SOUTH PEMBROKE CLIFFS

V.J. May

OS Grid Reference: SR958932–SR966928;SR922944–SR942940

Introduction

The coastline west of St Govan's Head contrasts with that of southern Gower because of its absence of emerged (‘raised') shore platforms and the presence of steep active cliffs. The two sections of cliffed coastline that form this site (Figure3.29) enclose some of the finest examples of coastal forms in England and Wales. Cut into massive limestones of Carboniferous age, the cliffs include exceptional examples of the development of geo, stack, cave and arch. Faults and other lines of weakness have been exploited by the sea to produce such well-known features as the Green Bridge of Wales, Elegug Stacks and the Huntsman's Leap. The importance of this site is greatly increased by the retreat of the coastline into an area of karstic landforms. Thus, the combined effects of solution, collapse and marine reworking of these landforms have produced an intricate and geomorphologically important assemblage of forms. Like a number of cliffed sites, the literature is limited (Steers, 1946a, 1969; Guilcher, 1958), and a single paper provides most information about the nature and origins of the site (John, 1978).

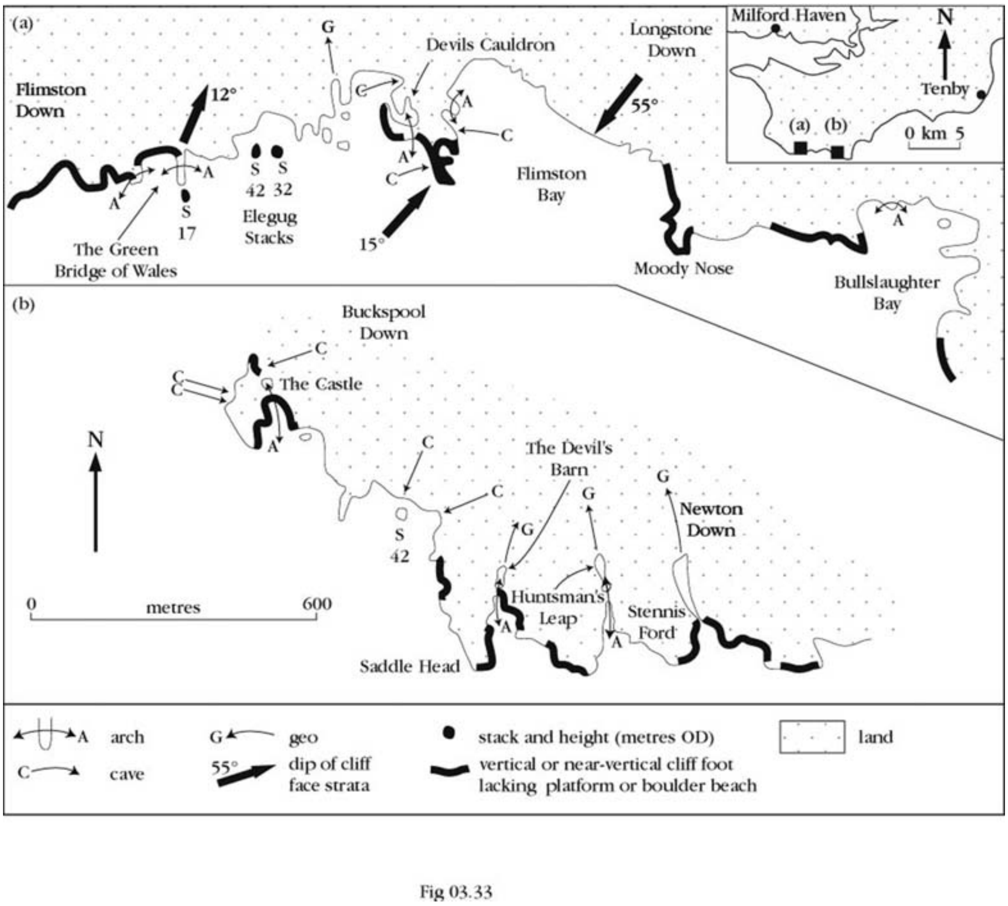

Figure 3.29: Erosional features of the south Pembrokeshire coast. (After John, 1978.)

Description

There are two parts to this site (Figure 3.29). The first part (SR 958 932 to SR 966 928) includes the Huntsman's Leap (an excellent example of a geo). The second (SR 922 944 to SR 942 940) includes the Green Bridge of Wales, Elegug Stacks and the Devil's Cauldron. The cliffs rise to between 45 m and 50 m where they cut the Flimston ‘coastal flats' – an erosion surface generally attributed (John, 1978) to marine erosion during Pliocene or early Pleistocene times. At the coastal edge, the structures of the Carboniferous Limestone are truncated not only by the cliffs, but also by this well-developed erosion surface. The dip of the Carboniferous Limestone exposed in the cliffs varies from landwards, west of the Devil's Cauldron, to seawards, east of Flimston Bay. Cliff forms that are steep, near-vertical and occasionally overhang, where the dip is to landward (Figure 3.30), are replaced by cliffs that are much gentler in profile and where the seaward-dipping beds largely control the cliff form. Much of the cliff foot is marked by a jumble of boulders from both recent and older rock falls.

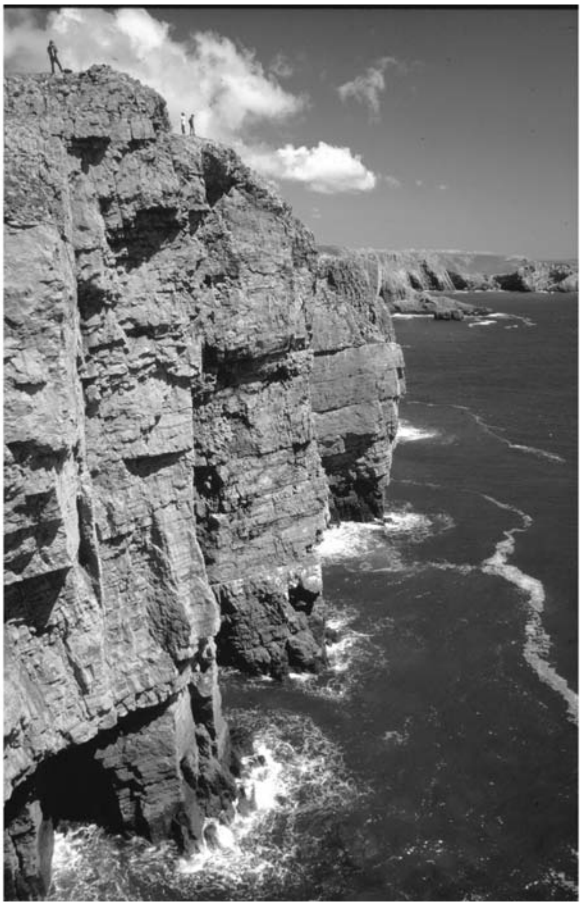

Figure 3.30: Cliff profiles, South Pembroke Cliffs GCR site. Cliffs are steep, near-vertical and occasionally overhang where the dip is to landward. (Photo: S. Campbell.)

The eastern part of the site is distinguished by the best-developed geos on the coast of England and Wales. In addition, the future development of similar features can be predicted as groups of aligned blowholes and caves provide the focus for marine erosion. The Huntsman's Leap and Stemmis Ford are two fine examples of geos, the latter extending about 180 m in from the coastline. The Devil's Barn includes two blowholes that are the cliff-top expression of an arch and marine erosion beneath them. At the Castle, there is a sequence of caves and arches as well as a blowhole. If their roofs collapsed much of this area would become separated from the mainland. They are probably solution forms that are being reworked by marine action.

The western part of the site includes some of the most unusual coastal forms of the coastline of England and Wales. The Green Bridge of Wales is an arch of about 24 m in height and it spans more than 20 m. Its upper surface slopes down from the cliff top. The outer limb of the arch rests on a broad pedestal-like base. Here the limestone dips inland. The Elegug Stacks, of which the higher reaches about 36 m, also rise from a broad, sloping pedestal. A fault runs through the eastern base of the larger of the two stacks. To the east of the Elegug Stacks, the sea has exploited a large number of faults and major shear planes, as well as deposits of gash breccia, to produce an intricate assemblage of caves, arches and geos (Figure3.31). Of 52 faults and major shear planes recorded by John (1978), 22 co-incide with a cliff face, 11 form the axis of geos and 19 are associated with neither. Only four co-incide with a cave or arch. This pattern continues to the east in Flimston Bay. It is largely absent on Longstone Down where the Bullslaughter syncline produces seaward dips of up to 55°. From Moody Nose eastwards, the local control of erosion by faults and shear planes is also very evident.

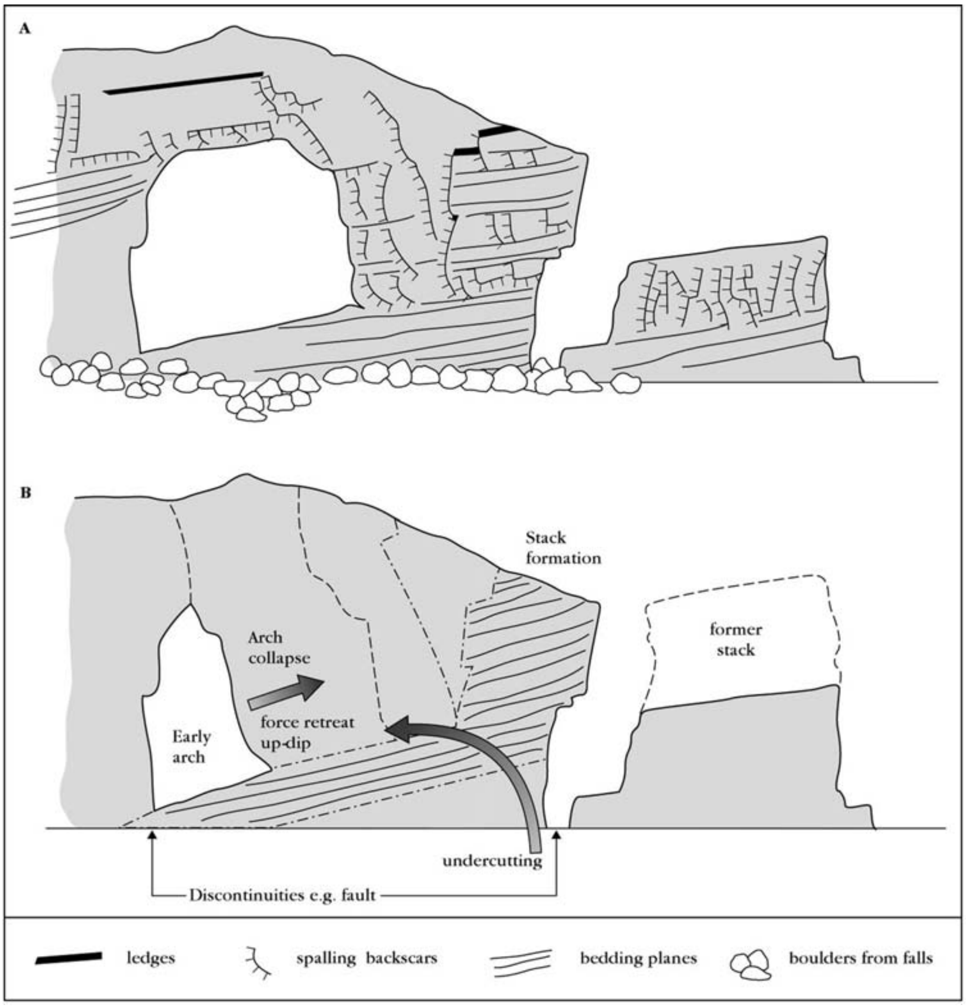

Figure 3.31: Arch and stack development. (A) Form of the arch and stack at The Green Bridge of Wales. (B) Interpretation of development of the feature. An initial arch develops on the line of a discontinuity, and extends up-dip by spalling and collapse of up-dip rock surfaces. The arch roof collapses and a new stack is isolated.

At Flimston Castles, the coastline is extraordinarily complex and includes the Devil's Cauldron. Here a shaft, 45 m deep with a maximum diameter of 55 m, is open to the sea via an arch 18 m high and 21 m wide, a narrow fault-guided chasm connecting with the sea.John (1978) cites Thomas' estimate that some 113 000 m^3 of rock was removed to produce the Devil's Cauldron. Its considerable interest arises from the fact that much of this coastline truncates solution features of the limestone landscape. The Devil's Cauldron, like several other features on this coast, is probably a karstic form that has been exploited by the sea as the coastline has retreated. Similar eroded features occur at Flimston Castles and at the Devil's Barn and the Castle.

Interpretation

There is no comparable site in England and Wales, and, with a few exceptions, similar examples around the European coastline have rarely been described in detail. The only other similar site in Britain in which exhumation of erosional forms has been well described is the Bullers of Buchan in Scotland. There, however, the stacks and geos are often cloaked by, and infilled with, till and so their preglacial or interglacial origins can be accepted with little question. Here, the evidence is more circumstantial. A rock platform that may be reworking an earlier form is subject to erosion at present by both chemical and physical processes.

Marine erosion of karstic forms is common along the north-eastern Adriatic coast, and comparable features on the south coast of Gozo, Malta have been described briefly (May and Schwartz, 1981; Paskoff and Sanlaville, 1978). Although stacks and arches are well represented in Chalk, such cliffs generally lack the development of geos found here. Some features where karstic forms are truncated by marine erosion occur in Chalk north of Flamborough Head. The South Pembroke cliffs include a well-developed coastal landscape in Carboniferous Limestone and, unlike much of the Gower peninsula, is not characterized by emerged ('raised') beaches and platforms. Nevertheless, the coast both to the east and west provides evidence of considerable longevity. In West Angle Bay, pre-Devensian till may underlie Ipswichian emerged beach deposits and both lie above a rock platform, which could therefore be attributable to higher sea level during the last Ipswichian interglacial (Campbell and Bowen, 1989). Inland at Hoyles Mouth and Little Hoyle's Cave sediments have been interpreted as showing that the limit of the Late Devensian ice was close to this site. Furthermore these caves record the occupancy by humans in Upper Palaeolithic times (c. 18 000 years BP) and suggest that the area to the south must have been ice free. Similarly Marros Sands farther to the east preserves evidence of intense Devensian periglaciation. It thus appears that the South Pembroke coast was ice-free during Devensian time, was probably affected by intensive periglacial processes and that parts of the coast may have been reworked. However, although John (1978) has suggested that parts of the cliffs may be more than 5 million years old and that others may date from the last interglacial, there is no direct evidence that the south Pembroke cliffs preserve former features. For example, the present sea-level platform may not be entirely contemporary, but no evidence is available to support or reject the hypothesis that it is exhumed. There is similarly no evidence to date for the age of the karstic features into which the cliffs are currently being cut. Solution forms are well developed on some parts of the platform (Guilcher, 1958) and are generally regarded as being contemporary features. Any attempt to relate the levels of the platforms to past sea levels must take account of the rates at which solution takes place. There has been, however, little research here into the detailed evolution of these forms.

The present-day changes in features such as the Green Bridge of Wales as recorded by photographs show that most changes this century have occurred on the down-dip side of the arch wall. Undercutting and spalling have narrowed this part of the feature and provide an insight into both its future and more generally the development of stacks in this hard-rock context (Figure 3.31). The original break through the promontory from which the bridge formed probably occurred at the point where the pedestal rock occurs at the cliff foot. The seaward face of the cave and then the arch has retreated more rapidly. This face has retreated most rapidly at its base and in due course when the arch collapses the stack will stand on a pedestal several metres above sea level. The largest geos are characterized by a narrow neck and/or blowholes. They appear to have developed by widening and lengthening around these blowholes (which may co-incide with karstic features) rather than by progressive lengthening.

In summary, the regional evidence points towards a very long history for this coastline, but the local evidence supports a modern origin for the coastal features as the cliffline cut into the existing karstic landscape. There is little evidence in the cliff forms that the cliffs are anything other than modern surfaces resulting from the undercutting, toppling failures and rock falls of an older cliffline.

Conclusions

This is a rare assemblage of active coastal erosional features, whose origins are better documented than many other cliffed sites. Well-developed geos, stacks, arches and cliffs truncate a former karstic landscape. In addition, it forms part of a southern British suite of structurally controlled coastal landforms, which includes Tintagel as the least dynamic and Old Harry (see GCR site report for Ballard Down) as the most rapidly changing. The marine erosion of former karstic features to produce an intricate coastline of arches and stacks is not found on this scale elsewhere on the British coast.

Reference list

Campbell, S. and Bowen, D.Q. (1989) Quaternary of Wales, Geological Conservation Review Series, No. **2**, Nature Conservancy Council, Peterborough, 237 pp.

Guilcher, A. (1958) Coastal and Submarine Morphology (translated by B.W. Sparks and R.H.W. Kneese), Methuen, London, 274 pp.

John, B.S. (1978) Valiant cliffs of Pembrokeshire. Geographical Magazine,**50**, 467–70.

May, V.J. and Schwartz, M.L. (1981) Worldwide coastal sites of special scientific interest. In Coastal Dynamics and Scientific Sites (eds E.C.F. Bird and K. Koike), Komazawa University, Tokyo, pp. 91–118.

Paskoff, R. and Sanlaville, P. (1978) Observations géomorphologiques sur les côtes de l'archipel Maltais. Zeitschrift für Geomorphologie, Neue Folge,**22**, 310–28.

Steers, J.A. (1946a) The Coastline of England and Wales, Cambridge University Press, Cambridge, 644 pp.

Steers, J.A. (1969) The Sea Coast, 4th edn, New Naturalists Series, No.**25**, Collins, London, 276 pp.