The Portuguese coast (high energy coast) and Chesapeake Bay (low energy coast). Western Australia (sediment cell)

Specification topic: Energy sources & sediment cells and budgets 3.1.3.2

Case studies: High energy coastline/ Low energy coastline/ Sediment cell.

Case study 1: High energy coastline – the Portuguese west coast.

The west coast is identified as high energy for a range of reasons.

One cause of the high energy destructive waves here is the long fetch impacting upon wave energy and direction. Waves generated by Atlantic winds across the fetch between the northern tip of Brazil and western Europe are driven towards the Portuguese coast as a result of the Gulf Stream. The Gulf Stream divides into two: the North Atlantic Drift and the Canary Current. The Canary Current diverges from the Gulf Stream in the centre of the North Atlantic Ocean. This divergence occurs at several locations with large volumes of water being swept past the Portuguese coastline to subsequently follow a south-westerly direction, towards the Canary Islands. High energy ocean waves are created by a combination of wind and current and as they break at the coast they have a steep vertical plunge and strong backwash (destructive waves) which erodes the coastline at a fast rate.

The second cause of the high energy wave action is due to the tidal range. The Portuguese coast experiences a meso-tidal range: this means that there's a tidal range of between 2 - 4 metres. This increases both the amount of sediment that the waves can carry, and the vertical height of coast against which waves can focus marine processes and intensifies the rate of erosion.

The third cause of the high energy waves is wind action. While winds travelling over the Atlantic Ocean experience a long fetch, equally, the strong winds create waves approaching the coast with a high crest. These waves crash against the coastline with destructive impact causing erosion. The waves produce longshore movement as they strike at an angle due to the Canary Current's impact, which further accelerates removal of material from the coastline, exposing fresh cliff faces to renewed wave action.

High energy coastlines directly relate to erosional processes. The lithology of the Portuguese coastline and the orientation of the strata also accelerates the rate of erosion. Much of the coastline is composed of high cliffs which are easily undercut and there are many areas of discordant coastline, whereby soft rock lies next to hard rock at a 90-degree angle to the coast. Soft rock is more easily eroded by the marine process, including abrasion, resulting in a series of headlands and bays and a heavily indented coastline. An example of a headland is Cape St Vincent at the southern tip of the country.

Landforms created along this coast include wave cut platforms along the stretch of coastline near Cape Mondego.

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Case study 2: Low energy coastline – Chesapeake Bay, USA.

This bay, along with many other areas along the eastern coast of northern USA, is a low energy coastline. This means that depositional processes exceed erosional processes and there is a net gain in the sediment budget.

The first cause of the low energy waves (constructive) being formed in this region of coast is due to the morphology of the bay itself. With an average depth of 9 metres (30 feet) the shallow bay reduces wave energy as it enters from the Atlantic; friction increases as more water is in contact with the sea bed. Waves reaching the shoreline have a longer wave length, which means reduced frequency, resulting in more material being deposited along the shoreline than removed.

Secondly, the fetch is limited as much of the bay is protected from the force of the Atlantic currents by land enclosing the bay area. Most of the high energy waves are travelling north-east – in the opposite direction - across the Atlantic towards Europe, so the east coast of the USA receives gentler waves.

Wave energy is reduced further by the many barrier islands which lie in the bay itself. Deposition caused by previous wave action (as well as river deposition, forming deltas) has led to the emergence of these islands which reduce the energy of incoming waves into the bay. Onshore wind strength is also reduced within the bay because of these barrier islands.

The small tidal range averages 1.7 metres, with an increased range along the eastern side of the bay. The western side receives much lower tidal ranges which reduces the sea's erosional impact.

Case study 3: Sediment cells and budgets - Cape Naturaliste to Moore River – Western Australia.

The main processes occurring within this sediment cell are as follows:

- Starting in the south at Cape Naturaliste, longshore drift moves material from the Cape, northwards towards the Moore River.
- Material is deposited at certain locations along the stretch of coastline as spits, tombolos and bars.
- Material is picked up by waves and currents travelling seaward and is carried out from the shore, but a large amount of this sediment is intercepted by incoming waves and carried back towards the shore. Some sediment is lost from the cell in offshore deposition.
- Loss of sediment is replenished by clastic sediments deposited by rivers where they enter the ocean in the shallow bay areas. This is added to by shoreline weathering and mass movement of cliffs. Deposited sediments will then be carried along the coast by longshore drift.

Exam style question:

1. **Explain how variations in coastal energy lead to the creation of contrasting coastal landscapes. (9 marks)**
2. **Describe the processes occurring in a named sediment cell (6 marks)**

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1. Explain how variations in coastal energy lead to the creation of contrasting coastal landscapes. (9)
This is a comparative question, so reference needs to be made to both examples used. Reference to explain why the coastal energy is different and how this impacts on the landscape is needed.

High energy coastlines key information:

- Long fetch.
- Ocean current.
- Strong wind.
- Gradient / lithology / rock structure.

Link the above causes of high energy to the impact on process. For example – long fetch creates destructive waves which erode powerfully through quarrying and cavitation processes.

Low energy coastlines key information:

- Short fetch.
- Limited impact from ocean currents.
- Barriers to wind.
- Shallow coastline.

Similarly, link the causes of low energy to the impact on process. For example – shallow bays provide a large area for the water to spread across so energy is lost, hence less likelihood of erosion processes such as corrasion/abrasion and hydraulic action.

2. Describe the processes occurring in a named sediment cell (6)

Describe the following processes using a systems approach:

- Define a sediment cell as a coastal area which has sediment recycled within a largely balanced sediment budget, forming a largely closed system.
- Inputs to the cell – onshore movement of material from the ocean, river deposition, weathered material from the coastline.
- Transportation within the cell – longshore movement of material.
- Stores within the cell – sediment stored via deposition as beaches, spits, tombolos and bars.
- Outputs from the cell – seaward movement of material to offshore sediment sinks.