

2 The Evolution of Gower Coasts

D Lees

Aims

- 1 To observe the main geomorphological features of the Gower coasts.
- 2 To observe the evidence of the evolution of the coastal landforms of Gower.
- 3 To interpret the evidence of the evolution of the coastal landforms of Gower.

Objectives

After completing the excursion you should be able to:

- 1 Provide a geomorphological description of the main features of the Gower coastline.
- 2 Describe the main evidence for the way in which the coastal landforms have been created.
- 3 Provide an interpretation of the way in which the contemporary landforms have evolved.

Maps

OS 1:50,000 Sheet 159 Swansea and Gower
OS 1:25,000 Sheet SS 48/58/68/ South Gower (and the Mumbles)

Suggested itinerary

- | | | |
|---------------------|---------------------------|--------------------|
| 1 Llanrhidian Marsh | 5 Worms Head | 9 Heatherslade Bay |
| 2 Whiteford Point | 6 Pliton Green | 10 Swansea Bay |
| 3 Broughton Bay | 7 Port Eynon/Oxwich Point | |
| 4 Rhossili Bay | 8 Pennard Cliffs | |

To visit all of the sites two days will be required. Suggested one day trip:

- | | |
|-------------------------|-------------------------|
| 0900 University College | 1500 Port Eynon |
| 0930 Llanrhidian Marsh | 1630 Heatherslade Bay |
| 1100 Broughton Bay | 1800 University College |
| 1300 Rhossili Bay | |

SECTION 1 THE PHYSICAL SETTING

The coastal morphology of the Gower peninsula is the product of the interaction of structure and geology, and of the changes in relative land and sea levels which took place during the Late Pleistocene and Pleistocene periods, of recent and present marine processes and human activity.

Structure

Reference should be made to the geological map of Gower found in the Excursion Guide to the physical landscapes of Gower.

It is widely agreed that the general shape of the coastline was formed prior to the Pleistocene period, and particularly in the Miocene and Pliocene periods during and after the time of the Hercynian and Alpine orogenies. The earth movements brought about the folding

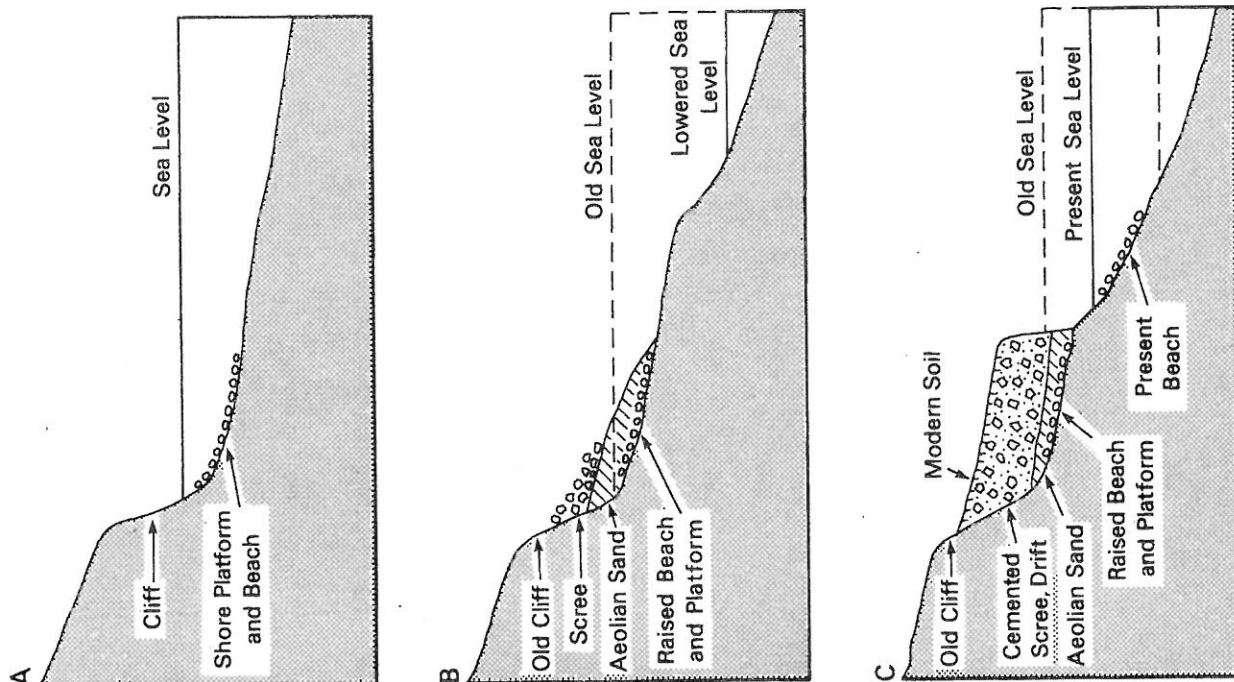


Photo. 2. Three Cliffs Bay and Southgate.



Photo. 3. Whiteford Burrows looking north from Llanmadoc.

Fig.1 Development of the Raised Beaches of Gower



of the Carboniferous rocks of the South Wales coalfield, with the fold axes trending approximately west to east. The flexing of the rocks, particularly of the limestones which are more competent than the overlying Millstone Grits and Coal Measures, resulted in the creation of a dense network of faults. Strike faulting in the form of thrust faults follow, the alignment of the fold axes, while tension and tear faults have created lines of weakness which can cross the axes of the main folds from north to south. Because the more rigid limestone is the dominant element in the geology of the south coast of Gower, the effects of the movements were far more dramatic than in other rocks which underlie much of the north coast. A further likely reason for the greater structural complexity of the south coast is the protection afforded to the north by the very rigid Old Red Sandstone anticlinal cores of Cefn Bryn, Rhossili Down and Llanmadoc Hill.

The anticlinal structures of Gower form headlands, for example of Mumbles Head and Oxwich Point, while the synclines form the major bays at Oxwich, Port Eynon and Swansea. The many lesser embayments of south Gower are etched along the innumerable faults which run perpendicular or obliquely to the coast, across the axes of the west-east aligned folds. The complex structure of south Gower is clearly displayed in the coastal cliffs, where the dip of the rocks exerts a strong influence on cliff form.

Much has been written concerning the influence of geological structure in the shaping of a coastline, particularly of Gower: 'Almost every bay, inlet, gully, mere, cave or sound is eroded along a joint or a fault or a soft bed.' (T.N. George 1933) 'No other erosional agency seems quite so sensitive as waves to slight variations of rock hardness or to the presence or absence of lines of weakness such as its faults and shatter belts' (R.J. Small 1978).

Geology

The geology of the Gower coast has been an important factor in the evolution of the present coastline. The pattern of bays and headlands is related to the pattern of anticlinal and synclinal folds and associated faulting. The excavation of the bays is intensified by the occurrence of softer Namurian shales within the core of the synclines, while the limestones of the headlands resist wave attack. The significance of geology is also seen in the present shore platforms on which a very interesting array of limestone solutional features peculiar to coasts, has developed. Details of these are provided with the appropriate site descriptions.

Land and Sea Levels

In general, the coastline of Gower was developed by the Late Pliocene period. Since then changes in land and sea levels have greatly influenced the detailed configuration of headlands and bays.

The high cliffs and the occurrence of marine abrasion platforms higher than the present sea level, show the Gower coastline to be one of 'emergence'. These elevated marine features indicate that however complex the relative land and sea movements have been, in general the land surface has been raised relative to the sea. The most extensive marine platform, thought to be of late Pliocene age, has been called The 200ft (61 m) Surface. Because it extends across so much of Gower, the surface of the peninsula has an appearance of topographic simplicity which bears very little relation to the underlying geological and structural formations. The platform is best seen from the summits of Cefn Bryn and Rhossili Down, which are thought to be remnants of the earlier and once more extensive 600ft (183 m) Surface (Goskar and Trueman 1934).

While the surface relief and coastline of the Gower Peninsula is in the main pre-Pleistocene, the detailed geomorphological features of the coast were formed in the Pleistocene and Recent periods. The high cliffs are not solely a result of recent or present day wave action, but were largely shaped in the Pleistocene when sea levels were higher relative to the land surface than

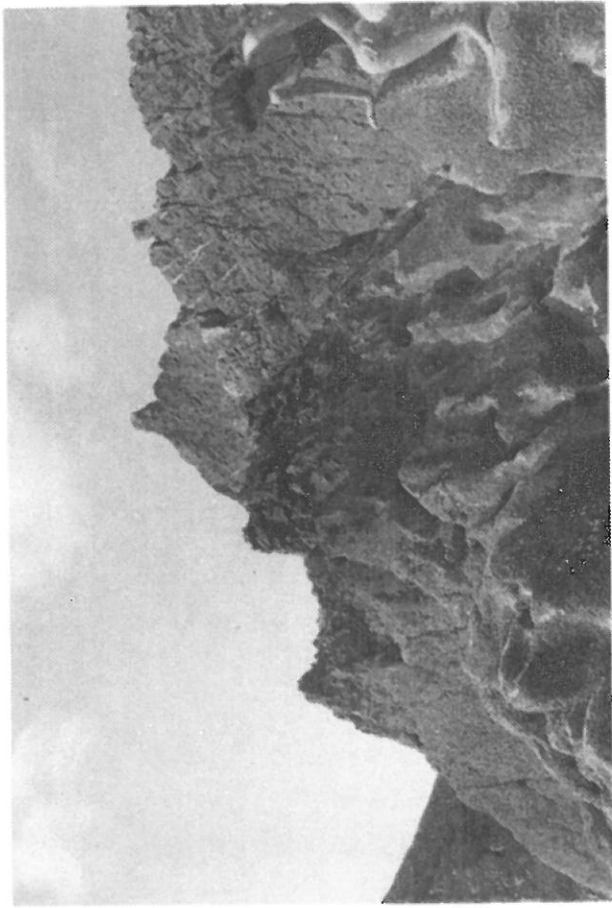
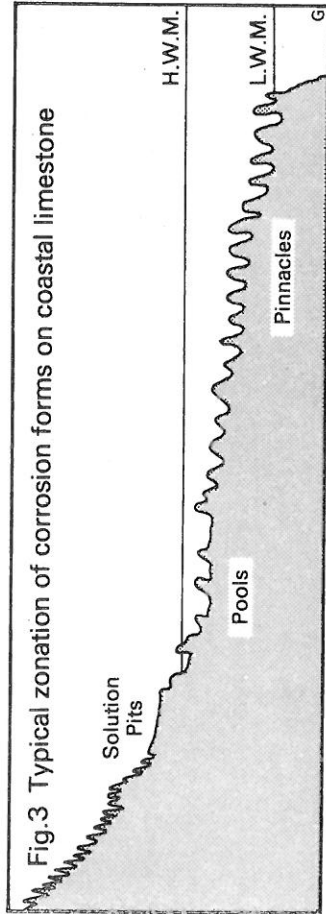
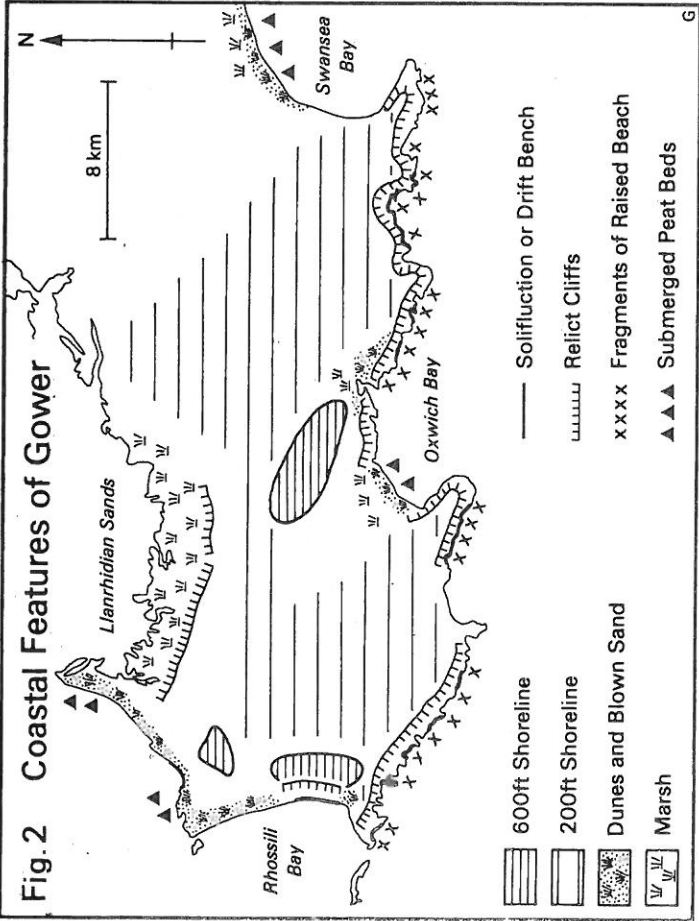


Photo 1 Coastal limestone at Tor Bay, Three Cliff Bay.

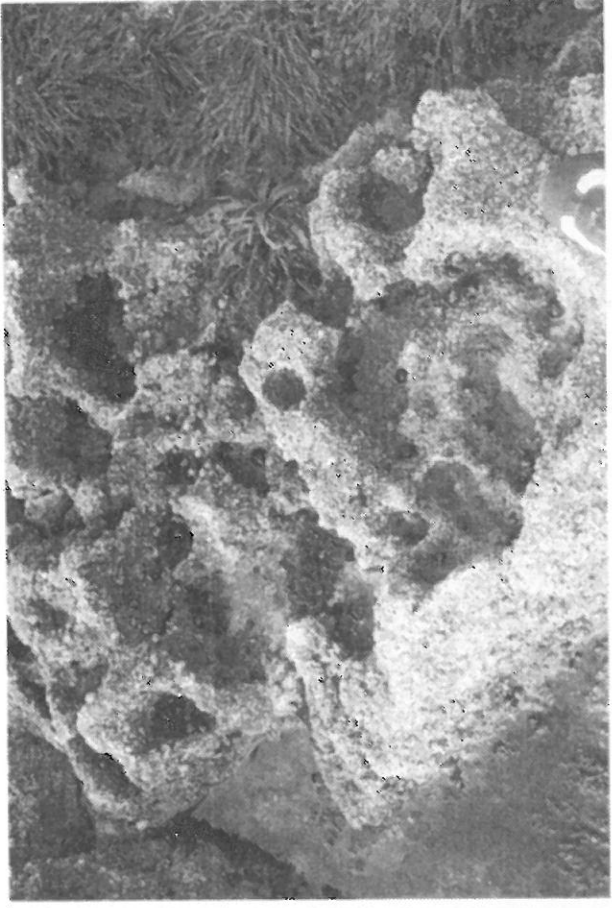


Photo 2 Detail of intertidal limestone at Worms Head Causeway, Rhossili.

they are today. The sea cliffs of north Gower which are now some distance from the sea, are in the main, 'fossil' cliffs, in that they are no longer subject to marine processes. Those of south Gower are 'relict' rather than fossil, because although they were largely sculptured in the Pleistocene period, in places they are subject to the attack of present marine processes.

Other features of Pleistocene age include the raised beaches which are composed of shelly debris, shingle and pebbles, cemented together by re-deposited calcium carbonate from lime rich water. The beach deposits are often very fragmented, although in places they form the basal level of a complete sequence of debris which spans a time period from the Ipswichian or last interglacial high sea level, through the Devensian glacial period low sea levels, to the present day, when the sea level appears to be little different from that of the interglacial periods. Deposits dating from the last interglacial period occur in the main close to, or a little above, the present high tide level (Fig 1). In places, higher rock platforms can be seen, etched in the limestone cliffs several metres above the raised beach deposits which may represent still earlier high sea levels. Contemporary beaches do not necessarily occur all at the same level since variables such as degree of fetch, exposure and coastal environment, cause them to vary slightly in height, while the possibility of recent 'warping' should not be discounted (North 1955).

The processes connected with the Flandrian Transgression also had an important impact on the coastal geomorphology of the Gower Peninsula. The rise of sea level meant a re-sorting of the glacial drift and meltwater deposits which had settled in Swansea Bay, the Loughor estuary and off the south Gower coast. Silts and clays were flushed out. Coarser debris such as sand and stones, were transported landwards to shape the spit of Whiteford Point (although the origin of this feature is still uncertain), to form wedges of sand in the bays of Port Eynon, Oxwich and Caswell, and, during periods of particularly severe storms, to form the dunes which fringe the bays and also rest in places on cliff tops as at Penarth and Llangennith. Marshes have developed behind the lee of Whiteford Point and behind the dunes of Swansea Bay and Oxwich Bay.

Human Influence

In a number of places the impact of human activity has been to alter the rate of natural processes and to directly reshape geomorphological features. For instance, the dredging of sand in the Loughor estuary and the building of training walls to deflect the River Loughor northwards to improve the navigational channel, has markedly modified the processes which have shaped the north Gower coastline. Sand dune reclamation programmes are being implemented at selected sites in Gower, since it was recognised that the pressure of walkers, horse riders and holiday makers was creating erosional problems and threatening the stability of extensive areas of dune landscape.

The direct shaping of geomorphological features can be seen in the salt marsh areas of north Gower, where land has been reclaimed for better grazing by the building of sea walls. The most dramatic reshaping of landforms however, has occurred in Swansea Bay, where coastal dunes and marsh have virtually disappeared beneath landscaped parks, golf links, roads, docks, industrial complexes, housing estates and other buildings.

The human impact has not been confined to the present. Around the coastal headlands of Gower, prehistoric earthworks can be seen, such as the ring work at Penmaen, which are significant features of cliff tops. Remains of varying age found in the Gower caves and within the dunes, suggest a long history of coastal exploitation and occupation which may well have contributed to the erosional problems being dealt with today.

Conclusion

In general conclusion, the outline of the coast is Pre-Pleistocene and is determined largely by 'endogenic factors' such as geological structure. The more detailed features of the coast,

particularly of the bays which act as sedimentary sinks, are of Pleistocene and Post-Glacial derivation. The greatest changes that have occurred since, are the human actions that have modified and are modifying the unconsolidated sediments of the coast for economic, social and aesthetic purposes.

SECTION 2 NORTH GOWER

1 Pen-Clawdd (535 958) A short distance west of Pen-clawdd on the B4295 road there is a car park on the north side of the road. It is built over a large dump of the shells of cockles which are abundant in the estuary and which are exploited commercially from Pen-clawdd. From this site the upper salt marsh vegetation can be observed. This is arranged in distinct zones from the road level to the creeks as follows:

- (a) A narrow band of *Juncus maritimus* forms the climax community of the marsh. It lies on the north side of the road where the marsh is stable and escapes tidal inundation.
- (b) Adjacent to the *Juncus* is a band of *Festucetum* (grasses) which generally occurs between 4.1 and 4.8 m (Bridges 1977).
- (c) The *Puccinellietum* covers a fairly extensive area and contains a wide diversity of species such as *Aster tripolium* (sea aster) which is a fleshy plant with lanceolate leaves. The flowers have lilac outer florets and yellow centres. *Scirpus maritimus* (sea club rush) occurs in patches and is distinguished by the triangular stem and reddish brown spikelets. *Armeria maritima* (sea pink) occurs sporadically. It has pink clover like flower seated on long narrow stems which rise from a basal tuft. This assemblage is intermingled with the stiff grass *Spartina anglica* which was introduced into Britain in 1870 and has been planted in a number of marshes to hasten the trapping of sediment. It was introduced in the marsh of north Gower in 1935 and is rapidly spreading, particularly in the area of marsh observed here.

- (d) *Halimione portulacoides* (sea purslane) forms a distinct assemblage fringing the marsh creeks. It is light green in colour and bushy, and is a very effective mud trapper. It is slightly raised above the level of the marsh creating a levee like effect. This is because of its very bushy nature and because it traps the coarser sediments which spill over from the creeks.

2 Weobley Castle (477 928) In an earlier excursion, a walk to observe the general features of the Burry Inlet is suggested, leaving the main road south west of Crofty. For smaller coaches and mini-buses, west of Llanrhidian the north fork in the minor road at Oldwalls (487 919) (the road to Landimore and Llanmadoc) leads to Weobley Castle (477 928). From the castle there are fine views across the salt marsh and to the promontory of Whitford Point to the west, in the lee of which the mud flats have accumulated. Weobley Castle lies at the top of the 'fossil' sea cliff.

The Burry Inlet follows the Gowerton syncline along an east to west alignment. It also follows a major line of weakness and like Swansea Bay is carved out of the relatively soft Coal Measure series. The general outline of this part of the coast was most probably established before the Pleistocene period. The tongue of ice which filled the valley in the Devensian glaciation greatly modified the coastal geomorphology by providing an abundant supply of silts, clays, sands and boulders, reworked during the subsequent rise in sea level to form the major depositional features seen along this stretch of coast.

It is also likely that ice touched the coastal cliffs, clearing frost shattered debris and solifluction material; its marginal streams etching the wide and flat bottomed valleys which run parallel or obliquely to the coast. One example this occurs adjacent to the west side of the castle. The cliff line shows signs of having been rounded off as a result of solifluction and subaerial weathering, particularly now that it is beyond the reach of marine erosion.

3 Whiteford Point (439 934) There is a good view of the promontory from Weobley Castle. Larger coaches should continue west from Pen-clawdd following the south fork of the minor road at Oldwalls (487 919) to turn north beyond Burry Green to reach Llanmadoc (440 932). On the descent to Llanmadoc observe the glacial spillway which runs parallel to the front cliff line.

Follow the road through the village and park by the church (439 935). Walk down the lane to Cwm Ivy (approx. 400 m) and follow the path to the beach.

Massive Carboniferous Limestones outcrop at the coast here, with the steepness of the cliffs closely related to the geological structure in that the steep angle of the dip forms the coastal 'slope'. The extent to which ice scouring affected the cliff line at this point is not known, nor whether the Flandrian transgression was most significant in carving the coastal features here (Bridges 1977). Some evidence does suggest that in the last glacial period ice reached as far west as this point along the coast. Glacial till of Devensian age has been found at the west end of Broughton Bay (Campbell 1980), which introduces the possibility of ice scour along this cliff line. If this is the case, then the origin of Whiteford Point must be questioned. It has been suggested that this promontory rests on a pebble ridge derived from a terminal moraine (Bridges 1977). In light of more recent evidence it may be that like Salthouse Point (521 958) to the east, Whiteford Point either rests on a recessional moraine or is a deposit of glacial derivation reworked by the advance of the sea during the Flandrian transgression.

The dunes which lie on the Whiteford Point promontory range from mobile and longitudinal foredunes, to the more mature and partly stabilised parabolic type. They represent a landward movement of sands reworked from glacial debris first by the sea and then by aeolian processes, during the post-glacial period. The considerable quantity of blown sand on this part of the coast, partly derives from the sand banks and extensive sand flats which are exposed at low tide.

Close to the north western end of Whiteford Point, peats with leaves, roots and other plant material preserved in them are exposed just below high tide level, representing a former land surface. They have not been dated, but Periman (1934) writes of Bronze Age remains on top of the clay and beneath the dunes which fringe Broughton Bay (423 933), and Roman remains resting on the overlying sand. This would indicate that sand began to sweep inland in significant quantities around the time of the Iron Age in the first millennium BC. In Swansea Bay the dating of the dunes which fringe the coastline is rather less ambiguous (Higgins 1933) and it is reasonable to assume that a similar sequence of events pertained in Broughton Bay. The dunes have been planted with coniferous trees which have helped to increase their stability. There is evidence that the foredunes are being eroded in places along the western side of Whiteford Point, possibly because the supply of sand has been reduced or because of marine undercutting. The balance of erosion and deposition has been and is determined partly by the movements of sand banks in the estuary and by dredging activities.

4 Broughton Bay (43 94) If the tide permits, from Whiteford Point walk around Hill's Tor to Broughton Bay. Alternatively, walk back to the church and car park, and follow the lane which runs along the south side of the church to the bay. This narrow lane follows a glacial spillway similar to that on the east side of Llanmadoc, which runs parallel to the coastline and may represent an ice marginal channel.

Broughton Bay is largely shaped by faulting. The Broughton Bay and Llangenydd faults converge at the western end of the bay. The former passes between Twic Point and Rhossili Down, while the latter between Rhossili Down and Llanmadoc Hill. The area of convergence is marked by a depression within which lies a pocket of glacial till. This deposit forms a platform approximately five metres in height which underlies a dune complex consisting of parabolic dunes in varying stages of stability.

The slope of the cliff at the eastern end of the bay follows the bedding of the limestone

which dips steeply seawards. Limestone has been quarried in this area, thus the cliff line is not entirely natural, particularly at Prissen's Tor (426 937). Here the cliff line has been cut back to a point at which it is beyond the reach of the sea so that it has become fossilised behind a line of growing dunes. The fact that sand is accreting here can be seen in the thriving Marram Grass which is dependent on a continual supply of sand. At the western end of the bay, by Twic Point (417 930) the Marram Grass is dying as the dunes and drift platform are retreating under incessant wave attack. At the same time public pressure on the dunes, especially close by the main path to the beach, is creating further erosional problems by reducing the stability of the dunes. While positive attempts are being made (such as the laying of brushwood) to encourage fixing of the sand, the dunes and cliff line are under very much more serious threat of collapse by wave attack. The vulnerability of these deposits is clearly seen in the position of the storm beach at the foot of the cliff and in the very flatness of the beach, an indication of the destructive marine processes operating in this area.

Erosion along this stretch has increased since dredging of the sand from out in Broughton Bay was halted in the early 1970s. This has caused the sand banks to increase in size, confining the tidal currents and thus scouring, to a narrow area close to Twic Point (Parsonson 1982).

5 Rhossili (416 881) Rhossili Down lies to the north east of the village. It is a remnant of the once extensive 600 Foot (183 m) Surface and in Llanmadoc Hill at 193 m (430 924) has one of the highest points of the Gower Peninsula. From the summit there are excellent views over the 200 Foot (61 m) Surface which extends over most of Gower and on which the village of Rhossili lies. Rhossili Down is a rather exceptional geomorphological feature. Unlike other ridges in the area, the axis of the anticline is aligned in a north-south orientation (which is against the grain of the general structure of Gower) rather than east-west. This is because the rocks which make up the ridge here were subject to rotational shear along the line of the Llangenydd Fault. The Broughton Fault runs along the western face of the Down and with the Port Eynon Thrust to the south of it, it is bounded on three sides by faults. This partially accounts for the steep angles of slope on the west, south and east sides of the Down. They are in fact fault faces. A bench of soliflucted debris lies beneath the Down on the western side. This bench is vulnerable to wave attack. A storm beach has accumulated at its foot which does provide a certain amount of protection to the slopes immediately behind it, which thus show considerable stability with an almost complete covering of bracken and gorse.

The 'island' of Burry Holms (400 925) can be seen in the distance. It is separated from the peninsula by a Sound which has been cut along the Broughton Fault mentioned above. Immediately below the village of Rhossili, in the south eastern corner of the bay, lies a wedge of wind blown sand. Buried within the sand are scattered remains of the old village of Rhossili dating from around AD 1200. Pieces of dressed stone, some of it still intact and forming parts of buildings or walls, can be seen where areas of the sand have been washed or blown off the structures. Archaeologists have excavated the original church, parts of which, including the original Norman porch, have been used in the building of the replacement church now standing within the modern village. The old village was thus inundated with sand sometime after AD 1200. Buildings of similar date are buried underneath sand elsewhere in Gower and in the Swansea Bay area. Documents record devastating sand movements in the thirteenth to fifteenth centuries corresponding with a period of known climatic deterioration involving increased magnitude and frequency of storms (Lamb 1966).

6 Worms Head (407 873) Follow the cliff path from the car park by the coastguard station (414 880) to Worms Head. The cliffs on the Rhossili Bay side of the path are deeply fretted and steep owing to the dip of the limestone downwards and eastwards. Marine erosional processes and subaerial weathering exploit the lines of weakness between the beds, causing the very rough outline of the coastal slopes. Worms Head is a remnant of an anticlinal core, the axis of which is aligned from the north-west to the south-east. The steeply inclined beds (with a dip of 80° on average) can be seen on the causeway between Worms Head and the mainland, and also in the cliff face to the east towards Tear's Point. The influence of structure

on cliff morphology can clearly be seen when the cliffs are compared with those observed at Broughton Bay.

Take the path towards the causeway, and while descending to it, follow the easterly path which heads around the coast towards Tear's Point (410 870). The path follows the surface of a platform of Pleistocene debris similar to that which lies beneath Rhossili Down. The drift deposit is made up of red silts and frost shattered scree debris. It rests on a raised beach deposit consisting of cemented shells, pebbles and shingle, which lies very close to the present high water mark and rests on a near horizontal limestone platform. Between the raised beach and the overlying drift is a cemented deposit of large rounded stones. This deposit could represent a remnant of a storm beach or the back of a beach, in which case it is evidence of marine regression. Pebbles of a more recent storm beach can be seen embedded in the retreating drift. Other raised beach remnants of the Gower are overlain by windblown sand, again evidence of the retreating sea of the last interglacial period.

The karstic features of the wave cut platform are arranged in an interesting zonation. The raised beach overlies, and is held within, widened joints of a well developed limestone pavement. Seawards of the shelf, some of the joints have widened to such an extent that blocks of limestone are isolated to form stack-like features.

Subaerial and salt spray weathering are more important erosional processes than tidal inundation. In the intertidal zone, algae cover the limestone rock and contribute to the corrosion of the limestone. The shore platform here, in contrast to the upper beach, is deeply fretted and has deep hollows and pinnacles. This is the characteristic 'honeycomb' weathering so often seen on limestone shores (Fig 3). Little is known about the processes which operate to bring about these morphological features but the dominant processes are very different for the intertidal zone, low tidal zone and upper beach, so that different end results in each are to be expected. Honeycomb weathering appears to occur where water cover is more continuous and therefore perhaps corrosion is also more intense. However, Bird (1968) has suggested that sea water washing over limestone rocks is so saturated with calcium carbonate as to be an ineffective corrosional agent. Clearly this is a matter which requires further investigation.

A final point to note is the influence of geology on beach deposits. Limestone beaches, particularly away from river mouths, produce little suspended sediment to be washed ashore, thus they are invariably clear of beach sands and consist of rounded pebbles only.

7 Pilton Green (446 871) The B4247 road east from Rhossili to Scurrage follows very closely the line of the Port Eynon Thrust. Between Tear's Point (410 870) and Port Eynon (465 855) there is no major fault which crosses the Port Eynon syncline, so that although there are no major embayments, the coast here is heavily pitted with small narrow bays which have been etched out of major joints or small faults. This stretch of coast faces south-west. It therefore has a long fetch and is exposed to the full force of the waves. It comprises very high, steep, fretted cliffs which plunge without break of slope into the sea. The outline of the cliffs again has much to do with structure. The beds dip down and away from the sea so that weathering processes can etch out the lines of weakness between them.

Park at Pilton Green (446 871) and walk about one kilometre along the public footpath to the shore. At the stile which joins the coastal path, take the footpath to the east where there is a short climb to the top of a hill. Follow the ridge of the hill to near the cliff line where there is a fairly steep descent to the small embayment of Foxhole Slade (439 858) on the eastern side.

Foxhole Slade lies at the end of a small dry valley, the long profile of which is clearly graded to a base level rather different from that of the present day. The gently sloping valley sediments end abruptly at the shore line, where they form a steep cliff which is being undermined by the sea which is eating into the limestone rock beneath. The deposit is several

metres thick. It consists of layers of red silt and cemented angular scree debris which forms the lowest level and is intercalated with the silts of various levels throughout the sequence. The karstic features beneath are impressive and include large and rounded solution hollows which retain pools at low tide. One interpretation of this sedimentary sequence is as follows. The great thickness of colluvium was probably formed by slumping, frost shattering and stream wash within a periglacial environment. The lowering of base level within the last glacial period may have corresponded with a steepening of grade and raising of the valley floor upstream in order that any stream action or till wash could cope with the greatly increased influx of debris. In the post glacial period where isostatic movements have been slight, sea level has risen to a level close to that of the Ipswichian interglacial. The result would be erosion of the colluvium which had previously choked the valley and raised its floor under periglacial conditions. Although the coastal geomorphology may well be simply returning to its former equilibrium state, it has the appearance here of being subject to ongoing intensive erosional activity. The undercutting of the periglacial scree slopes which were once graded to a higher valley floor, is reactivating the scree by reducing slope stability.

8 Port Eynon (468 862) Two and a half hours should be allowed here if the walk to Oxwich Bay is included. If there is time, the stretch of coast between Port Eynon and Oxwich bays provides an interesting walk of 10 km. Port Eynon Bay rests within a syncline of Namurian Shales. Like the other large bays of Gower, it is cut into an outcrop of softer rocks of the Carboniferous series and into a zone of fault convergence. On the western side of the bay the limestone has been quarried, but around the point in the direction of Culver Hole (465 845) the steep cliffs of the northern limb of the Port Eynon anticline can be seen, with extensive stretches of shore platform displaying the range of karstic features which can be seen in much narrower zones at Worm's Head.

On the eastern side of the bay the dune system is suffering from erosion caused by the heavy recreational pressure exerted on them. Attempts are being made to improve their stability by restricting the public to the laid paths and by planting. The coast path follows behind the line of dunes to Horton (474 856) and then emerges on top of an apron of Pleistocene deposits similar to those between Tear's Point and Worms Head which were described earlier. The sediments are described fully on the excursion to look at the Quaternary evolution of Gower.

The cliff line morphology consists of the following elements :-

- 1 A free cliff face fossilised behind the drift platform.
- 2 A scree slope mostly buried beneath a vegetation cover.
- 3 A platform of Pleistocene drift.
- 4 A modern cliff.
- 5 A raised beach and wave cut platform.
- 6 A modern wave cut platform.

The changing vegetation assemblages reveal the drainage patterns associated with the cliff features. For instance, the free drainage of the upper scree encourages heather and bracken, whereas the junction between the scree and the drift platform is a point of water accumulation. *Molinia* grasses give way to *Festuca rubra* and then bracken and heather on the drier parts closer to the shore line. The platform is approximately three metres high, the first metre consisting of a limestone bench on which rests the raised beach. The drift deposits are much thinner here than in the Slade sections such as at Pilton Green and Deep Slade. This reflects the much smaller catchment areas on the coastal fringes than are drained by the wide and deepened valleys which emerge at the coastline. The cliff here is being undercut by the sea. The storm beach rests at its foot, with strand line material embedded within it. The honeycomb formation on the limestone of the lower shore platform can be seen along the length of coast to Oxwich Point, closely associated with the distribution of algae.

At Oxwich Point (512 850) the Common land is left behind and with it the management of

probably very similar to those seen today.

11 Three Cliff Bay (53 88) The bay is about one kilometre west from the car park at Southgate. It may also be approached from Parkmill (550 891) along a path following the east side of lison stream. The estuary is carved along a line of weakness created by the tension fault (The Three Cliff fault). This is a tear fault which has caused the horizontal displacement of the rock structure on either side of it. As a result, the shape of the coastal landforms either side of the bay differ. At the west end of the bay the coastal cliffs are cut into the nearly vertical beds forming the southern limb of the anticline. The hollow below Nothill (535 886) is cut into shale occurring in the northern limb of the Three Cliff Bay anticline. On the east side of Three Cliff Bay the beds dip more gently towards the sea. This results in a lower and smoother topography concealed beneath the very large sand dune system of Pennard Burrows (54 88). Away from the influence of the sea, towards the upper part of the bay, the cliffs are 'bevelled', that is, subaerial weathering is operating at a similar or more rapid rate than marine erosion and thus they are rounded above the low marine cliff. This is particularly well seen at the western side of the bay just seaward of the coastal dunes.

On the top of the marine cliff here, there is an ancient aeolian sand deposit cemented by calcium carbonate. This could be part of a Pleistocene beach feature, since it overlies a narrow rock bench which is at a similar height to that described at the western end of Heatherslade Bay. It also appears to occur at this height only along this particular stretch of coast.

The very extensive dune system of Pennard Burrows reached its present extent in the 15th and 16th centuries. The sands have buried a church of similar date to that buried beneath sand at Rhossili. It is also likely that Pennard Castle (544 885) was built before the advance of the sand had posed a serious threat. An abandoned farmhouse (546 876) seen on the walk along Pennard Cliffs (the west end of the tarmac road), is reported as the residence of the vicar Henry Hoskins in 1525 when his church and presumably vicarage, were besanded (Davies 1971).

12 Swansea Bay (620 900) Geologically Swansea Bay is very similar to the Burry Inlet of north Gower. It is cut into the lower and middle Coal Measures where there are numerous north-north-west to south-south-east trending faults. The limestone rim, of which the Gower peninsula is a fragment, was breached probably before the Pleistocene period, since the basin became a sink for thick deposits of Pleistocene material. The rigid limestone 'headlands' of the Gower and the Vale of Glamorgan, have contributed to the very sheltered nature of Swansea Bay, creating a 'low energy' marine environment. As such, the deposits resting in the bay are muddy rather than sandy, since the Pleistocene and early post-glacial riverine and glacial silts and clays have not been eroded to the same extent as they have been in south Gower. Post glacial peats can be seen exposed just below the high tide level between Brynmill (635 918) and Blackpill (620 906).

The dunes are thought to have advanced inland in the late Bronze Age and Iron Age, perhaps from a marine barrier dune complex. The peats have been dated to the Iron Age on the basis of their pollen content and a Bronze Age beach underlying the dunes has been found near Portcawl (85 77) on the eastern side of Swansea Bay (Higgins 1933).

The dunes and the marshlands have been modified greatly by construction and reclamation schemes. The buildings of Oystermouth (617 881) rest on sand, as did the Mumbles railway which is now the line of the coast walk. Further east the dunes have been converted to golf links at Blackpill (623 911) parkland with a boating pond at Singleton (628 916) and have been levelled for construction purposes in the Sandfields district of Port Talbot (740 905). The marshes, more extensive on the eastern side of the bay where the dune systems are also considerably larger, have been reclaimed for industrial purposes, for building and for communications.

vegetation for pasture. On the north eastern side of the promontory, bracken and heather give way to deciduous forest. This includes a stand of ancient oak which is dwarfed by excessive exposure to the bitter easterly winds and salt spray.

Oxwich Bay like Port Eynon Bay lies within a major syncline where erodable Namurian shales outcrop at the surface. Oxwich Point is an anticlinal structure and is levelled at the top art around the 200 Foot (61 m) Surface level. In fact the surface relief varies between 76 metres and 85 metres (Owen and Bridges, 1979). The floor of the bay acted as a large depositional for glacial meltwater and river sediments through the Pleistocene period. A submarine channel runs in a south-south-east direction from Oxwich Bay. This is thought to have been scoured by a subglacial stream close to the convergence zone of Welsh and Irish Sea ice during the Wolstonian or penultimate glaciation (Culver and Bull 1979). The line of dunes which fringes the bay is the end product of aeolian reworking of the sand wedge in Oxwich Bay derived from Pleistocene sediments. The concentration of sands is representative of a high energy marine environment. The dunes are on the whole parabolic and are fronted by a line of mobile foredunes. They are orientated from east-south-east to west-north-west. This is not typical of dune systems in general on Gower, most of which have a west-south-west to east-north-east orientation in line with the prevailing south-westerly winds. Oxwich Bay is sheltered from these winds to a certain extent by the long promontory of Oxwich Point and the dunes are orientated in line with the easterly component of the wind resultant at 95°. The dune system is backed by brackish water marsh made up of marine and river sediments.

9 Pennard Cliffs (554 874) From Port Eynon follow the A4188 east to Kilvrough (565 896) then the B4436 to Pennard (566 888) then the minor road west to the car park at Southgate (553 873).

From the National Trust car park at Southgate walk south-east towards East Cliff (554 871) until Pwll du Head (570 864) can be seen in the distance. There, the cliff morphology is strongly influenced by structure and present a very different outline to that seen looking westwards towards Three Cliff Bay (533 879). At Pwll-du Head the beds become nearly horizontal and therefore the cliff has a stepped appearance, with a series of free vertical faces separated by scree. Towards the Three Cliff Bay the angle of dip increases and the seawards inclination of up to 80° corresponds with the angle of the cliff. The cliff form here is therefore rectilinear rather than stepped.

Follow the path below the car park into Heatherslade Bay which is cut into the southern end of a large dry slade. The morphological features of this stretch of coast follow a similar sequence to those already described at Pilton Green, Port Eynon and Worms Head. Marine erosion has cut into a considerable thickness of Pleistocene material which is very unstable.

Underlying this material can be seen the raised 'Patella' beach. Two beaches which are very close in height were identified here by George (1933) close to the high water mark. The lower of the two beaches is known as the 'Neolithic' Heatherslade Beach. It fills the widened limestone joints and appears in gullies beneath the platform of the higher beach. More recent work (Bowen 1974) has shown that the two beaches are parts of a single 'Patella' beach which can be identified at a number of Gower coastal sites. At the western end of Heatherslade Bay there is a rock cut beach which is 4-5 metres in height. It is best seen from the edge of the high cliffs at the eastern end of the bay. It may well represent a still older beach level, the deposits of which have been removed by erosion.

Above the Patella beach of Heatherslade Bay there is a great thickness of Pleistocene drift, which is hardly surprising in view of the wide catchment area from which unconsolidated sediment could be reworked and transported. On the modern shore platform a number of solution forms can be seen including honeycomb formations and smoother pavement-like structures and wide solution pans close to high water mark. These latter features underlie the modern beach pebbles and also the raised beach fragments at a slightly higher level. These indicate that in the Ipswichian interglacial, the morphological features of the coast here were

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Photo 3 Three Cliff Bay.