BEACHY HEAD - SEAFORD HEAD

V.J. May

OS Grid Reference: TV490980–TV600968

Introduction

The Chalk of the South Downs reaches the sea between Brighton and Eastbourne in a series of cliffs that become generally higher towards the east and culminate in the 150 m-high cliffs of Beachy Head (see Figure 4.1 for general location). This site comprises a cliff–beach–platform system developed on the Chalk, includes the classic world-renowned cliffs of Beachy Head and the Seven Sisters, and cuts across the mouth of the Cuckmere Valley (Figure4.25). The cliffs reach a maximum height of 156 m at Beachy Head (TV 588 956) and vary between 14 m and 79 m in height along the Seven Sisters. Retreat of the cliffs has been estimated at 0.42 m a^{-1}, reaching a maximum of 0.91 m a^{-1} at Birling Gap (May, 1971a). A narrow fringing beach of chalk and flint rests upon the cliff–platform junction, except where major falls, especially at Beachy Head, extend below low-tide level (Figure4.26). Debris ramparts from cliff-falls are common at Beachy Head. The coastline plan is controlled primarily by dominant and prevailing wave energy from the south-west, with Seaford Head and Beachy Head acting as more resistant points between which a predominantly wave-energy controlled shoreline has developed. Structural variations seem to have had little effect upon the overall coastal plan, the cliff materials being sufficiently rapidly eroded to ensure control by wave action. However, in detail the cliffs are controlled by a rectilinear jointing pattern (see Figure4.27). The beach is one of six major SW-facing beaches in southern England, all of which differ significantly in their geological characteristics. Most of the site faces south-west and is exposed to Atlantic waves. The fetch from the south-west is similar to that which affects all the major beaches in the English Channel. The cliff and beach of Seven Sisters in particular is unusual in having a very strong similarity in its alignment to such beaches as Chesil Beach and Dungeness. Of the beaches, Seven Sisters beach is the most rapidly and consistently fed by flint from cliff-falls. The most directly comparable cliffs also comprise Upper Chalk along the Normandy coast, but they lack the same aspect and degree of exposure.

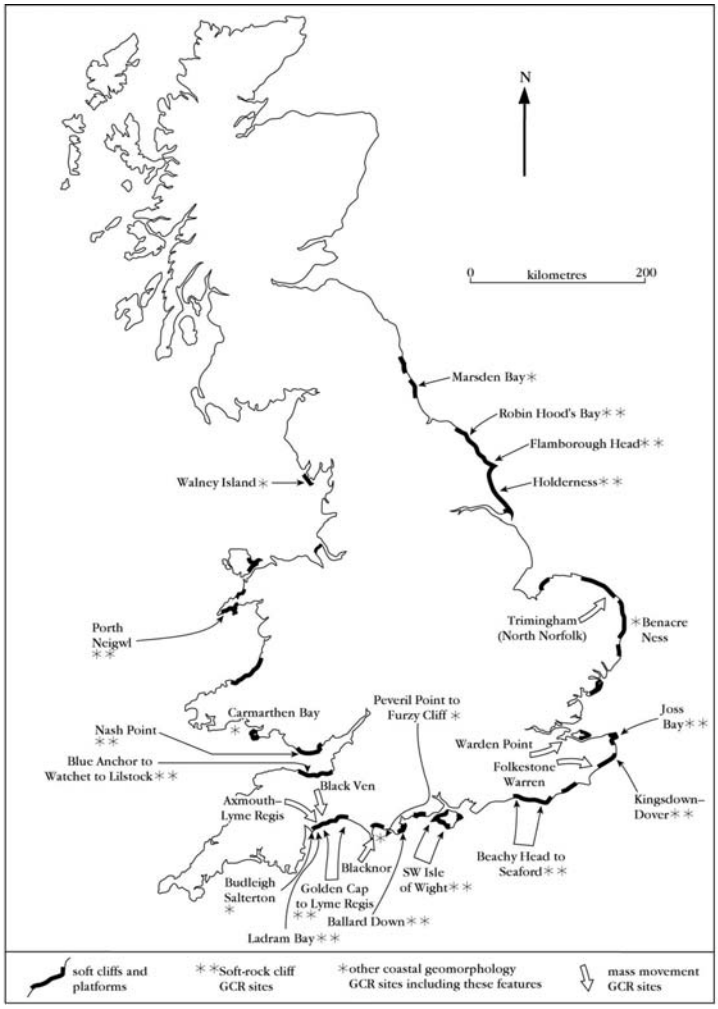

Figure 4.1: Location of significant soft-cliffed coasts and platforms in Great Britain, indicating the sites selected for the GCR specifically for soft-rock cliff geomorphology. Other coastal geomorphology sites that include soft-rock cliffs and sites selected for the Mass Movements GCR 'Block' that occur on the coast are also shown.

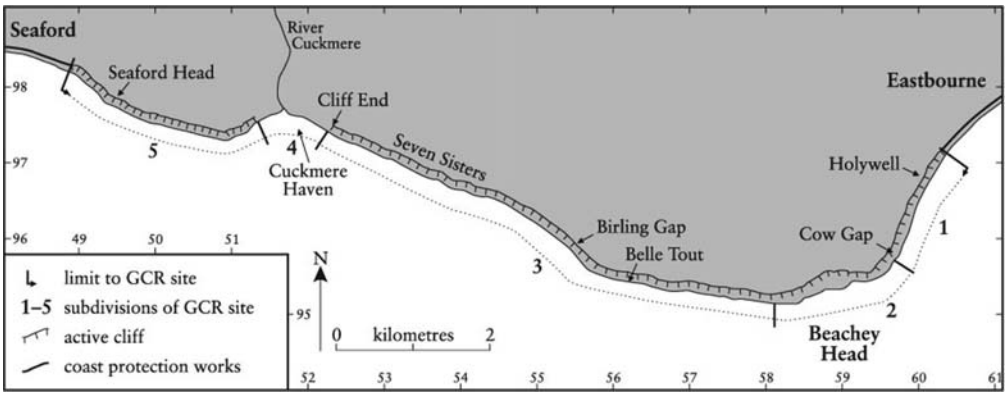

Figure 4.25: Sketch map of the Beachy Head to Seaford Head GCR site, showing the five subdivisions of the site as described in the text.

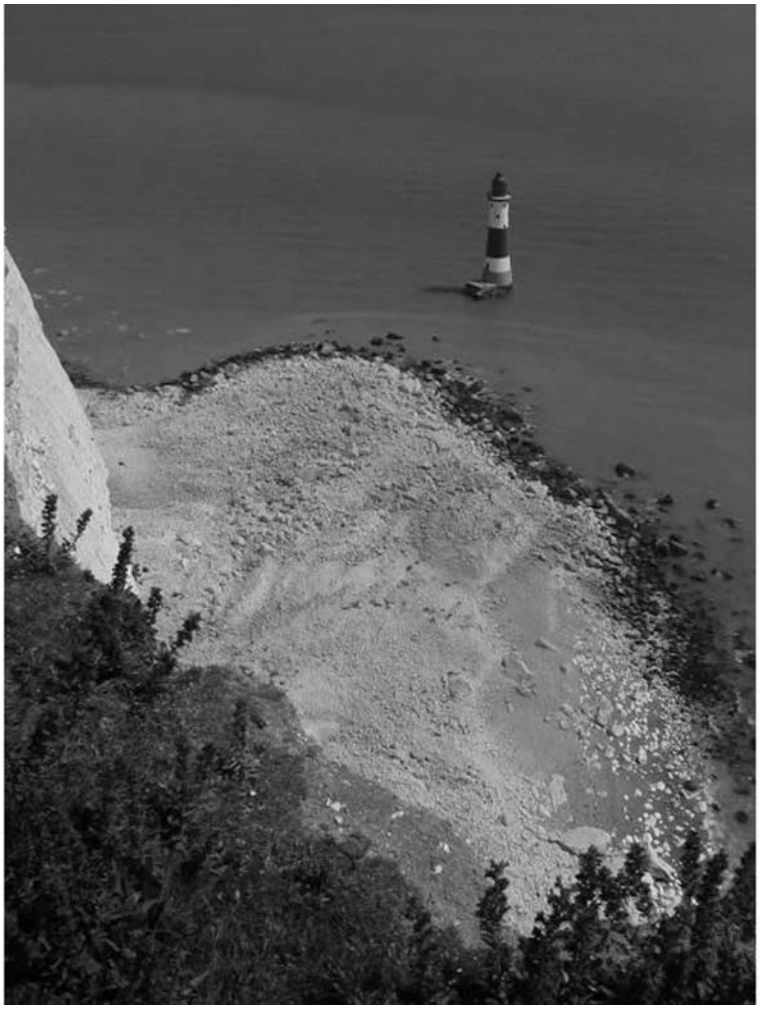

Figure 4.26: (a) Beachy Head, cliff top view looking east, the cliffs are characterized by slab failures in the lower cliff that gradually undermine the upper cliff. (b) Cliff collapse at Beachy Head, early 1999; the failure affected the whole cliff face and produced a very large debris area at the cliff foot. (Photos: V.J. May.)

Figure 4.27: Relationships between joints, cliff morphology and retreat near Birling Gap. (Photo: V.J. May.)

Research here has been mainly restricted to understanding the nature and rates of cliff retreat (May, 1971a) and the relationship between the cliffs, platforms and the processes operating on them (Robinson and Jerwood, 1987a,b). They are nonetheless cited by a number of texts including Bird (1984), Holmes (1965), Small (1978), and Precheur (1960), the latter considering the contrasts with the similar Chalk coast of Normandy.

Description

The site comprises five sub-units (Figure 4.25):

1. The Chalk cliffs and Greensand and Gault Clay platforms below Cow Gap and Whitebread Hole (TV 600 968 to TV 595 955).

2. The high complex cliffs of Beachy Head (TV 595 955 to TV 579 953).

3. The truncated dry valley mouths, cliffs and platforms of the Seven Sisters, including Birling Gap (TV 579 953 to TV 521 976).

4. The shingle beach and marine delta at Cuckmere Haven (TV 521 976 to TV 514 976).

5. The Chalk cliffs and platforms at Seaford Head and Hope Gap between TV 514 976 and TV 490 980.

Although most of the site is cut into the Upper Chalk, at Beachy Head the orientation of the coastline trends across the escarpment and virtually the whole of the Chalk from Lower to Upper Chalk is exposed (Figure 4.26). In addition, the Upper Greensand and the Gault Clay beneath crop out on the shore platform east of Beachy Head.

The easternmost part of the site is aligned south-west–north-east and has a cliff height of 24 m. The upper part of the cliff is formed by a staircase of narrow slipped blocks. At the foot of the cliffs, both the Upper Greensand and the Gault Clay crop out, failures in the latter giving

rise to the upper cliff features. The platform is distinguished by several repeated outcrops of these rocks, which appear to be related to mass-movements that have penetrated below sea level. At the northern end of the site several springs flow from the top of the Plenus Marl and may affect the erosion of the cliffs. The beach is formed of flint and chalk rubble, and extends northwards towards Eastbourne where it is dominated by flint, the Chalk typically being worn down over a distance of about 1 km.

On the eastern side of Beachy Head, the coastline is aligned WSW–ENE and cuts across the line of the South Downs escarpment. The cliffs reach a height of 160 m and have three, and sometimes four, distinct slope segments.

1. An upper vertical or near-vertical cliff, much broken by tensional fissures. In the past, it was distinguished by a series of pinnacles known as the ‘Seven Charleses', which stood about two-thirds up the vertical face. Although the pinnacles are said to have disappeared before the end of the 19th century (Castleden, 1982), similar forms continue to occur on this slope. Failures of the cliff carry debris to its foot.

2. A middle vegetated segment, which has angles around 60°. The length of the slope varies considerably, sometimes forming the majority of the cliff. At some points, it is almost totally bare of vegetation and appears to be a shear plane along which failure has occurred.

3. A lower steep bare rock cliff, which is currently attacked by wave action, but may have been exhumed from beneath a debris fan. Wave energy at the foot of the cliff is much-modified by the alternation of debris with cliffed embayments.

4. A debris slope formed of material that has fallen from the upper cliffs.

Generally having angles of about 30°, these debris slopes often extend from below low-water mark, sometimes joining the middle slope segment. They provide considerable protection to the foot of the cliff. Older debris has often left a residual cover of boulders on the platform. At the western side of Beachy Head, these act as a natural groyne reducing the transport of shingle eastwards from the Seven Sisters. Pocket beaches of flint and chalk rubble occur between the debris fans.

The Chalk shore platform extends beyond low-water mark, providing the foundations for the Beachy Head Lighthouse. The water around this part of the site is characterized even during gentle seas by greatly increased turbidity because chalk fines are commonly in suspension.

Between the western side of Beachy Head (TV 579 953) and Birling Gap, the cliffs are similar to those of the Seven Sisters. In contrast to the Seven Sisters, however, these cliffs produce large debris fans and many residual boulders form curved low ridges on the platform, a pattern noted along the coastline east of Dover. Beachy Head itself is distinguished by many small high-frequency rockfalls, but there are also infrequent very large events, the most recent occurring on 11 January 1999. A mass-movement event affected the whole height of the cliff over 200 m in length. The debris from the slide extended seawards to the base of the lighthouse and was marked by a seaward boundary of very large boulders (in excess of 3 m in diameter). Similar events are recorded on maps dating from the earlier part of the 20th century (Figure 4.26b).

The Seven Sisters have been cut across the dip of the Chalk and the cliffline truncates seven dry valleys (Figure 2.9). The cliffs rise to over 72 m in height, but their lowest points occur at the valley mouths (heights of 18 m at Crowlink and 12 m at Birling Gap). The dry valleys are underlain by Coombe Rock, and the Chalk has also been affected by periglacial heaving and shattering. At both Crowlink and Birling Gap, this sub-valley weaker material passes below sea level and the platform is cut lower here than elsewhere as a result. At Birling Gap, the rate of retreat has been higher than on the other cliffs (Table 4.2). The cliffs are vertical, with a narrow platform upon which rests an intermittent beach of chalk and flint shingle. Much of this sediment is derived from the erosion of the cliffs.

Figure 2.9: Cliff height, and to some extent cliff form, is a function of the height of land cut by the cliffline. The photograph shows the cliff form of the Seven Sisters, Sussex, an almost straight cliffline truncates a series of dry valleys, the seven intervening ridges forming the Seven Sisters. (Photo: V.J. May)

May (1971a) showed that between 1950 and 1962 cliff-top retreat at Birling Gap varied substantially both from year to year and between winter and summer. Of cliff-top land-loss, 87% occurred during winter. Most retreat took the form of long narrow strips or small lens-shaped areas. Over the timescale of this survey the cliff-top retreat was close to parallel, whereas over the seasonal scale it was much more spasmodic in time and location. Very large falls, such as at Baily's Brow in 1925, estimated at half a million tonnes (Castleden, 1982), are less common. Along this cliff, marine erosion is very effective in removing the debris from cliff-falls of all sizes. The cliff is undercut and frequently collapses along the line of joints, which are at a slight angle to the cliff-face. The failures appear to have a toppling nature, responding to the slight seawards dip of the Chalk. The strong winter frequency of cliff retreat may also be attributed to the effects of frost, and increased pore pressures. Weathering of the cliffs and platform produce substantial quantities of smaller debris, which together with the debris from falls, provide the main input to the beaches. In contrast to the generally narrow and discontinuous beaches below the Seven Sisters, large beaches occur at Birling Gap (Figure 4.27) and below the western cliffs of Beachy Head. Like the others, they are predominantly composed of rounded chalk pebbles and angular flint. The beach at Birling Gap fills the slight embayment formed by the more rapid retreat of the cliffs and lowering of the platform. Its alignment is strongly related to the dominant and prevailing waves. As a result it tends to smooth the plan of the shoreline between the cliffs east and west of the beach. The platform is lower at Birling Gap partly as a result of the deep weathering of the Chalk associated with the dry valley and also the absence of flint layers within the platform (Figure4.28). To both east and west, the beds dip slightly eastwards and flint bands form sloping surfaces that are truncated.

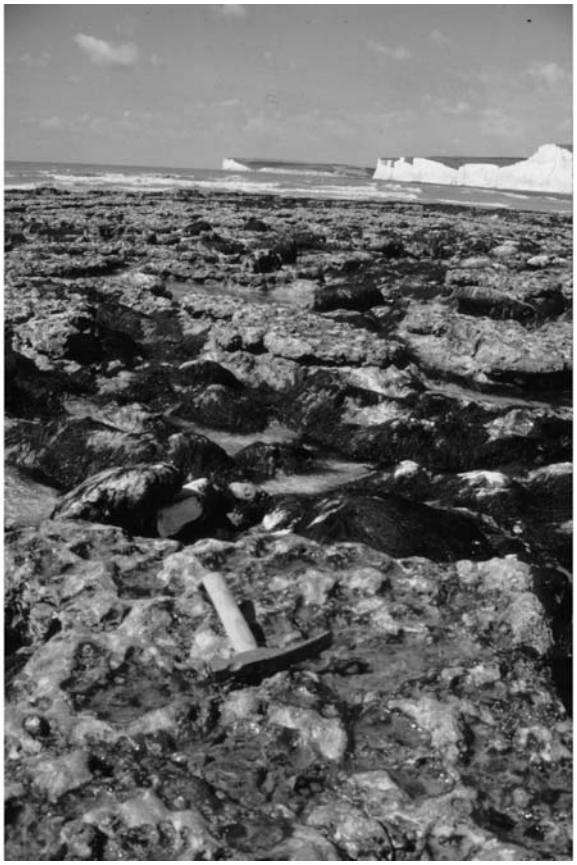

Figure 4.28: Detail of the chalk and flint platforms east of Birling Gap. (Photo: V.J. May.)

Although the platforms along this coast have been commonly described as erosional features, little account has been taken of the role of the flint bands in controlling the micro-relief. Thus although there is an accordance of heights along the platform, the platform is a series of gently sloping micro-cuestas (Figure 4.28), with scarps on their western side at a point where the undercutting of the underlying chalk brings about collapse of the flint cap.

At Cuckmere Haven, the lower River Cuckmere is now channelled artificially between two groynes. In the past however, the river was deflected to the east by a shingle spit to enter the sea below Cliff End. Both in the past and at the present, the river forms a series of frequently changing distributaries that produce a small delta. This is an unusual feature, both on the coast of south-east England and on a coast undergoing rapid erosion. It suggests an effective fluvial sediment supply to the beach as well as considerable reworking of beach sediments by the river distributaries. This is the only beach within the site that contains rolled oxidized flint shingle as the predominant constituent. Elsewhere, high proportions of the beach comprise rolled chalk and much angular and subangular flint recently derived from the cliffs and platform.

The westernmost part of the site is formed by Upper Chalk cliffs that rise to 85 m at Seaford Head. The cliffs east of Seaford Head itself are affected by a series of vertical joints and have a generally vertical form. At Short Cliff, the cliffs are less steep and include gentler facets. At Hope Gap, the cliffs truncate a dry valley exposing the weakened chalk beneath the valley floor to erosion both in the cliffs and in the platform. Parts of the Chalk are overlain by deposits of orange-brown sands, silts and clays that are well-exposed at Short Cliff. They have been described as Palaeogene beds modified during the early and mid-Pleistocene (Castleden, 1982) and appear to have played an important part in the development of pipes in the Chalk. The pipes can be seen in the cliff face, sometimes descending, as at Short Cliff, to high-water mark. On the platform, Castleden has noted up to a dozen circular holes up to 1 m in diameter which show that piping extended well below present sea level. Their rims sometimes stand several centimetres above the platform (see also GCR site report for South Haven Peninsula in Chapter 7). The platform is well-developed, and its micro-relief is strongly affected by differential erosion along joints that run at right angles to the shoreline. As much as 1 m in depth, these

eroded joints act as drainage channels for the platform.

Interpretation

The cliffline of the Seven Sisters shows strong adjustment to the primary direction of wave approach from the south-west, the headlands at Seaford and Beachy Head acting as strongpoints between which it is aligned (see Figure2.9). The mouth of the Cuckmere River also affects the coastal alignment. Nevertheless, this coast retreats more-or-less parallel and at a similar rate to shingle beaches that share the same wave climate, such as the southern side of Dungeness. The modern production of beach sediment is small and does not offer much protection to the cliffs. At Birling Gap, the beach should provide greater protection, but this is not the case. The role of the debris overlying the cliff foot and the platform may be considerable, both in supplying tools for abrasion and erosion and also in affecting water flow over the platform. There is little understanding of the sub-beach weathering of chalk platforms (but see GCR site report for The Dorset Coast: Peveril Point to Furzy Cliff in Chapter 11), in contrast to Robinson's (1977a–c) work on Lias platforms around Robin Hood's Bay. Robinson and Jerwood (1987a,b) have demonstrated the importance of subaerial weathering of the platforms during severe winters, when freezing and thawing produce considerable breakdown of the platform surface. This process releases both chalk and flint clasts, but as elsewhere on the Chalk coasts, only flint makes any long-term contribution to the beach sediment budget. The flint bands play a critical role in controlling the micro-relief of the platforms and so allow higher wave energy inputs to the cliff foot at lower points.

Erosion along this coast has been very active throughout its recent history, but despite the considerable activity at Beachy Head the Head itself has remained salient. The large debris fans provide a substantial degree of protection, with wave energy reduced slightly as the coastal alignment changes. Even so, the equilibrium between effective removal of debris and its retention is finely balanced. It appears to be strongly related to the size of debris produced by the rockfalls, for debris of small size is rapidly removed. Where a rockfall contains a large boulder element, it appears that the rate of boulder reduction (which is a function of boulder size) brings about greater roughness of the intertidal platform and thus more effective wave attenuation.

The longshore transport of beach sediment, particularly rounded flint shingle, from the west is largely prevented by long jetties at Newhaven and a long groyne at the eastern end of Seaford Beach. The older rounded and oxidized flint shingle, which forms beaches in West Sussex and to the east of this site at Pevensey, has been replaced almost exclusively in this site by recent subrounded and subangular flint and chalk clasts. The effects of longshore transport are such that only limited quantities of shingle derived from the falls at Beachy Head can travel to the west. As a result, this beach system now relies upon contemporary inputs of sediment. Both Seaford Head and Beachy Head act as headlands between which the less-protected more-active cliffs and beach of the Seven Sisters have adapted to the dominant and prevailing south-westerly waves. In this respect, these Chalk cliffs contrast strongly with all other chalk cliffs in England. The majority are more strongly controlled in their alignment by structural features (e.g. Kingsdown to Dover), the nature of the cuesta into which they are cut (e.g. south-west Isle of Wight) or have very complex shorelines resulting from structural weaknesses at high angles to the shoreline (e.g. Flamborough Head). The rapidity of erosion and the relatively sparse beach mean that much of the Seven Sisters coast acts in a similar way to major beaches in adjusting to the alignment of the dominant wave direction. Among British cliffed coasts, other than those in weak sands and clays, this is unusual. This site is a member of a suite of some six beach or beach–cliff English Channel sites that show a similar alignment towards the south-west and comparable adjustment to the wave energy input, even though they occur in different rocks or have variable supplies of beach sediment.

The geomorphological interest of this site is very high, even though, like most cliffed sites, it has not been thoroughly investigated. The potential for increasing our understanding the ways in which cliffs and platforms develop through studying this site is substantial.

The Beachy Head to Seaford Down GCR site is of particular importance to coastal geomorphology because of the following features:

1. the well-developed cliff–beach–platform sequence, in which platform development is directly related to cliff retreat and both processes depend upon, but also control, beach volume;

2. well-developed platforms, notably at The Mares and Birling Gap;

3. solution piping in the cliffs and platforms;

4. a marine delta at Cuckmere Haven;

5. truncated dry valleys in the Seven Sisters;

6. rapid cliff erosion associated with efficient removal of debris from falls and a limited supply of flint to the beaches;

7. very active high cliffs at Beachy Head supplying substantial quantities of sediment to the local beaches;

8. the development of a platform across slipped blocks of Gault Clay and Upper Greensand, an especially rare feature because it preserves several major mass-movement events.

Conclusion

The cliffed coast between Beachy Head and Seaford Head is a GCR site of worldwide landscape importance, and international importance to research into coastal geomorphology because of the links between cliff, beach and platform development, the alignment of the shoreline to the dominant wave conditions, the contemporary sediment supply to its beaches, the almost total lack of relict sediment ources, and its contrasts with other coastlines formed in the Chalk.

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