Seven Sisters Coastline

**What are the Seven Sisters made of?**
The cliffs at the Seven Sisters Country Park are composed of sedimentary chalk limestone,

**What is chalk limestone?**
Chalk is made up of the calcite remains (or coccoliths) of marine algae which died and fell to the bottom of the sea to be reworked by burrowing animals and currents. It also contains marine fossils including bivalves, ammonites and sea urchins.

**When were the Seven Sisters formed?**
The cliffs at the Seven Sisters Country Park were formed between 60 and 130 million years ago during the Upper Cretaceous Period. During this period the dinosaurs died out and the evolution of birds as we know them began. They were formed over a period of 20 to 30 million years, in warm, shallow seas at a time when England was joined to Europe and the climate was similar to that of our modern day Sahara desert. The formation of the chalk took between 20 and 30 million years.

**What happened next?**
50 million years ago major earth movements occurred as the African Teutonic Plate moved northwards and collided with the European plate, pushing up the Alps, Pyrenees, and the Downs. The latter formed a large dome, which has been eroded by water, leaving only the rim of the South and North Downs still standing and, sandwiched between them, the gault clay of the Weald. At the Seven Sisters the chalk is exposed.

**How important is chalk?**
The South East of England has 68% of the total extent of coastal chalk exposures in Great Britain and 40% of European. Chalk exposures stretch for 77 km in the Southeast. Beachy Head to Seaford and Newhaven to Brighton account for 22 km of this.

**What is flint?**
Bands of tabular flint can be seen in the chalk face of the cliffs. They normally run parallel to the bedding of the chalk although flint can be seen in vertical and oblique cracks.
Flint is a compact, hard, brittle mineral, brown-black or grey in colour, consisting of fine grained silica (silicon oxide) similar to quartz. It was probably formed from the silica spines of fossilised remains of giant sponges, which congealed together, and following a chemical reaction with sulphur from algae floating in the sea, hardened to make flint.

**What else is found in the cliffs?**
Occasionally sea urchins can be found in which the original calcite shell and soft parts have been replaced by silica producing a flint fossil.
The Shaping of the Coastline at the Seven Sisters

What does the coastline look like?

The best view of the coastline is from the top of the Downs looking out to sea, overlooking Cuckmere Haven. Cuckmere Haven is sandwiched between The Seven Sisters and Seaford Head.

The Seven Sisters

These inspiring cliffs rise 200 metres above sea level and run between Cliff End at Cuckmere Haven and Birling Gap.

What to look for.

At low tide it is possible to walk out onto a shingle spit at the western end of the beach and see all seven of the cliffs and Belle Tout lighthouse further along the coast.

Bands of flints can be clearly seen running horizontally through the chalk.

There is evidence of fresh rock fall on the beach near Cliff End.

At low tide a platform of chalk can be seen running from the base of the cliffs out to sea.

Chalk and flint extend out into the Channel along the stretch of the coastline running from Chichester to Beachy Head. In particular a long tongue of chalk runs out eastwards from the Seven Sisters and Beachy Head to the Meridian Line in the middle of the Channel.

This underwater chalk cliff has been subjected to erosion and cut back by waves, forming a platform running from Seaford Head to Beachy Head. This has been planed off by wave action to give a level surface that contains rock pools, steps and runnels into which the tide is channelled.

At low tide these rock pools are visible at the base of the Seven Sisters.

Sublittoral rock (i.e. beneath the low water mark) is unusual in the Southeast, only accounting for 1% of the seabed.

Standing on the beach looking across this wave cut platform, it becomes clear that the existence of this platform prevents further erosion of the chalk on the first stretch of the beach beneath the cliffs. The fall of rock on this part of the beach is due to weathering, particularly frost damage rather than wave erosion.

Looking along to the first headland, however, it is possible to see where wave action is eroding the chalk. At high tide waves can be seen crashing against the protruding rock and at low tide evidence of where the sea undercuts the chalk is clear.

The cliffs are subject to erosion from wind, rain, frost, and wave action, all of which help to reduce them to beach material.

They are also home to the Common Piddock, which is a mollusc that has adapted to boring into the chalk by rotating its shell. It can bore a foot into the rock, and feeds by
reaching out for floating debris when the tide is in. When the piddock dies the sea invades the tunnel, weakening the chalk. If this freezes in the winter, it can cause the chalk to fracture. Piddock holes can be found along the edge of the wave cut platform at low tide.

**Seaford Head**

**What to look for.**

The cliffs to the west of the river mouth show clearly where chalk has been overlaid with a glacial cap of sandstone and gravel. This was deposited by melt water moving south and out to sea as temperatures rose at the end of the last Ice Age.

Coastguard cottages perched on the edge of the cliff are in imminent danger of falling into the sea. Photographs of a hundred years ago portray them with long back gardens overlooking the sea.

**The Beach**

**How was it formed?**

The beach at Cuckmere Haven is post glacial. The beach was formed by material that was washed down and deposited by melt water moving south and out to sea as temperatures rose at the end of the last Ice Age.

**What is it made up of?**

The pebbles found here are either white or grey chalk and flint or orange brown sandstone from Seaford Head.

**How did the pebbles get here?**

This beach material has been eroded from the cliffs and deposited as sediment offshore. Friction between the water and the seabed stirs up these sediments which are picked up by waves and washed back to the shore. As they are washed up and down the beach by the sea these pebbles erode away more of the cliffs.

Seabed materials are transported in an anti-clockwise direction around the coast of South East England. On the beaches of West Sussex the movement of sand and pebbles along the coast is from West to East. This is known as long shore drift.

When a wave carrying sediment hits the beach it does so at an angle of 45 degrees. This is known as the ‘swash’. The water returns to the sea, at an angle of 90 degrees to the shore. This is the backwash. The balance of power between the swash and backwash determines whether a beach is being built up or gradually removed. If the swash is more powerful it is a constructive wave. In calm conditions and sheltered areas like Cuckmere, waves spill over gently, pushing shingle up the beach and the energy of the backwash is dissipated by percolation through the shingle. Between Chichester and Brighton the beach is eroding whilst accretion is occurring along the cliffs at the Seven Sisters.

Evidence of long shore drift can be seen at the mouth of the river, which would silt up if it were not for a training wall that prevents shingle from being swept into the river channel.
Pebbles on the beach are graded, with the largest stones found at the top of the beach, smaller pebbles nearer the water and in places at low tide can be found very small pebbles which can be used to demonstrate how sand is formed. This grading of pebble size is caused by the fact that as waves roll into the beach they have the energy and power to carry material up the beach. As the water slips back it has less power. This means that large waves rolling up the beach can carry large and small pebbles with them, but as they return to the sea only small pebbles are carried back down.

**How do waves work?**
Waves are formed by the action of the wind out to sea. The stronger the wind, the greater the waves, although the size of waves is affected by the fetch of the sea (the uninterrupted distance over which the wind has play). In the open sea waves have a circular form which develops as the wind drives individual particles of water in oscillatory movements. Water particles move round without moving forward. A seagull sitting on the waves does not move forward. As the swell approaches land and the water becomes shallower the shape of the wave changes and the water particles take on an elliptical form, gradually flattening towards the bottom until at the sea bed the movement is backwards and forwards. Out at sea the speed of the individual water particles is less than the speed of the wave as a whole. When the wave is slowed down by contact with the sea bed, the speed of the circular movement of the water particles catches up until at the crest it is the same as the speed of the wave itself. The wave then breaks. Wave action in the form of cusping can be seen along the beach at low tide and in certain conditions. This is where waves have scoured out hollows in the shingle running up the beach. It is not clear what causes cusping but there is a theory that waves hitting the shingle from two different directions may result in this phenomena.

**How do tides work?**
In most places in Britain there are two high and two low tides in every twenty-four hours. This is because the major force causing tides comes from the moon which rotates around the earth roughly once every twenty-four hours. In fact the exact period of rotation is 24.84 so that tides are later by .84h each day. There are two tides a day because there are two forces at work;
- there is the gravitational attraction between the earth and the moon,
- this is balanced by centrifugal forces pushing the earth and the moon apart. The centrifugal forces occur because the earth and the moon rotate about a common axis. The point of rotation of this axis is not in the centre of the earth, so that the centrifugal forces on the earth act on the side of the earth opposite the moon. There they cause the sea to bulge creating a high tide.
- In the mean time the gravitational forces on the side of the earth nearest to the moon cause a second, equal bulge, making another high tide. As the moon rotates around the earth these two tides move round the earth.

Between the peaks and troughs of the tide, the water rises for approximately six hours from low water to high water (flooding tide) and falls for six hours from high to low water (ebbing tide). The difference in height between these levels is the **range of tides**.
There is an uneven rate of rise and fall during the passage of the tide. When the tide is flooding, the first third of the rise takes two hours, the second third takes an hour, and the last third another three hours. When the tide is ebbing this is reversed. It takes three hours to fall the first third, an hour to fall the second third and two hours to fall the last third. At the middle range the tide is moving fastest.

As the tide rises and falls water is being moved from one part of the coast to another, creating a tidal current, which is the difference in height between one place and another. Tides in the Channel flood eastwards and ebb westwards. Therefore, high tide is progressively later the further east one travels.

The strongest current along the South East coast is off its headlands, like Beachy Head.

How high the tide rises or falls depends on the phases of the moon.
- At the new or full moon, when the earth, sun and moon are in a straight line and the effect of gravity is greatest, tides will have their greatest ranges, that is high tides will be at their highest and low tides at their lowest. These are Spring tides.
- For seven days following each new or full moon, the earth, moon and sun move out of alignment until the sun and moon lie at right angles to the earth. This reduces the gravitational pull on the sea, which results in a reduction in the range of the tides. These are known as Neap tides. The rise and fall of the tides is less.
- Between the Neaps and Springs the range builds up and then down again every seven days. This is referred to as ‘making and taking off’.

At Cuckmere, as else where, as the tide builds towards a Spring tide each successive tide takes away debris left on the strand line, just leaving one strand of debris on the beach. As the tide falls to a neap tide each successive strand line is left to explore.

- At the Spring and Autumn equinox (21st March and 21st September) when the earth, sun and moon are perfectly aligned, equinoctial Spring tides occur with the highest and lowest tides of the year.

Atmospheric Pressure and strong winds effect the levels of the tide by as much as a third of a metre. Low atmospheric pressure will lead to rises in sea level while high pressure will depress it. Changes in pressure can cause a variation of a foot in sea level heights.

- Winds can advance or delay high tides. The wind raises sea levels in the direction it is blowing so that strong onshore wind will pile up the water and cause sea levels higher than predicted.

At Cuckmere Haven autumn and spring storms together with low atmospheric pressure could lead to very high tides which could damage the walls of the canal.

**How is the coastline here managed?**
The cliffs at Cuckmere Haven are being allowed to erode naturally. Apart from a small area beneath the Coast Guard Cottages there are no sea defences in place along this stretch of the coastline.
**How will the coastline change in the future?**

It has been predicted that there will be a rise of 1.5 degree C to the year 2100, which will result in a sea level rise of .5 metre. There will also be an increase in storminess and rainfall.

Along the South East the rate of sea level rise is amongst the highest in the U.K. This is partially because of global warming but also because of the lowering of the land. Britain is tilting down to the South East as it readjusts from conditions existing during the last Ice Age.

The rate of relative sea level rise is 6mm per year.

If sea levels rise as predicted the Cuckmere valley could become permanently flooded resulting in the formation of salt-marsh up to the A259.