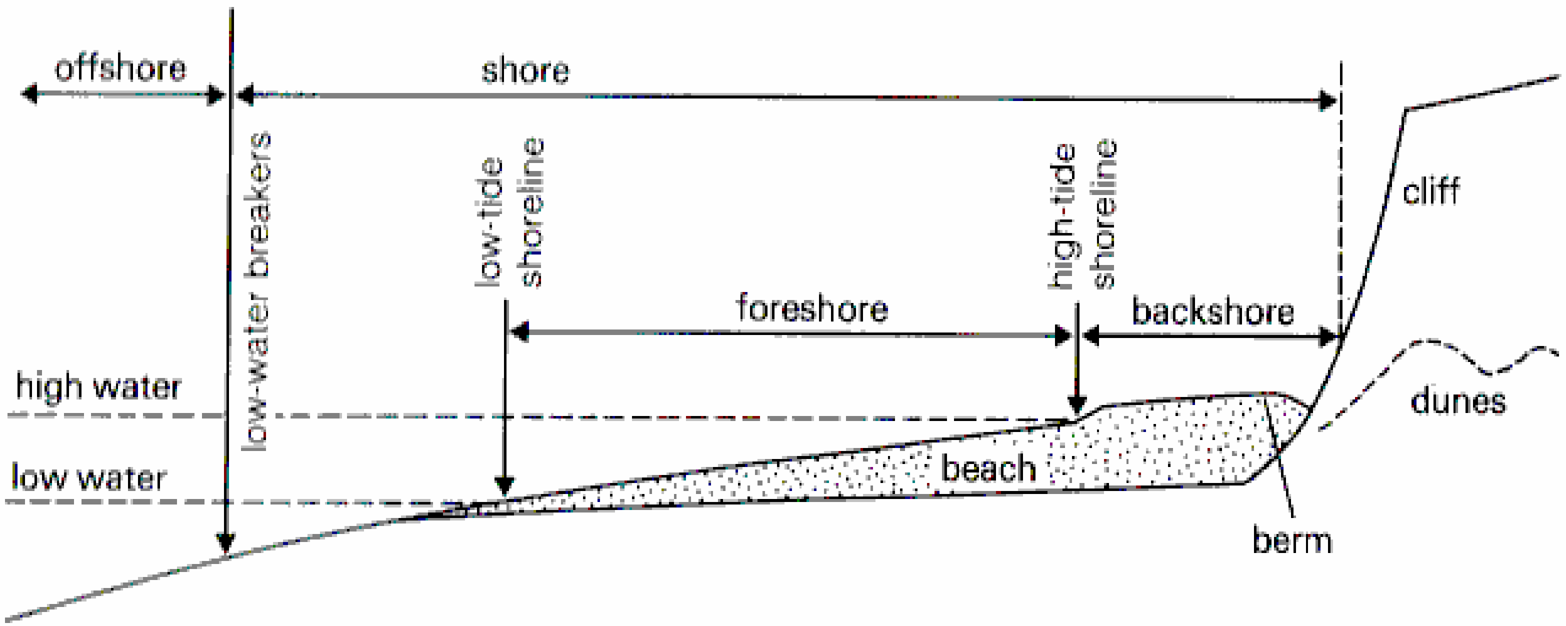
Coastal processes create characteristic landforms

The processes of marine erosion, transportation (longshore drift) and deposition

You need to know the specific mechanisms by which the sea erodes (including hydraulic action, abrasion, attrition and corrosion) and transports material along shore (swash, backwash and longshore drift).

The coast is a narrow overlap zone between the land and the sea. The sea is the main source of energy in the coastal system and the land is the main source of rock material and sediments from river processes, glacial processes, and slope processes (including weathering and mass movements). Waves and tides are used to divide the coast into distinctive zones. Examples in these notes are taken from a range of locations, particularly the North Devon and the Dorset coasts.

The zonation of the coast

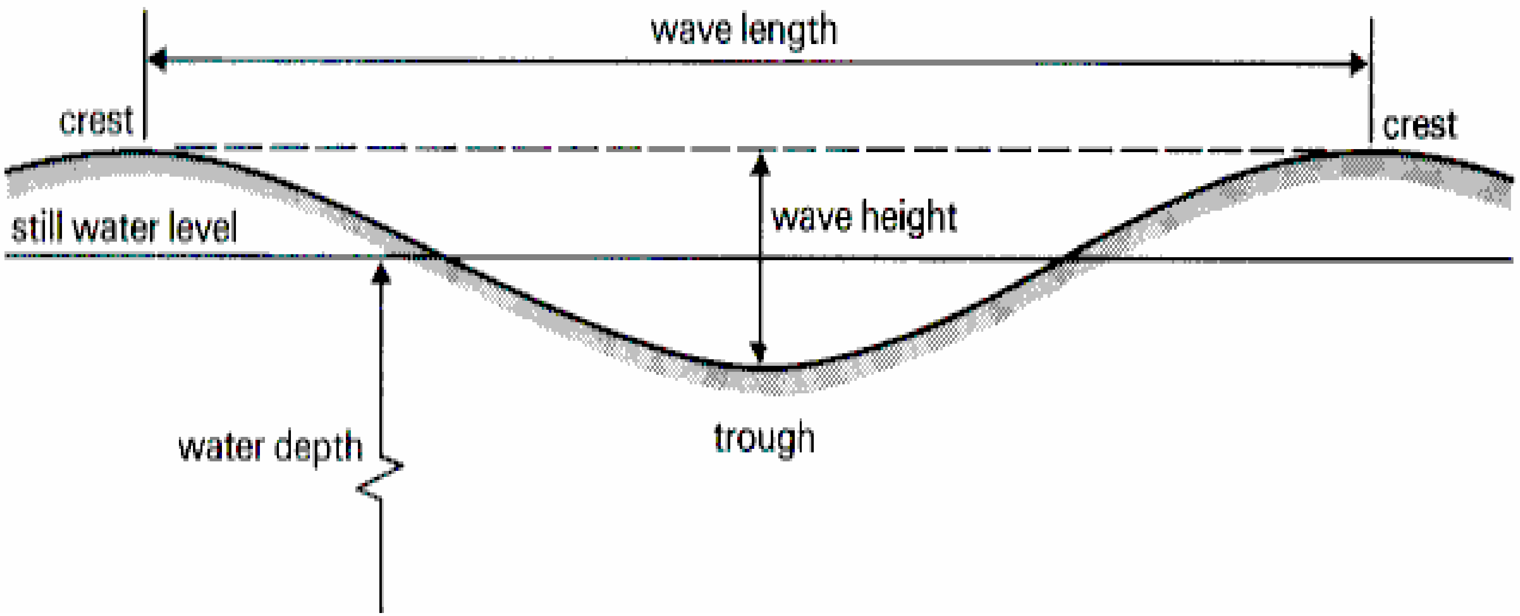


Wind blowing across a smooth water surface wills experience some friction with the surface.

This creates small pressure differences and eddies which instigate small ripples.

As the wind continues to blow the ripples grow into waves. A wind blowing at 50km/h for 30 hours will generate waves with a height of about 6m.

Basic terms used in the description of waves



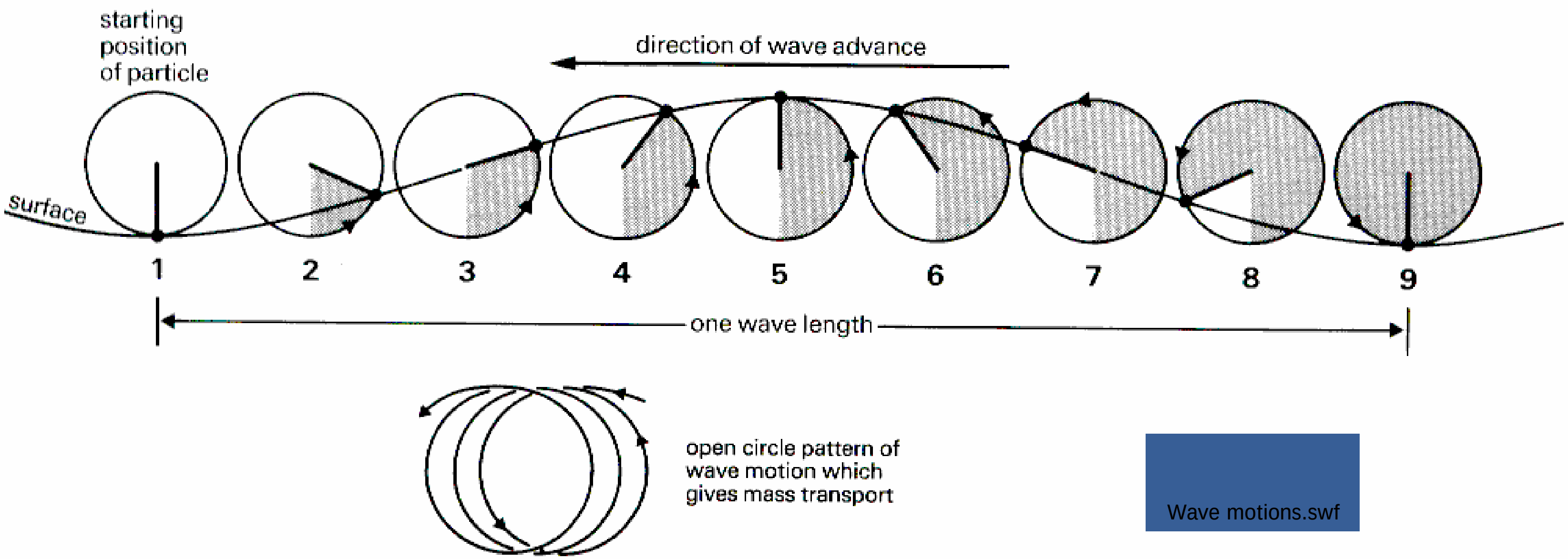
Fetch. The potential distance of open water over which a wave can travel is called its fetch. The largest waves occur where the fetch is at its greatest, for example at Hartland Quay in North Devon where the fetch is over 2,800 km whereas the Norfolk coast has a fetch of less than 200km.On both the North Devon and the Dorset coast, the fetch varies considerably depending on the orientation of the coast.

Swell Waves and Sea Waves. Waves can exist where there is little or no wind. These swell waves have been generated elsewhere and have travelled away from their place of origin. They are lower and flatter. Sea waves, which are usually steeper, are generated by local storms.

Swell waves at Well Bay at Hartland Quay

The Motion of Waves. Objects that float in water describe a circular motion as a wave passes. This demonstrates how, although the wave may move thousands of miles, transmitting its energy, the water particles do not move far. In reality, there is some forward motion called *mass transport*, but it is very small in relation to the velocity and movement of the wave.

The motion of a particle as a wave passes

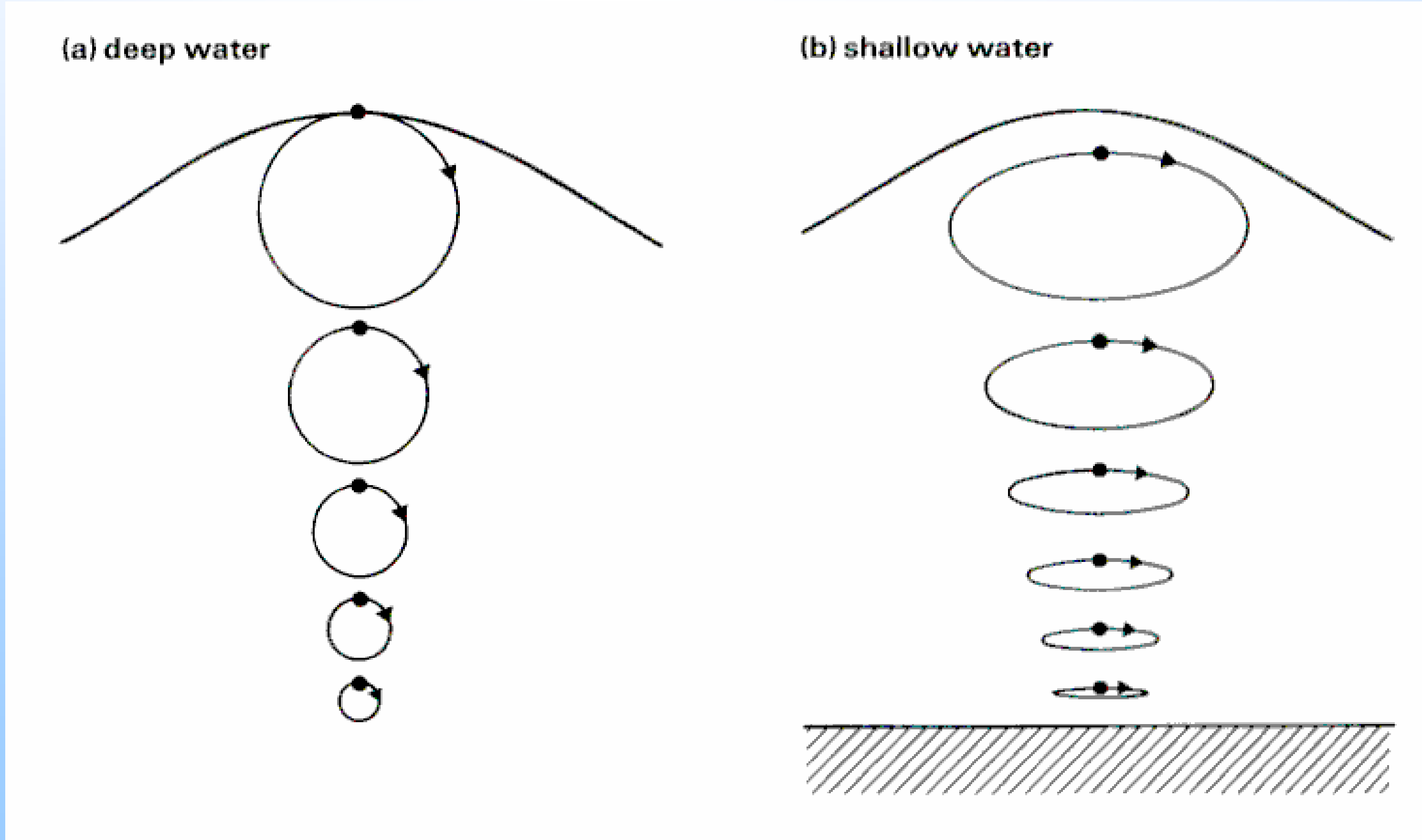


Wave motions.swf

The Wave Period. This is the time taken for successive wave crests to pass a fixed point. Local waves will usually have a period of 5-8 seconds. Swell waves may have periods of up to 20 seconds.

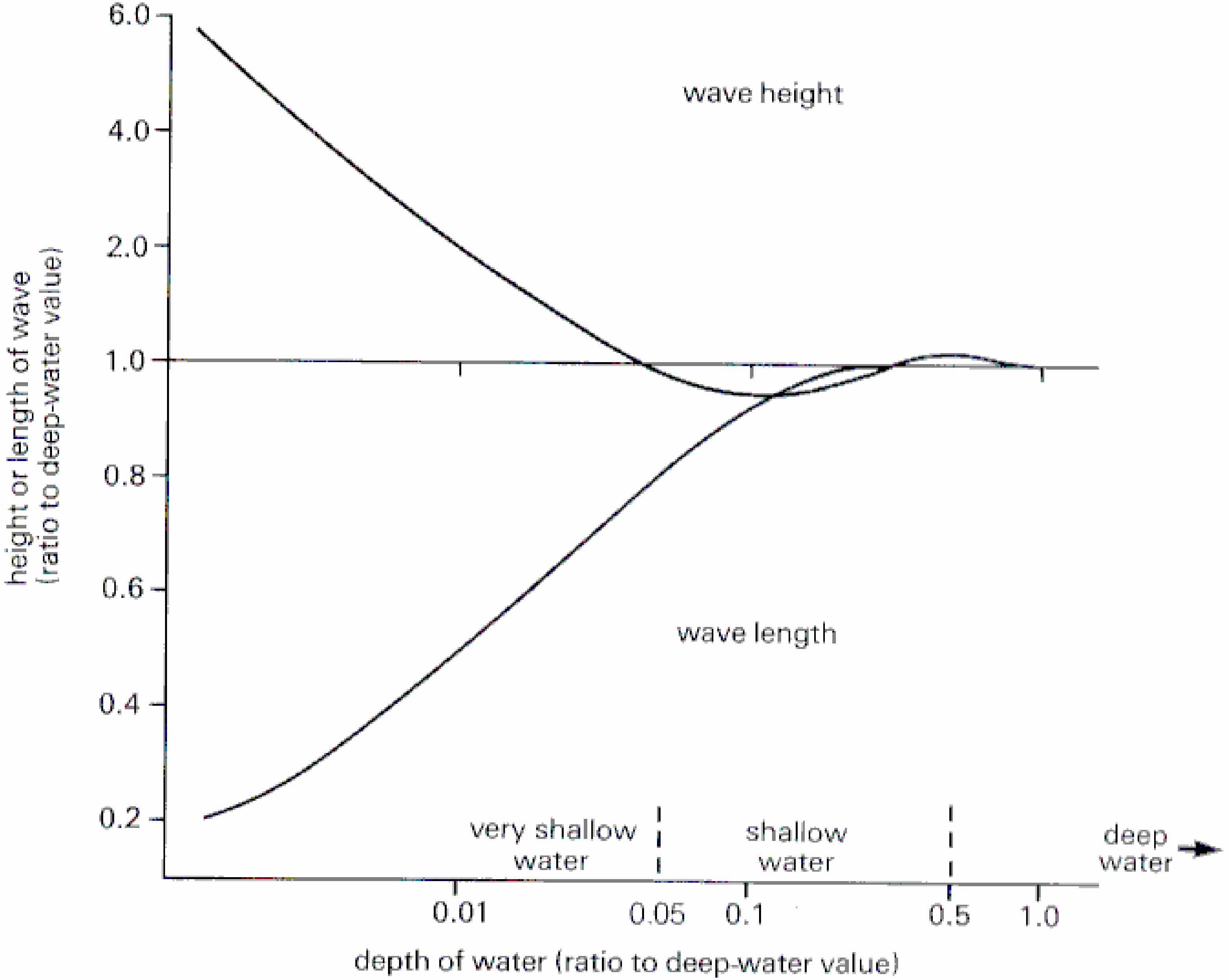
Wave Energy. This is partly **potential energy**, resulting from the height of the wave and partly **kinetic energy** caused by the wave's movement.

Waves in Shallow Water. The circular motion of water as a wave passes decreases with depth. Below a depth equivalent to one wavelength, there is very little motion. As the depth falls below half a wavelength, friction with the seabed slows down the wave and changes its characteristics. The circular motion become elliptical and its lower path slows down, wavelength decreases and wave height increases, increasing the steepness of the wave. This is a process of **wave refraction**. Waves appear to catch one another up. Beyond a gradient in 1 in 7, the wave crest loses its stability and topples forward: the wave breaks.



Breaking and refracting waves at Westward Ho!

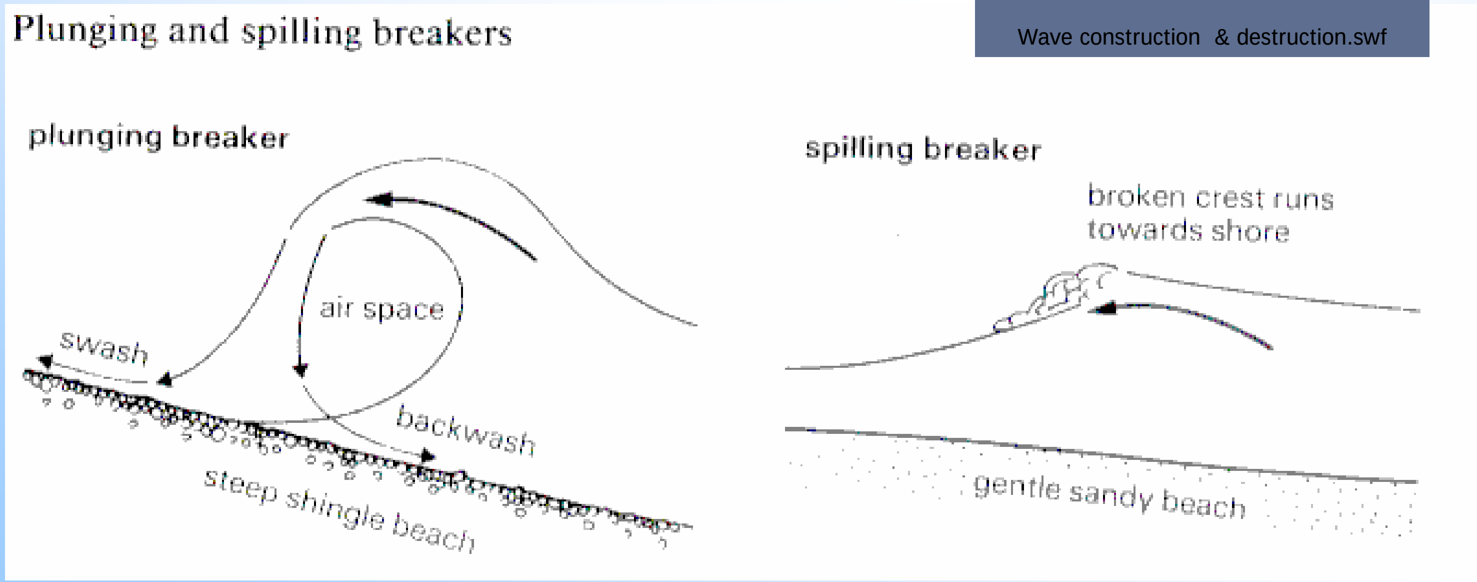
Changes in the dimensions of waves entering shallow water.



Breaking waves. As the wave breaks, the water rushes forward translating the potential energy of the wave into kinetic energy. Waves break in a number of ways. In ***Plunging breakers*** the crest rolls forward and downward, temporarily enclosing an air space. Such waves are common on steep shingle beaches when waves are slow moving. The ***swash***, or up-beach component is less important than the ***backwash*** or down-beach component. Such waves are often classified as **destructive waves** as sediments may be moved from the foreshore. Destructive waves dominate the coast at Warren Bay at Hartland Quay in North Devon.

In ***spilling breakers***, the ***swash*** is directed up the beach so it will be stronger than the ***backwash***. Such waves are sometimes classified as **constructive waves**. Constructive waves dominate in more sheltered locations such as Swanage Bay in Dorset.

Wave construction & destruction.swf



Tides.

Tides are oscillations in the sea surface caused by the gravitational pull of the moon and sun. In the UK there are two high tides every 12 hours 25 minutes. Spring tides occur when the moon and sun are in line and are the highest and lowest tides (they occur just after the new moon and the full moon). Neap tides occur when sun and moon are at right angles and display a small range (they occur just after each first and third quarter moon). The tidal range can vary spatially.

Britain has particularly high tides. (A macrotidal coast). The impact of tides can be accentuated by changes in atmospheric pressure and wind direction. Under low pressure, there will be a small rise in sea level (a surge). Onshore or offshore winds can also change the height of the tide.

Tides can lead to strong currents, which can scour and remove or redeposit sediments in estuaries or other tidal environments. Tides can also increase the effectiveness of wave processes. Most coastal erosion, for example, takes place at high tide when waves can easily reach the base of cliffs.

The Processes by which The Sea Erodes.

- ***Hydraulic Action.***
- ***Wave Quarrying.***
- ***Abrasion.***
- ***Attrition.***
- ***Corrosion/solution.***
- ***Subaerial Processes including:***

  physical weathering

  chemical weathering

  mass movements (flows, slides & falls)

You need to be able to describe and explain these processes

Erosion of most cliffs is not a regular, steady process. Instead it is a result of infrequent catastrophic events by which large fragments of the cliff slope will fail.

Evidence of hydraulic action, abrasion and attrition at Warren Bay.

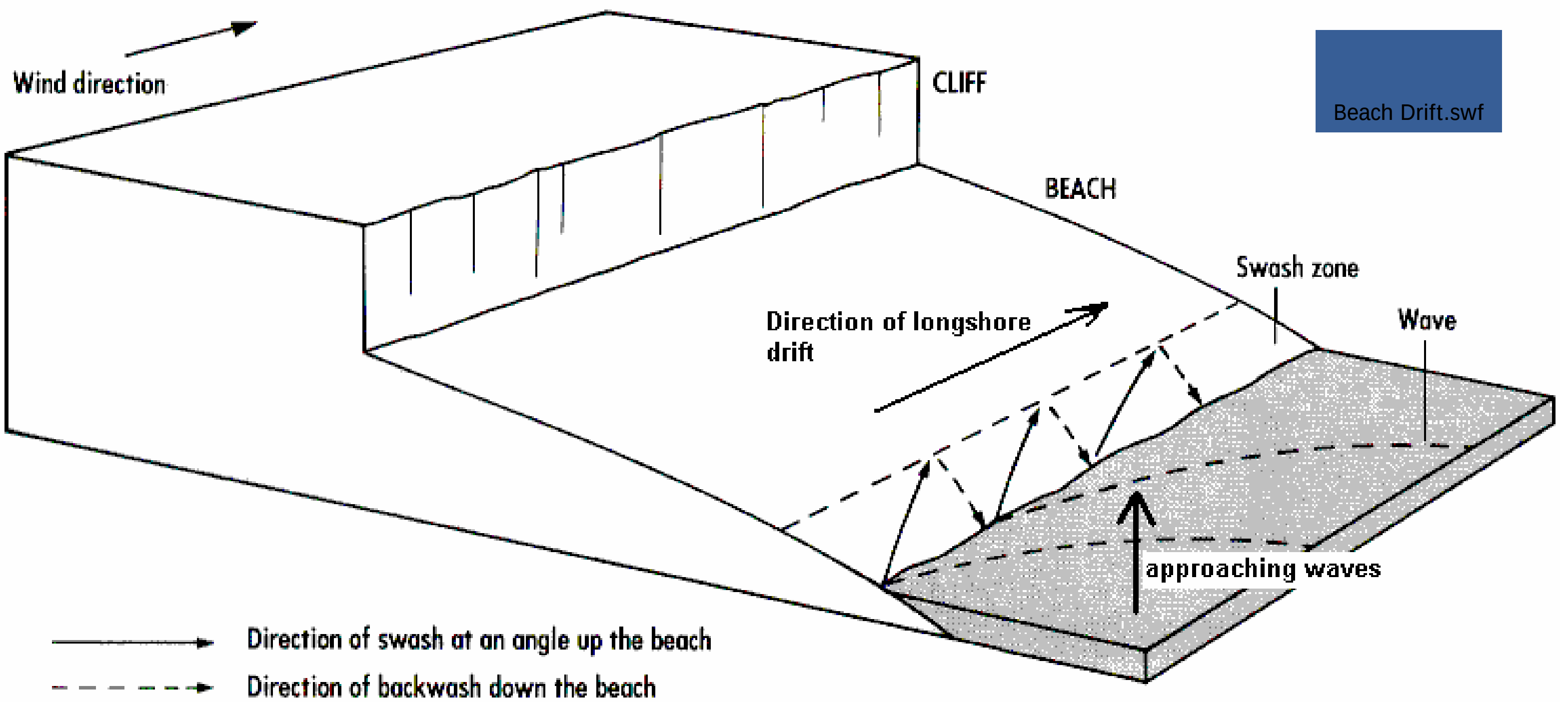
Notice how the cracks at the lower level of the rock face are wider than the same cracks further up, indicating an upper limit of wave activity.

An eroding coast at Portland Bill under attack from destructive waves.

The Processes By Which Waves Transports Material Along The Shore (swash, backwash and longshore drift).

A large number of beaches show alignments at an angle to the dominant wave fronts. This usually occurs where the beach gradient is relatively steep and the wavelength is short. In the swash zone, fragments are washed up the beach diagonally. As the **swash** slows it becomes the **backwash**. It flows, under gravity, back down the beach, taking the most direct route and dragging beach particles with it. In 24 hours there may be up to 15,000 waves breaking, each dragging the beach fragments along the beach. The total movement of sediments can be very great. The process is known as **longshore drift**, **beach drift** and **littoral drift**.

Longshore Drift



Beach Drift.swf

Note that longshore drift can operate in more than one direction along a coast as it is determined by the wave direction, which, in turn is determined by the wind direction. Some coastlines may experience longshore drift associated by both the prevailing wing and the strongest wind directions, which may be different.

Coastal Deposition

Deposition occurs when there is a loss of energy in the coastal system. This is usually in sheltered locations where wave and tidal influences are minimised. As with rivers, the coarsest material is deposited first where energy levels are still relatively high. Only in the lowest energy environments will the finest silts and mud be deposited. Such locations include the low energy environments of estuaries and salt marshes as well as parts of the offshore zone where wave energy is at its minimum.

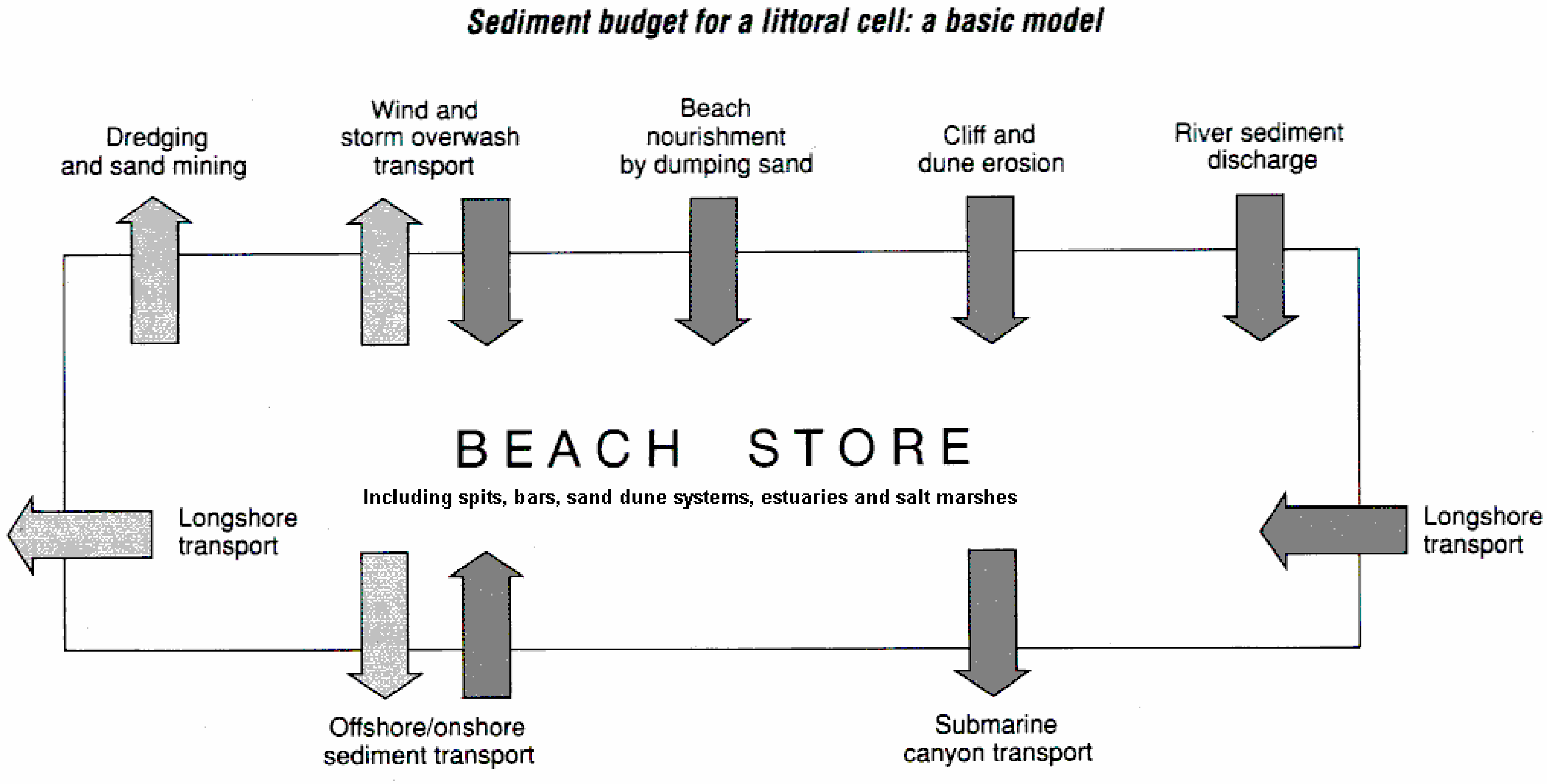
In some environments, coastal deposition is closely associated with the presence of vegetation in ecosystems such as sand dunes, salt marshes and tropical mangrove swamps.


Salt Marsh in Pool Harbour

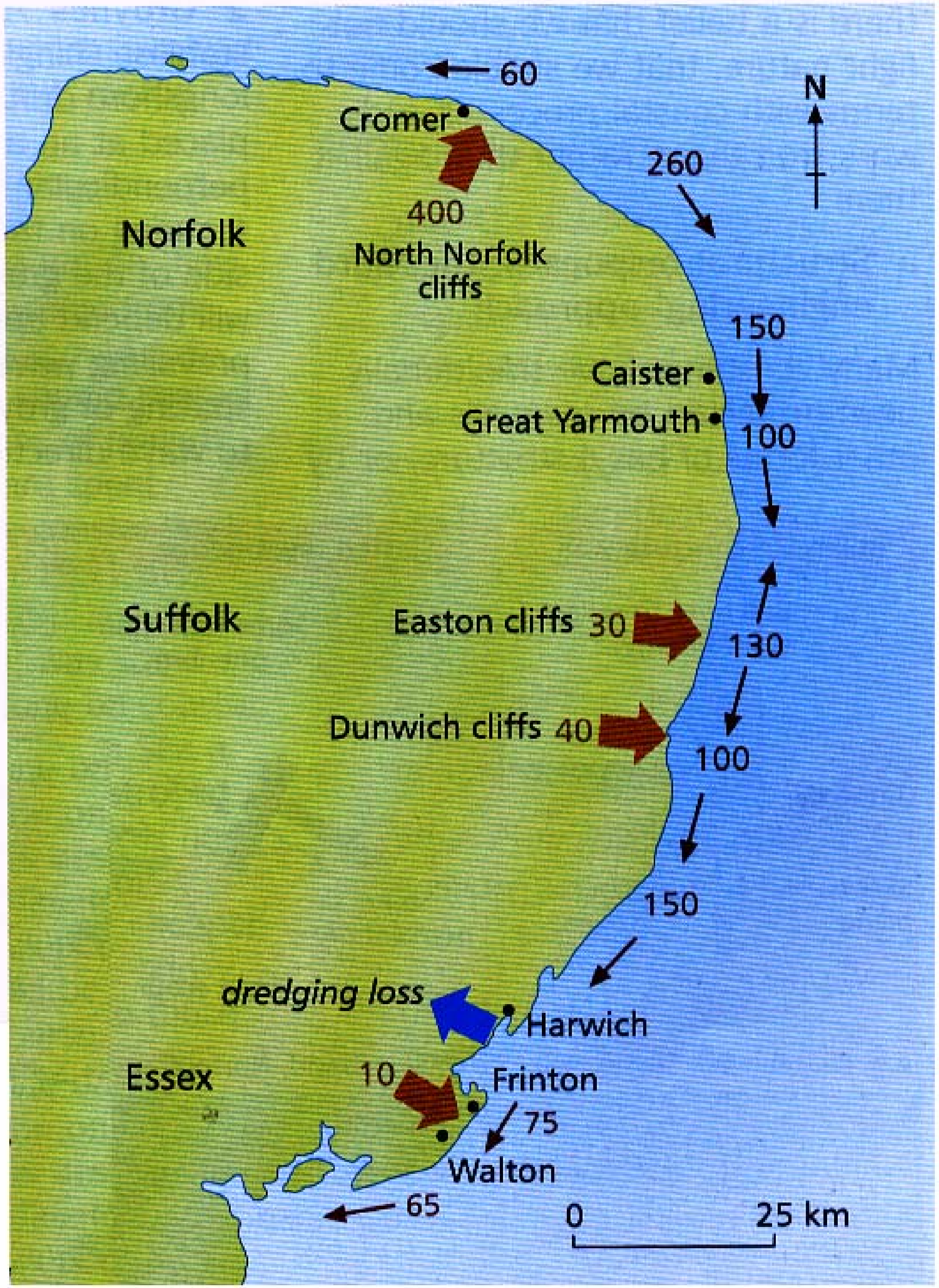
The budget of sediment movements can be analysed.

A "systems approach" can be applied to the movement of sediment along a coastline. The term **littoral cell** or **coastal sediment compartment** is used to describe a stretch of coastline where a complete cycle of littoral (longshore) transportation and sedimentation occurs. It is a useful way of explaining patterns of coastal erosion and deposition at a variety of scales, from single bays to more substantial lengths of coastline called **sediment cells**. Eleven such cells have been identified around the coast of England and Wales, which are the basic units of coastal management. They can be treated as virtually closed systems.

A littoral cell will have inputs (wave energy, cliff erosion, river sediments, onshore transport of sediments, littoral or longshore drift, biogenic inputs and beach nourishment by people), throughputs (longshore drift, beach destruction and construction), stores or sinks (beaches, spits, bars, estuaries, salt marshes, sand dunes) and outputs (offshore transport, longshore drift, landward dune erosion and human dredging). The cell in a bay may be considered a closed system with negligible sediment transfer around headlands. The cell may be in a state of dynamic equilibrium, depending on the balance of inputs and outputs.



Using a sediment budget, it is possible to assess the potential impact of major storms, of dam construction (such as on the Colorado), of harbour construction, or of other coastal management schemes.



Consider how:

- **rock type,**
- **rock structures (e.g. jointing)**
- **beach width,**
- **rivers**
- and **human activity**

could influence the sediment budget for East Anglia.