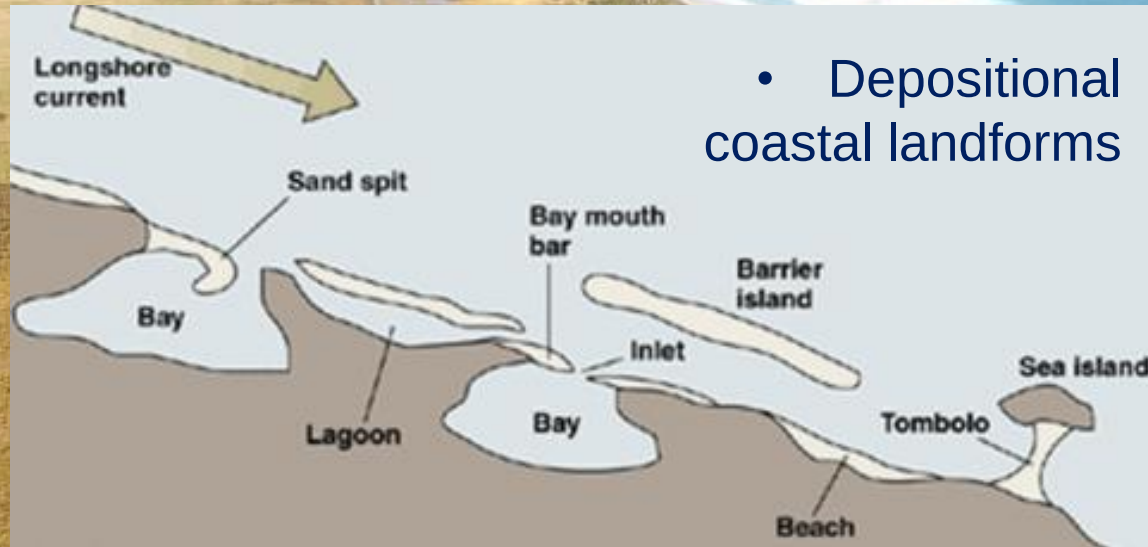
- Recent dune activity is largely driven by fires and is likely to relate to aboriginal occupation

What drives waves?

- Wave diffraction (obstacles) and refraction (depth)....
- Wave celerity decreases with decreasing depth → seaward wave sections are faster → wave crests become progressively parallel to coastline, bend towards headlands



Wave dominated coasts

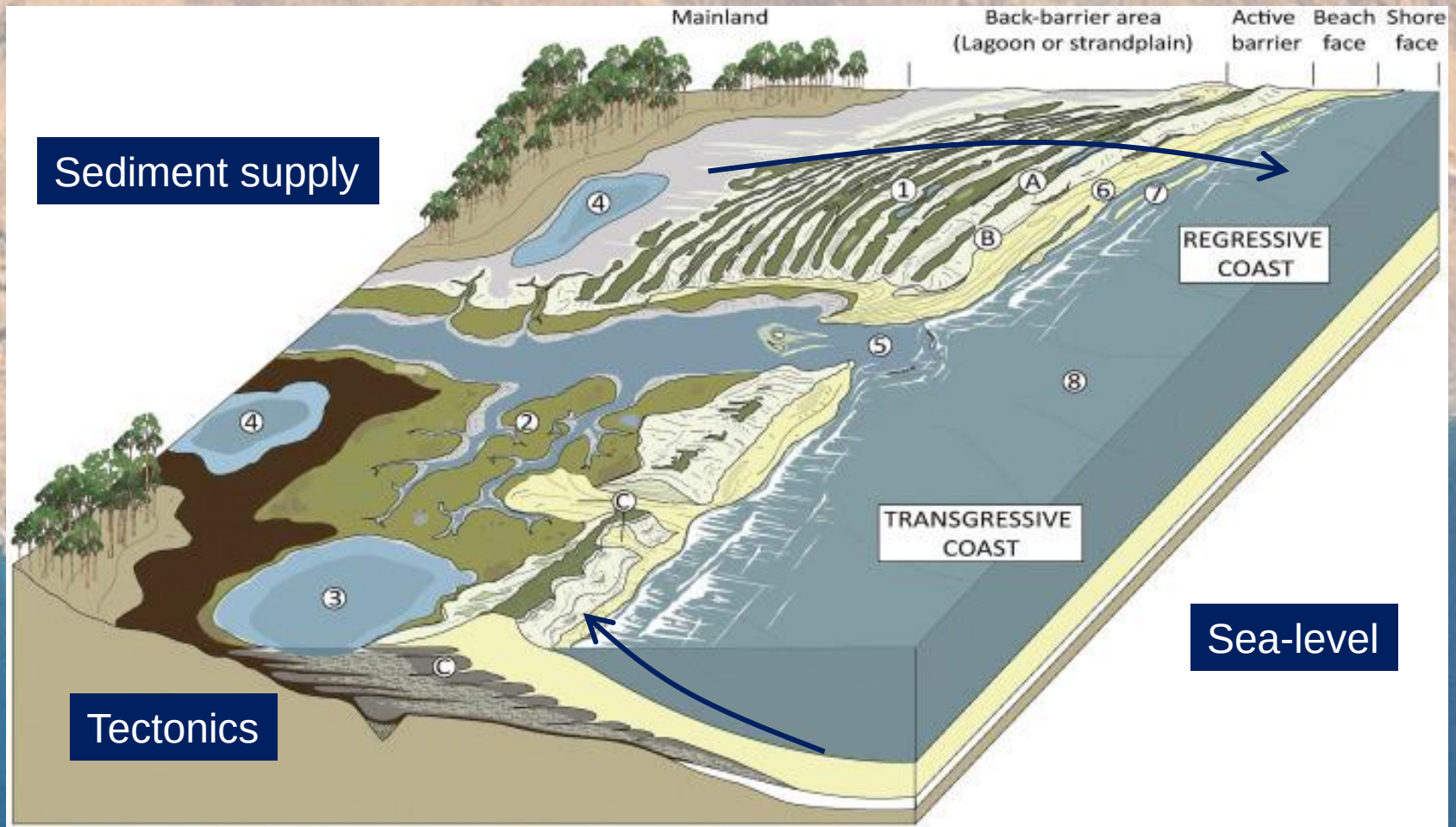


- Longshore drift at the Fitzroy River mouth



Wave dominated coasts

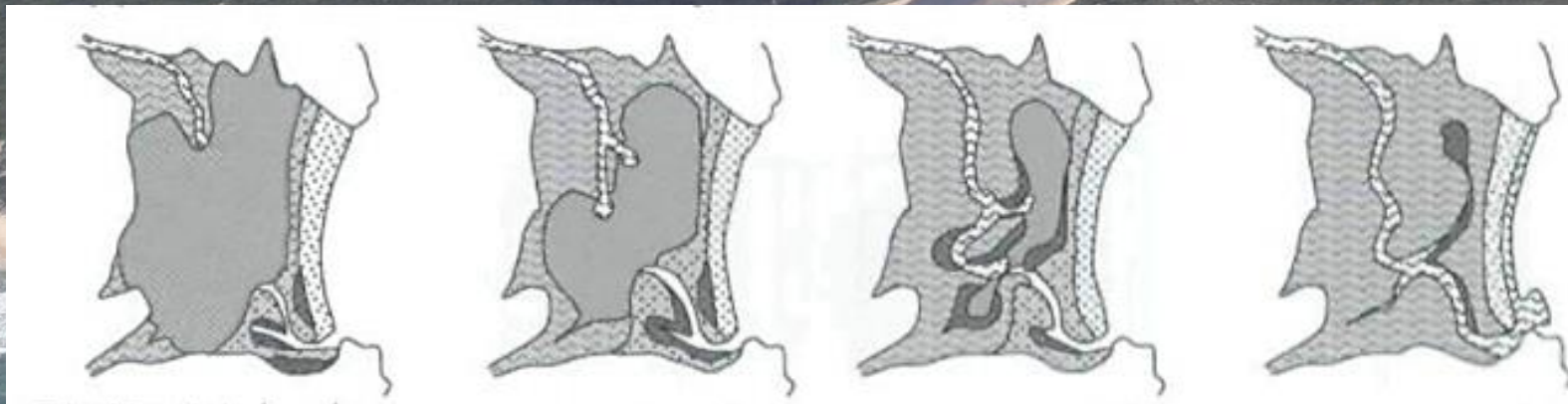
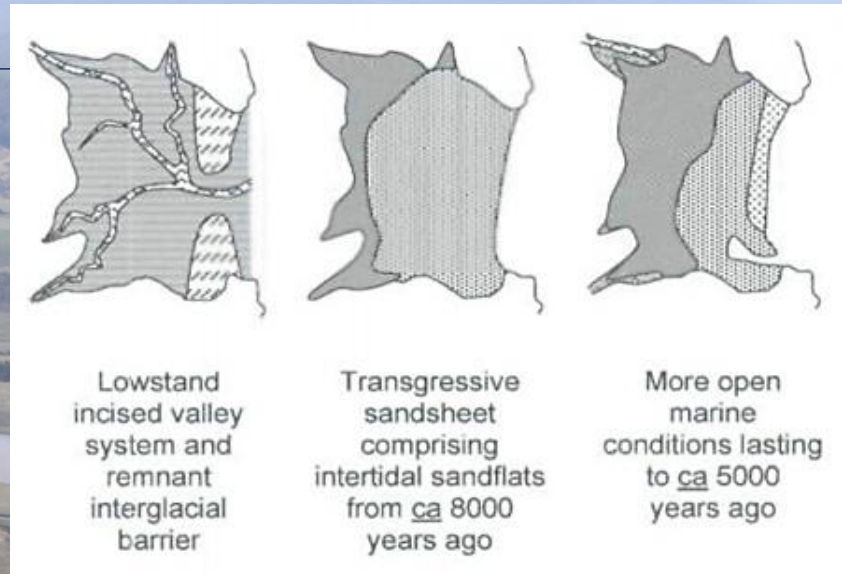
- Transgressive and regressive costal **barrier systems**



1-Beach-ridge succession (strandplain); 2-Back-barrier lagoonal saltmarsh; 3-Brackish coastal mire; 4-Freshwater coastal lake, 5-Tidal inlet & flood/ebb delta sedimentary features, 6-Beach berms, 7-Swash bars, 8-Shoreface

Wave dominated coasts

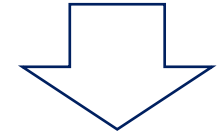
- Wave-dominated estuaries....
- ... receive sediment from fluvial and marine sources that is influenced by wave, tide, and fluvial processes



Wave dominated coasts



- High wave energy, variable river Q



- Closure occurs during low river flow
- waves deposit sand berm
- Opening occurs during high river flow
- breaks through berm

Wave dominated coasts

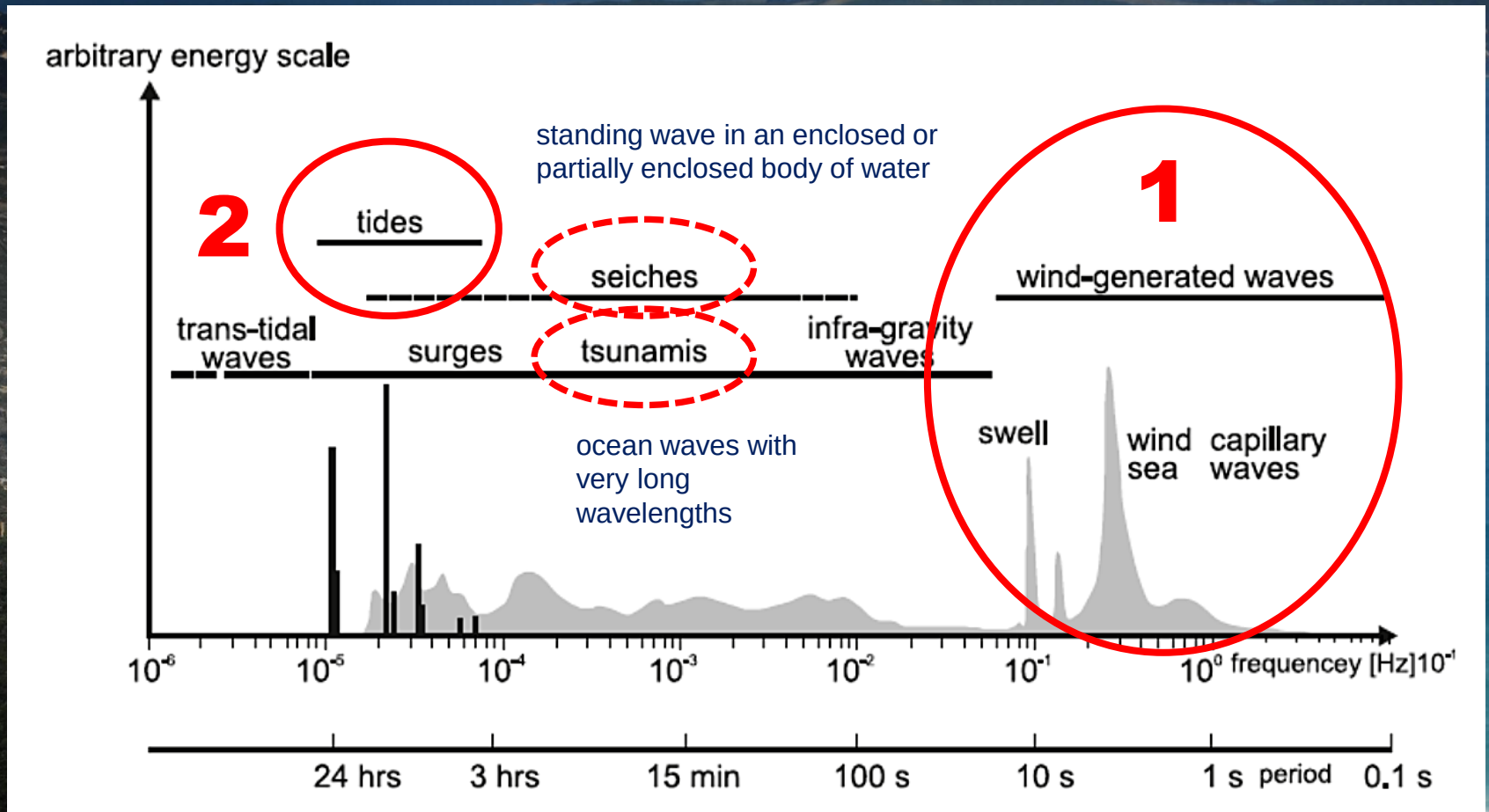


9 am high tide: overwash fills basin



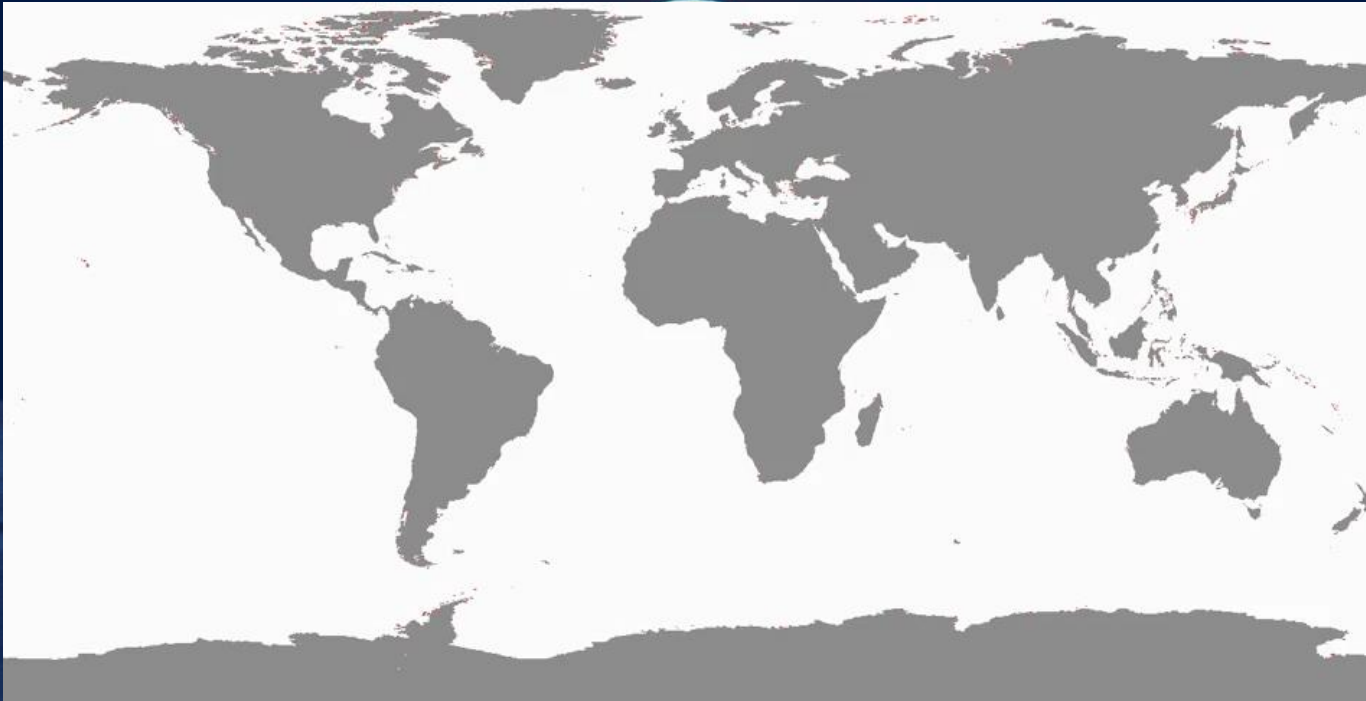
3 pm: opening on low tide

Waves and Tides...



Tides

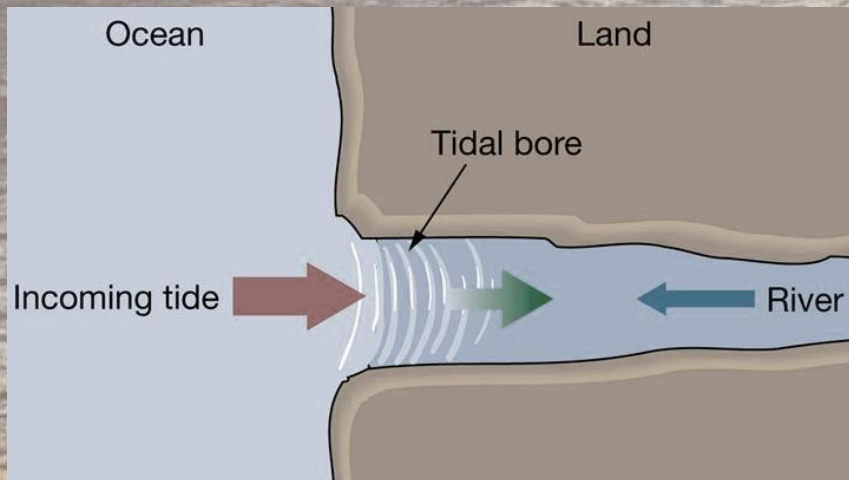
- What Causes Tides? https://www.youtube.com/watch?v=tcGEjzt_4is



simulation

- Amplification of tides is due to resonance with continental shelf, coastline configuration, narrow straits

Tide dominated coasts

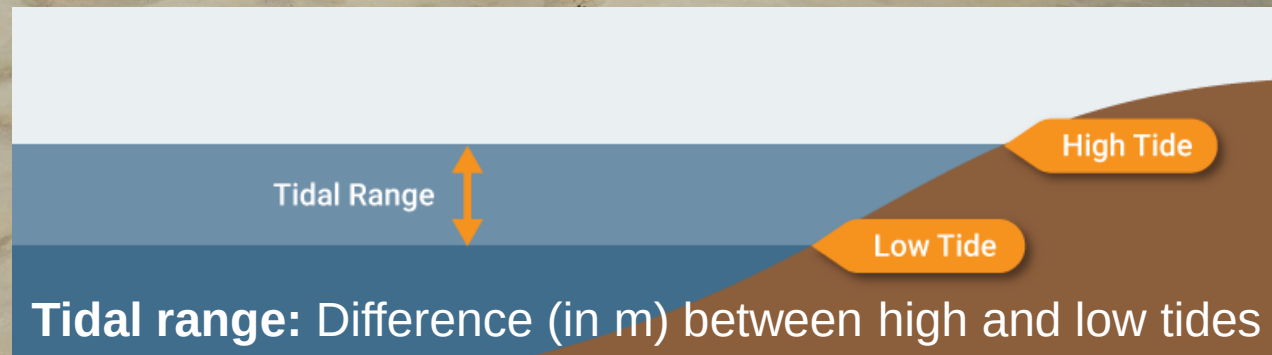


- Tidal bore: edge of the incoming tide forms a wave that travels up a river or narrow bay, reversing the direction of the river

<https://www.youtube.com/watch?v=XvO5Ckd7mIU>

Tide dominated coasts

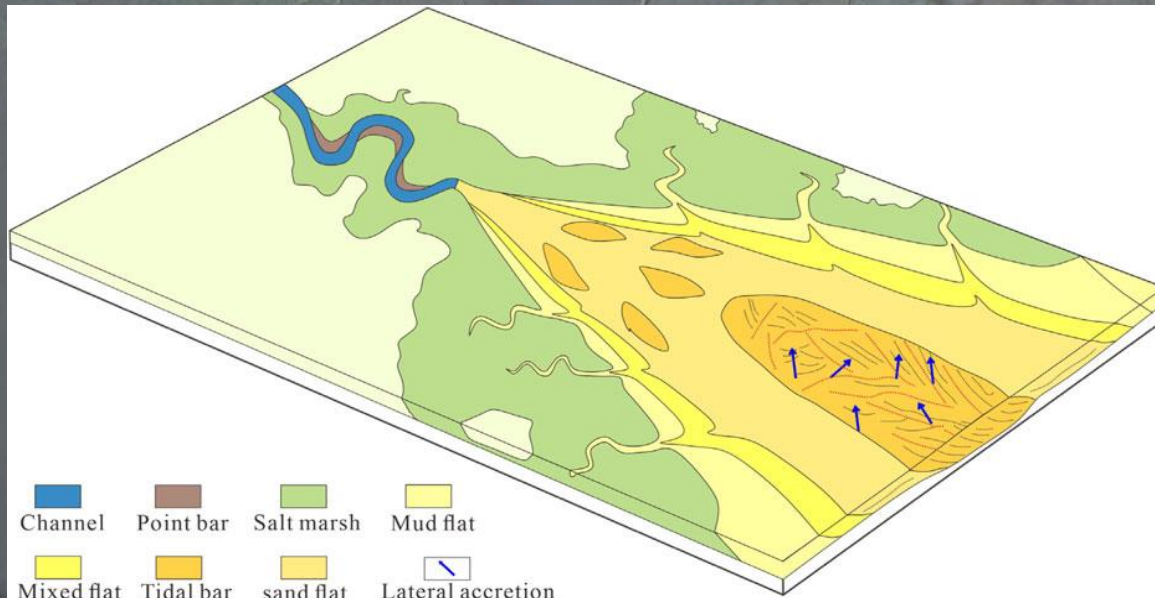
- Tide dominated coasts are those where strong tidal currents act to redistribute sediment along the vector of falling and rise tidal currents
- Tidal flat...
 - Fine sediments (muds, silts, and fine sands)
 - Tidal channels and ridge/runnels.



Tide dominated coasts



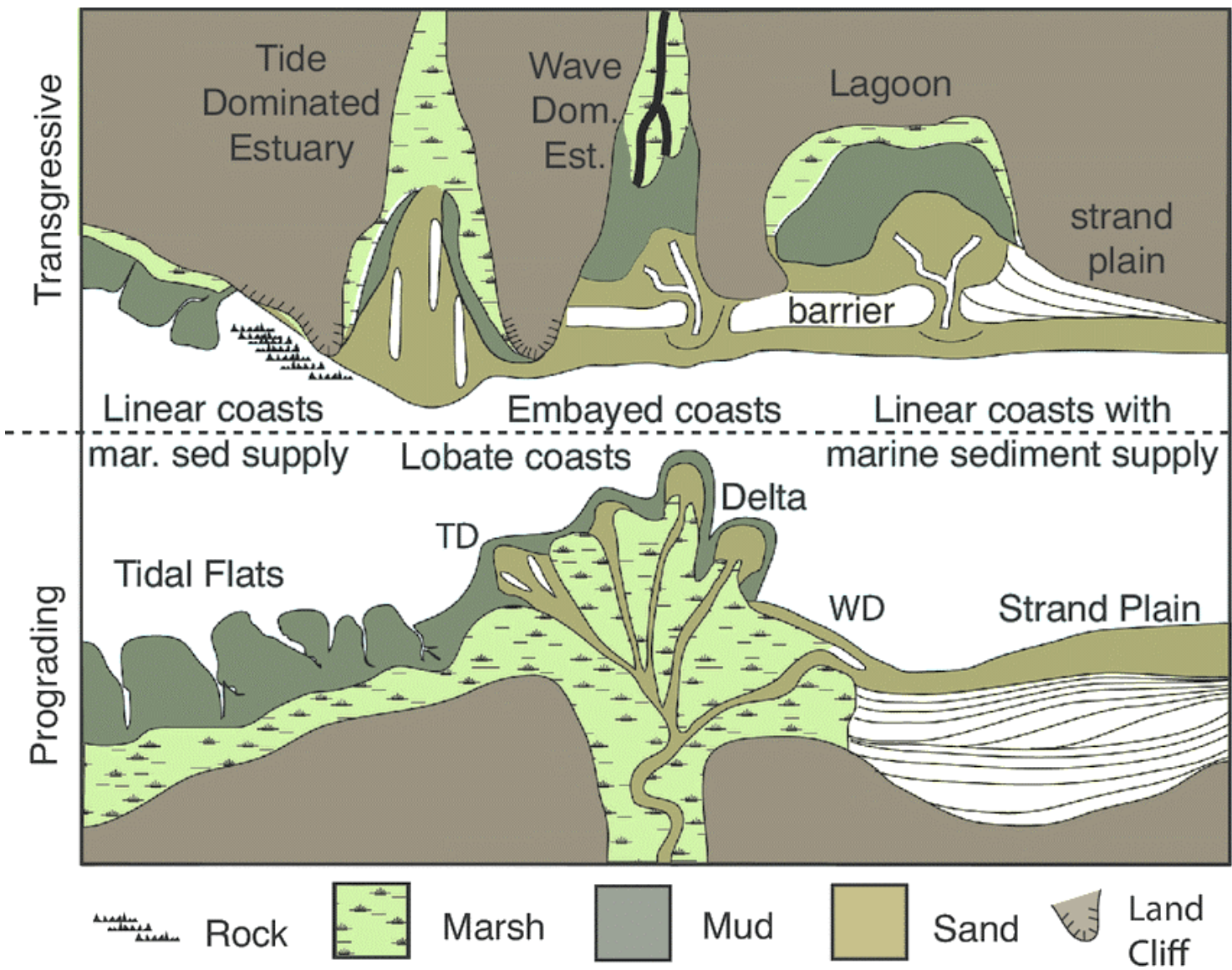
- Tide-dominated estuary represents a coastal embayment that has been partially infilled by sediment derived from both the catchment and marine sources



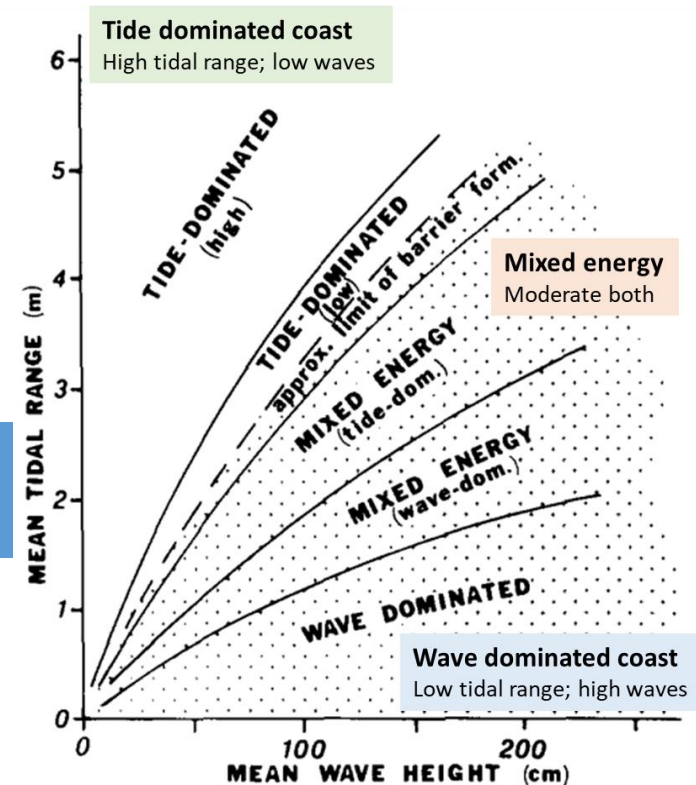
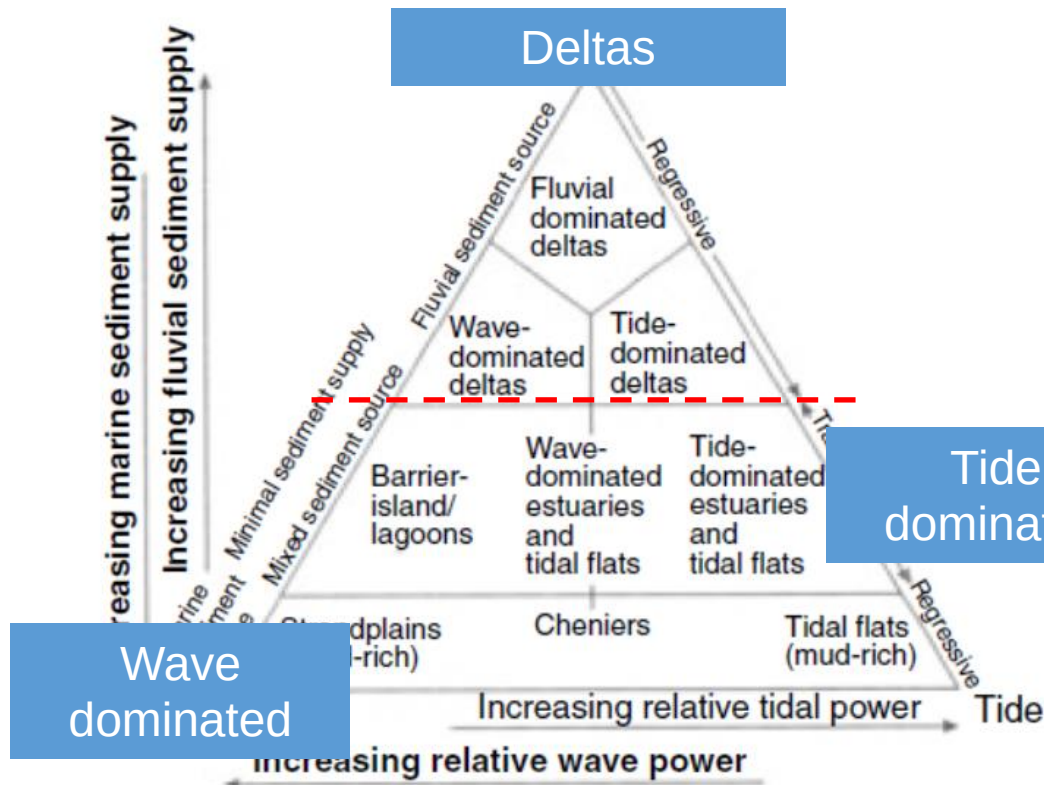
- Tidal currents, rather than waves, are the dominant force shaping the gross geomorphology

Coasts – Summary 1

Tides ← Energy → Waves



Classifying coasts...



Rocky coasts ??

- International classifications found in text books typically restricted to sedimentary coasts...

Rocky Coasts

- Depends on lithology (i.e. rock strength) vs weathering rate
- Cliffs and shore platforms - all are erosional features
- Can preserve past sea levels (e.g. notches) - consider uplift rates



Weathering

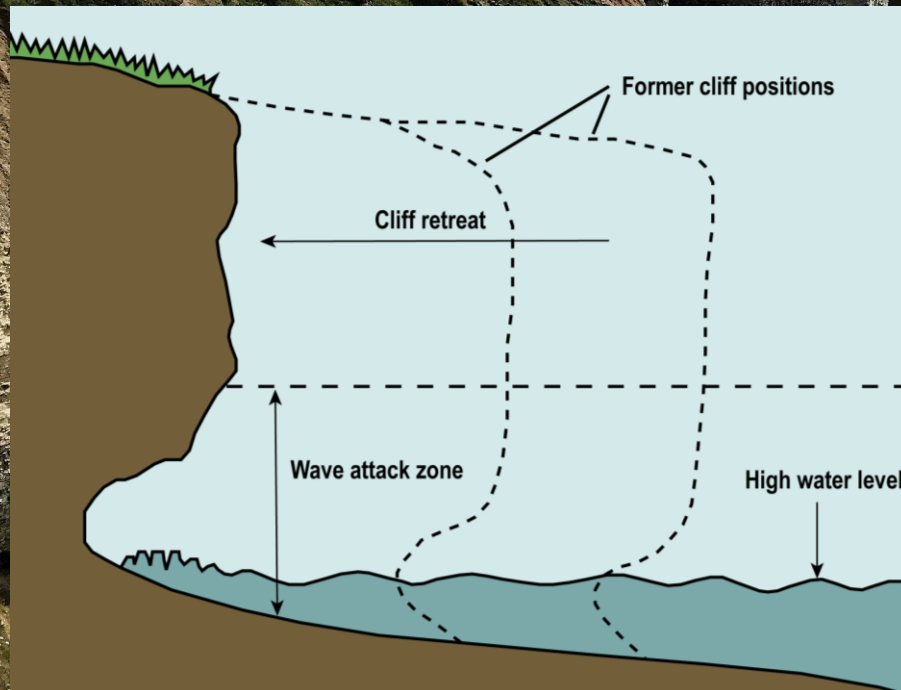
Wave cut platform
and cliff

Abrasion

Abrasion

Weathering

Rocky Coasts

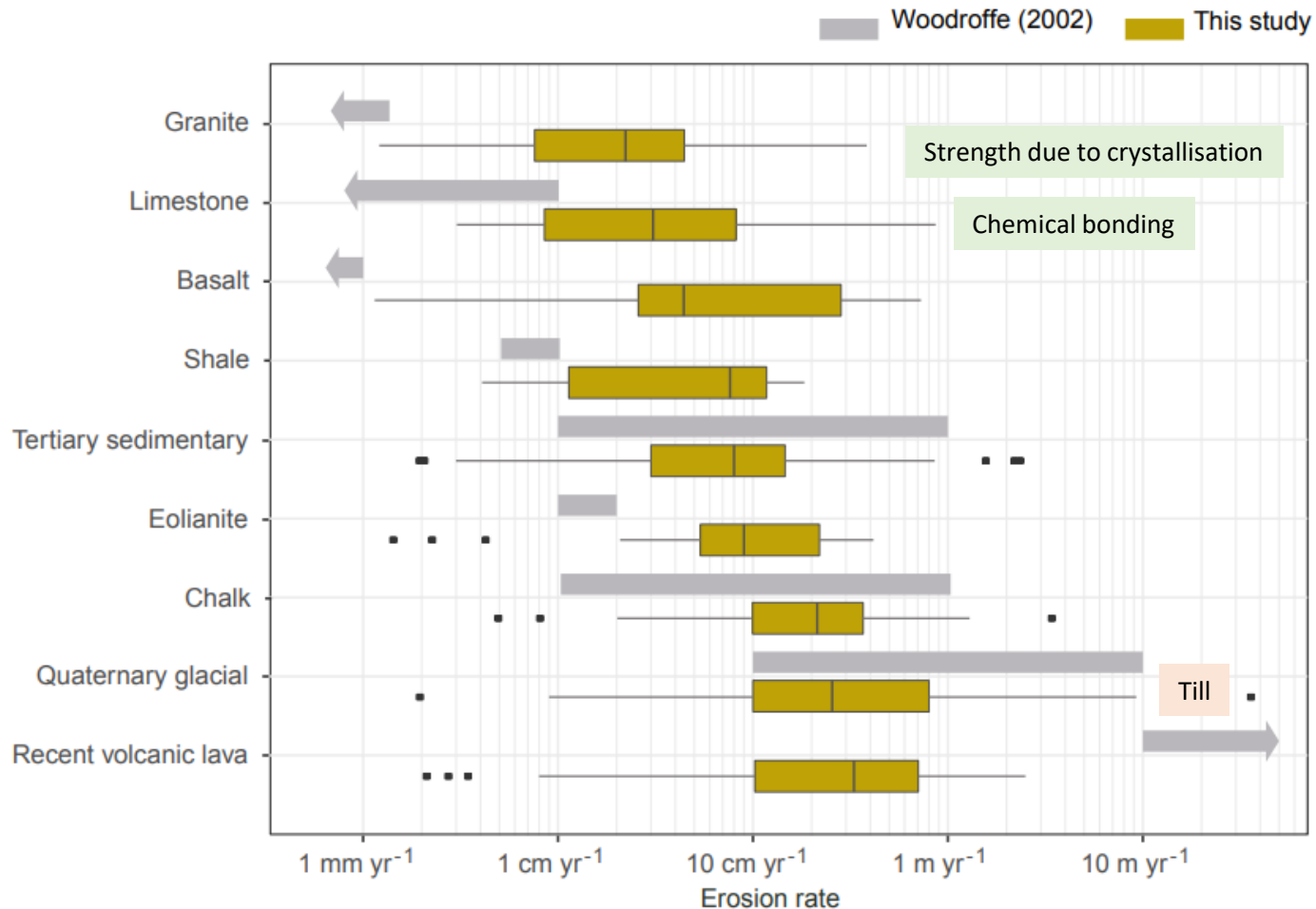


Shore platform

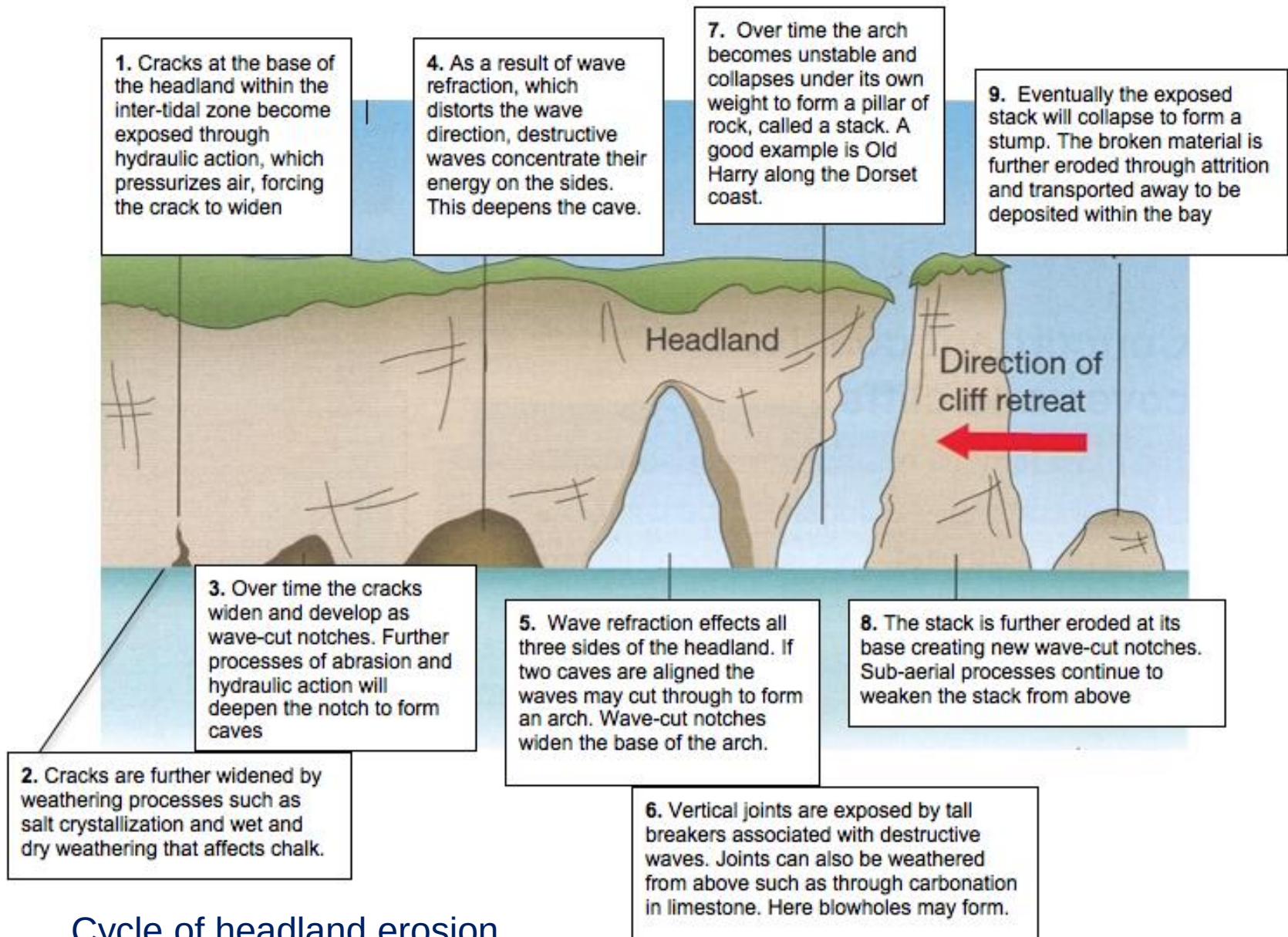
- Erosion concentrated in fractures, bedding planes, and weak rock
- Waves at the toe undermine the cliff - cliff retreats landward.

Rocky Coasts

- Rock strength vs weathering and erosion processes



Rocky Coasts



Cycle of headland erosion

Rocky Coasts

Sea Stacks - Last
man Standing



Coasts – Summary 2

- Modern coasts are shaped by the relative energy balance between tides and waves

- Sea level and geology create boundary conditions
- Estuaries are where rivers meet the sea
- Rocky coasts are erosional

