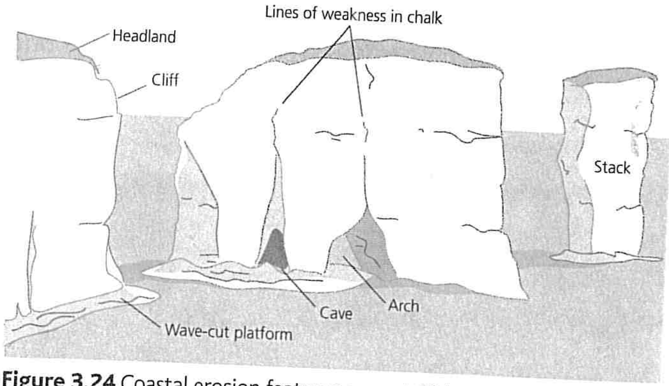

Figure 3.24 Coastal erosion features seen at Old Harry Rocks, Purbeck

processes will eventually reduce the upstanding parts of this area to a wave-cut platform.

Skills focus

This chapter has already highlighted the importance of thinking about coastal features using a systems approach. Look back at the section on headlands and bays. Now use a systems approach to help you understand the formation of the other landforms of coastal erosion. Make sure you are as specific as possible and include details from located examples you have studied. Landforms include:

- cliffs and wave-cut platforms
- geos, caves, blowholes, arches, stacks and stumps.

Origin and development of landforms of coastal deposition

Landforms of coastal deposition occur on coastlines where sand and shingle accumulate faster than they are removed. It often takes place where the waves are low energy or where rapid coastal erosion provides an abundant supply of material.

Beach characteristics

Beaches are found at the point where the land meets the sea and represent the accumulation of sediment deposited between low spring tides and the highest point reached by storm waves. They are mainly composed of sand and shingle. Sand tends to produce beaches with a more gentle gradient (usually below 5°) because its small particle size means the sand becomes compact when wet, and allows very little percolation. Most of the swash therefore returns as backwash, little energy is lost to friction, and material is carried down the beach. This leads to the development of **ridges** and **runnels** in the sand at the low-water mark. These run parallel to the shoreline and are broken by channels that drain the water off the beach (Figure 3.25).

Shingle may make up the whole or just the upper parts of the beach. The larger the size of the material, generally the steeper is the gradient of the beach (around 10–20°). This is because water rapidly percolates through shingle, so the backwash is somewhat limited in its ability to transport material back down the beach. This, together with the uneven surface, means that very little material is eroded from the beach.

At the back of the beach, strong swash at spring high tide level will create a **storm beach**. This is a ridge composed of the biggest boulders thrown by the largest waves, above the usual high tide mark. Below this will be a series of ridges marking the successively lower high tides as the cycle goes from spring to neap. These beach ridges are known as **berms** and are built up by constructive waves. **Cusps** are semi-circular-shaped depressions which form when waves break directly on to the beach and swash and backwash are strong. They usually occur at the junction of the shingle and sandy beaches. The sides of

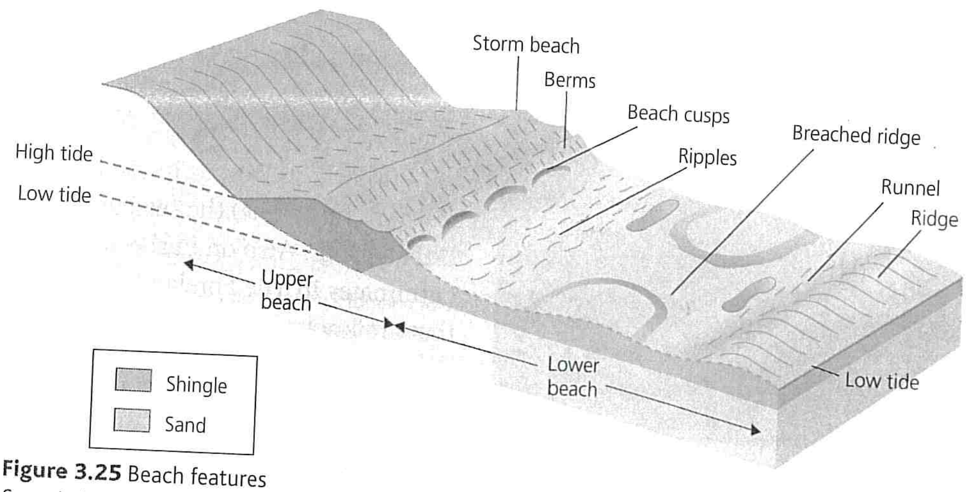

Figure 3.25 Beach features
Source: AQA.

the cusps channel incoming swash into the centre of the embayment and this produces a stronger backwash in the central area which drags material down the beach, deepening the cusp. Below this, **ripples** are developed on the sand by wave action or tidal currents.

The angle at which waves generally approach a coastline will determine the nature of the kinds of beach features that develop. Some authors use the terms **swash-** and **drift-aligned beaches** as a broad classification of beach types to reflect the nature of equilibrium between erosion and deposition a beach tends towards.

Swash-aligned beaches:

- are generally oriented parallel to the incoming wave crests
- experience minimal longshore drift
- can be found on irregular coastlines where longshore drift is impeded, and waves hit sections of the coast head-on.

Drift-aligned beaches:

- are generally oriented parallel to the direction of dominant longshore drift
- can have considerable amounts of sediment transported long distances along them
- initially develop where a section of coastline is fairly regular, or where the predominant wave direction is at an angle to the beach
- can extend out from the coastline if there is a sudden change in the direction of the coastline, for example upon reaching an estuary.

The idea of equilibrium is especially significant for drift-aligned beaches as without a continual supply of sediment the longshore drift would remove the sediment faster than it was deposited.

Fieldwork opportunities

There is an opportunity here to visit a local beach and investigate the characteristics of sediment in different locations on the beach.

Spits, tombolos, bars and barrier-beaches

A **spit** is an elongated, narrow ridge of land that has one end joined to the mainland and projects out into the sea or across an estuary, usually on a drift-aligned coast. Like other depositional features, it is composed of sand and/or shingle and the mixture is very much dependent upon the availability of material and the wave energy required to move it.

Figure 3.26 shows the formation of a spit. On the diagram, the prevailing winds and maximum fetch are from the southwest, so material will be carried from west to east along the coast by the process of longshore drift. Where the coastline changes to a more north–south orientation, there is a build-up of sand and shingle in the more sheltered water in the lee of the headland. As this material begins to project eastwards, storms build up more material above the high-water mark, giving a greater degree of permanence to the feature. Finer material is carried further eastward into the deeper water of the estuary, and as the water loses its capacity to transport it further is deposited, extending the ridge (spit) into the estuary.

Increasingly the end of the spit begins to curve round as wave refraction carries material round into the more sheltered water. The second most dominant wind direction and fetch may contribute to this, pushing the spit material back towards the mainland. The spit cannot grow all the way across the estuary as the material is carried seaward by the river and the deeper water at the centre inhibits growth.

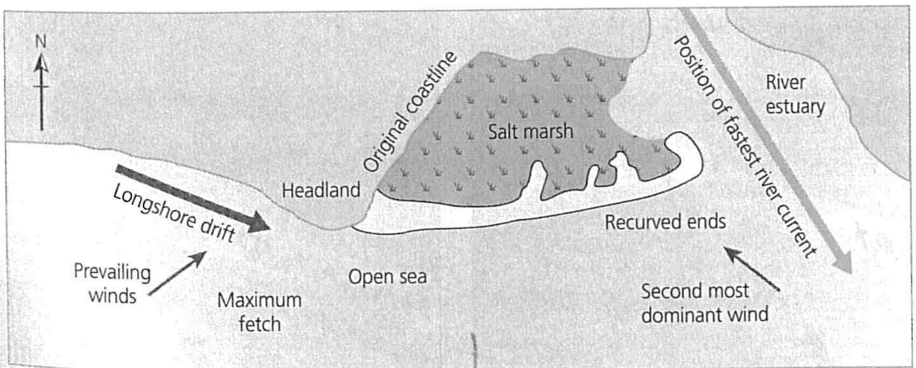

Figure 3.26 The formation of a spit

Figure 3.27a Spurn Head in East Yorkshire, illustrating some of the features of a simple spit

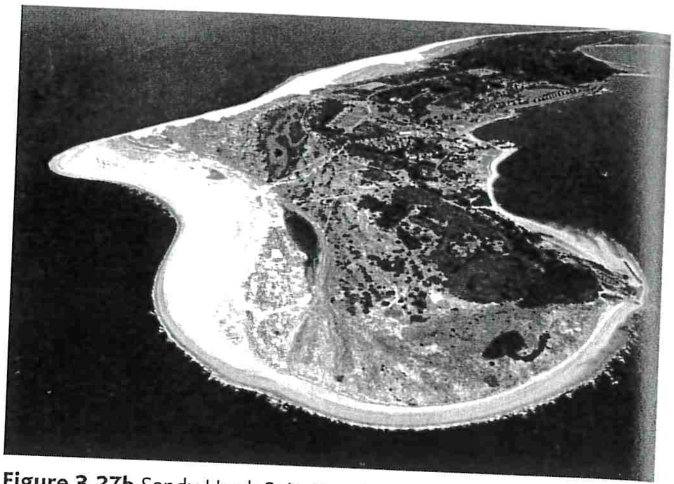

Figure 3.27b Sandy Hook Spit, New Jersey, USA

A simple classification of spits includes **simple** or **compound spits**. Figure 3.27a illustrates the characteristics of a simple spit. Simple spits:

- are either straight or recurved
- do not have minor spits, or recurved ridges, along their landward edge.

Figure 3.27b is an example of a compound spit. Compound spits:

- may have similar features to simple spits
- have a number of recurved ridges, or minor spits, along their landward side, possibly marking the position where they terminated in the past.

As spits mature, **sand dunes** can also develop as deposited sand dries out and is blown to the landward side of the spit, where it can accumulate and become stabilised by vegetation as species like marram grass get established. Also, as the spits increase in size, an increasingly large, more sheltered area develops between the land and the spit. Low-energy, gentle waves enter this area and deposit finer material such and silt and clay. These deposits build-up and are colonised by vegetation to become **salt marshes.**

Some examples of spits have been mentioned above but other well-known spits around the British coast are found at Borth (west Wales), Dawlish Warren (Devon), Orford Ness (East Anglia) and Blakeney Point (Norfolk). Other famous spits from around the world include Farewell Spit, New Zealand and Homer Spit in Alaska.

A spit that joins an island to the mainland is known as a **tombolo** (Figure 3.28a). The best example in Britain is Chesil Beach on the south coast of England. This links the Isle of Portland to the mainland and is about 30 km long. One of the most beautiful and often photographed tombolos from around the world has to be The Angel Road of Shodo Island, Japan.

If a spit develops across a bay where there is no strong flow of water from the landward side, it is possible for the sediment to reach across to the other side. In this case, the feature is known as a **bar** (Figure 3.28b).

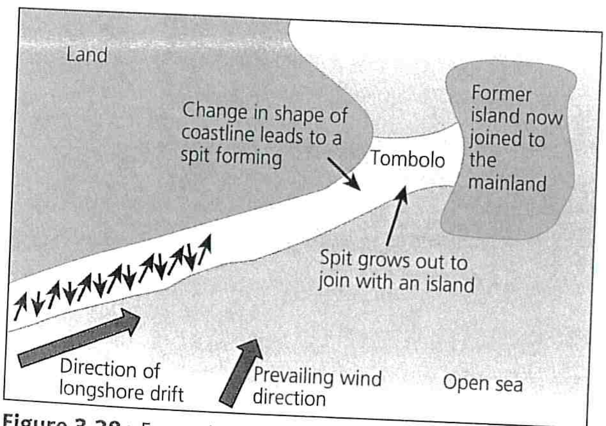

Figure 3.28a Formation of a tombolo

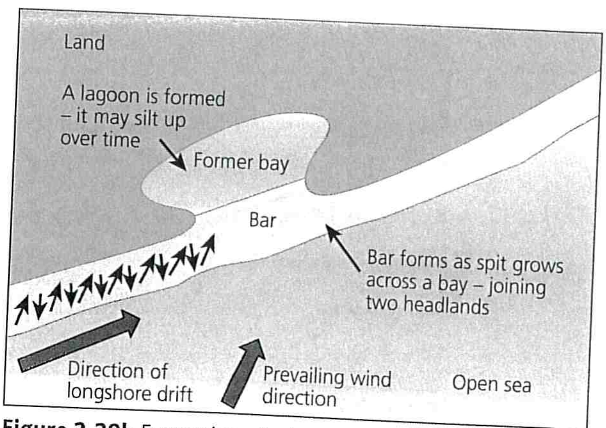

Figure 3.28b Formation of a bar

Some bars, however, may simply be the result of the onshore migration of material from offshore as sea levels rose following the last ice age. Like beaches, these bars may be completely or partially submerged by incoming tides. Slapton Ley, a bar found in Devon, is believed to have formed in this way. Some research suggests that it is a combination of this onshore migration and longshore drift that also formed Chesil Beach. The longest spit in the world, Arabat Spit in the Sea of Azov, is a bar, and joins towns in Ukraine to the north and Crimea to the south.

Where a ridge of beach material that remains semi-submerged accumulates seaward of the breaker zone then it is known as an **offshore bar**.

A **barrier beach** or **barrier island** is an elongated bank of deposited sand or shingle lying parallel to the coastline and not submerged by incoming tides. Where the bank is high enough to allow sand dunes to develop it is known as a barrier island. Often the sheltered area between the barrier beach and the land becomes a lagoon or coastal marsh, or in more tropical locations mangrove swamps may develop. One of the most famous barrier beaches is the Lido of Venice. They may be formed by the breaching of a spit or by constructive waves pushing a bar towards the land.

Skills focus

In the previous section you used a systems approach to help understand the formation of the various landforms of coastal erosion. Now do the same for the depositional landforms. These include:

- beaches, spits, tombolos, bars and barrier beaches.

Process, time, landforms and landscapes in coastal settings

It is important to view each unique coastal landscape as an assemblage of features and landforms that combine in that place to give it its own characteristic landscape. In order to understand why that landscape looks the way it does today, it is crucial to look beyond the processes that are happening in the present and think about how different processes may have shaped its features through time.

There is certainly not one combination of landforms that creates one distinct coastal landscape. Where the sea and land interact there is a huge diversity of characteristic coastal landscapes including:

- bays
- estuaries
- beaches
- deltas
- dunes
- mud flats and salt marshes.

The list could go on and more landforms are explored below, but it is also important to recognise that with the large and ever-changing amounts of energy available from wind-driven waves, tides and currents, coastal landscapes are dynamic and constantly changing.

The characteristic coastal landscapes that we see today are a result of the factors that shaped them during the Holocene (roughly the time since the end of the last glacial period some 12,000 years ago). Therefore a range of factors has been important in producing the present coastal landscape features, and continues to do so today. These include:

- local tectonic processes
- sea level change – global and local
- climatic change – natural and that enhanced by human activity
- changing ocean currents and wave regimes
- natural disasters or events – including, for example, storms or tsunamis
- changing sources, types and amounts of sediment
- the changing nature of human activity.

All of the above, and more, have continually changed over the millennia, but all will have left their mark as features in the coastal landscapes of the present day, where contemporary coastal processes will inevitably continue to alter and modify them further.

Coastal sand dunes

Coastal sand dunes are accumulations of sand shaped into mounds by the wind. They represent a dynamic landform. Like other coastal landforms sand dunes can be studied using a systems approach. Important inputs include:

- a plentiful supply of sand
- strong onshore winds
- a large tidal range