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THE SUSSEX COAST PAST AND PRESENT

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Introduction

Sussex has a varied coastline with a long and complex history. In West Sussex the coast is everywhere low lying but in East Sussex there are bold cliffs of chalk and sandstone separated by alluvial lowlands. The present coastline is very recent in origin and continues to evolve. In the past, changes in sea level, processes of erosion and accretion, and the hand of man have all contributed to dramatic changes in the position and configuration of the coast. Some of these changes are known in great detail but others remain less clear and are the subject of continuing debate.

Raised Beaches and Old Cliff Lines

At one time, the coastline of West Sussex was relatively straight and lay across the dip slope of the Downs far inland from its present position. The sea stood at a height of 35 to 40 m O.D. and carved a line of cliffs with a shore platform in front (Fig. 7). Sand and flint shingle were deposited at the foot of the cliffs and on the platform surface. Known as the '100 foot' or 'Goodwood' raised beach. The sand and shingle can be traced for a distance of over *25* km along the Downs from Slindon in the east past Boxgrove and Goodwood House and on into Hampshire. Although the beach must once have continued across East Sussex, no remnants survive.

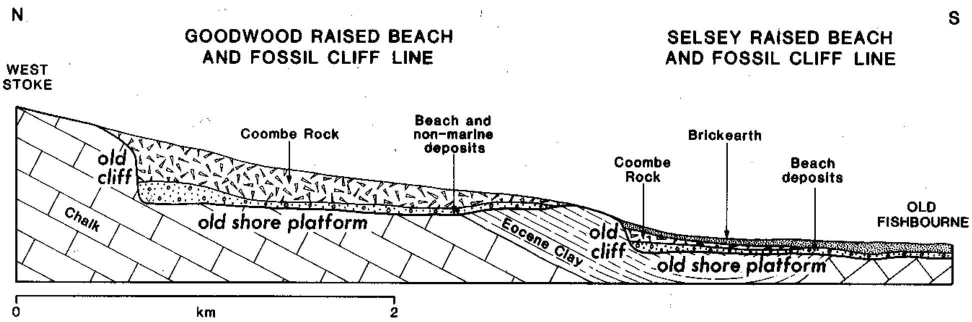

Fig. 7 Raised beaches and ancient cliff lines in West Sussex. After Hodgson, 1964 (see note 3)

Fossil foraminiferids, ostracods and occasional marine molluscs are found in the sand at Eartham.' The fauna provides somewhat equivocal evidence of the climate at the time of deposition, but the view most commonly held is that the climate was temperate. A silty clay overlies the sand at Eartham and this contains rodent teeth, poorly preserved shells of trial molluscs, and pollen. The flora and fauna both suggest temperate forest with some grassland. Flint hand-axes of Acheulian type been discovered in the silty clay, some so perfectly preserved as to prehistoric man lived in the vicinity of the site.[2] Both the sand 'clay are buried beneath a thick covering of soliflucted chalky flinty debris (Coombe Rock) which completely conceals the former cliffs. A thin silty loam within the soliflucted debris has yielded more flint hand-axes.

The age of this varied sequence of deposits is uncertain. The beach sand and shingle are commonly supposed to have formed in the Hoxnian interglacial period about 250,000 or 300,000 years ago. There is evidence from other parts of the British Isles that sea-level was relatively high during this period. The silty clay may also be Hoxnian because the hand-axes are similar to those found at other Hoxnian sites in the British Isles. The solifluction deposits may date from both the Woistonian (penultimate) and Devensian (last) glacial periods.

A second ancient cliff line parallels the first at a lower level forming the inner margin of the West Sussex coastal plain (Fig. 7). The plain is an old shore platform cut across the Chalk and Tertiary deposits.[3] It is thinly covered by shelly sands and gravels that are remnants of beach and near-shore deposits. They are known as the '25 foot' or 'Selsey' raised beach, the Selsey peninsula being an area where they are particularly well developed. Coombe Rock overlies the marine sediments in the vicinity of the South Downs and conceal the cliff line.

At Selsey the beach overlies freshwater and estuarine beds that were deposited early in the Ipswichian (last) interglacial in an old river channel.[4] The beach is clearly younger than the channel deposits and must have been deposited later in the Ipswichian because the overlying Coombe Rock is clearly Devensian in age.

The shore platform beneath the beach deposits cannot be dated satisfactorily at present, because its stratigraphical relations with the Selsey channel deposits have not been studied. If the platform is cut across the top of the channel deposits, it must be younger, and, as the overlying beach dates from the mid or late Ipswichian, this would seem to make the platform also mid or late Ipswichian. However, the platform reaches a width of 13 km in the Chichester and Selsey areas and if it was cut entirely in the mid or late Ipswichian this would imply a phenomenal rate of marine erosion. A more likely hypothesis is that Selsey channel is cut down into the platform which was at least partly formed before the Ipswichian, possibly in the late Hoxnian or the earlier Cromerian interglacial. It is perhaps significant that marine deposits that may be late Cromerian in age have recently been found in shallow water off the Selsey coast.[5] The presence of these deposits at low level, however, calls into question the usual dating of the high level Goodwood beach as Hoxnian.

Boulders of distantly derived rocks such as granite and quartz porphyry are embedded in silt or clay at the base of the Selsey channel.[6] During the Ipswichian marine transgression some boulders were incorporated into the beach deposits. The source of the boulders is uncertain: some may have come from south west England but others may be French in origin.[7] It is generally assumed that they were rafted along (or across) the Channel on ice-floes in pre-Ipswichian times, possibly at the start of the Anglian (antepenultimate) glacial period. An alternative theory is that they were carried by a glacier advancing up the Channel from the west or south west.[8] There is no convincing evidence, however, to suggest that Sussex was ever glaciated, and for this reason the ice-floe theory is preferred.

The West Sussex coastal plain narrows in an eastwards direction and ends at Black Rock, Brighton. Here the present sea cliff meets the Ipswichian cliff line at an oblique angle exposing not only the old cliff but also the raised beach and shore platform.[9] The beach is mainly composed of flint shingle, but pebbles of far travelled rocks also occur. Judging from the height of the base of the Ipswichian cliff the contemporary sea-level was about *7.5* or 8 m.

Incised Valleys and Alluvial Infills

During the course of the glacial periods sea-level became progressively lowered as a result of the build-up of ice on the continents. The sea retreated westwards leaving the bed of the Channel as dry land. When the Devensian ice-masses reached their maximum extent about 15,000 year ago sea-level probably stood at -130 m [10], and the nearest coastline to Sussex is likely to have lain to the south west of the Scilly Isles about 450 to 500 km distant.

The lowering of sea-level in the Devensian caused the Sussex rivers to incise their channels, particularly in their lower valleys near what is now the coastline. In many cases the rivers were able to cut their floors down well below present sea-level. The Arun, for example, excavated its valley to a depth of —36 m O.D. at Arundel, and the Ouse reached a depth of -30m O.D. at Newhaven.[11] The former floors of the valleys are now buried beneath a considerable thickness of Late-glacial and Post-glacial sediments.

The rivers of Sussex now have very gentle gradients as they approach the sea. The Ouse, for example, has a gradient of about 0.1 m per km between Lewes and Newhaven. During the Devensian the rivers were very much steeper and presumably much faster flowing. The gradients seem to have varied considerably from river to river. For example, the Ouse had a gradient of about 2 m per km between Lewes and Newhaven while the Cuckmere seems to have had a gradient of about 4 m per km between Litlington and Cuckmere Haven.[12]

Sea-level rose rapidly at the end of the Devensian as the ice-sheets began to diminish. By about 10,000 years ago it had risen to -35 m and by about 7,500 years ago to -15 m.[13] There is serious disagreement as to when it first reached its present level, but it was certainly close to achieving it, and some would say it had actually overshot, around 3000 years ago.[14]

During the rise of sea level, a series of cliff lines were cut to the south of the present Sussex shore and these are now submerged. One prominent example lies in the floor of the Channel about 14 km off Beachy Head and trends first west and then south-west, passing some 22 km south of the Isle of Wight.[15] The sea seems to have reached parts of the present shoreline over 5000 years ago. The best evidence comes from the south-west corner of Pett Level where estuarine clays with *Scrobicularia* shells are overlain by freshwater peat and a layer of ancient tree stumps and fallen timber. These interesting deposits are exposed on the foreshore at low tide. Samples of peat and wood from the 'submerged forest' have been radiocarbon dated and suggest that it grew about 5,200 to 5,300 years ago.[16] The estuarine clays point to the arrival of the sea in this area sometime before this date. Much of the forest consisted of Alder and probably grew in swampy conditions not far from the shore.[17]

The rising sea level caused the Sussex rivers to infill their lower valleys, depositing a complex sequence of sediments. The earliest sediments are clayey sands and gravels that were presumably transported and deposited by flood water during spring and summer thaws in the Late-glacial period. At a later stage the rivers deposited silty and peaty clays that are interbedded with fenwood peats that accumulated in riverside swamps. Peat formation must have begun very early in the Post-gacial because a peat layer at Langney Point near Eastbourne has been radiocarbon dated at 9510 B.P. (Before Present), while another at Arlington in the Cuckmere valley has been dated at 9435 B.P.[18] Peat was still continuing to form in parts of the Ouse valley as late as 3190 B .P. judging from a radiocarbon date obtained from the Vale of the Brooks.[19] Pollen analysis of the peats suggests that the surrounding Downs were still well wooded at this time despite some clearances by early farmers (see Chapter 6).

Around 3000 B.P. (the precise date is uncertain) the sea invaded the lower portions of the main river valleys turning them into tidal estuaries. Pevensey Levels and Romney Marsh became wide, shallow bays backed by sea-cliffs that have become degraded with time but are still clearly recognisable. Marine silts, silty clays and sands were deposited in the estuaries and bays following the submergence. Sedimentation was evidently a fairly slow process for even in Romano-British times the coastline remained very deeply embayed (see Fig. 60, Chapter 14) in contrast to the gently curving outline that it now possesses. Pevensey Levels and the lower Cuckmere, Ouse, Adur and Arun valleys must still have been tidal inlets in Norman times because the Domesday Book records numerous salt-works where sea-water was evaporated to make salt. Some were surprisingly far upstream, for instance at Bramber on the Adur and at Laughton and Ripe on the Glynde. Pevensey Levels were reclaimed for agriculture in the twelfth and thirteenth centuries, but in the Ouse valley final reclamation was delayed until the sixteenth century.[20]

A silty clay with freshwater shells underlies modern alluvium in the Ouse valley around Lewes and is also found at equivalent distances from the sea in some of the other river valleys. Peats are present in a few places, for example at Amberley Wild Brooks in the Arun valley north of the Downs, at Lottbridge Drove near Eastbourne, and at Filsham (Combe Haven) between Bexhill and Hastings.[21] The silty clays and peats overlie the marine silts, silty clays and sands and represent a return to freshwater conditions at the heads of estuaries and on the landward margins of the bays. Their precise age is uncertain. The peat at Amberley has been dated at 2620 B.P.[22] which suggests a fairly rapid retreat of the sea from the head of the estuary in the Arun valley. However, the silty clay around Lewes may be a much more recent deposit, possibly even post-medieval.

The growth of the shingle spits and Langney Point

Waves generally approach the Sussex shore from the south-west, and slowly move the sand and shingle eastwards along the beaches. In past centuries this led to the eastward growth of shingle spits across bays and estuaries. River mouths were diverted eastwards and often partly blocked by drifting shoals of sand and gravel. Flood waters had increasing difficulty escaping to the sea leading to frequent inundation of the floors of the lower valleys and increased silting in the river channels. Ports at the river mouths had great problems maintaining access to the open sea.

On the Adur, for example, the original port was at Old Shoreham some 1.5 km north of the present coastline and 3 km from the present harbour mouth at Kingston (Fig. 8a). By the eleventh century, silting in the Adur had become such a serious problem for the port of Old Shoreham that the town and port of New Shoreham (later simply called Shoreham) were built 1 km downstream. Throughout the Middle Ages this new port suffered ever increasing problems of access as the river mouth was diverted ever further eastward by a growing spit. By the mid-eighteenth century, the river mouth and harbour entrance lay some 6 km east of Shoreham, at Aldrington. In 1760, it was decided to improve access to the port by making an artificial cut through the spit at Kingston and closing the exit at Aldrington. Within fifteen years shingle began to drift across this new exit which began to migrate eastwards. By 1815 the exit was 2 km east of Kingston and access to the port was again difficult. In 1818 the Kingston exit was re-opened and, with the protection of groynes and breakwaters, remains the exit at the present day. In the 1850s, the former channel of the Adur east of Kingston was converted into a canalized harbour basin controlled by lock gates.[23] This is now the major commercial and industrial area of the port.

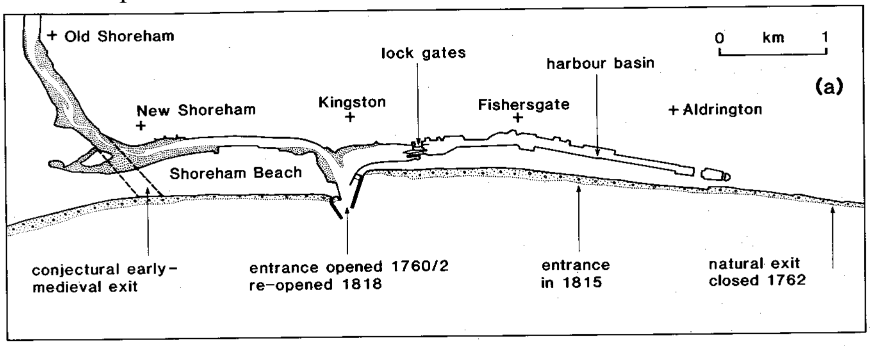

Fig. 8a Changes in the outlet of the Adur (Sources listed in note 23)

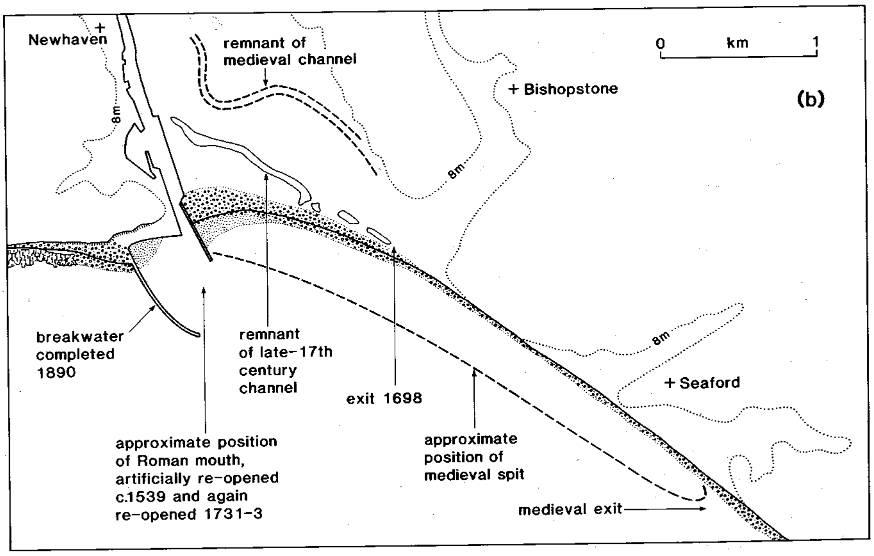

Fig. 8b Changes in the outlet of the Ouse (Sources listed in note 24)

The mouth of the Ouse was similarly deflected by the growth of a shingle spit and the present western exit is entirely artificial (Fig. 8b). In Roman times, the mouth of the Ouse appears to have been close to its present position beneath the western slopes of the valley. By medieval times the eastward growth of a spit had diverted the mouth to Seaford which became an important port. By the early sixteenth century the mouth at Seaford had become so heavily silted and choked with shingle that flood waters were having difficulty escaping to the sea. To alleviate this problem a new cut was made through the western end of the spit at 'new haven', probably in 1539. Drifting banks of shingle frequently obstructed the new exit and made entry into the harbour at Newhaven difficult throughout the sixteenth and seventeenth centuries. By 1698, an Admiralty chart showed the new exit blocked off by shingle and the Ouse outlet positioned 1 km to the east near Tide Mills. Renewed problems of drainage and navigation prompted the re-excavation of the western exit in 1731 with protective piers to keep it open. Drifting shingle remained a problem, however, and a breakwater was built in 1791. In 1847 a groyne over 150 m in length was built to the west of the harbour and this was subsequently replaced in 1890 by the much longer breakwater that survives to the present day.[24]

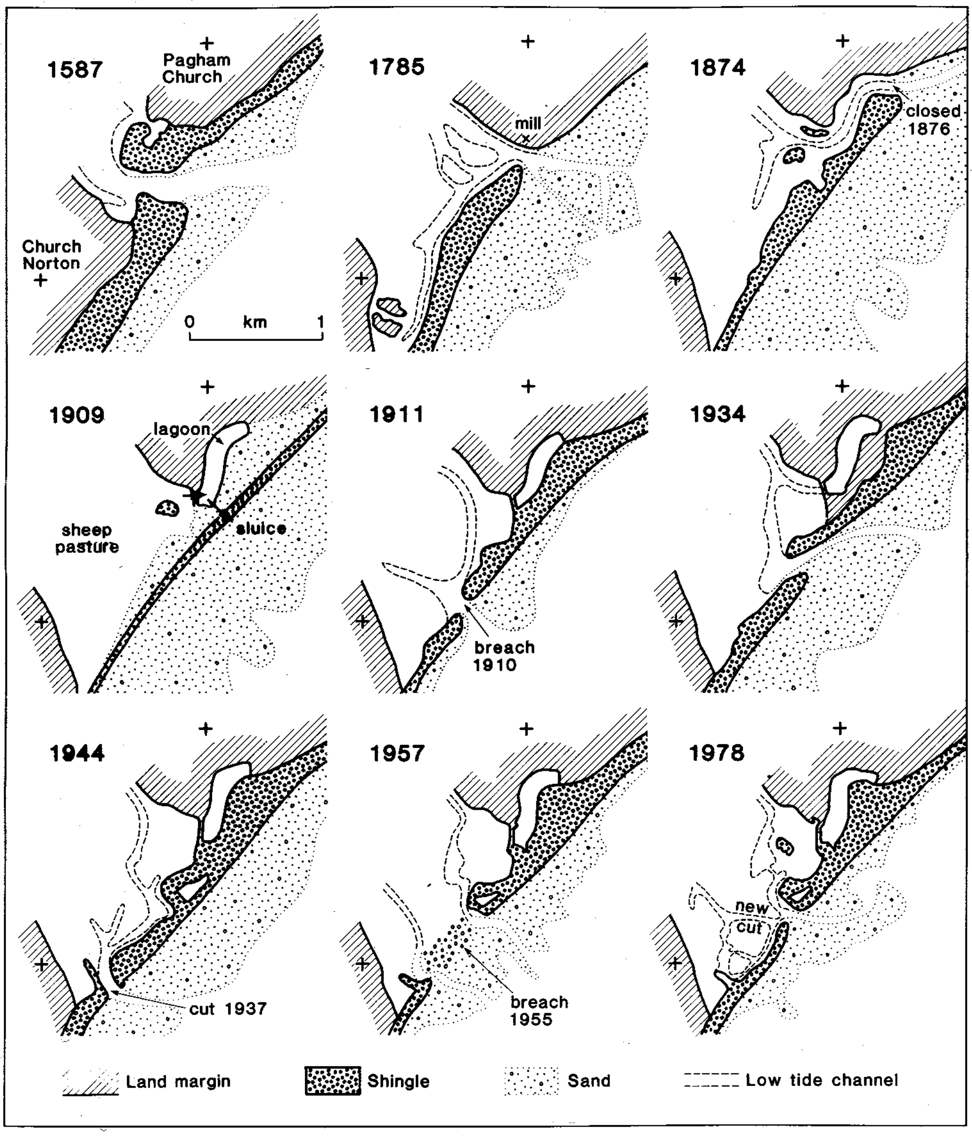

Fig. 9 Changes in the shingle spits at the entrance to Pagham Harbour (Sources listed in notw 26)

The shingle splits across the mouth of Pagham Harbour have undergone the most spectacular sequence of changes of any spits in Sussex (Fig. 9). Pagham Harbour is a tidal inlet rather than an estuary for there is no major river that flows out to sea. The earliest reliable map of the Pagham coastline, drawn in 1587,[25] shows two shingle spits projecting part-way across the mouth of the harbour, one extending north-eastwards from the southern shore, the other south-westwards from the northern shore. At the time of the next reliable surveys in 1672, and 1724, the southern spit had extended north-eastwards and little remained of the northern spit. Between 1672 and 1785 the southern spit grew 80 to 90 m and then between 1774 and 1885 grew a further 900 m causing the rapid retreat of the low clay cliffs of the northern shore.

In 1876, the harbour entrance was closed to stop further erosion of the cliffs which had already caused the loss of a mill and was threatening Pagham Church. The old outlet channel was transformed into a lagoon controlled by sluices, and the mudflats within the harbour were reclaimed for sheep pasture. However, in 1910, the shingle barrier was breached by a storm and the harbour was flooded once more. This created two opposing spits recalling the situation in 1587. Subsequent attempts to stabilise the breach were unsuccessful and the southern spit again grew north-eastwards, necessitating the cutting, in 1937, of a new entrance in the south, near Church Norton. By 1944, the old mid-point entrance had become a small lagoon within the spit. In 1955, the spit was breached once again by a storm and a detached portion of the spit was moved 800 m back inside the harbour, leaving a wide southern entrance.[26] The entrance to the harbour has gradually been reduced until today it is a narrow gap in the centre of the spits which is kept open by steel retaining walls.

In the past the Pagham spits were supplied with shingle from the erosion of the cliffs at Selsey Bill and from the offshore sea floor. Today, erosion at Selsey has been reduced by the building of a sea wall and the main source of shingle must be offshore.

In East Sussex, large volumes of drifting shingle have accumulated at Langney Point and Winchelsea Beach. Langney consists of a series of parallel shingle ridges aligned approximately south-west to north-east that are truncated along their south-west margins by erosion. It is believed to have originated as a simple spit that grew eastwards across the shallow waters of Pevensey Bay. By the date of the Armada survey, in 1587, this supposed spit had been transformed into a vast shingle foreland apparently projecting 3 km seaward (Fig 10a).[27] This foreland has been greatly reduced by subsequent erosion. By 1778, it projected about 2 km and by 1844, only 1.4 km. During the eighteenth century, retreat of the point appears to have averaged between 6 m and 9 m per year. A string of twelve Martello Towers was built along the Langney shore between 1806 and 1808 but only four remain today. Those situated along the south-west shore were all destroyed within 70 years by coastal retreat that averaged 1.2 m per year.[28] Throughout the known history of the foreland erosion has been concentrated along this south-west shore with the result that the actual point has migrated northwards. Along the north-east shore, shingle has accumulated since 1806, in places by as much as 300 m. Erosion of the Langney beaches has now been largely checked by the construction of groynes, a protective embankment and a short stretch of sea wall.

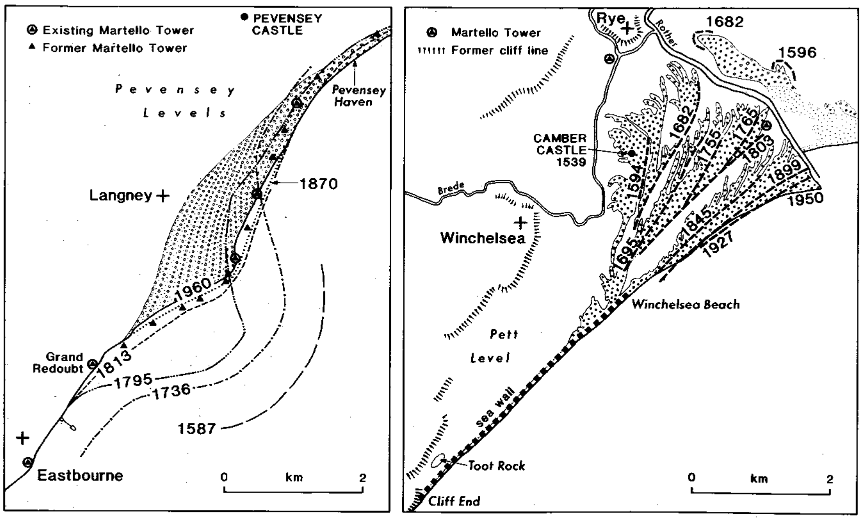

Fig. 10 (a) Changes in the form of Langney Point
(b) Growth of shingle ridges at Rye Harbour and Winchelsea Beach (sources listed in notes 25, 28, 29 and 31)

Shingle accumulation at Winchelsea Beach has mostly occurred since the sixteenth century. In the latter part of the thirteenth century, low lying land around the margins of Rye Bay suffered serious erosion. The town of Old Winchelsea was destroyed by storms in 1287 and the population transferred to a planned new town on the cliff top behind. By the early sixteenth century shingle was accumulating and in 1539, Camber Castle was built on the edge of a gently curving spit that formed the landward margin of Rye Bay (Fig l0b) [29] Subsequent growth of new spits, seaward of the original, has left the castle further and further inland. By 1594, the shoreline was already some 200 m away from the castle and further accumulation of shingle in the seventeenth century caused the shoreline to recede a further 300 m. When the Martello Tower was built at the entrance to Rye Harbour in 1804, the coastline was over 1 km seaward of the castle and it retreated a further 0.5 km in the first half of the nineteenth century.[31] After this date, deposition of shingle decreased dramatically and today deposition occurs only at the north-eastern end of the beach adjacent to the mouth of the Rother. The retreat of Fairlight Cliffs has resulted in erosion of the south-western end of Winchelsea Beach and a sea wall has had to be constructed to protect Pett Level.

The Present Day Beaches

The higher parts of Sussex beaches are composed predominantly of flint pebbles that have been eroded either directly from the Chalk or derived from the Tertiary Beds that overlie the Chalk. Originally excavated from the Chalk many millions of years ago, the derived flints were probably rolled and battered by Tertiary seas before being incorporated into the Tertiary Beds from which they have since been re-excavated. Many of the flints excavated directly from the Chalk were probably eroded from the floor of the Channel when sea level was lower than at present and were carried up to the present shoreline as sea-level rose.

A sand beach frequently underlies the pebble beach and is often exposed at low tide. Restricted stretches of beach composed entirely of sand also occur, notably at Camber where an extensive, gently shelving, sandy beach is backed by sand-dunes (Fig. 11). There are also sand-dunes in West Sussex at East Head and Climping, where they immediately overlie shingle and may not be actively forming at the present day although local redistribution of sand undoubtedly still occurs. The dunes at Camber and East Head have both suffered severe erosion in the recent past due to holidaymakers destroying their vegetation cover and both have had to be extensively fenced and replanted with marram grass to re-stabilise the sand.

During recent centuries, the free movement of beach material along the coast has been increasingly hindered by extensive groyning and the building of breakwaters designed to protect the major harbour entrances. The groynes were intended to increase the volume of the beaches by intercepting and trapping beach material as it drifted mostly along the coast. They were originally constructed only along major holiday beaches or to protect short stretches of coast suffering particularly serious erosion. However, beaches downdrift of groyned stretches of coast frequently suffered increased erosion as their supply of beach material was cut off. The response has been continually to extend the groyned stretches until today practically the whole coast is groyned, except for some of the areas backed by tall cliffs (Fig 11).

A large breakwater accumulates shingle on its updrift side and deprives the beach on the east side. However, some accumulation of beach material can occur on the east side immediately in the vicinity of the breakwater. Material driven against the breakwater by easterly gales tends to remain there because it is subsequently protected by the breakwater from south-westerly waves.

The western breakwater of Newhaven Harbour provides an excellent example. The present breakwater which is some 800 m long, was completed in 1890, and shingle immediately began to accumulate against its western side. Some 61,000 cu m of shingle was reported to have accumulated within the first three years of its existence.[32] Today, an accumulation of shingle starts 800 m west of the breakwater and increases to a maximum width of 200 m next to the breakwater (Fig 8b). The natural supply of shingle has been severely reduced to the east of the breakwater and this has accentuated the erosion of the shingle beach that stretches across the Ouse estuary from Newhaven to Seaford Head. In 1897, a storm washed away part of the beach causing serious flooding. Further breaches have occurred since.[33] Protection of the seafront at Seaford remains a serious problem despite groynes, a sea wall and recharging of the beach with shingle.

The long term effects of Brighton Marina have yet to become apparent but accumulation of shingle has already occurred against both breakwaters, and in recent years the undercliff wall between the Marina and Rottingdean has suffered increasing damage. Beach levels have also fallen along this stretch of coast.

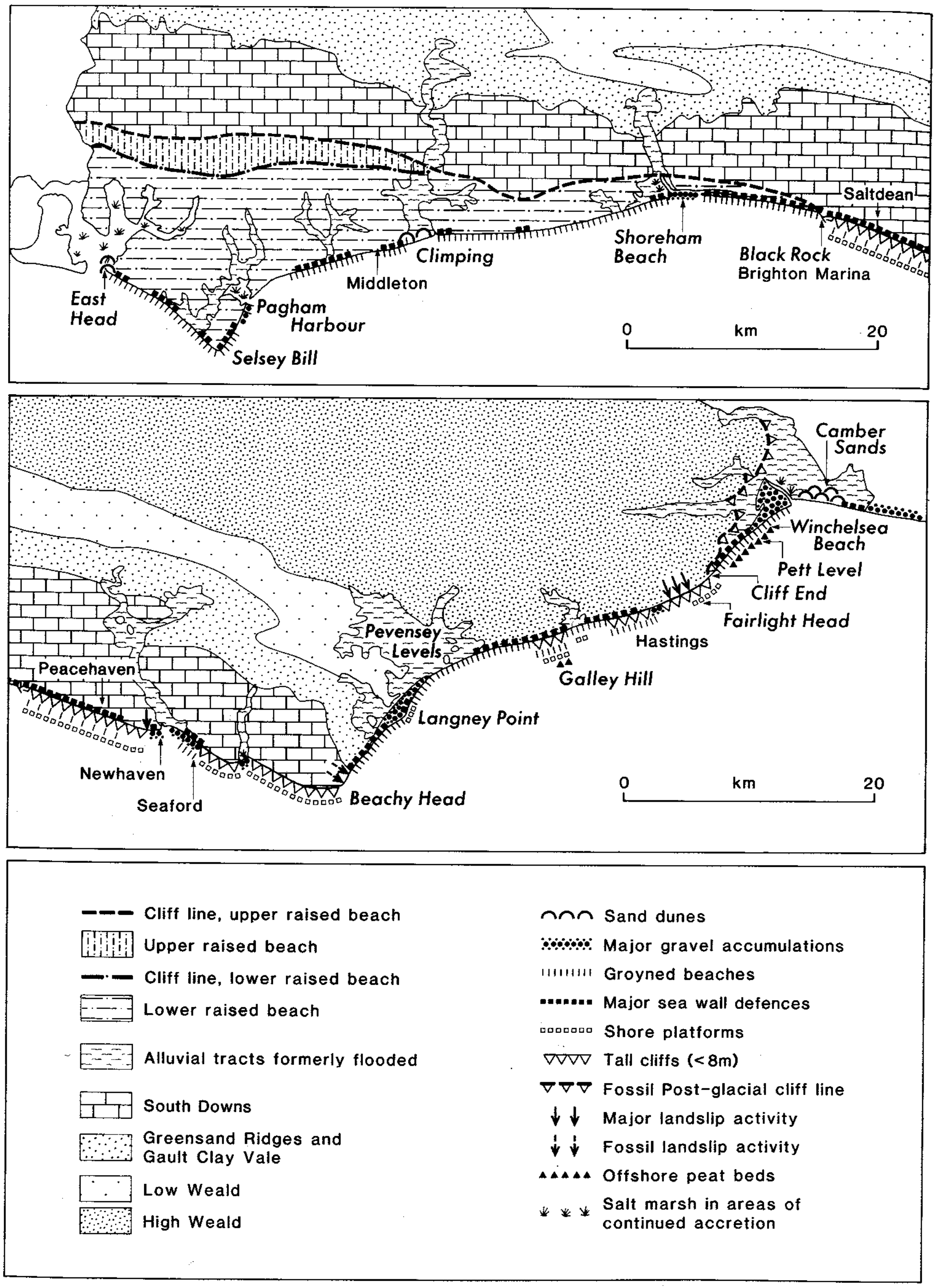

Fig. 11 Sussex coastal features

Cliffs and cliff retreat

Between Brighton and Eastbourne lie the famous white chalk cliffs of Sussex, which are divided into three blocks by the wide mouths of the Ouse and Cuckmere. Vertical or near vertical throughout their entire length, the cliffs reach their greatest height of 165 m at Beachy Head. The cliffs are retreating rapidly at the present day. Over the whole length of cliff, the average retreat is between 0.3 m and 0.5 m per year, but some stretches are retreating at up to 1.25 m per year (Table 4).[34]

Retreat of the cliffs is caused by the combined action of rain, frost and salt, and the frequent pounding of the sea at their base. It is concentrated in the winter months, especially during thaws following severe frosts, and during gales, when wave attack is fiercest and the chalk above is saturated and heavy. The cliffs are particularly vulnerable after dry summers when vertical fissures develop behind the cliff faces.

Cliff retreat is intermittent. Periodically, short stretches of cliff collapse and the debris accumulates on the beach, temporarily protecting the base of the cliffs behind from wave attack, Further falls do not normally occur for 8 or 9 years, until the sea has removed the debris and undercuts the cliff again.

TABLE 4 EAST SUSSEX
Average annual rates of retreat of the most rapidly eroding cliffs

Site	Geology	Average Annual Retreat (in)
Peacehaven	Chalk	- 0.46
Seaford Head	Chalk	- 1.26
Birling Gap	Chalk and Coombe Rock	-1.22
Beachy Head	Chalk	- 1.06
Ecclesbourne Glen	Hastings Beds (Sandstone dominant)	- 1.19
Fairlight Glen	Hastings Beds (Clays dominant)	- 1.43
Cliff End	Hastings Beds (Sandstone)	- 1.08

Source: A. Thorburn, Report on the problems of coastal erosion, E.S.C.C., Lewes, 1977.

Between Brighton and Peacehaven most of the base of the cliffs has been protected by a groyned sea wall and concrete platform which forms an undercliff walk. The face of the cliffs has been artificially trimmed back but weathering continues and produces debris which collects on the undercliff walk. Along the open coast the debris is generally washed away by storm waves which overtop the wall but behind Brighton Marina it tends to accumulate, fouling the walkway.

A gently sloping shore platform usually extends seawards from the base of the cliffs for up to 200 m, to below the low water mark. The upper part is frequently covered by sand or shingle but the rest is a bare chalk platform. The platform is most steeply sloping in the vicinity of Eastbourne and Beachy Head, where it reaches a gradient of 4° (1:14).[35] In some places the platform is smoothly sloping but elsewhere it descends in a series of steps up to 1 m in height, sometimes capped by a band of flint. The platform surface is often dissected by systems of runnels that deepen seawards. Water movement is concentrated along these runnels during the rise and fall of the tides.

Retreat of the cliffs is accompanied by lowering of the platform surface, and backwearing of the steps and seaward margins of the platform. In 1981 - 2, Ellis measured the lowering of the platforms between Brighton and Newhaven at 44 sites, and found that rates varied from 1 mm to 10 mm per year, with an average of 3 mm per year.[36] Most of the lowering occurred in the winter months.

Lowering and backwearing have many causes. Large pieces of chalk are sometimes broken off either by frost action or the pounding of waves, and exceptionally severe frosts can break up the whole surface of the platform.[37] Limpets and other molluscs dissolve the surface of the chalk with their secretions while some bore deep tunnels into the surface. Solution of the chalk, and wetting and drying in the presence of salt, helps weaken the surface which, in some places, becomes soft and slimy. In stormy weather the sea often turns milky with suspended particles of chalk removed from the platform.

The Hastings Beds, which reach the coast between Bexhill and Pett Level, give rise to cliffs almost as impressive as the grandest chalk cliffs. The cliffs are most continuous east of Hastings where they reach a maximum height of *145* m at Fairlight. They are variable in form because of lithological differences within the Hastings Beds. (See Chapter 1) Immediately east of Hastings, the cliffs are mostly composed of massive sandstones and tend to be bold and vertical. Further east towards Fairlight, the sandstones are underlain by clays. The clays become saturated with water and the cliffs are subject to mudflows and landslipping. Along relatively protected stretches of coast, such as around Fairlight Glen, the cliffs have developed a stepped profile as a result of landslipping but the stretches exposed to greater wave attack tend to be more vertical. Clay and silt debris reaching the foot of the cliffs is quickly washed away by the waves leaving sandstone blocks littering the foreshore. Shore-platforms are only intermittently developed, principally in the sandstones. They tend to be more irregular in profile with larger and more frequent steps than those developed in the Chalk.

Former cliffs cut into Hastings Beds can be seen behind the sea-front at St Leonards and Hastings. An older line of more degraded cliffs runs behind Pett Level and Winchelsea Beach. The Toot Rock near the south-west end of Pett Level was once a cliffed, offshore islet of sandstone.

In West Sussex, only very low cliffs are developed which reach a maximum height of 3 to 4 m. For the most part, they are protected by sea walls or hidden behind groyned shingle beaches. In the past, rapid erosion has occurred along this coast and still continues along unprotected or poorly protected stretches, notably on the west side of Selsey Bill. The east side of Selsey Bill suffered particularly rapid erosion until it was protected by a sea wall. Between 1923 and 1960, the coast near the lifeboat house at Selsey retreated no less than 225 m at an average rate of 6 m per year.[38] Similar rapid rates of erosion have occurred elsewhere in West Sussex. At Middleton, for example, the coast is reported to have retreated 400 m between 1839 and 1911, an average retreat of 55 m per year.[39] At West Wittering, the coast has been retreating at a rate of 4.5 m per year in the recent past.[40] The rapid retreat of the West Sussex coast has resulted in the loss of a number of villages whose sites now lie up to a kilometre out to sea.[41]

Although much of the Sussex coastline has become heavily urbanised, many scenically attractive stretches of important amenity and scientific value remain. In East Sussex, the shingle ridges at Winchelsea Beach and Rye Harbour are much altered by continuing gravel extraction, but are still of great interest to nature conservationists. The impressive cliffs and deep glens east of Hastings are now protected as the Hastings Country Park. The National Trust and East Sussex County Council now own the magnificent chalk cliffs of the Seven Sisters, which have been declared a Heritage Coast. Cuckmere Haven, the only important river mouth in Sussex to escape development, has become another Country Park, together with the adjacent downland on the east. The downland and cliffs at Seaford Head are protected as a Local Nature Reserve. In West Sussex, the areas around Pagham and Chichester Harbour still retain great natural beauty, and are important for nature conservation and recreation.

Responsibility for coastal defence in Sussex is shared by 15 separate authorities. An annual survey is made of beach volumes in order to monitor changes. Retreat of the coastline has been reduced by the construction of sea walls, an extensive system of groynes artificial beach recharging and other defensive measures. However, the fight against the sea is a continuing one which cannot be safely abandoned despite escalating costs. Over long stretches of the coast renewed retreat or the breaching of sea defences would result in damage to, or loss of, domestic and industrial properties. At the present day, major sea defences are being constructed near Bexhill and at the foot of the cliffs between Saltdean and Peacehaven. The cost of defending just 2.2 km of coast at the latter site is £4.72m.

ACKNOWLEDGEMENT

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NOTES AND REFERENCES

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