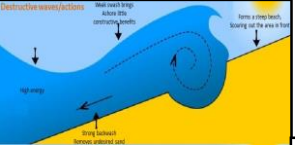


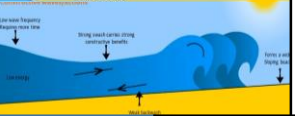
**Waves**  
Waves are caused by friction that is generated when **wind** blows across the surface of the sea!

As a wave reaches the beach:  
The water running up the beach is called the **swash**. As the wave loses energy, the water begins to run back down the beach to the sea, and is called the **backwash**. If you've ever been to the beach, you will have felt this motion under your feet when paddling in the shallow waters!

Two types of waves!



**Destructive Waves:** Strong winds, powerful waves and cause coastal erosion. They are tall and steep. The backwash is stronger than the swash, so material is carried out to sea.

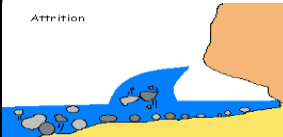


**Constructive Waves:** Light winds, not powerful and cause deposition, rather than erosion. Stronger swash, so material is carried up the beach and deposited.

**Erosion**  
Erosion is a term used to describe a wave removing material from the coastline

**Attrition**

Small rocks that the waves are carrying, collide in to one another. The rocks break up, becoming smaller and rounder. This continues to occur until the rock becomes sand.



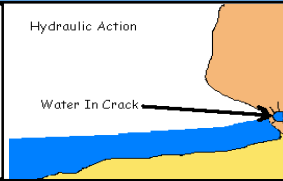
**Abrasion**

Rocks that the wave is carrying are thrown against the coastline. This wears away at the coastline overtime.



**Hydraulic Action**

Large waves break against the cliff. The cliff will often have faults/cracks in. The water is forced into these faults/cracks in the cliff, which causes immense pressure. When this pressure is released, it produces a force that makes the crack larger.



**Solution**

Sea water has lots of different chemicals in, and these can sometimes react with the rock, causing it to dissolve. This occurs most frequently with limestone.



**Headlands and Bays**



**Discordant Coastline:** Bands of differing rock strengths (resistant and less resistant) run perpendicular (in the opposite direction) to the coastline. Along this coastline, a mixture of clay (less resistant), chalk and limestone (resistant) run perpendicular to the coastline.

**Concordant Coastline:** Bands of rock run parallel to the coastline. Along this coastline, limestone (resistant rock) runs along the entire length of the coast.

So what does this have to do with headlands and bays?

**Headland**

Along a discordant coastline, the rocks of higher resistance erode at a slower rate to the rock of lower resistance. As a result, the high resistant rocks protrude out from the coastline, producing headlands.



**Peveril Point, South Coast of England**

**Bays**

Along a discordant coastline, the rocks of lower resistance erode at a faster rate than the rocks of higher resistance. This results in the rock eroding back more quickly to produce bays. Constructive ways often bring sediment to form a beach.



**Swanage Bay, South Coast of England**

**Cliffs**

Cliffs are produced through the process of hydraulic action and abrasion, where destructive waves erode the cliff between the high and low tide marks to create a wave cut notch. As this notch is eroded, the cliff above becomes unstable, collapses and is removed by waves.

**Wave Cut Platform**

Below the wave cut notch, an area of exposed rock is left, which is visible during low tide. The surface is not smooth, as erosional processes such as abrasion, and weathering, continue to erode the rock face.



**Caves, Arches and Stacks**

**Headland**

Caves, arches and stacks often form at headlands, should make sure you remember how headlands initially form!



**Akraberg Headland, Scotland**

**Cave**

Destructive waves break against the cliff face, weaknesses in the rock are attacked. Through hydraulic action, the crack widens, eventually widening the crack enough to form a cave.



**Merlin's Cave, Cornwall, England**

**Arch**

Waves erode the cave, via the process of hydraulic action, and abrasion, with rocks and pebbles swirling within the cave. If the cave sits in a narrow headland, waves erode through the cave, creating an arch.



**Green Bridge, Wales**

**Stack**

Continued erosion of the base of the arch weakens the structure, until a point where the roof collapses due to instability, leaving a stack, separated from the mainland, as shown above and to the right.



**Merlin's Cave, Cornwall, England**

So where is the coastline eroding fastest in the UK?

Happisburgh, Norfolk: This area has eroded by almost 90m over the last 10 years, due to a failure in coastal defences.



**What other processes change our coastlines?**

**Sub-aerial**

**Mechanical (freeze thaw)**

Water enters cracks, and in cold climates, freezes, expanding by around 10%. This increased pressure weakens the cliff face. This process repeats, until the rock is weak enough to fragment. In warmer climates, the salt crystals of the sea expand when they dry, resulting in a similar process.

**Chemical**

Rain water contains a chemical called carbonic acid, which when comes into contact with certain rocks such as limestone, can react and weaken the rock as it dissolves.

**Biological**

The roots of plants and trees, burrowing animals and nesting birds can all help to weaken the rock.

**Mass Movement**

This term refers to the downwards movement of rocks and soil under the influence of gravity. It can occur in three different forms!

**Slumping:** After a period of rainfall, the permeable rock (absorbs rainfall), becomes heavy, and can slip at the point where it meets an impermeable rock (doesn't absorb rainfall), often in a rotational manner.



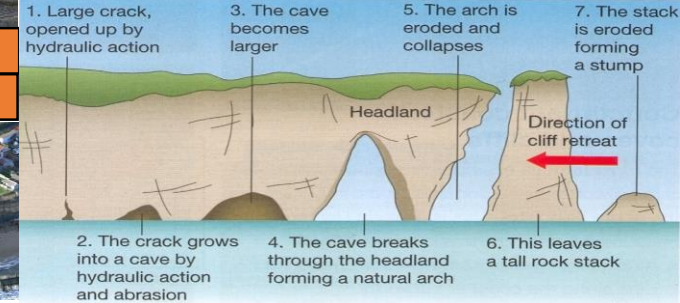
**Rock falls:** Sudden fall of rocks, often due to weathering from above, or a growing wave cut notch that has resulted in an unstable cliff face.



**Sliding:** Similar to slumping, but occurs along a flat surface, usually a bedding plane.

**Weather**

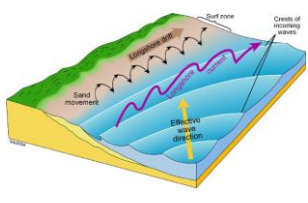
In the UK, we often experience winter storms (such as Storm Brian, Dylan etc.), which can bring torrential rain and winds in excess of 100mph. These storms bring very large waves and tidal surges, increasing erosion rates.





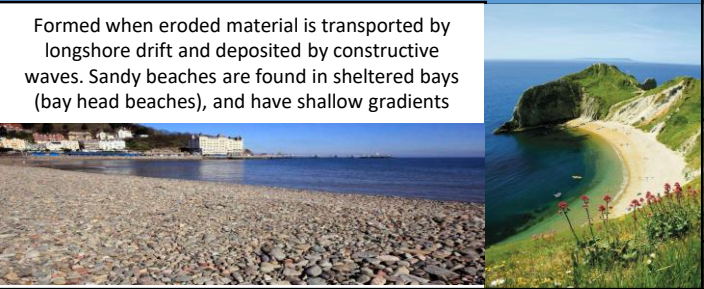
### Longshore Drift

Waves approach the beach at an angle equal to the prevailing wind. Material is moved up the beach at an angle (swash), returning perpendicular to the coast. Along the south coast of the UK, the prevailing wind is from the South West, moving material from west to east.



### Beaches

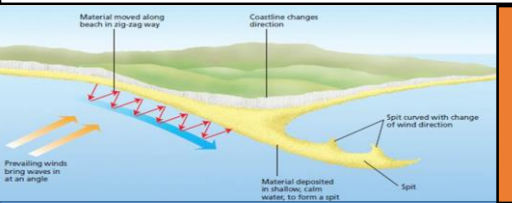
Formed when eroded material is transported by longshore drift and deposited by constructive waves. Sandy beaches are found in sheltered bays (bay head beaches), and have shallow gradients



Pebble beaches are found in areas where cliffs have been eroded by high energy waves, and have a steep gradient.

### Spit

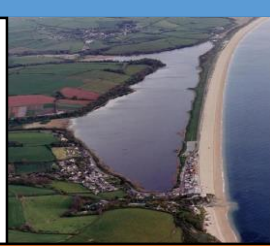
A spit is a narrow ridge of sand or shingle, that stretches out from the coastline, into a gap in the coastline. A spit forms due to longshore drift. Sediment moves along the coastline until a change in coastline occurs. This results in material being deposited. This builds up overtime until the spit extends out further into the gap. Saltmarshes begin to form being the spit due to it being enclosed. A spit may begin to curve due to wind and waves from other directions.



**Dawlish Warren Sand Spit, Devon.**

### Bar

A bar is a ridge of sand or material that extends across a bay or river mouth, creating an enclosed water body. A bar forms through the same process as longshore drift. Behind the bar, fresh or slightly salty water becomes contained to form a lagoon. In the image to the right, a bar extends across the river mouth, with a lagoon behind.



### How do humans affect the coastline?

<b>Settlement</b>	Over 20 million people in the UK live near to the coast. Along the Holderness coast, 29 villages have been lost due to coastal erosion.
<b>Tourism</b>	Coastal tourism is BIG business! 13% of jobs at Dawlish are in tourism. Coasts are often managed for tourists, such as building groynes to trap sediment for beaches.
<b>Infrastructure</b>	Roads, railways, shipping ports and oil refineries are just some of the infrastructure found at the coast. The Esso oil refinery at Southampton sees 2000 ships dock each year. Hard engineering features are often built to harness infrastructure.
<b>Construction</b>	Dredging the sea to construct ports can have adverse effects to wildlife. It can also impact areas further down the coastline, due to altering the sediment budget and cell.
<b>Agriculture</b>	Sea level rise and increased coastal erosion will impact farmland due to it being of a low economic value, and therefore low priority in management.



**Bournemouth Beach.**  
Tourism, settlement and infrastructure.



**Southampton Port.**  
Settlement, infrastructure and construction.



**Holderness Coastline.**  
Agriculture, settlement.



### What challenges do coastal landscapes present?

Many people choose to live near the coastline in the UK due to the economic (jobs), environmental (QOL) and social (ommunities) benefits it brings. Coastal erosion removes material from the coastline, with many areas in the UK at risk of this. Dawlish in South Devon is a great example of this, with roads, railways and homes damaged in recent years due to storms.



### Rising Sea Level

Sea level in the English Channel is expected to rise by 15cm by 2030 due to global warming. A warmer climate causes water to expand, and ice sheets and glaciers to melt.



### Storms and Storm Surges

A storm surge is a large increase in sea level due to a storm. Strong winds drive the waves, whilst low pressure allows the sea level to rise up to 3m above normal in the UK. These events can last for days, and can cause significant harm, and loss of life.

### Winter UK 2014 Storms

In January and February of 2014, the UK was hit by a series of low pressure systems, bringing heavy rainfall and extremely strong winds. The south west of England was worst hit, with some areas having their wettest January since records began.



### Can we protect our coastline?

Planners must try to find sustainable ways of managing the coastline, and do this using a process called Integrated Coastal Zone Management (ICZM). This involves Shoreline Management Plans (SMPs) being drawn up, which recommend to do one of the following things:

<b>No Intervention</b>	No investment in flood defences.
<b>Hold The Line</b>	Maintain the existing coastline with defences.
<b>Managed Realignment</b>	Allow the shoreline to change naturally, but manage this process and the impacts.
<b>Advance The Line</b>	Build new defences on the seaward side.

### What are the advantages and disadvantages of coastal defences?

Defence System	Advantages	Disadvantages
<b>Sea Wall</b>	Protects base of cliff. Made of resistant concrete that deflects energy.	Expensive and unattractive. Restricts access.
<b>Groynes</b>	Maintains a wide beach and attracts tourists	High cost of maintenance. Can impact other areas of the coastline.
<b>Beach Replenishment</b>	Looks natural, attracts tourists and is cheap.	Material is easily eroded. Needs constant replenishment.
<b>Slope Stabilisation</b>	Prevents mass movement, and is safer for people using the beach.	Difficult to install and is very expensive.

Slapton Sands, Devon