Topic: Coastal landform and landscape development
3.1.3.3 Coastal systems and landscapes

What you need to know
Origin and development of coastal landforms associated with erosion
Origin and development of coastal landforms associated with deposition
The development and evolution of coastal landscapes

Introduction:

A coastal landform is a characteristic feature that has developed as a result of high energy conditions operating on coastal material (erosion feature) or low energy conditions following a period of high energy (deposition feature). Combinations of feature (both erosional and depositional) accumulate along a stretch of coastline and over time to create distinct coastal landscapes that differ from neighbouring stretches.

Coastal processes of weathering and erosion

A process is the mechanism by which change is imposed on a geographical component. The main processes leading to the degradation and break-down of existing features can be classified as those that take place 'in situ' leading to rock disintegration (weathering) and those that break up and remove the resultant debris (erosion)

Subaerial weathering processes:

- **Thermal expansion/extraction**: alternating warming (sunshine) and cooling (cold sea water) of rock can lead to expansion/contraction of outer layers of coastal rocks.
- **Wetting/drying**: mineral in rocks may absorb and release moisture as tides rise and fall leading to internal loss of coherence.
- **Freeze-thaw action**: sub-zero air temperatures can cause rain water in surface fissures to freeze and expand. Under extreme conditions, sea water may freeze.
- **Chemical solution**: minerals in coastal rocks are dissolved by chemicals in sea water and by acid rainfall.
- **Biological weathering**: plant roots enlarging rock fissures, nesting sea birds, marine organisms that drill into rock such as the paddock.

Erosional marine processes:

- **Abrasion/corrasion**: under storm conditions rock fragments may be launched from the sea bed by waves at exposed cliff faces, chipping off fragments of rock.

- **Hydraulic action:** heavy vibration of cliff faces can occur as storm waves break against them. The resulting rock fracturing can produce quarrying at the base of cliffs leading to undercutting.

- **Cavitation**: Compression of air in sea-facing joints as waves crash against cliffs can cause sea water to be severely compressed. As the wave recedes the pressure reduces and air comes out of solution in violent 'fizzing', enlarging fissures within joints.

- **Attrition:** large angular fragments of rock produced by weathering and erosion are rounded, smoothed and reduced in size by wave friction against other fragments. The smaller pebbles are ammunition for abrasion and may eventually form depositional material.

Mass movement

Large-scale loss of rock coherence at the coast may result in movement of substantial material quantities under gravity onto a shoreline:

- Run-off: when heavy rain washes material from the surface of a cliff over the edge and down onto the shore.

- Landslide: an unsupported mass of rock or cliff material collapses onto the beach.

- Slumping: usually unconsolidated cliff material (boulder clay) detaches at the cliff face along a slip plane and slide down onto the shore, usually after heavy rain has lubricated the weakness and made the material heavier.

- Soil creep: the mass effect of individual particles taking a downwards trajectory over time from a cliff face as a result of wave-impact, rain splash, weathering and gravity.

Features of coastal erosion

A geographical coastal feature is a physical manifestation of processes operating upon a shoreline component: currents operating on sand, tides upon shores, waves colliding with cliffs…etc. From a systems point of view, most features are in transition – they keep being subject to change as long as the processes that created them continues to operate. If the processes change (as a result of isostatic uplift, for example), the feature may become a relict feature illustrating previous, but no longer current, conditions. Other features may be transitory in a sequence from one to another (an arch results from one or more enlarged caves, but is often on the way to becoming a stack).

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Key features of coastal erosion:

Headlands and bays: where harder, more resistant rock lies adjacent to softer, more easily eroded bands of rock. Where these are orientated at right angles to the coast, it is known as a discordant coast (opposite is concordant coast where a uniform rock forms the coastline).

Caves: enlarged from natural weaknesses, joints and bedding planes by marine erosion processes.

Arches: where a cave has eroded through a headland or curtain of more resistant rock. May be from the coalescence of two or more caves.

Stack: results from a collapsed arch roof. Frequently above marine erosional processes, an arch roof is degraded by subaerial weathering processes.

Stump: a reduced stack eroded at its base by marine processes and at its summit by subaerial weathering.

Wave-cut (marine) platform: wide, rock base of eroded cliffs that extends as cliffs retreat. Forms at inter-tidal zone between high and low tide in the area of maximum wave impact.

Wave-cut notch: point of maximum impact of destructive waves at the base of a cliff. Results in undercutting of the cliff face and subsequent rock fall.

The degree of natural erosion is affected by the components, processes and energy:

- Lithology: the nature of the rock at the coast
- Rock structure: the orientation, and degree of internal rock coherence (stability)
- Climatic environment: range of temperatures, intensity of rainfall, air pressure gradients.
- Energy inputs: high energy environments of strong winds, waves and currents versus low energy environments.

Features of coastal deposition

Depositional coastlines are characterised by an input of sediment from cliffs, beaches, river estuaries of sea-bed stores. Material is redistributed by waves, tides and currents and in low-energy conditions is deposited along the shore or just off-shore to create distinctive features. These may be temporary and altered during high energy conditions, but re-formed once conditions calm and a state of dynamic equilibrium is restored.

Beaches: result from the dominance of constructive waves over destructive waves leading to a net gain of beach material over time creating a store of sediment.

Spit: the deposition of material transported along a coast by longshore drift (littoral movement) at a break in coast orientation and where the dominant current slows and weakens to produce an extended finger of depositional material, often with a recurved

end. **Compound spits** exhibit a number of recurved 'spurs' along their length as each recurvature represents a 'break in coast orientation' and the development of a new extension of the main spit under conditions of consistent longshore drift.

Bar: a continuation of a spit to join on to the coast across a bay. Usually where there is a break in coastline with longshore drift operating but without an intervening river current to disrupt continuous deposition.

Tombolo: where a spit happens to extend and join to an island, linking it to the mainland by a narrow beach of deposited material.

Offshore bar and barrier islands: characteristic of shores with a large influx of sediment, often from major rivers and currents which deposit and build accumulations of material into long, low mounds of sediment parallel to the coast. Offshore bars are largely submarine features while barrier islands are usually above high tide and contain sand dune formations.

Coastal features and coastal landscapes

A coastal landscape is a section of coastline that has a range of coastal features; some erosional, some depositional. It is distinguishable from neighbouring coastal landscapes by prevailing characteristics that dominate the form of the coastline there.

A coastal landscape will be an interaction between:

- The nature and structure of the rock or materials constituting the coastline.
- The climate component determining the range and intensity of weathering processes.
- The marine processes operating to produce features of erosion and deposition.
- The input of energy and sediment into the coastal zone.
- The amount of time that has passed to develop or interrupt processes operating to produce features.

Different coastal landscapes may represent:

- A high energy coastal environment dominated by developing features of erosion
- A low energy coastal environment dominated by relatively stable features of deposition.
- A variable energy (dynamic) coastal environment dominated by transfers of sediment between phases of erosion and periods of deposition.
- A coastal environment with little long-term change and time for the full evolution of coastal landforms into a state of stable equilibrium.
- A metastable coastal environment where processes (and thus, features) change rapidly such as with tectonic uplift, leaving relict features apparent.
- A historic coastal environment with evidence of ancient processes, sea levels and features with more recent features superimposed as a result of different conditions operating at times up to the present.

