Edexcel Geography GCSE

Coastal Change and Conflict

Detailed Notes

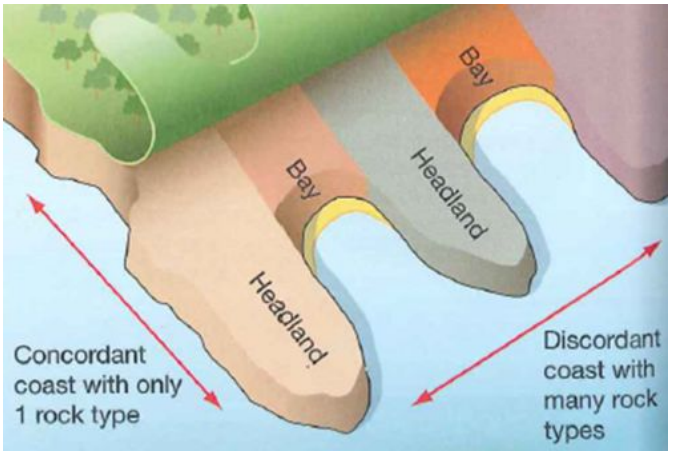
Coastal Zones

The **coastal zone** is a constantly **evolving** landscape, wherever the land meets the sea. Coasts are **valuable** physical environments since they **provide resources** such as oil and fish, homes for humans and habitats for species as well as being a **tourist attraction**.

Geology of Coastlines

The **type of rock** is very influential to the shape of the coastline. Coastlines can be **concordant** or **discordant**, depending on which way the rock beds run compared to the sea:

- If the **rock beds run parallel** to the edge of the sea, the coast is called concordant. Concordant coasts can be identified by **high cliffs** and **coves**.
- If the **rock beds run perpendicular** (at right angle) to the edge of the sea, the coast is called discordant. Discordant coasts can be identified by **headlands** and **bays**.



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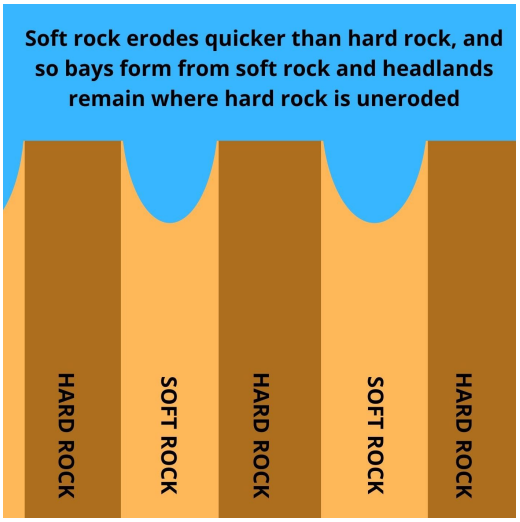


Discordant Coastlines

This is where the rock strata run **perpendicular** to the sea, which can create successions of headlands and bays; less resistant rocks are eroded faster than the more resistant rocks, which leads to the formation of bays.

Concordant Coastlines

Concordant coastlines are where the rock strata run **parallel** to the coast. This means that if you walked into land, the rock beneath your feet would alternate between **bands of more resistant and less resistant rock**. These different rock types erode at different rates, and so form different landforms.

Concordant coastlines can lead to the formation of **coves and cliffs.** The next page shows how a **cove** is formed.

For a cove to form, hard and soft rock must alternate

HARD ROCK

SOFT ROCK

HARD ROCK

SOFT ROCK

The hard-rock cliff face may suddenly crack as erosion weakens a section of the cliffs

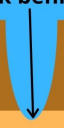
HARD ROCK

SOFT ROCK

HARD ROCK

SOFT ROCK

Over time, the hard-resistance rock erodes to expose the less resistant rock behind.



HARD ROCK

SOFT ROCK

HARD ROCK

SOFT ROCK

The less resistant rock erodes much quicker than the hard rock, so the cove widens more in the soft rock band

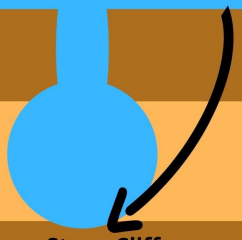
HARD ROCK

SOFT ROCK

HARD ROCK

SOFT ROCK

Erosion continues to widen the cove, but cannot extend further inland due to another band of hard rock, which forms steep cliffs.



HARD ROCK

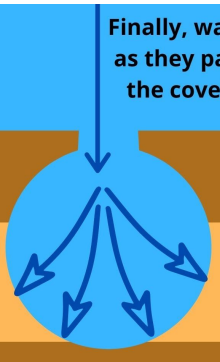
SOFT ROCK

Steep Cliffs

HARD ROCK

SOFT ROCK

Finally, waves diffract as they pass through the cove's opening



HARD ROCK

SOFT ROCK

HARD ROCK

SOFT ROCK

Rock Faults

The geology of the rockbed is not the only factor that will affect the shape of the coastline. The weaknesses of the rock will also affect whether it erodes away. Rock weaknesses include:

- Joints - Small, vertical cracks found in nearly all rocks
- Faults - Larger cracks where a rock has moved, often from past tectonic activity.

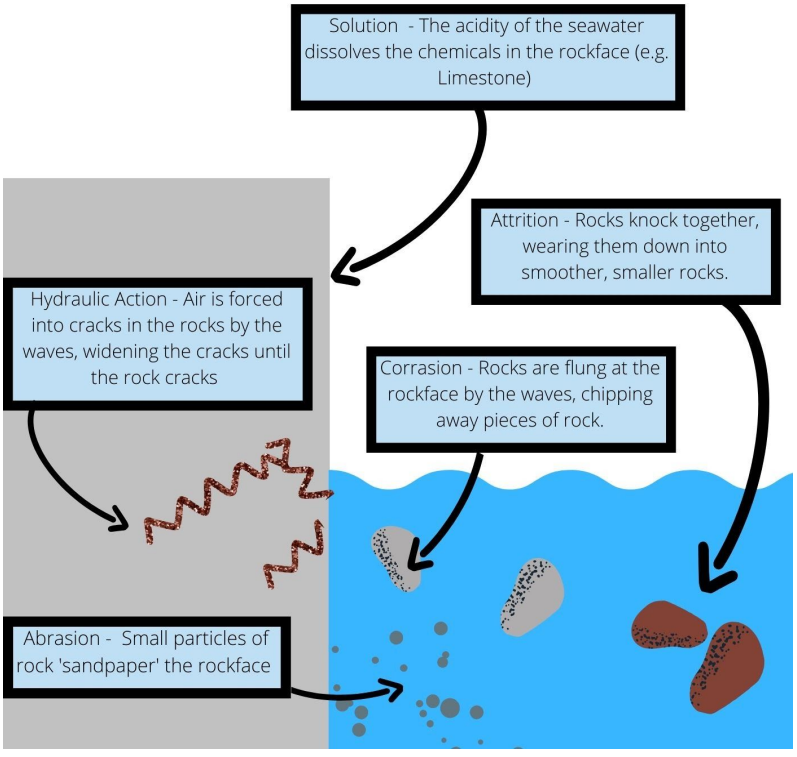
Rock weaknesses can increase the chance of erosion occurring, and create distinctive landforms such as **Caves, Arches, Stacks and Stumps**.

Coastal Processes and Land Formations

There are five coastal processes that you need to know for your exam: **erosion**, **weathering**, **transportation**, **mass movement** and **deposition**. Each process can produce several coastal features, which can be found all along the UK coastline.

Erosional Processes

Erosion is the removal and destruction of rocks and sand along the coastline. There are five different types of erosion, but they tend to work together to break down a rock face in their own ways:



The **five erosion processes** are:

- **Corrasion** - Sand and pebbles are picked up by the sea and **hurled against the cliffs** at high tide, causing the cliffs to be eroded. The shape, weight and quantity of sediment picked up, as well as the wave speed, affects the rate of erosion.
- **Abrasion** - This is the process where sediment **scrapes and bangs** against the base of a rockface, and so wear away the face gradually (like **sandpaper** against a piece of wood). The pieces of rock brush past the rockface, rather than being launched against the rockface in corrasion.
- **Attrition** - Wave action causes **rocks and pebbles to hit against each other**, wearing each other down and so becoming round and eventually smaller. Attrition is an erosive process within the coastal environment, but has little to no effect on erosion of the coastline itself.

- **Hydraulic Action** - As a wave crashes onto a rock or cliff face, **air is forced into cracks** within the rock. The high pressure causes the **cracks to force apart and widen** when the wave retreats and the air expands. Over time this causes the rock to fracture.
- **Corrosion (Solution)** - The **mildly acidic seawater** can cause **alkaline rock** such as limestone to be eroded. This is similar to chemical weathering (later in these notes) were acid rain dissolves limestone within the rockface.

Erosional Landforms

Caves, Arches, Stacks & Stumps - This sequence occurs on pinnacle **headlands**.

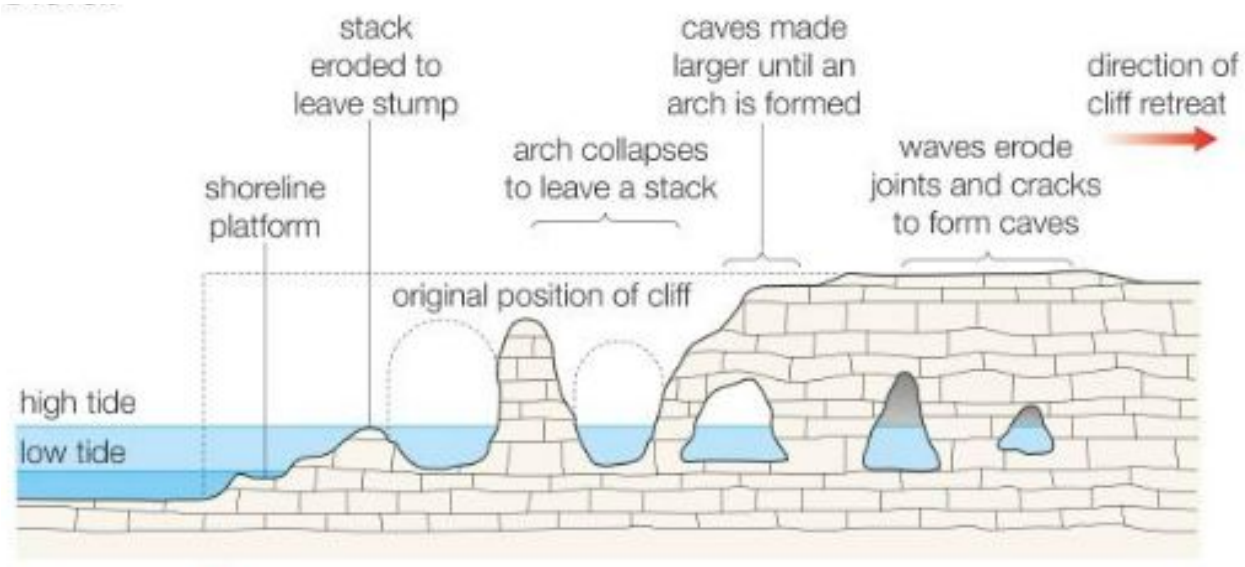
Marine erosion widens cracks in the base of the headland, these get bigger over time and create a **cave**.

The cave widens and deepens due to both **marine erosion** and **sub-aerial processes**, and eventually a large hole will form through to the other side of the headland. This is known as an **arch**.

The arch continues to widen until it is unable to support itself, the top falls due to its own weight through **mass movement**.

This leaves a **stack** as one side of the arch becomes detached from the mainland.

With marine erosion attacking the base of the stack, eventually the stack will collapse into a **stump**.



Below is **Old Harry Rocks** in **Studland, Poole**. The white rock is **chalk** which is a **hard rock** which is difficult to erode. **What landforms can you identify in the picture? Can you label them?**

Source: https://chelseamamma.co.uk/walking-the-southwest-coast-path-to-old-harry-rocks/

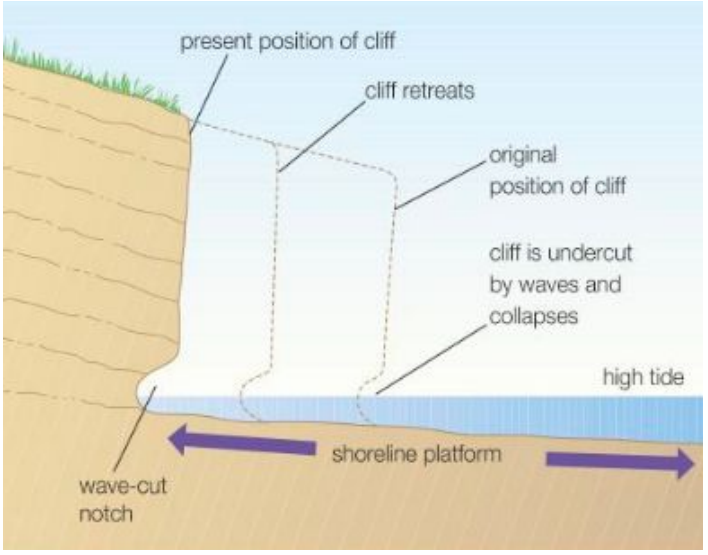
Below is **The Green Bridge of Wales, Castlemartin**. The lines you can see in the cliff face means it is made from **sedimentary rock**. Sedimentary rock is made from **layers of sediment** which build up over time and are compacted. **What landforms can you see in the picture?**

Source: www.britainexpress.com/wales/pembrokeshire/green-bridge-of-wales.htm

Wave-cut notch and platform - Marine erosion attacks the base of a cliff, creating a **notch** of eroded material between high tide height and low tide height.

As the notch becomes deeper (and **sub-aerial weathering** weakens the cliff from the top) the cliff face becomes **unstable** and falls under its own weight through mass movement.

This leaves behind a **platform** of the unaffected cliff base beneath the wave-cut notch.



Below is a **wave cut platform** at **Thornwick Bay**, near Bridlington in Yorkshire.

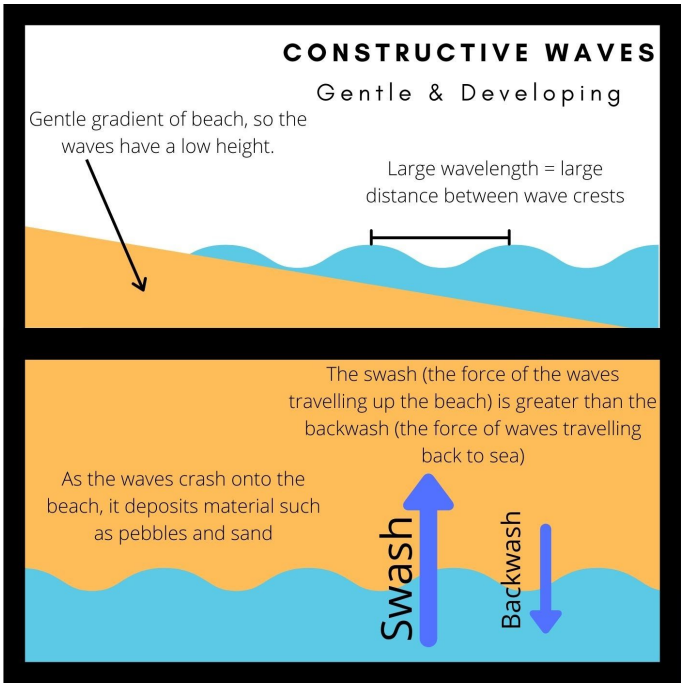
www.paulbeal.com/routes-and-photos/yorkshire-coast/bridlington-and-flamborough-head/

Activity

- What **type of rock** do you think the cliffs in the distance are made out of?
- What **landforms** can you see at the bottom of the cliffs in the distance? Are they caused by **erosion** or **deposition**?
- You can see there are layers of rock in the cliffs closest to the camera on the right. What **type of rock** is this?

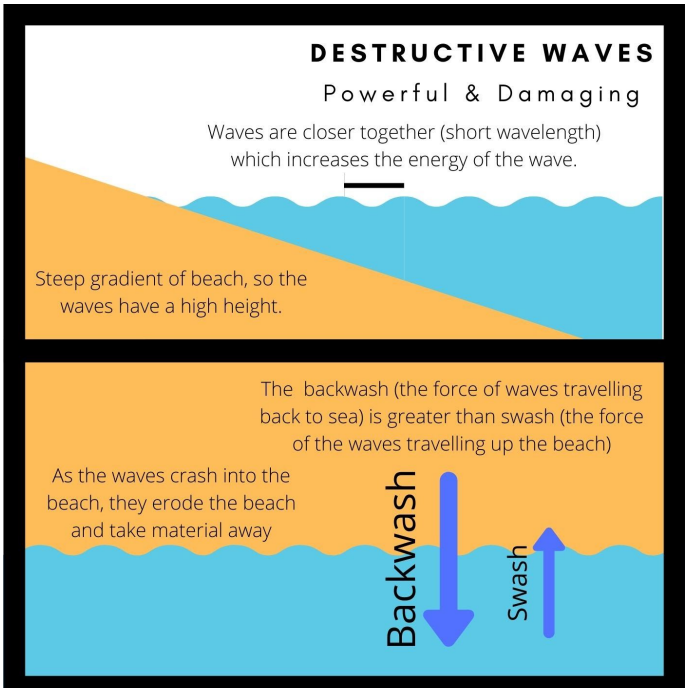
Waves and Sea Levels

Most waves form due to the wind blowing across the surface of the sea. The waves pull the surface (through friction) and create ripples that increase in height as they travel towards the beach. There are two types of waves: **constructive** and **destructive**.



Constructive waves

- Strong swash, weak backwash
- Low wave height, large wavelength
- Low frequency
- Depositional - the waves leave material on the beach, and so build up the material (sand, pebbles, etc) over time.



Destructive waves

- Strong backwash, weak swash
- High wave height, small wavelength
- High frequency
- Erosional - the waves erode the beach and any rocks and take the material away to other locations. Over time, the beach wears away.

Coastlines that are hit by **destructive waves** typically have **rocky headlands and landforms**, such as tall cliffs and caves. Destructive waves tend to have a **long fetch** and so are the most powerful waves. These coastlines tend to erode away and retreat.

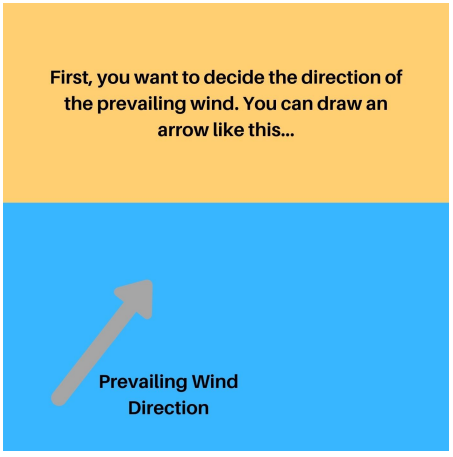
The coastlines that are hit by **constructive waves** tend to be sandy beaches, since the waves are less powerful and **deposit** material (sand, pebbles, etc) rather than taking it away from the beach.

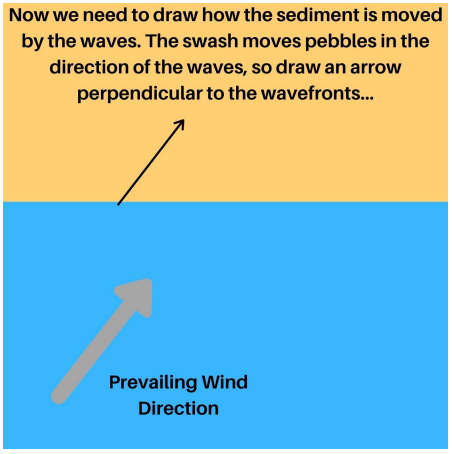
The size of a wave depends on various factors including:

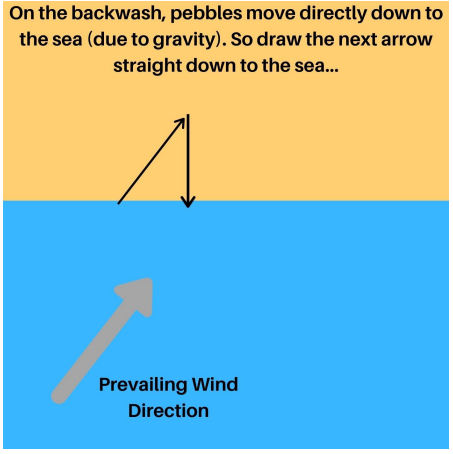
- The **strength** of the wind
- How long the **wind** has been blowing for
- **Water depth**
- Distance of **fetch**

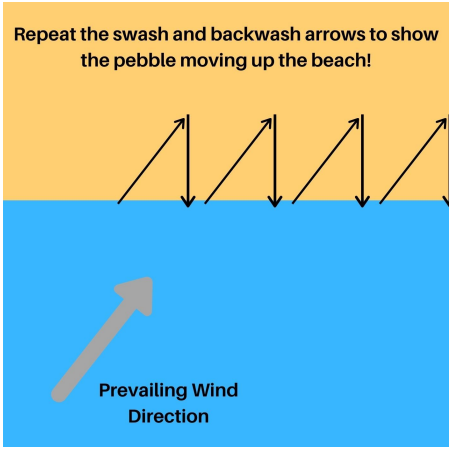
Transportation

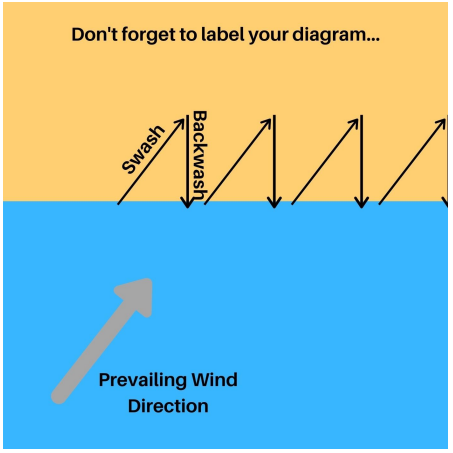
Longshore Drift - Sediment is transported along the coast through the process of **longshore drift**. You might be asked to draw and label a diagram to explain how longshore drift works; if so, follow our steps below!









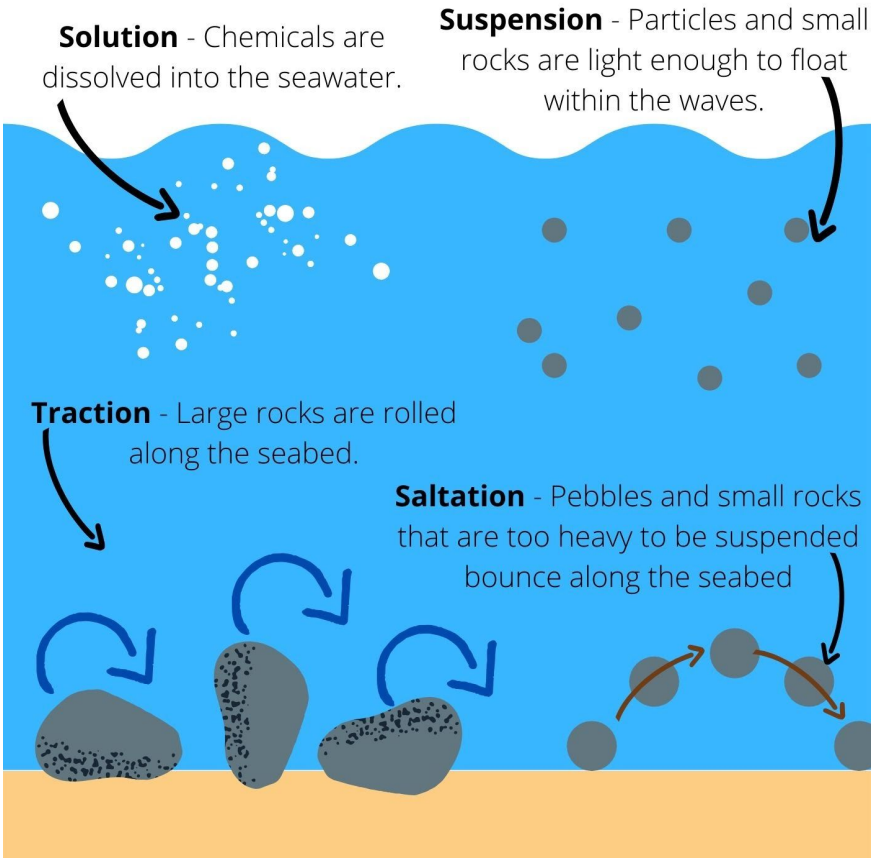


Alternatively, if you'd rather explain in words the process:

- Waves hit the beach at an angle determined by the direction of the **prevailing wind.**
- The waves push sediment in this direction and up the beach in the **swash.**
- Due to **gravity**, the wave then carries sediment back down the beach in the **backwash.**
- This moves sediment along the beach over time.

It is one of the reasons why when swimming in the sea, you often move along the coast in a particular direction. So you can imagine yourself being a pebble or rock, being carried up the beach by the waves!

Other processes of transportation include:



Deposition

Deposition occurs when a wave **loses energy** meaning the **sediment becomes too heavy** to carry. Deposition tends to be a gradual and continuous process - a wave won't drop all of its sediment all at once.

Depositional Landforms

Beaches - Beaches are large deposits of sand and shingle and are caused by **constructive waves** hitting a coastline. Beaches typically have **berms** - ridges where high tide reaches and deposits a ridge of sand and materials (seaweed, driftwood, etc).

You can see the **berm** at the beach in **Broughton Bay, South Wales** in the picture on the left.

Spits - A spit is a long narrow strip of land which is formed due to **deposition**. **Longshore drift** occurs along the coast line but as the waves **lose energy** (normally due to going into a sheltered area such as behind a headland) they deposit their sediment. Over time this creates a **spit**.

Periodically, the **prevailing wind** will change direction causing a **hook** to appear. You can see the hooks in the diagram below. Over time, the sheltered area behind a spit can turn into a **salt marsh.**

The length of a spit is influenced by surrounding currents or rivers. For example, in the diagram the spit is forming in an **estuary** (where a river meets the sea) and the current from the river is preventing deposition from occurring across the bay. Instead a **recurved spit end** has formed.

Bar - Bars can form from **spits**, but only in certain locations. A bar is a spit that has grown across the mouth of a **bay**. This cuts off the sea water from the bay, creating a **lagoon** with still water and over time this will become a **freshwater lake**. Occasionally, a bar can be made between the land and an island, which is known as a **barrier beach**. This is when a spit doesn't have a recurved end, instead it grows straight out to an island, joining it up to the mainland.

Source: Visit South Devon

Sub-Aerial Processes - Weathering and Mass Movement

Weathering is the **breakdown of rocks** over time. This process produces material which creates coastal landforms or the sediment taken away through **transportation**. There are **three** types of weathering processes:

- **Mechanical (Physical) Weathering:** the breakdown of rocks due to exertion of physical forces without any chemical changes taking place.
  - One example of mechanical weathering is **Freeze-thaw**. This is where water enters cracks in rocks and then the water **freezes** overnight during the winter. As it freezes, **water expands by around 10%** in volume which increases the pressure acting on a rock, causing cracks to develop. Over time these cracks grow, weakening the cliff making is more vulnerable to other processes of erosion.

- **Chemical weathering -** the breakdown of rocks through chemical reactions. The most common type of chemical weathering is **carbonation**, where **acid rain** reacts with **calcium carbonate** in rocks to form a chemical compound which can then be easily dissolved.

- **Biological Weathering** - the breakdown of rocks due to the actions of plants, bacteria and animals

Mass Movement

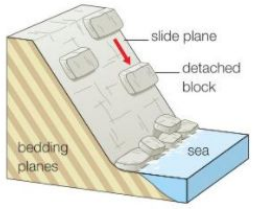
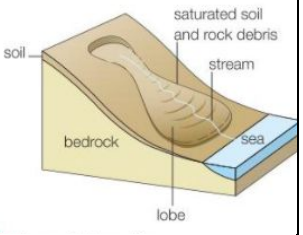
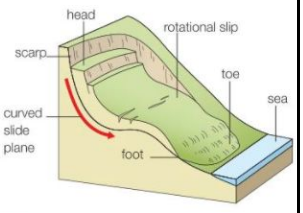
There are several types of **mass movement**, which tend to be determined by the **weight** of the sediment and its **ability to flow downhill**.

The type of mass movement that occurs depends on:

- the **angle** of the slope/cliff
- the rock type (**lithology**)
- the **saturation** of the ground from previous rain or flooding

You can tell the type of mass movement based on the shape of the cliff or rock face:

- **Rock falls** - Occur on sloped cliffs (over 40° to the beach floor) when the rock becomes exposed to mechanical weathering (often freeze thaw).
- **Landslides** - Water between sheets of rock (called **bedding planes**) and the rock face reduces friction and allows large chunks of rock to slide down the cliff.
- **Mudflow** - Saturated (waterlogged) soil flows down the face of a hill like a fluid, bulging at the bottom in a **lobe**.
- **Rotational Slip** - Also known as **slumps**, soil and rock fragments become saturated with water. However, instead of sprawling down the hill like a mudflow, chunks of rock and soil slip, creating stepped 'heads' down the cliff face.

			
Rock Fall	**Landslide**	**Mudflow**	**Rotational Slip**

Coastal Development and Management

Human Activities on the Coast

Many coastlines are habitable and a good source of income. Many major towns and cities in the UK can be found on the coast and human activities at these locations will affect the natural environment and coastline:

- **Housing** - Coastal towns and villages are **popular** to live in, due to the **natural beauty** and 'quieter' lifestyle compared to a busy city. However, as the demand for coastal housing increases, house prices increase and new housing estates develop. The quiet town will **sprawl** and increase in size, losing its **quiet charm**.
- **Tourism** - Coastlines are a **tourist attraction**, with many people travelling to stay on the shores for their **holidays**, visit the beaches or promenades or to do **water sports** and sea activities (boating, scuba diving/snorkelling, surfing, etc). This brings both benefits and problems to coastal towns; many locals rely on tourism for **income and employment**, but tourists can overcrowd these towns with **traffic and pollution**.
- **Business Offices** - Some businesses are **relocating** their offices to the coast, to avoid the high rent prices in the city centre. This brings **regular income** for the locals, but new building developments can **destroy the natural environment** and increase the number of people living and commuting to a coastal town.
- **Agriculture** - As the price of land at the coast rises, farmers have to **increase their profits** with what land they have. This adds **pressure** to the land, since farmers will more intensively farm to make more profit. This means they don't let the land rest between crop harvests (called a **fallow**) or they rear too much cattle, which tramples the ground and removes much vegetation.
- **Industry** - There are many major **industrial plants** found along the coast, as some industry requires a large volume of water during an industrial process. Industry such as **oil refineries** and **power stations** can be found close to the sea. These sites are of **high economic value** and so must be protected from risks at the coast.

The picture on the right shows **Brighton** which is home to **290,000 people**. It's a vibrant city which has **two universities** and a large student population.

According to the Brighton & Hove council website the economy comprises **140,000 jobs** and **16,000 businesses**.

The city attracts over **11 million** trips a year which adds nearly **£886 million** to the local economy.

Source: The Financial Times

Risks to the Coastline

At the coast, there is a risk that property and the environment becomes flooded. This normally occurs during extreme weather:

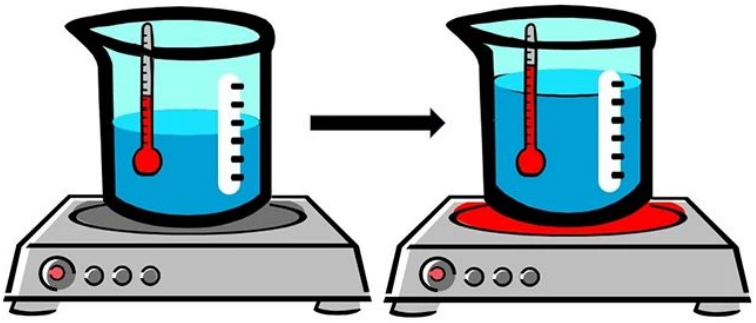
- The **air pressure drops** due to a low pressure weather system
- If the pressure drops, the sea is pulled upwards which forms **storm surges**
- Storm surges are tall waves, which can overflow onto the land when they reach the coast, causing **flooding**

The picture on the left shows the effect of a huge **storm surge** which hit **Morecambe Bay, Lancashire** in 2013.

https://photographingnorth.wordpress.com/2013/12/07/largest-storm-surge-in-60-years-hits-morecambes-promenade/

The risk of **coastal flooding** will increase due to **global warming**.

➔ Global warming causes the **sea levels to rise** around the world as the seas warm up and expand (this is called **thermal expansion**). For low lying coastlines, this may mean some coastal towns and villages become at risk of more flooding as they are at sea-level.



Source: https://fireball.ca/blogs/news/thermal-expansion-lubrication-systems

➔ For small tropical islands and some coastal settlements, the sea level may rise to flood the town permanently. This means the locals will lose their homes under water and will have to **migrate** elsewhere.

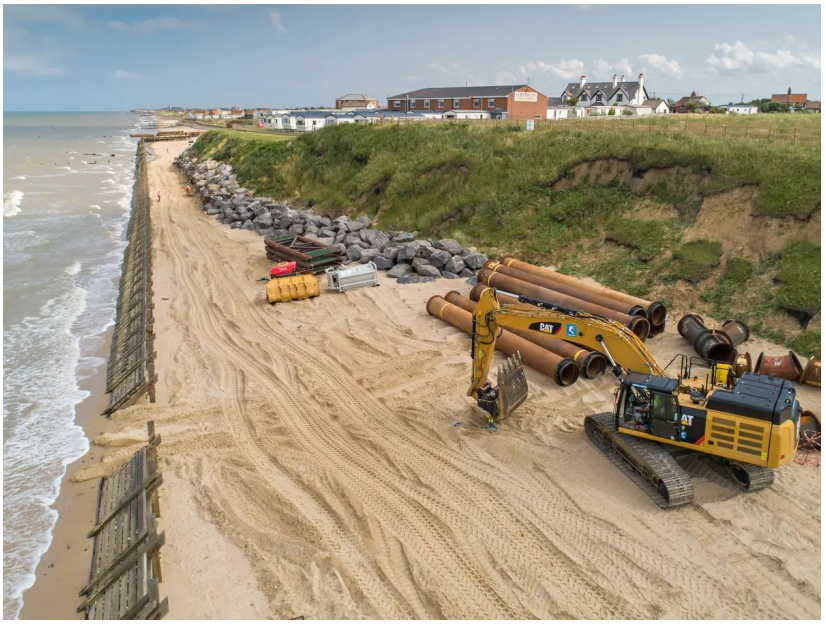
➔ Global warming will also increase the **frequency of extreme weather**, such as **hurricanes** and low pressure weather systems, which in turn cause more **storm surges**.

➔ The coastline is also at risk from **erosion**, which could accelerate as the **sea levels rise** and more cliff faces become exposed to erosional processes. If houses or businesses are built on these cliffs, the risk of them falling into the sea increases.

Some property is more at **risk from collapsing** into the sea than others. This is due to:

- The **geology** of the cliffs - Soft rocks will erode quicker than hard rocks. For example, chalk erodes more quickly than granite.
- **Increased weathering** on the top of the cliff - More vegetation growing, walkers trampling the rocks or increased cold weather can all weaken the rock face from the top, increasing its risk of collapse.
- The type of **waves** hitting the cliff face - Destructive waves will increase erosion more than constructive waves. In addition, waves that have travelled further from where they originated from (they have a long fetch) tend to be more powerful, and so erode the cliffs more.

However, some coastal settlements are **managing** this risk and constructing **coastal defences** to protect their property.



This picture is from an area of the **Norfolk coastline** near **Bacton** which is being protected from erosion by the creation of **artificial sand dunes**.

www.theguardian.com/environment/2019/sep/20/norfolk-slows-down-coastal-erosion-with-sandscaping-scheme

Coastal Management Strategies

Coasts are important places for the people that live there, who work and earn money from tourism and for the wildlife and habitats that exist along the coastline. Therefore management is important to protect certain areas of coastline from coastal flooding or high rates of erosion.

There are three types of management - **hard engineering, soft engineering** and **managed retreat**.

- **Hard engineering** uses man-made, artificial structures to reduce or halt erosion. They are often very effective at preventing erosion in the desired area, but are high cost and have a **significant environmental impact due to the use of concrete** and other man-made materials.
- **Soft engineering** uses more natural materials to reduce erosion, in a more environmentally friendly way. Unlike hard engineering, soft engineering aims to **complement the physical environment** by using natural methods of coastal defence. They are useful for protecting against sea-level change as well as coastal erosion.

➔ **Managed retreat** is to allow erosion rates to carry on unchanged, but instead monitor the rates and try to adapt in the future. This is becoming **more popular** since the cost of hard and soft engineering is too much for local councils. However, individual cases can often be ignored to save money: for example, a few houses may be lost in managed retreat instead of using engineering to save them.

There are many factors to consider when choosing the most **appropriate** management strategy:

- The value of the land for the **economy**:
  - How many jobs depend on the coast?
  - Will industry be lost if erosion continues?
  - What will the insurance cost be of damaged properties (if buildings collapse into the sea or become flooded)?

- The **cultural or social** value:
  - Is the coast historic or a location of cultural/religious importance?
  - Do events or festivals happen here, and on what scale do they affect lives (locally, national, international events)?
  - Is the coast home to a village or town? Will these people need to migrate and live elsewhere if erosion continues?

- The **environmental** value:
  - Are there any rare or endangered species living along the coastline?
  - Would nature reserves become at risk if erosion and flooding continues?
  - Are there any farms at risk? What would happen to the cattle?

It is important to note that managing a section of coastline will have a **knock on effect** further down the coastline. For example, groynes trap sediment in front of a town. This stops the sediment from being transported down the coast and being deposited elsewhere. This means that the area down the coast where deposition was meant to take place won't get replenished and will instead become eroded. This is called **terminal groyne syndrome**.

Types of Defences

Soft Engineering

Dune Stabilisation

Source: Wikipedia

Description: Marram grass planted. The roots help bind the dunes, protecting land behind. Fences can be put in place to catch the wind too.

- 👍 Cost effective and creates an important wildlife habitat
- 👍 Relatively cheap and minimum impact on the natural environment
- 👎 Planting is time consuming
- 👎 Can easily be damaged in a storm

Beach Nourishment

Source: Downbeach Buzz

Description: Sand is added to the beach to replace the material lost through erosion and transportation.

- 👍 Maintains the beach, which is a major tourist attraction
- 👍 This blends in with the rest of the beach, so isn't unattractive
- 👎 Large quantities of sand needed on a regular basis

Hard Engineering

Groynes

Source: Tripadvisor

Description: Timber or rock protrusions that trap sediment from LSD

- 👍 Builds up beach, protecting cliff and increasing tourist potential
- 👍 Cost effective
- 👎 Visually unappealling
- 👎 Deprives areas downwind of sediment increasing erosion elsewhere

Sea Walls

Source: Southampton University

Description: Concrete structures that absorb and reflect wave energy, with curved surface

- 👍 Effective erosion prevention
- 👍 Promenade has tourism benefits
- 👎 Visually unappealling
- 👎 Expensive to construct and maintain
- 👎 Wave energy reflected elsewhere, with impacts on erosion rates

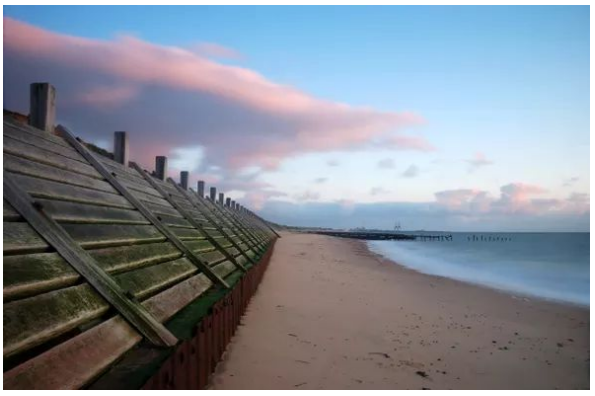
Rip Rap (Rock Armour)

Source: Stacey.Peak-Media

Description: Large rocks that reduce wave energy, but allow water to flow through

- 👍 Cost effective
- 👎 Rocks are sourced from elsewhere, so do not fit with local geology
- 👎 Pose a hazard if climbed upon

Revetments



Source: Geographical.co.uk

Description: Wooden or concrete ramps that help absorb wave energy

- 👍 Cost effective
- 👎 Visually unappealling
- 👎 Can need constant maintenance, which creates an additional cost