SL IB Geography

Your notes

5.2 Interactions Between Oceans & Coastal Places

Contents

5.2.1 Physical Influences on Coastal Landscapes

Your notes

Waves & Tides

Waves

- Waves form our coastlines through erosion, deposition and transportation
- Wind causes waves to move over the **surface** of the sea:
  - Wind creates friction, causing the water to ripple
  - These ripples grow into waves
- Waves can have different **energy levels** depending on:
  - Wind **strength**
  - The **length of time** the wind blows
  - The **fetch** (the distance the wave has travelled)
- If the fetch is larger, the wave will be more powerful
- If the wind is powerful and blows over a longer period, the wave will be larger
- The **swash** is when a wave moves up the beach
- The **backwash** is when the wave pulls back out to the ocean
- Waves slow down as they reach a coastline and the water becomes shallower:
  - The bottom of the wave experiences friction with the seabed below
  - The top part of the wave (**crest**) gains momentum, pushing over the bottom of the wave
  - This is when the wave will **break**

Diagram of a wave

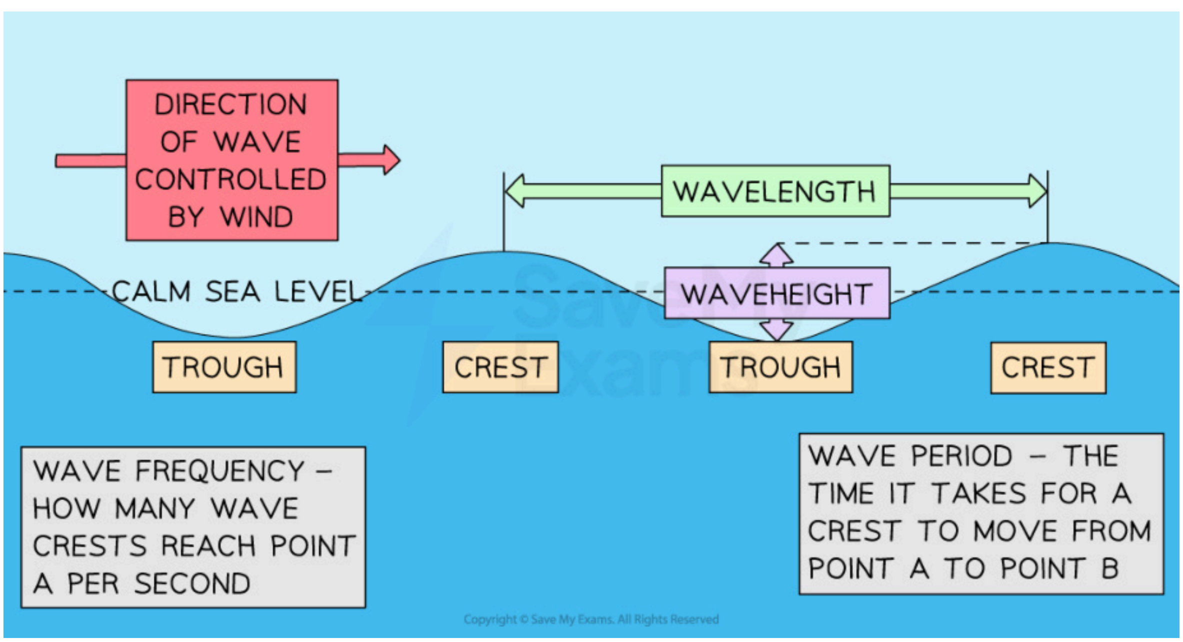


Diagram of a wave

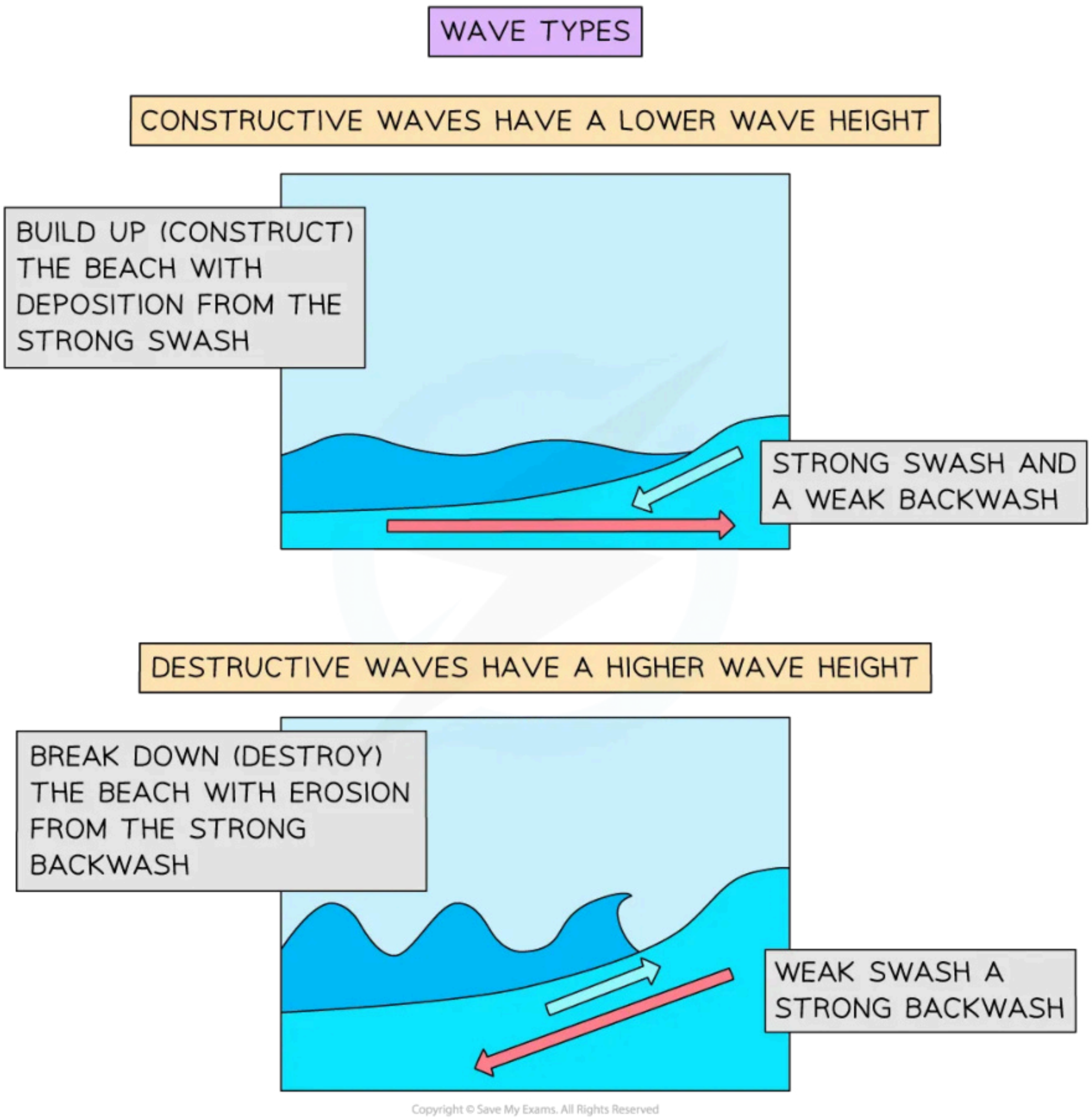
Your notes

- There are two types of waves:
  - **Constructive** waves – constructive waves construct or build up beaches through deposition processes
  - **Destructive** waves – destructive waves destroy the coastline through erosion processes

Table comparing constructive and destructive waves

	Constructive Wave	Destructive Wave
Swash	Strong	Weak
Backwash	Weak	Strong
Wavelength	Long with low height	Short with high height
Frequency	Low (6–8 per minute)	High (10–12 per minute)
Type of beach	Sandy - depositional	Shingle - erosional
Fetch	Small fetch	large fetch

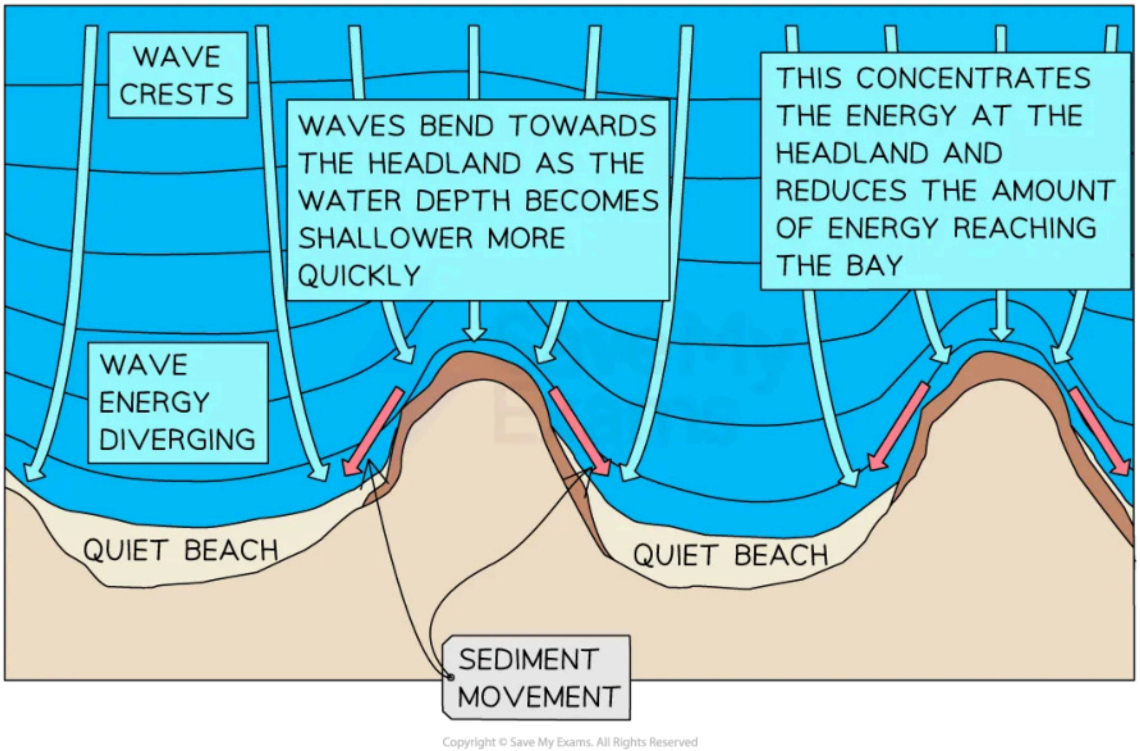
Your notes



- Waves can reflect, refract, diffract and interfere:
  - Waves can change direction when they slow down through **refraction**, often seen at headlands and bays

Diagram showing wave refraction

Your notes



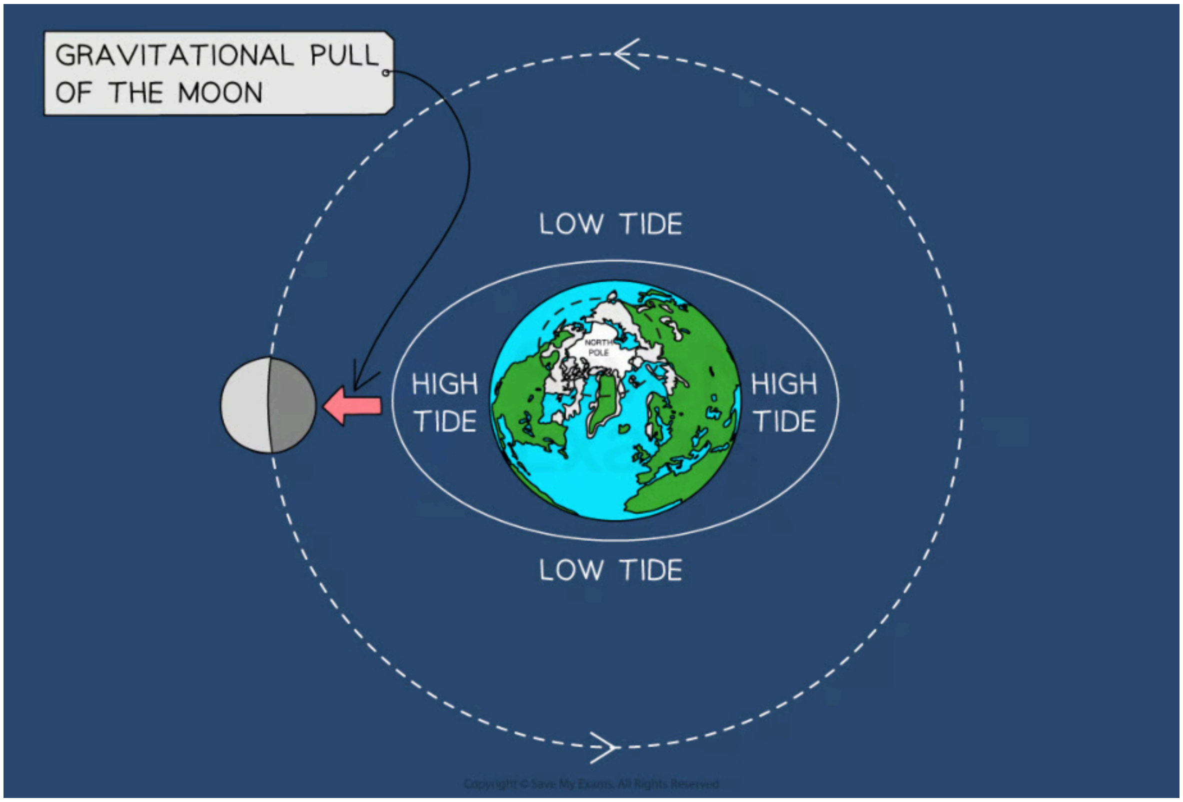
Wave refraction

- Waves can **reflect**, typically seen if a wave collides with a cliff
- Two waves from different directions may meet, causing wave **interference**
- Waves can also bend, or **diffract**, when they meet an obstacle or a gap

Tides

- Tides are when the surface of the sea moves up and down
- **Gravitational pull** (from the moon) controls tidal movements
- The **rotation of the earth** causes different tidal patterns across the globe
- When the water reaches its highest level, this is **high tide**:
  - As different areas of the earth face the moon, gravity will pull the ocean in the moon's direction
  - Directly on the other side of the earth, high tide will also occur
  - High tide causes ocean waters to **bulge** outwards
  - High tide causes the water to **spread** up the coastline
- As the water sinks back to its lowest level, this is **low tide**:
  - Low tides are located between the two high tides
- The difference between high and low tide is the **tidal range**
- **Spring tides** occur if the moon, earth and sun all line up, causing tides to be higher
- **Neap tides** occur when the moon, earth and sun are at right angles to each other, causing tides to be lower

Tidal differences as the earth rotates



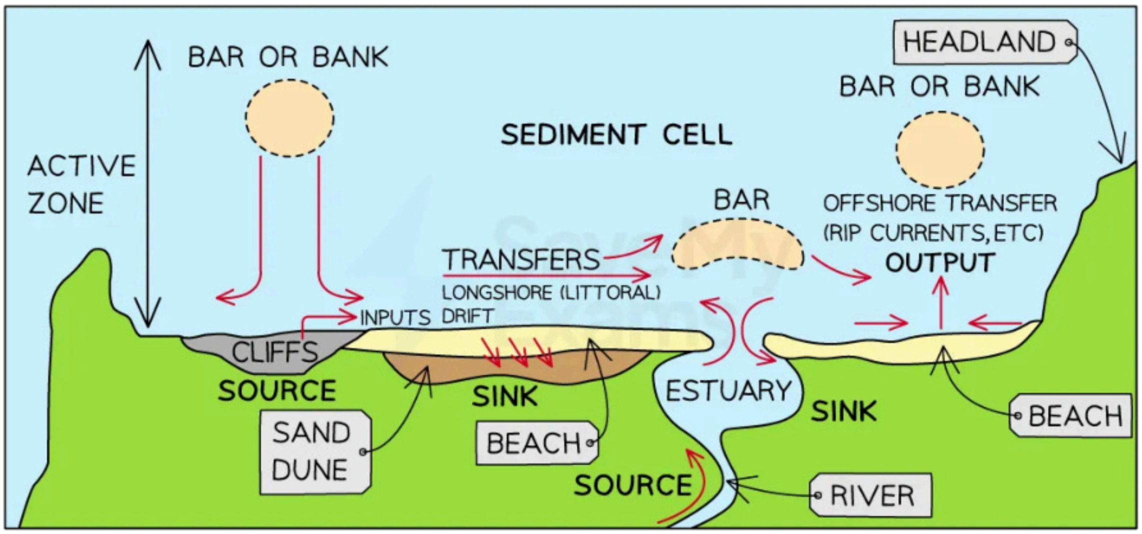
Tidal differences as the earth rotates

Your notes

Sediment Supply

- Sediment is the material on a coastline, e.g. sand, shells, silt
- The coast is a **system** of inputs, transfers and outputs of sediment:
  - **Sediment cells** (littoral cells) are areas of coastline where this system takes place
  - Sediment moves around in each cell
  - Each cell is typically a **closed system** that recycles sediment

Diagram of a sediment cell

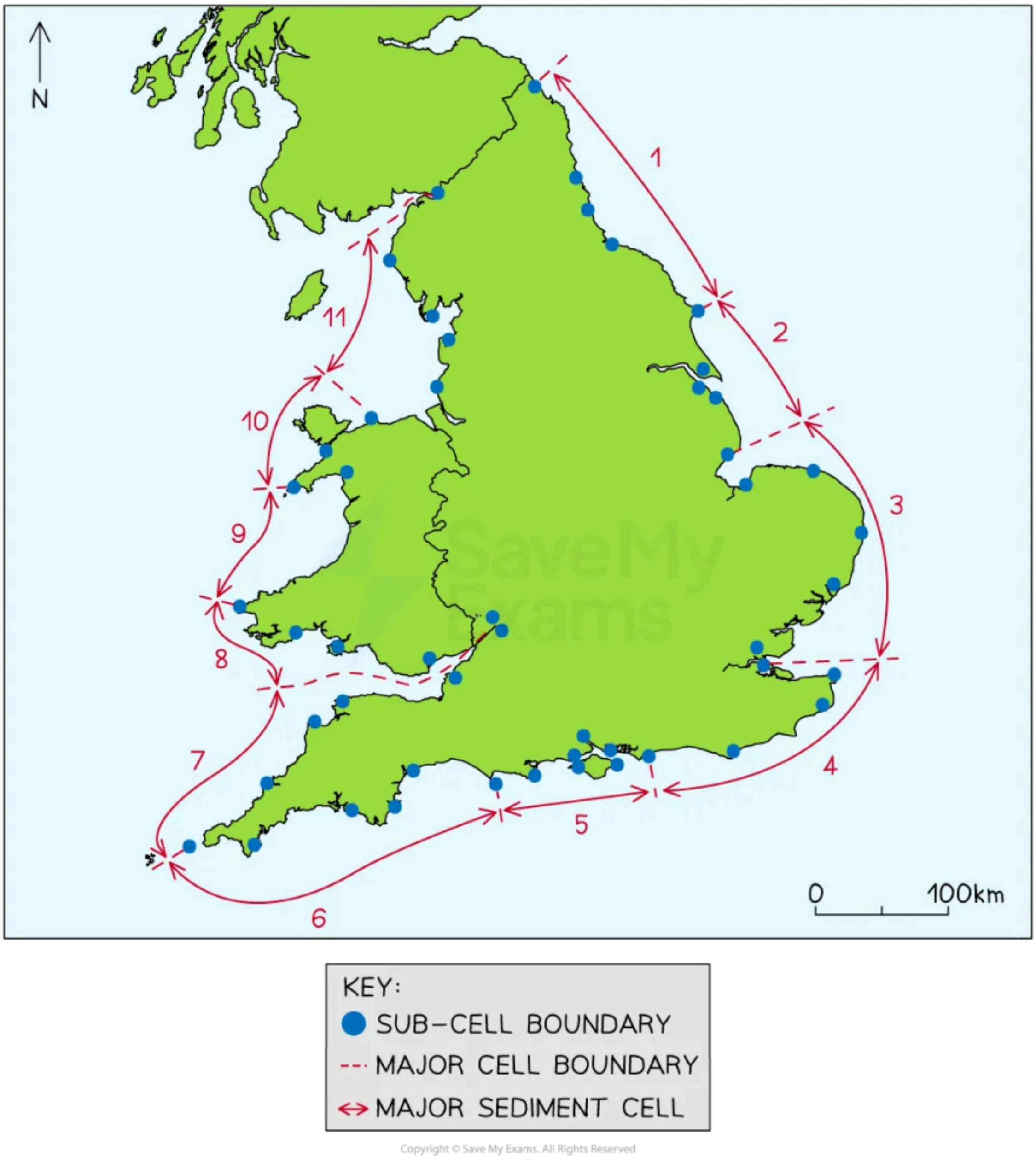


A sediment cell

- Sediment supplies and sources (**inputs**) come from:
  - Rivers
  - Erosional processes and mass movement
  - Onshore currents
  - Subaerial processes (weathering)
  - Aeolian processes (wind)
  - Biological processes (particles from dead marine life)
  - Human activity (hard and soft engineering)
- Sediment transfers occur along the coastline by:
  - **Longshore drift**
  - **Swash** and **backwash**
  - Wind
  - Ocean and tidal currents
- **Output** of sediment occurs through:
  - **Deposition**. It produces **sinks** (depositional landforms)
  - Ocean currents

Your notes

Sediment cells of England and Wales



Map showing the sediment cells of England and Wales

- The **sediment budget** is the balance of sediment that enters and exits the system
  - If more sediment enters than exits the system, this will produce a **positive** sediment budget
  - A **negative** sediment budget occurs when more sediment exits than enters the system

Your notes

- The system is in **equilibrium** when inputs and outputs are in balance. Sediment moves equally through the system
- Changes to inputs and outputs affect the sediment budget
- **Positive and negative feedback loops** can alter the equilibrium by heightening and balancing changes within the system:
  - **Positive feedback** can cause instability, moving the system out of equilibrium
  - **Negative feedback** brings the system back into equilibrium

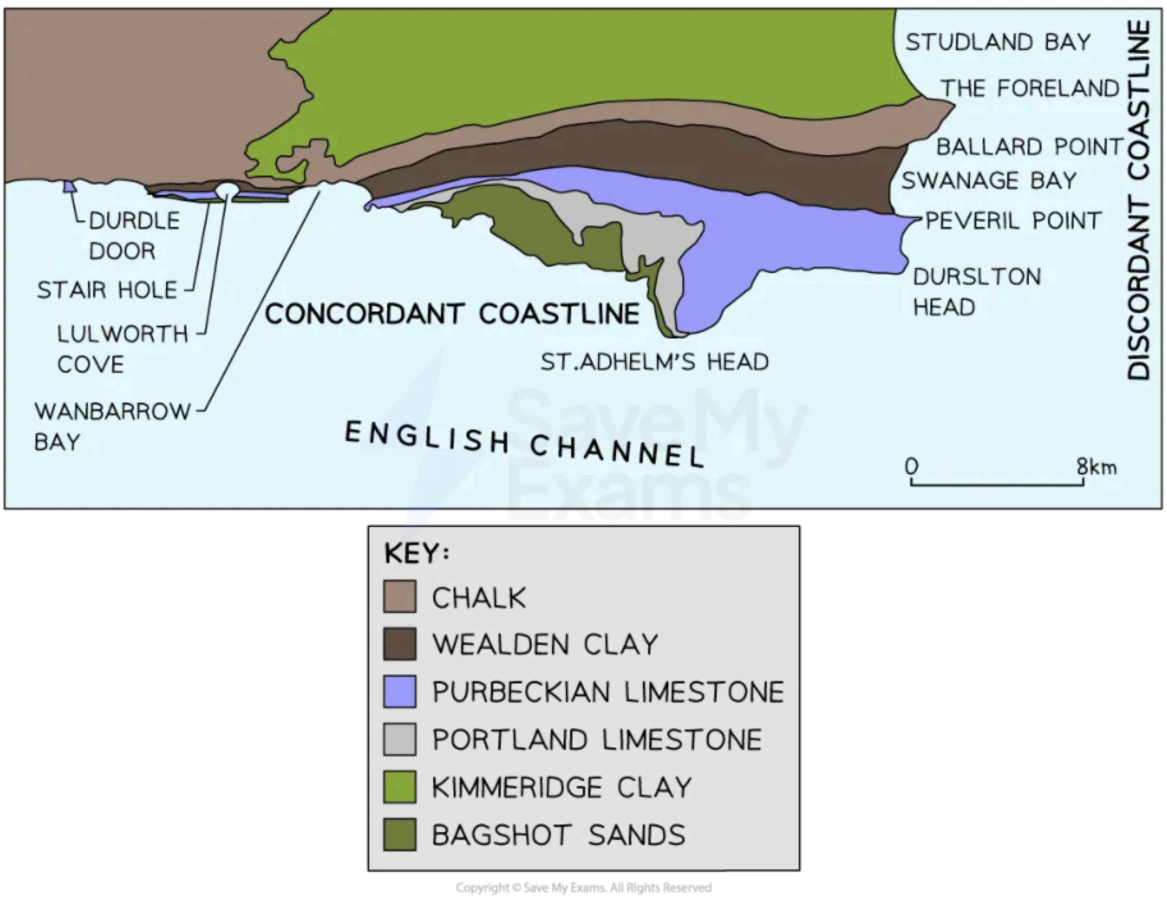
Exam Tip

Think about what could impact the equilibrium of the sediment budget. For example, climate change, weather differences and human activity like coastal management.

Coastal Lithology

- **Lithology** is the study of the physical characteristics of rocks
- **Discordant** coastlines contain both hard and soft rock types:
  - Discordant coastlines have more bays and headlands
- **Concordant** coastlines contain one type of rock

Map showing concordant and discordant coastlines on the south coast of England



Concordant and discordant coastlines

- The **rate of recession** describes the speed at which coastlines retreat
- **Sedimentary** rocks, like sandstone, erode more easily:
  - Softer rocks contain more **faults**, like cracks, which increase the rate of erosion
  - Rocks like limestone are more vulnerable to **chemical weathering**
  - They are clastic rocks
  - Rocks like gravel or sand are not cemented well together, making erosion easier
  - Sedimentary rocks will likely form bays or beaches as waves easily erode the cliff
- **Igneous** rocks, like granite, are harder to erode:
  - They are formed of interlocking crystals which are more resistant to erosion

Your notes

    - There are fewer weaknesses and faults
    - Headlands will more likely to form due to erosion resistance
- **Metamorphic** rocks are not eroded as easily:
    - They contain **crystals**, which reduce the rate of erosion
- The type of rock on a cliff face can also impact the shape of the cliff

Table showing rock type and its effect on cliff shape

	Hard Rock	Soft Rock
Shape of cliff	High and steep	Generally lower and less steep
Cliff face	Bare rock and rugged	Smoother, evidence of slumping
Foot of cliff	Boulders and rocks	Few rocks; some sand and mud

Coastal Vegetation

- Vegetation is vital for **stabilising** coastlines
- Vegetation reduces the coastline's vulnerability to erosion and increases deposition:
    - Roots of plants can **bind** the sediment together
    - Stems and leaves **protect** the ground
    - Plants **shelter** the sediment from the wind
    - Plants can help to **slow down** wind and water, increasing deposition
    - Once vegetation dies, organic matter is **recycled** back into the soil
    - Vegetation protects coastal landforms like sand dunes, salt marshes and mangroves
- Coastlines are harsh environments for vegetation e.g. high salt levels
- Hardy, adaptable plants colonise areas like this
- If a landform has existed for a long time, plants will more likely colonise
- **Plant succession** is the colonisation and development of new plants:
    - Pioneer plants **colonise** in bare environments, e.g. sediment
    - They help to **stabilise** the sediment and improve the fertility of the soil
    - Other species can then begin to colonise
    - As more species colonise, the **hardier** they become
    - The **climax community** settles at the end of the succession

5.2.2 Coastal Processes

Your notes

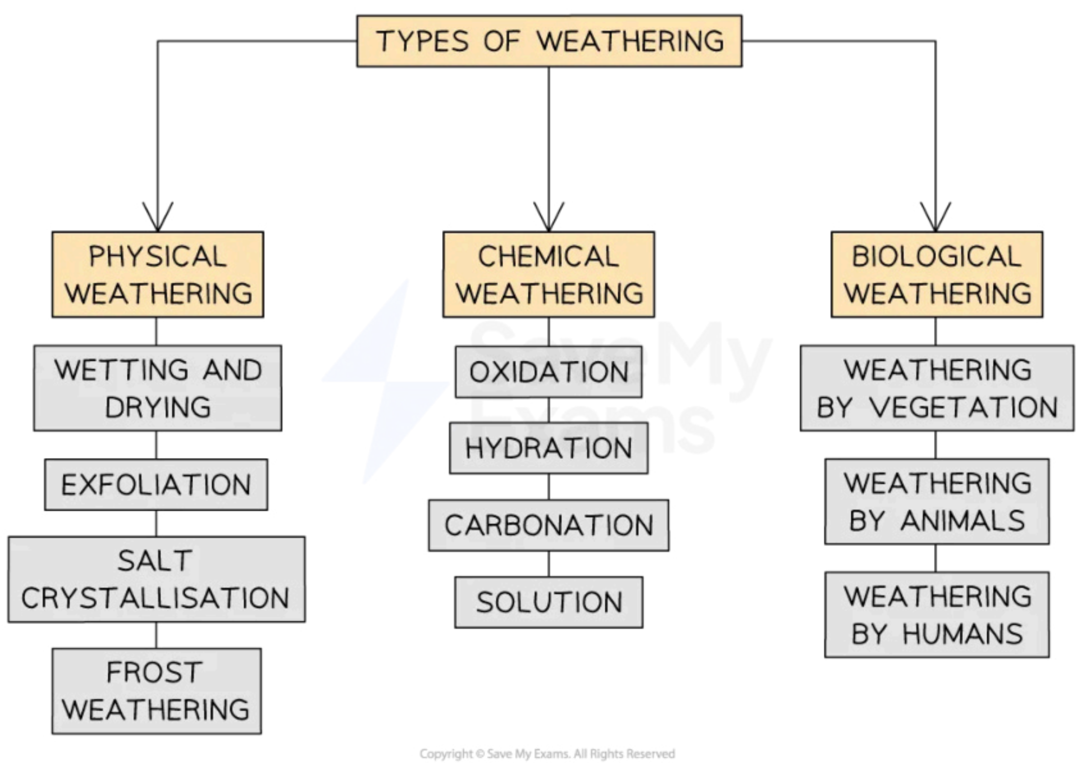
Sub-aerial processes

- **Sub-aerial processes** occur on the land
- These processes shape our coastlines

Weathering

- When weathered, rocks disintegrate or break down in situ
- Weathering impacts **sediment** on the coastline
- Weathering also influences the **rate of recession**
- The different types of weathering are:
  - **Mechanical** (physical) – rocks fracture and break into pieces
  - **Chemical** – chemical reactions cause rocks to degrade
  - **Biological** – animals and plants cause rocks to weaken

The types of weathering and causes



The types of weathering and causes

Mechanical weathering

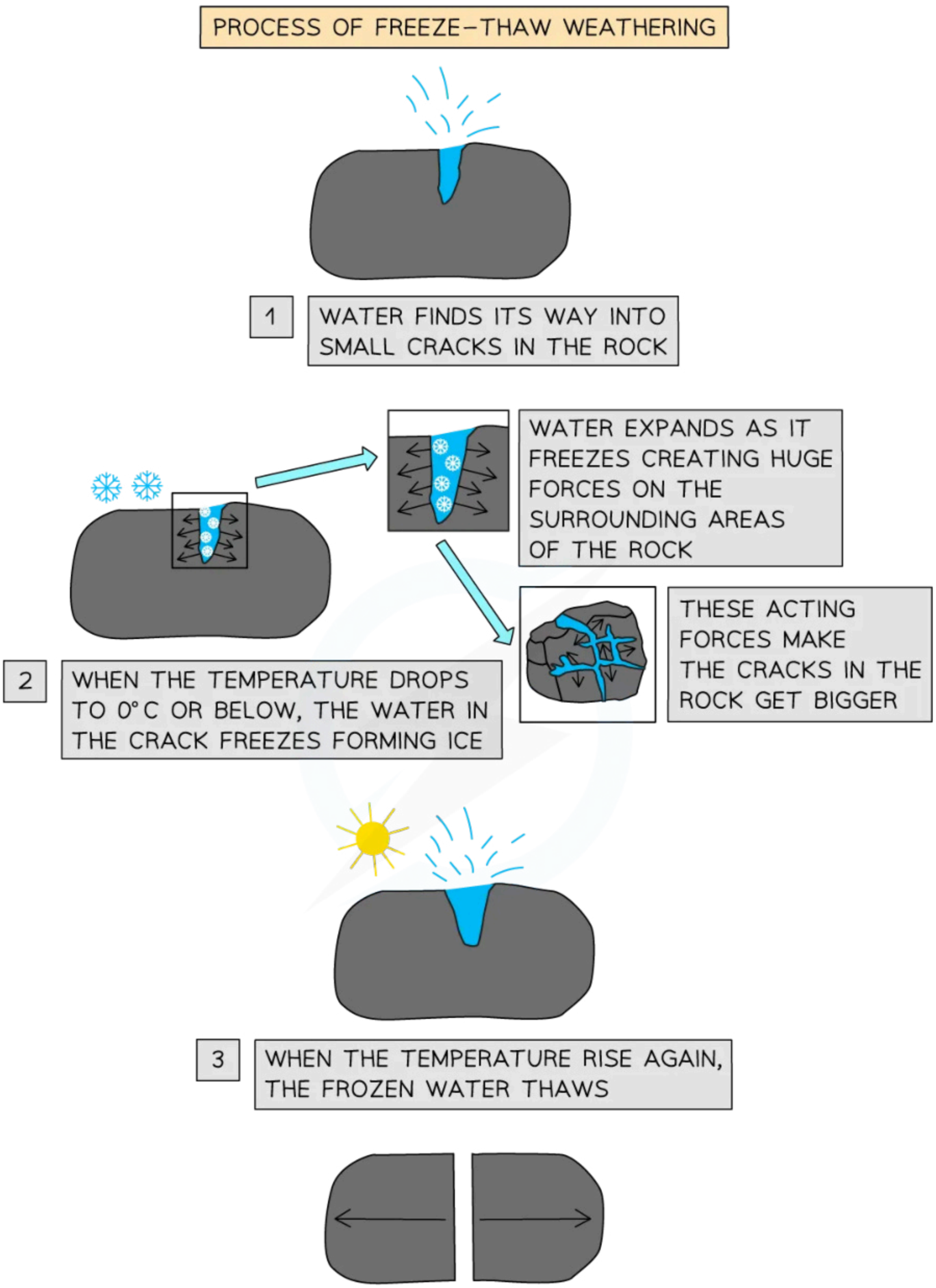
- **Freeze-thaw weathering** occurs when water finds its way into the cracks in the rock

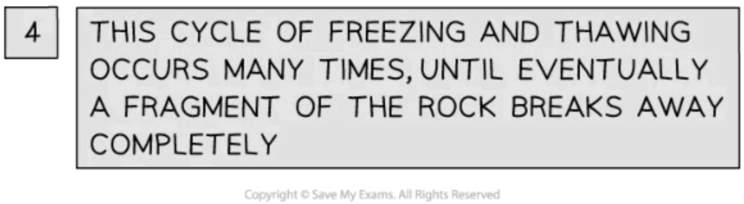
- Water **freezes** and **expands** (roughly 10%), increasing the **pressure** on the surrounding rock
- Water then **thaws** and moves further down into the gaps and cracks
- As this process repeats, the rock will eventually give way and break
- This typically occurs during **colder** months

Your notes

The process of freeze-thaw weathering

Your notes


PROCESS OF FREEZE–THAW WEATHERING
1
WATER FINDS ITS WAY INTO SMALL CRACKS IN THE ROCK
WATER EXPANDS AS IT FREEZES CREATING HUGE FORCES ON THE SURROUNDING AREAS OF THE ROCK
THESE ACTING FORCES MAKE THE CRACKS IN THE ROCK GET BIGGER
2
WHEN THE TEMPERATURE DROPS TO 0°C OR BELOW, THE WATER IN THE CRACK FREEZES FORMING ICE
3
WHEN THE TEMPERATURE RISE AGAIN, THE FROZEN WATER THAWS



The process of freeze-thaw weathering

- **Salt Crystallization**
  - Salt crystals can enter cracks in the rock through **deposition** or **evaporation**
  - Water enters cracks at high tide and evaporates at low tide
  - This leaves **salt crystals** behind, which build up over time
  - The increase in salt can put pressure on the surrounding rock, causing it to break

- **Wetting and drying**
  - This process typically affects clay-type rocks
  - Rocks get wet during high tide and **expand**
  - As they dry, they **contract**
  - As this process repeats, the rock can fragment and break

Chemical weathering

- **Oxidation** – Oxygen can react with other chemicals, e.g. calcium to form **iron oxide**. This causes the rock to degrade
- **Hydration** – rocks absorb minerals, which can create **crystals**. Just like salt crystals, they cause the rock to break
- **Carbonation** – as carbon dioxide reacts with seawater, it produces **carbonic acid**, which damages the rock
- **Solution** – some minerals can **dissolve** when they come into contact with water, causing the rock to break down. This is commonly seen with **acid rain**

Biological weathering

- Animals, vegetation (and even humans) can cause rocks to break down
  - Tree **roots** can grow from small cracks in the rock and exert pressure. This causes the rock to break
  - Some creatures **bore** into rocks, causing weaknesses
  - Some plants and animals can produce **acids** that wear away the rock

Mass movement

- Mass movement moves material downwards due to the force of **gravity**
- There are many different types of mass movement
- Factors determining the amount of mass movement include:
  - **Sediment** type or size
  - Amount of **water**
  - Presence of **vegetation**
  - **Speed** of movement (how steep the slopes are)
- **Soil creep**

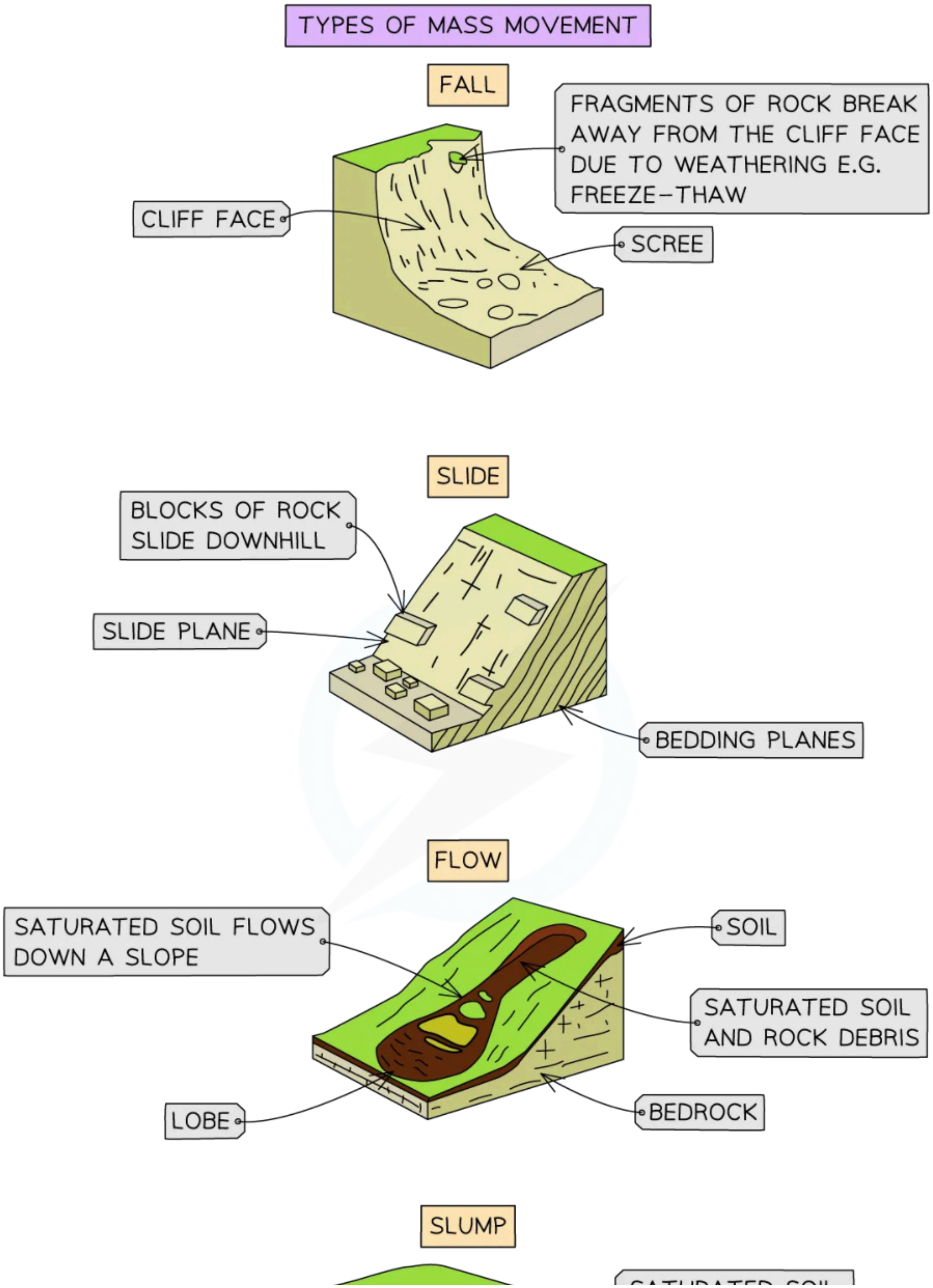
Your notes

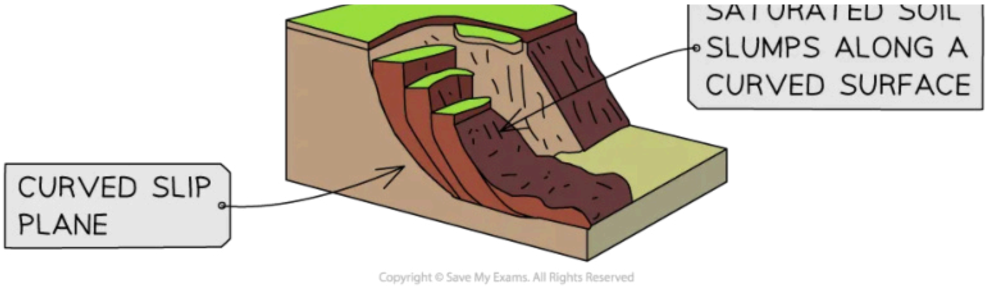
Your notes

    - This is a very slow process
    - This occurs on **gentle** slopes
    - The material expands and contracts when in contact with water or ice
    - This expansion moves the material downwards
- **Earth flows and mudflows**
    - Soil moves downhill when it has become **saturated** with water
    - Earth flows act like a **liquid**
    - This leaves behind a **depression** at the top and a **lobe** shape at the bottom
    - Mudflows occur when the material is **extremely wet**

- **Landslides**
    - A **large chunk** of material moves down a slope
    - It splits into smaller pieces of material when it reaches the bottom of a slope
    - This is very common when slopes are **steep**
- **Slumping**
    - **Rotational slumping or slip** is very common at the coastline
    - The material moves as a single piece downwards, leaving behind a curved gap
    - It occurs when weaker rocks or rocks made of unconsolidated materials become saturated with water
- **Rockfall**
    - Rocks can fall downwards at steeper slopes
    - This is typically caused by **freeze-thaw weathering**
    - It leaves scree behind at the base

Types of mass movement


TYPES OF MASS MOVEMENT
FALL
FRAGMENTS OF ROCK BREAK AWAY FROM THE CLIFF FACE DUE TO WEATHERING E.G. FREEZE–THAW
CLIFF FACE
SCREE
SLIDE
BLOCKS OF ROCK SLIDE DOWNHILL
SLIDE PLANE
BEDDING PLANES
FLOW
SATURATED SOIL FLOWS DOWN A SLOPE
SOIL
SATURATED SOIL AND ROCK DEBRIS
LOBE
BEDROCK
SLUMP



Types of mass movement

Your notes

Exam Tip

To help you remember the different types of mass movement, try splitting them up into these four categories: fall, slide, flow and slump.

Your notes

Wave processes

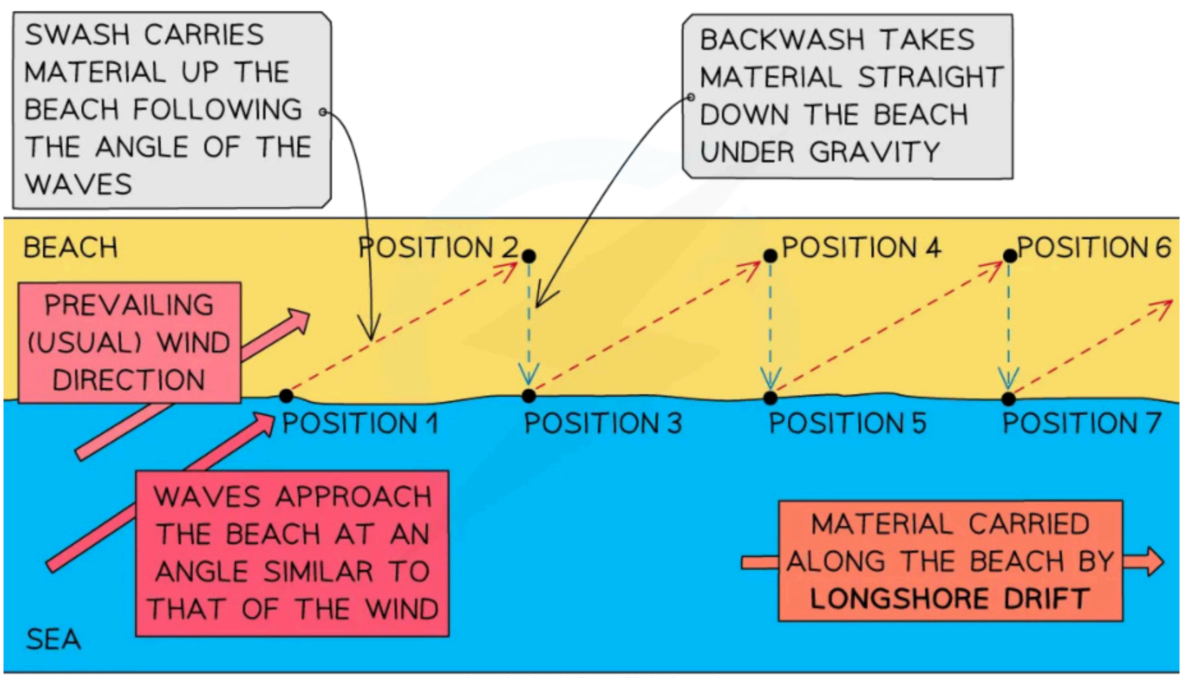
- Wave processes **transfer**, **erode** and **deposit** material at the coast
- Wave processes are responsible for shaping the coastline

Littoral drift

- Littoral drift is also known as **longshore drift**
- This is the main process in which waves **transport** and **deposit** sediment
- Waves hit the coastline at an **angle** due to **prevailing wind** forces
- Swash carries material up the shore and **backwash** brings the material back towards the sea at a **right angle** (gravity)
- Material moves along the beach through the wave processes of:
  - **Traction** – large rocks roll along the seafloor
  - **Saltation** – smaller rocks or pebbles bounce on the seafloor
  - **Suspension** – small particles of sediment float in the water
  - **Solution** – the water carries dissolved material
- Longshore (littoral) drift creates depositional landforms along the coast, such as **spits**

> **Exam Tip**
>
> make sure you know how the process of littoral drift works. You may be asked to describe what kind of landforms it creates!

The process of littoral drift



The process of littoral drift

Your notes

Hydraulic action

- **Destructive waves** with **high energy** can cause the rock to break from the impact
- Destructive waves can also force air into the cracks and faults in the rock
- Changes in **air pressure** cause rocks to crack
- This can cause pieces of rock to break off as the cycle repeats

Abrasion

- Waves carry all types and sizes of sediment
- Destructive, high-energy waves **throw** this sediment against the rock at the coastline
- As this process repeats, chunks of rock break away
- It mirrors **sandpaper**, where smaller pieces of sediment wear away the rock
- **Softer** sedimentary rock is more affected by **abrasion**

5.2.3 Coastal Landforms

Your notes

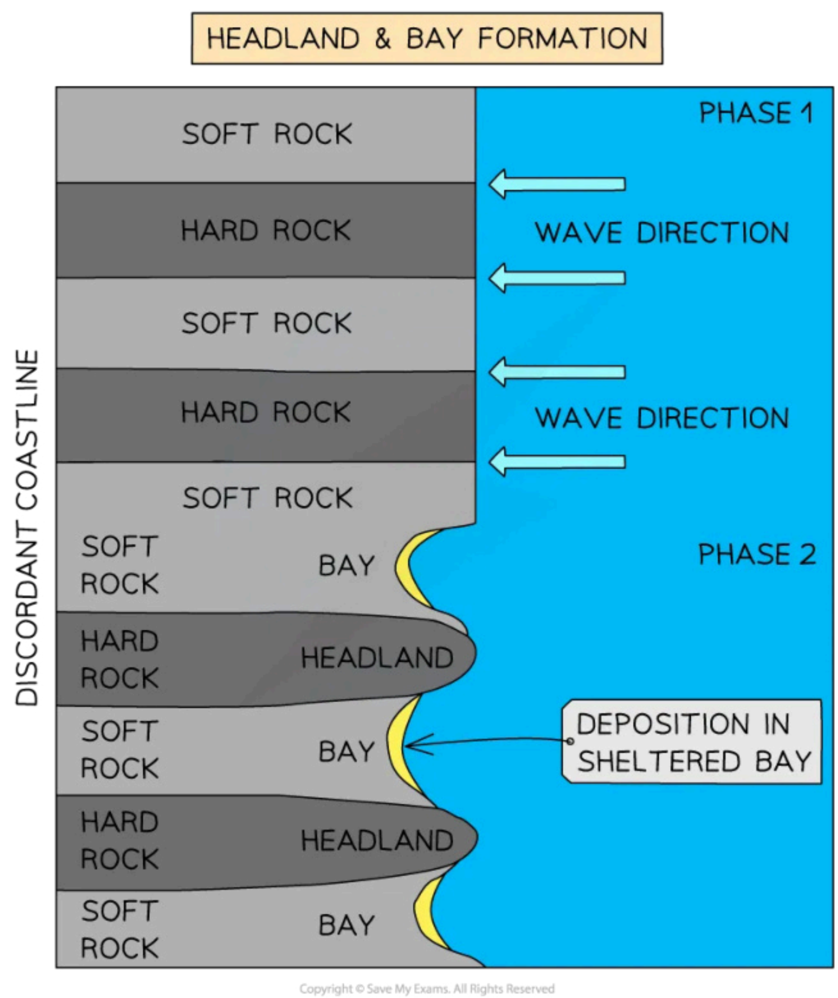
Erosion Landforms

Headlands and bays

- Headlands and bays form at discordant coastlines:
  - Different types of rock alternate along the cliff face
  - The rock runs **perpendicular** to incoming waves
- Softer rocks, like clays, erode more easily than harder rocks, like chalk
- **Bays** form where softer rock is prevalent due to wave erosion:
  - Bays are curved, partly enclosed inlets of water
  - Bays often contain beaches
- Harder, more resistant rocks leave **headlands** sticking out at sea

Formation of a bay and headland

Your notes



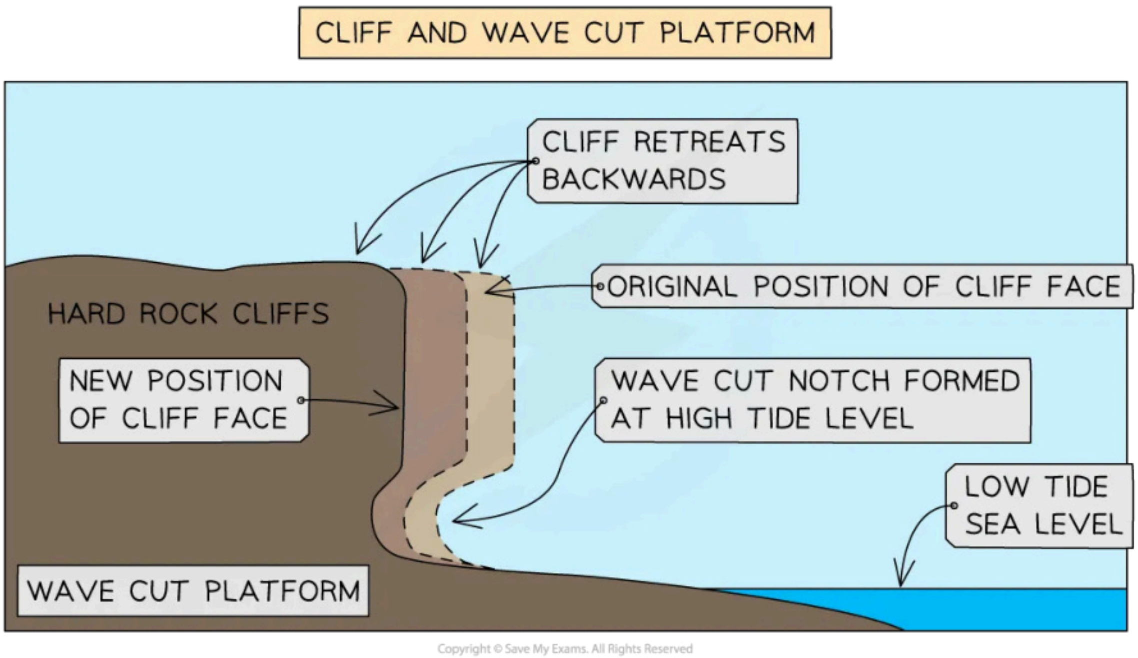
Formation of a bay and headland

Cliffs and wave-cut platforms

- Cliffs are vast walls of rock found on the coastline
- **Constructive waves** and softer sediment help form gentle, sloping cliffs
- **Destructive waves** and resistant rock help form steep cliffs
- **Wave erosion processes**, like **hydraulic action** and **abrasion**, wear away at the base of the cliff
- **Wave refraction** causes the highest wave energy to focus on the headland
- Waves break near the bottom of the cliff, so wave power is stronger
- Repeated erosion at the base of the cliff forms a **wave-cut notch**
- This notch widens with further erosion
- **Sub-aerial weathering** weakens the top of the cliff
- These combined processes cause the top of the cliff to collapse:
  - **Over time**, this process repeats, causing the cliff to retreat

- **Backwash** brings the cliff material outwards towards the sea, forming a **wave-cut platform**

Formation of a wave-cut platform



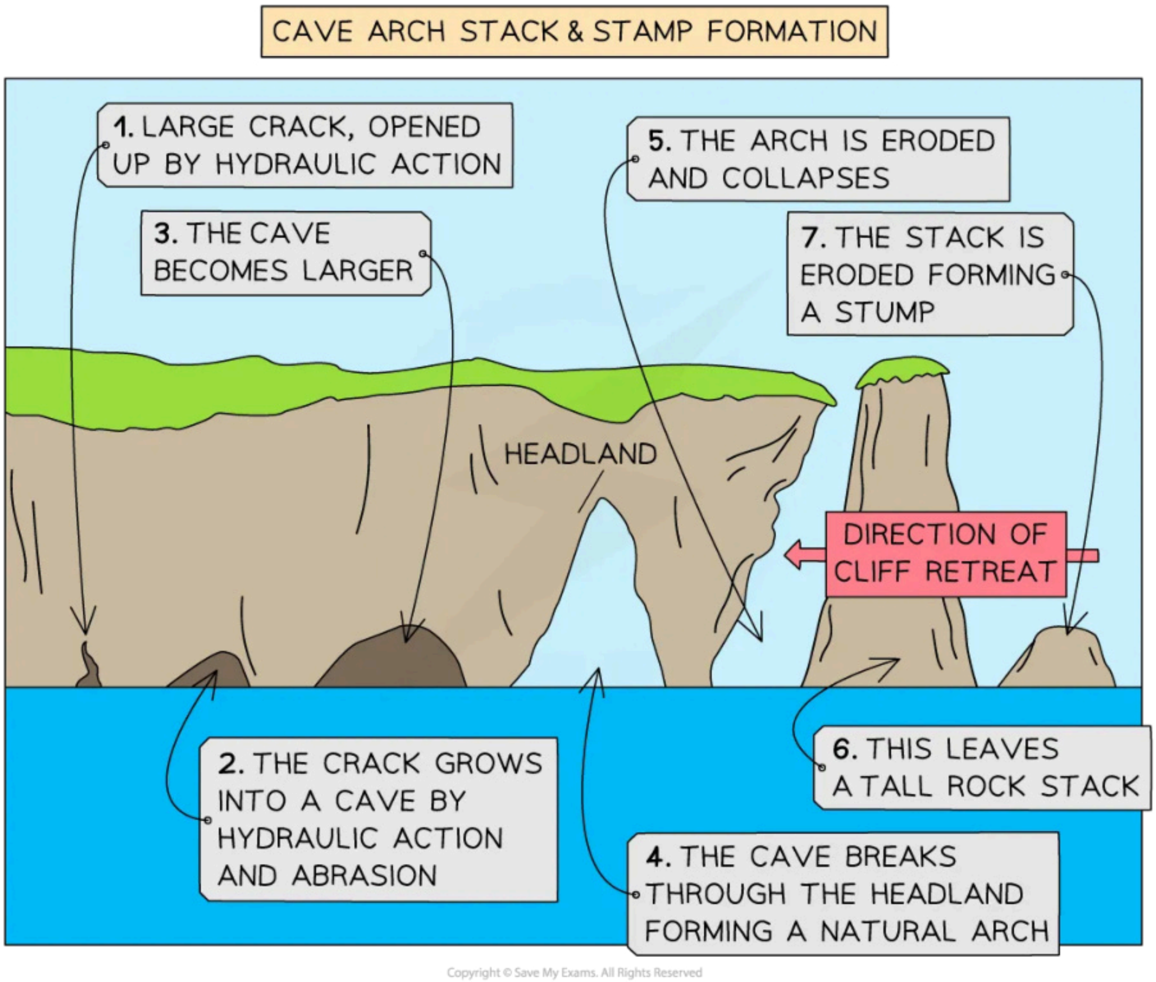
Formation of a wave-cut platform

Cave, arches, stacks and stumps

- **Wave and sub-aerial processes** wear away at headlands, causing weaknesses
- These weaknesses expand into cracks, eventually growing into larger gaps or **caves**
- Continuous erosion and weathering from both sides of the headland will form an **arch**
- With wave erosion at the base and weathering at the top, the arch will give way and collapse
- This leaves behind a long, vertical piece of rock out at sea, called a **stack**
- Erosion undercuts the base of a stack. Weathering continues from above, until the stack collapses, leaving behind a **stump**

Formation of a cave, arch stack and stump

Your notes



The formation process of a cave, arch stack and stump

Exam Tip

Make sure you know what these landforms look like. Practice drawing these landforms with their labels – you might be asked to draw them or analyse an image in the exam

Deposition Landforms

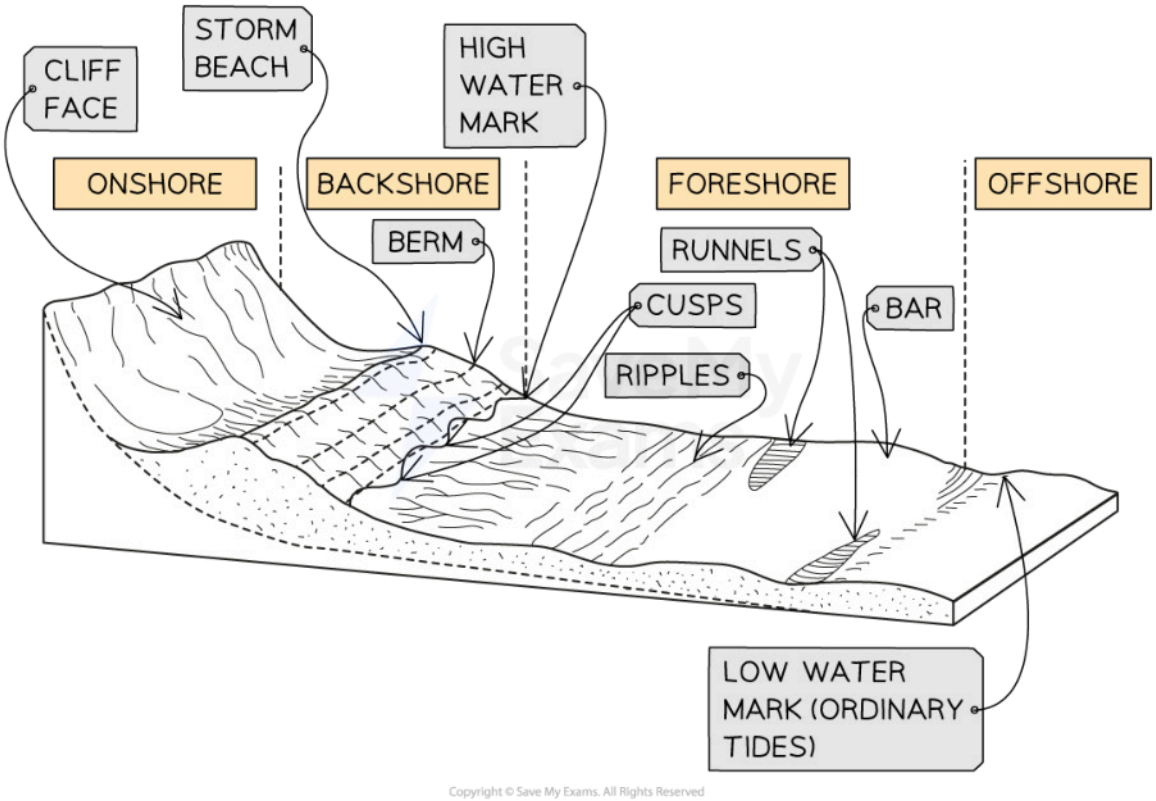
Beaches

- Beaches are the **buffer point** between the ocean and the land
- Constructive waves have a stronger **swash**, moving more sediment up the coastline:
  - Lots of larger sediment builds up at the back of the beach
- Constructive waves have a weaker **backwash**, so deposit sediment more easily:
  - The water also percolates into deposited sediment, so less water returns with the backwash
- Constructive waves occur more in summer, so beaches build up during this season (beach **accretion**)
- Destructive waves take away sediment from the beach, typically during the winter (beach **excavation**)
- Other landforms can form on beaches:
  - **Ridges** – raised areas along the beach
  - **Runnels** – dips along the beach
  - **Berms** – ridges that represent the high tide mark
  - **Cusps** – arc-shaped indents or hollows on the beach
- Sediment moves along the beach through **longshore (littoral) drift**, controlled by prevailing winds
- The differing angles of prevailing winds can produce different types of beaches:
  - **Swash aligned** – waves hit parallel to the shore and there is less longshore drift. Beaches are large and wide, with landforms like berms and sand dunes
  - **Drift aligned** – more influenced by longshore drift, moving sediment along the coast. Produces more narrow beaches, and other depositional landforms like spits and bars

Cross section of a beach profile

Your notes

Your notes



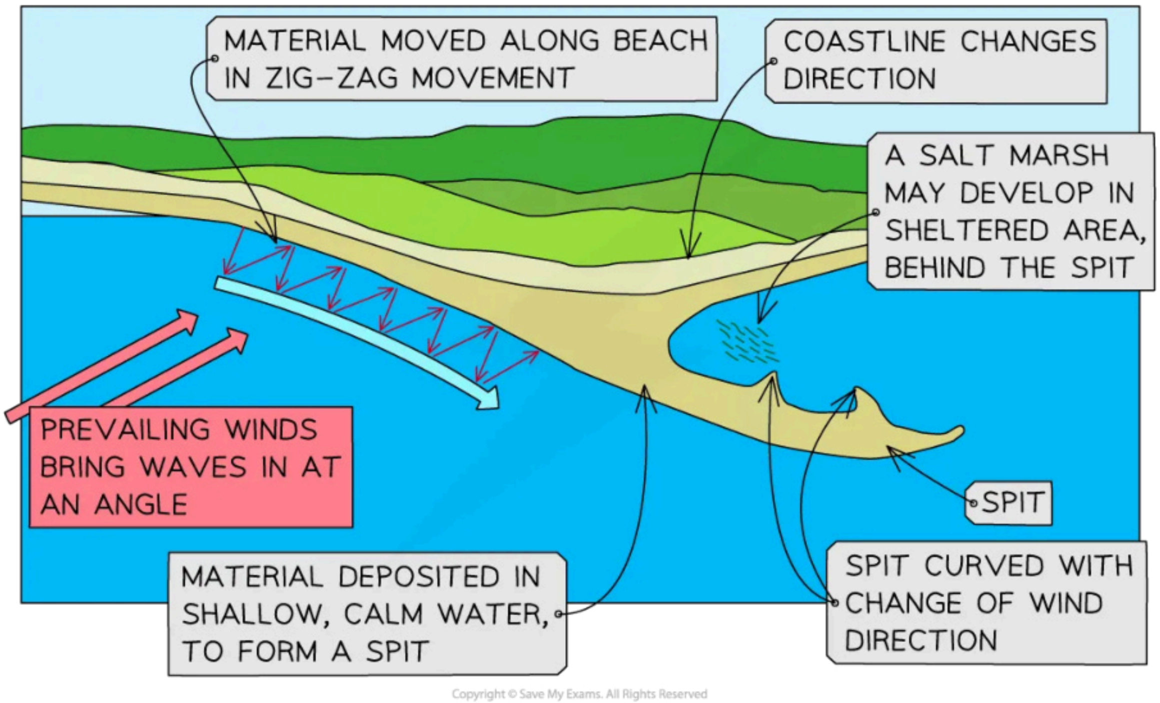
Cross section of a beach profile

Spits

- A spit is an elongation of beach sediment, connected to the mainland and jutting out to sea
- **Longshore drift** transports and deposits sediment as it moves along the coastline
- Waves deposit sediment if the coastline changes, e.g. changes direction or reaches a river:
  - Waves lose energy due to friction or counter-currents
- This material builds up over time, extending outwards into the sea
- Depending on the direction of the prevailing wind, the spit can curve inwards at the end
- ***Salt marshes*** *can develop behind the spit where there is protection from wind and waves*

Formation of a spit

Your notes



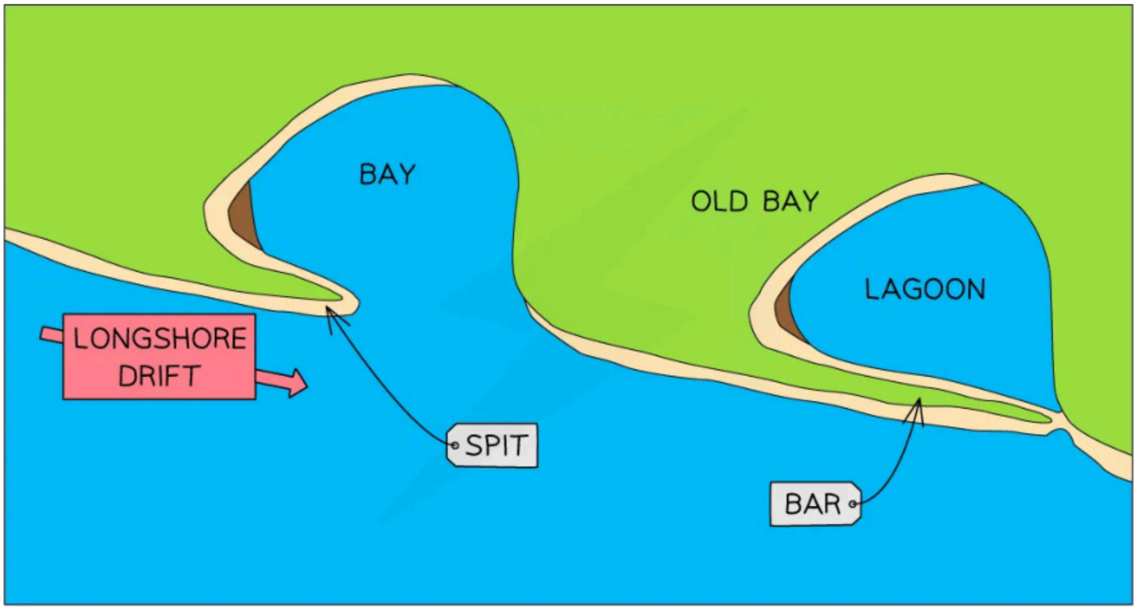
Formation of a spit

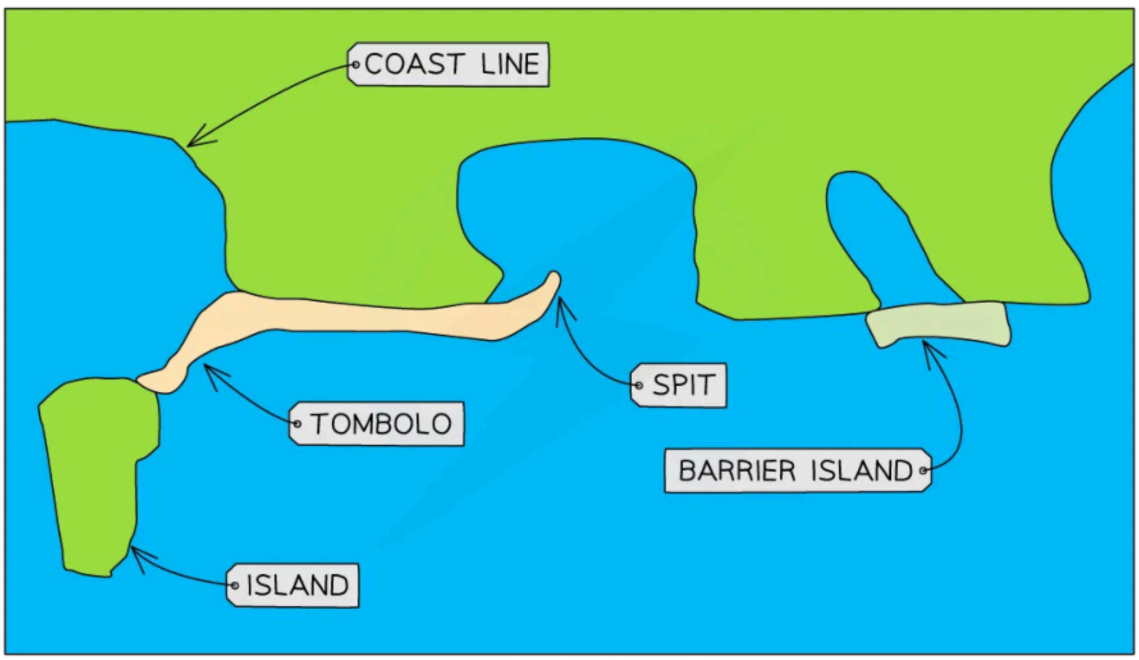
Bars, tombolos, lagoons and barrier islands

- **Bars** are spits that join two separate headlands together
- They are more visible during low tide
- During high tide, bars can make the water shallower, so the wave breaks sooner
- This can cause a **lagoon** to form in a bay behind the bar
- If a spit joins a mainland with an island, this forms a **tombolo**
- **Barrier islands** form parallel to the coast. They are areas with lots of built-up sediment
- Barrier islands can contain beaches, sand dunes and even forests

Diagrams showing different landforms of deposition

Your notes





Diagrams showing different landforms of depositio

5.2.4 Coastlines

Your notes

Advancing & Retreating Coastlines

- **Advancing** and **retreating** coastlines are **short-term** processes
- If erosion is higher than deposition, this will cause an eroding (**retreating**) coastline
- If deposition is higher than erosion, this will cause an outbuilding (**advancing**) coastline
- Coasts can also advance and retreat as a result of **long-term isostatic** and **eustatic** change

Diagram based on Valentin's Classification of Coasts

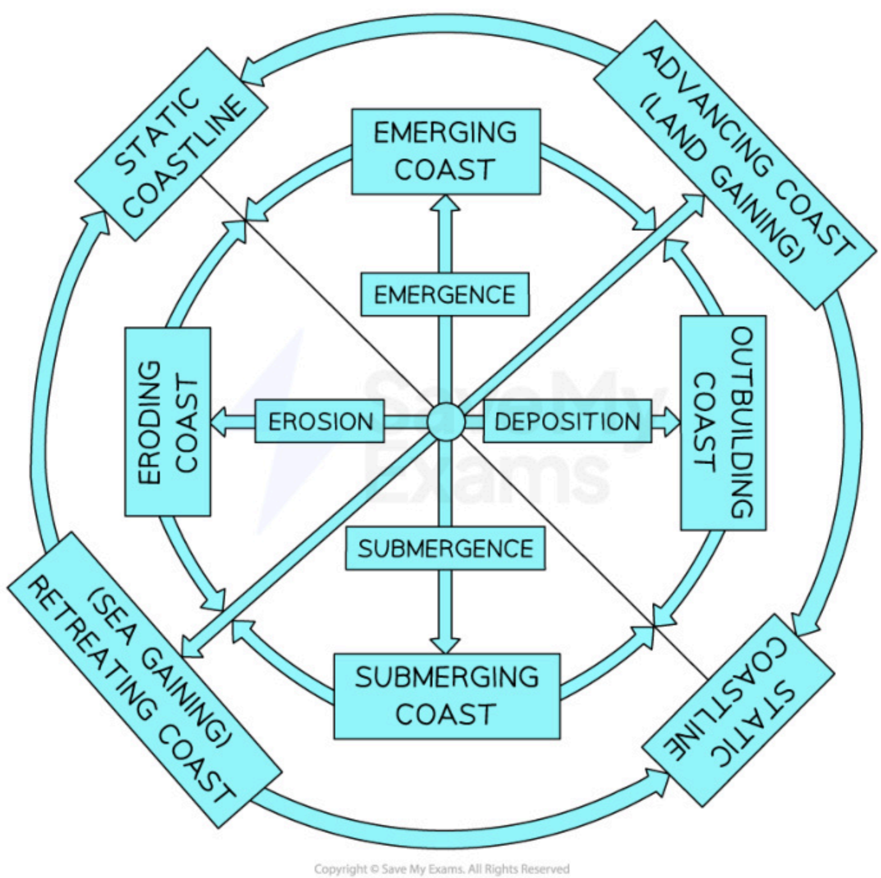


Diagram based on Valentin's Classification of Coasts

- There are many factors affecting advancing and retreating coastlines:
  - **Erosion and weathering** – wearing away the coastline
  - **Wave type** – destructive or constructive waves
  - **Climate change** – increased storms and removal of coastal protection
  - **Tides** – carrying sediment that can erode or deposit

- ***Geology*** *– resistant or non-resistant rock type*

Your notes

Isostatic & Eustatic Processes

Your notes

- Isostatic and eustatic change refers to differences in **sea level**
- Sea level changes regularly and at smaller scales e.g. the tide
- Sea level change can also occur on a bigger scale
- Eustatic and isostatic change can occur simultaneously and coincide. Some coastlines flood whilst others, which were previously submerged, are now visible
- Sea level change can produce **emergent** and **submergent** coastlines

Eustatic change

- Eustatic sea level change is due to differences in ocean water **volume**
- This is a **global** process and the result of:
  - **Changing climate**
  - **Thermal expansion**
  - **Tectonic activity**

Changing climate

- The hydrological cycle pauses during an ice age
- Sea levels fall as the water freezes in ice or snow stores
- When this ice melts, sea levels rise again

Thermal expansion

- As water warms, it expands
- This increases water **volume** and raises sea levels

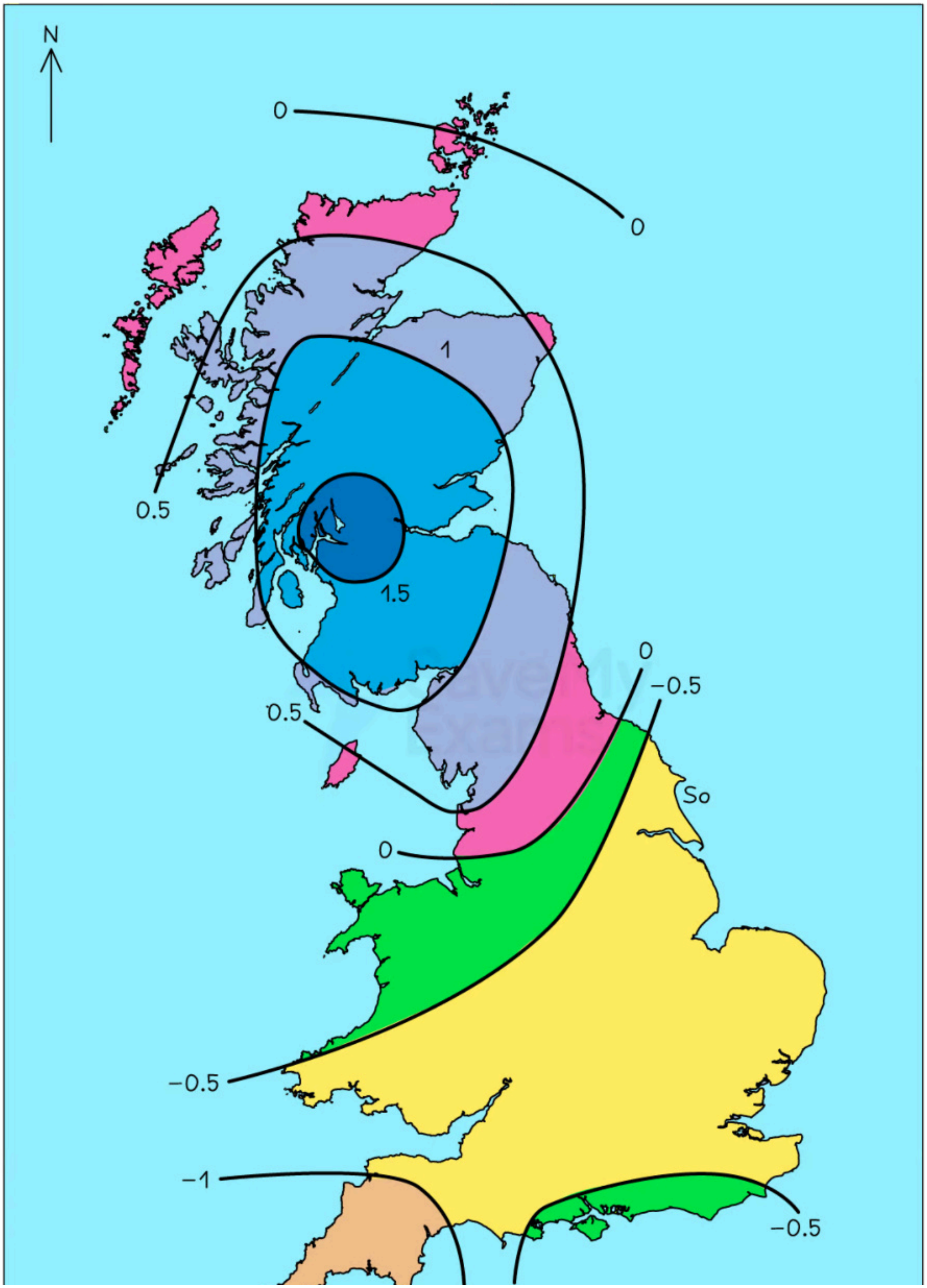
Tectonic activity

- **Tectonic activity** can change ocean **topography** e.g. ocean basins
- Earthquakes or volcanic magma under the ocean can change the shape of ocean basins
- If the ocean basin expands (and the amount of water stays the same) sea levels will sink and vice versa

Isostatic change

- This is the change in sea level due to differences in **land height**:
  - If land height increases, sea levels will reduce and vice versa
- Isostatic change is a more **localised** process
- **Post-glacial adjustment**
  - During an ice age, the weight of the ice compresses into the earth's crust, causing it to subside
  - After an ice age, the crust **rebounds** (isostatic rebound) and **uplifts**
  - Isostatic rebound can occur quickly, like the removal of a plug
  - It can also occur over a long period, as the mantle readjusts itself. This process is still occurring in some areas of the world after the last ice age
- **Tectonic activity**
  - Tectonic movement can also cause uplifting and subsidence

Isostatic change in the UK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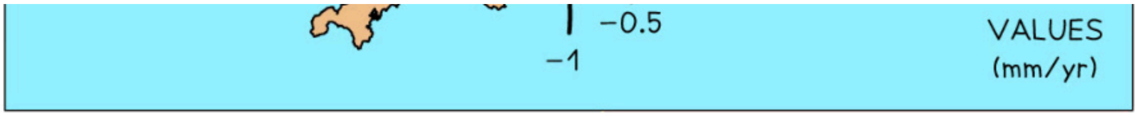
Your notes



Isostatic change in the UK

Exam Tip

Think about the future of isostatic and eustatic change, especially as climate change worsens. Will sea levels rise further? What could happen to our coastlines?

Your notes

Landforms Associated with Isostatic & Eustatic Processes

Emergent landforms

- Emergent landforms form when isostatic change is **faster** than eustatic change
- Sea levels sink, revealing emergent landforms
- They sit above the current sea level (as they were formed when the sea level was higher than present)

Raised beaches

- Beaches that are much higher than the current sea level
- They are flat and made of sand or rounded sediment
- They are covered in vegetation due to plant succession

Relict cliffs

- Steep slopes sit at the back of raised beaches, above sea level
- Falling sea levels reveal other erosional landforms e.g. caves, arches, wave-cut notches
- A fall in sea level can leave whole coastlines of relict landforms behind

Submergent landforms

- Submergent landforms form when eustatic change is **faster** than isostatic change
- As sea levels rise, they submerge areas of land, producing submergent landforms
- Located in inland areas, **flooded** by rising sea levels

Fjords and Rias

- As the sea level rises, water inundates **glacial valleys**, forming **fjords**
- Fjords mirror straight **U-shaped valleys** that glaciers produce
- Fjords can be lower than sea level but are slowly getting shallower due to isostatic change
- The mouth of the fjord meets the sea and is typically much shallower
- **Rias** are areas where water has flooded river valleys
- Rias mirror the steep **V-shaped valleys** carved out by rivers
- They twist and turn, just like a **meandering** river

Labelled image of a Fjord

Your notes

Labelled image of a Fjord

Exam Tip

Make sure you know what emergent and submergent landforms look like. You might be given a picture like this in an exam to assess

5.2.5 Sand Dunes

Your notes

Coastal Processes & Sand Dune Formation

- The coastal processes of **erosion** and **deposition** generate sediment for dune building
- Dunes form primarily by **prevailing winds** blowing sediment up the beach
- **Plant succession** stabilises sediment, which is vital for dune formation
- Dune formation requires:
  - Lots of sediment
  - Continuous wind
  - Large beaches
  - Large **tidal range**, so sand sediment has time to dry
  - Obstacles for the dune to form over
  - Hardy, pioneer species to bind the sand

Formation of a sand dune

- The wind blows up the beach, transporting sediment
- When sediment reaches an obstacle, large pieces settle in front of it to create a ridge
- Behind the obstacle, smaller pieces of sediment settle
- This will build up over time, forming a sand dune
- The sand dune is steeper on the windward side, and more gentle on the other
- A **psammosere** is the plant succession of a sand dune

Embryo dunes

- These are young, very **small** sand dunes (only a few metres)
- Pioneer species colonise in embryo dunes and stabilise the sand e.g. lime grass or saltwort
- Sand accumulates around the newly colonised plant
- These dunes are **fragile** and tides can easily wash them away

Foredune

- Further up the beach, behind the embryo dune, a foredune develops
- Foredunes form as embryo dunes build up
- Marram grass begins to grow, stabilising the dune further
- Sea holly grows on the sheltered side of the dune
- Species start to become more **diverse** and cover the ground

Yellow dune

- These dunes sit above the beach level
- These are mainly made of sand rather than soil
- The **diversity** of organisms increases, e.g. ragwort
- Marram grass (dead leaves) incorporate organic matter (**humus**), into the dune, creating soil:
  - This makes the sand/soil more **nutrient-rich** – a perfect environment for further plants to develop

Grey dune

Your notes

- Grey dunes have more protection from the other dunes in front
- Sand is more protected from the wind and stabilised by vegetation
- These dunes are **fixed** dunes
- Gorse and heather can grow as soils improve

Dune slack

- The **dip** between sand dunes is the **dune slack**
- They may be moist or entirely filled with water
- They are nutrient-rich and home to a variety of plants and animals

Mature dune

- This is the last stage of dune succession, reaching the climax community
- Conditions are much more favourable, with moisture and nutrient-rich soils
- They are far above the high-tide level
- These could be brambles, pine or birch trees

Diagram of dune succession

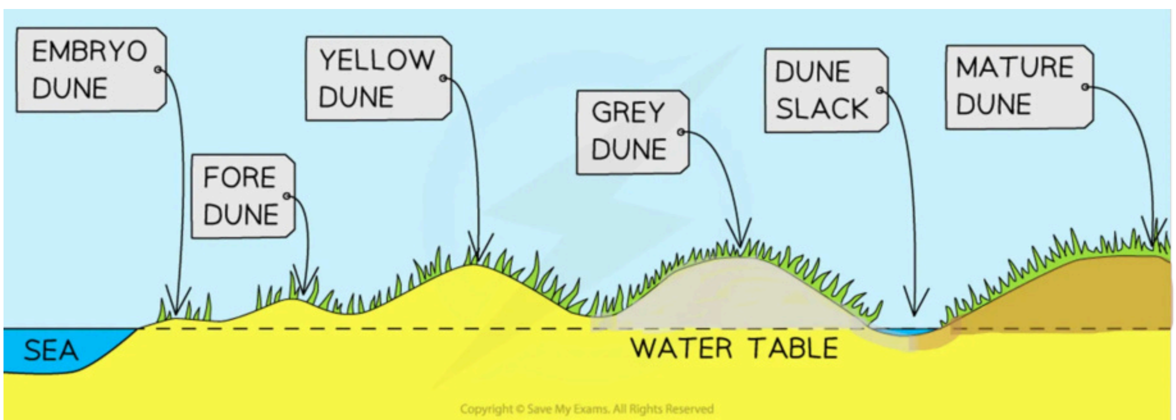


Diagram of dune succession