

Foreword

Swansea lies at the heart of a local area with such a range of landscapes and patterns that it might have been designed to delight geographers. The natural environment includes a variety of coasts, fluvial landforms of different kinds, lowland and upland limestone scenery and a full range of glacial and periglacial features. For those more interested in the human scene, there are wide contrasts within a short distance, between the former steel and tinplate towns such as Gorseinon and Gower and the newer, sprawling, suburban, middle class, dormitories of south east Gower, between the major modern industrial developments around Swansea Bay and the dairy farming lowlands of Dyfed, between the urban forms of the coastal conurbations and the ribbon pattern mining towns of the coalfield. There is too, a rich legacy of historical features; Norman castles and Medieval abbeys, Welsh, English and Scandinavian place names, relict open field patterns and the remains of four centuries of varied industrial and transport development. Those more concerned with the future can wrestle with the challenge of planning for industrial development and urban sprawl in the south, or of planning for industrial decline and rehabilitation of mining valley towns to the north. These attractions are reflected in the very large number of geographers who visit the Swansea area every year, ranging from school pupils on field trips to visiting professors from every part of the world. Swansea is also the destination for many holidaymakers and tourists. It is for all these that the excursion guides are published. They originated as part of the fieldwork programme for undergraduate students in Geography at the University College of Swansea. Their use by and for other visitors prompted their being more formally prepared and assembled for publication first in 1978 then with a revision in 1983, a new edition in 1985 and this second revised edition in 1990.

No attempt is made to provide a general introduction to the area which is readily available in "Swansea and its Region" edited by Professor W.G.V. Balchin and published by the University College of Swansea for the visit of the British Association for the Advancement of Science in 1971, and in "The City of Swansea" edited by Professor R.A. Griffiths and published by Alan Sutton Publishing to mark the visit of the British Association for the Advancement of Science to Swansea in 1990. More detailed information can be obtained from references provided at the end of each of the excursion guides.

The editor is grateful to the authors for the care with which they prepared their manuscripts. The volume could not have been produced without the willing and enthusiastic support of the technical staff of the Geography Department at the University College of Swansea. The maps were prepared by the Cartographers, Guy Lewis, Tim Fearnside, Gienys Bridges and by Gary Llewellyn, the photographic reduction and preparation of printing plates was undertaken by Ted Price and Alan Cutcliffe. Eileen Baker and then Rosemary Humphrys typed the manuscripts and the printing was carried out by Ted Price. Finally, all our thanks are due to the Head of the Geography Department Professor David Herbert and his predecessor, Professor Nick Stephens, both of whom encouraged the editor and contributed to the excursion guides.

Graham Humphrys
August 1990.

1 The Physical Landscape of Gower

E M Bridges

Aims

- 1 To observe and explain the various landscape features.
- 2 To illustrate a chronological sequence of landscape development.

Maps

OS 1:50,000 Sheet 159 Swansea and Gower
Geological Survey Sheets 246, 247

Suggested Itinerary

0900 University College - Killay - Dunvant - Gowerton - Penclawdd - Llanrhidian
1030 Lliethryd - Parkmill
1230 Reynoldston - Cefn Bryn - Knelston
1430 Rhossili
1530 Oxwich - Pennard
1730 University College

SECTION 1 PHYSICAL DESCRIPTION OF GOWER

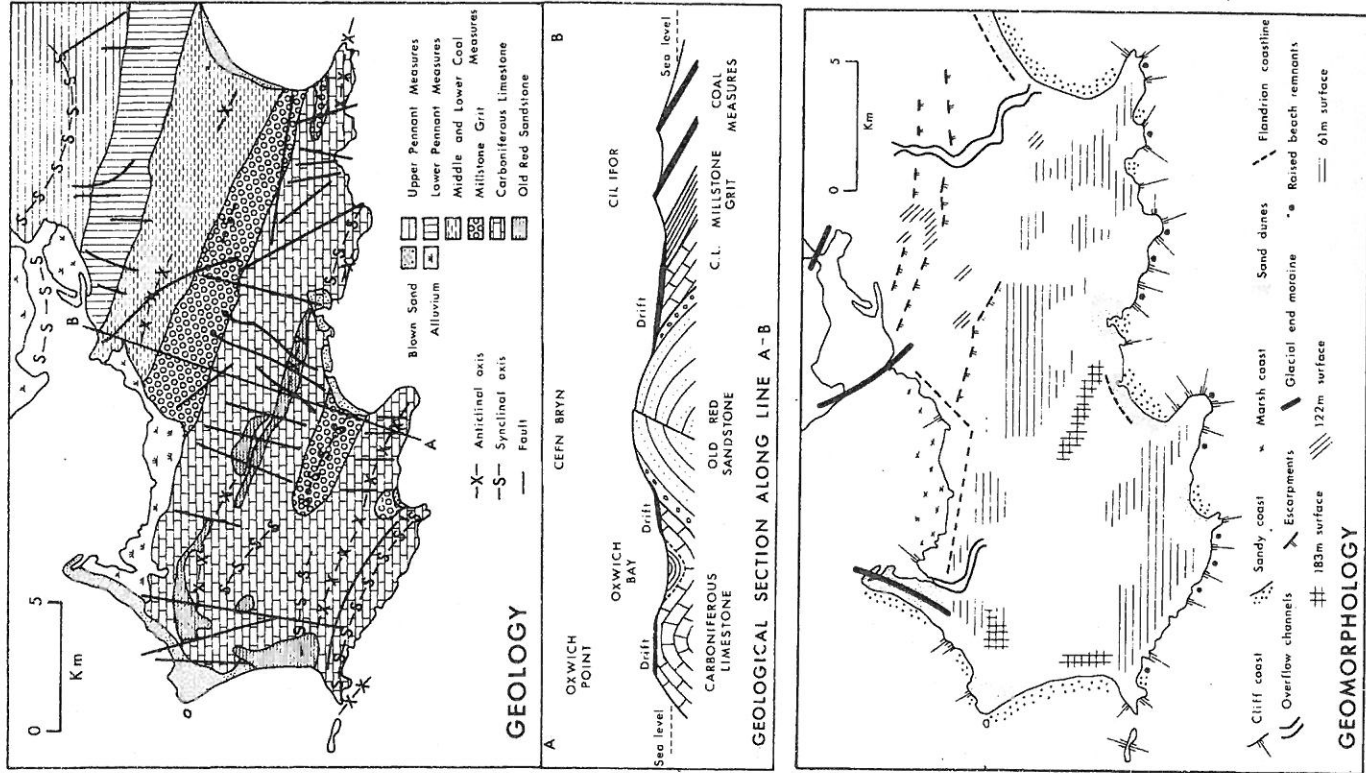
Introduction

To describe Gower simply as a peninsula is concise but is rather limited. Extending westwards from the City of Swansea, the Gower peninsula is approximately 25 km in length and between 5 and 10 km in width. It has an area of 170 sq km and is bounded on the east by Swansea Bay, by the Bristol Channel on the south, Carmarthen Bay on the west and by Burry Inlet, the estuary of the River Loughor, to the north.

The greater part of Gower lies between 60 m and 85 m above sea level. Numerous hills in the centre and west of the peninsula rise to about 180 m, the highest being Rhossili Down at 193 m. There are no large rivers, but numerous streams such as the Morlais, and Burry Pill drain to the Burry Inlet. Others such as the Bishopston and Iston brooks, drain directly into the sea. The Clyne Valley leading to the pronounced Dunvant Gap and the lower Llan River, form a convenient landward limit of the peninsula.

The rocks underlying Gower belong to the Devonian and Carboniferous formations, laid down between 395 and 280 million years ago. Since deposition, they have been folded, faulted, uplifted and eroded. The oldest rocks, Devonian sandstones and conglomerates, are characteristically red in colour and form the cores of anticlinal hills such as Cefn Bryn and Llanmadoc Down. The cream coloured Carboniferous Limestone, exposed along the south coast, together with the Millstone Grit shales, were tightly folded by the Hercynian earth movements, with a series of folds *en echelon* from Mumbles to Worms Head. In the northeast of the peninsula, the Coal Measures dip northwards beneath the Burry Estuary, forming here the southern limb of the South Wales coalfield basin. A small outcrop of Triassic breccias near Port Eynon, provides the only evidence of earth history during the Mesozoic era. However, recent investigations have shown the presence of Jurassic strata just off-shore to the south and they also occur 30 km to the east in the Vale of Glamorgan.

Even if Jurassic and Cretaceous strata once covered South Wales, as postulated by some authorities, erosion during the Cenozoic has removed them completely from Gower. The



origins of the present landscape can be traced back as far as the late Pliocene but strong earth movements in the Oligocene and Miocene make recognition of previous development difficult.

A chronological sequence of events for landform development in the Gower peninsula is suggested in the table below. It is simplified from several sources.

	Historical time	Dunes blown inland
Holocene	Flandrian	Rising sea levels drowning estuaries and causing aggradation in rivers with reported glacio-fluvial debris. Cutting of cliffs, now abandoned.
Pleistocene	Devensian late	Periglacial conditions preceded by glacial advance between 26,000 BP and 14,000 BP. Cutting of meltwater channels, deposition of gravels in Singleton Park and solifluction in Gower. Lower sea levels.
	early	Periglacial conditions, sludging of former red soils and drift material partly over the raised beaches.
	Ipswichian	Soil formation in climate similar to Mediterranean conditions giving red soils. Formation of raised beaches, sea levels higher than at present (125,000 BP).
	Wolstonian	Complete glacial cover from Irish Sea and from South Wales Coalfield provided the till which covers much of Gower.
	?	?
Pliocene		Initiation of present drainage systems as plains of marine abrasion were cut and sea level fell relative to land.

Glaciation appears to have affected the Gower peninsula twice. On the first occasion, complete coverage of ice took place leaving a mantle of glacial debris. There appear to be two components of this mantle of till. North of Cefn Bryn it contains a greater content of material derived from the South Wales coalfield, but south of the ridge it has a mineralogy which suggests an 'Irish Sea ice' origin. The ice of the second glaciation was mainly confined to the valleys of the Loughor and Tawe and impinged on the northern coast of Gower. At the

same time weathered debris was removed from the cliffs and the presence of steep-sided valleys parallel to the coast suggest its marginal drainage was superimposed onto the northern side of Gower. The accompanying periglacial conditions caused sludging of the unconsolidated debris left by the first glaciation, to give characteristic smooth hillslopes throughout the peninsula. On the south-facing outcrops of the Carboniferous Limestone, frost shattering and scree formation took place, and some glacial debris was sludged on to Ipswichian inter-glacial raised beaches.

After the glaciations, sea level gradually rose again in what has been called the Flandrian transgression. At the maximum extent, low cliffs were cut in Oxwich and Swansea Bay. Subsequently sedimentation in front of these low cliffs has isolated them from the sea and sand dunes have accumulated.

The present shape of the land enables the physical geographer to interpret how the landscape has developed according to principles elaborated in geomorphology. The landscape of Gower can be analysed in this way under the following sub-headings: surfaces, valleys and coasts.

Surfaces

Erosional surfaces which cut across the geological structures of the Gower peninsula and the rest of South Wales were recognised in the 1930s. These surfaces, plains of marine abrasion, are named The 600ft Surface (183 m), The 400ft Surface (120 m) and The 200ft Surface (61 m). The highest accords with the summits of the hills of Gower, the intermediate is represented on Clyne Common and on the escarpments of northeast Gower, while the lower surface is extensively developed along the south coast, typified by Oxwich Point. Thus the general appearance of Gower is plateau-like with occasional hills rising above the general surface. These erosion surfaces have glacial deposits on them and appear to have been cut in the Pliocene or early Pleistocene. Subsequent erosion of the lowest surface along fault lines has created the 'slades' and other steep-sided valleys, which give variation and charm to the peninsula. The surfaces are obvious at many places on the peninsula, especially from Cefn Bryn where the road east from Reynoldston crosses the hill (Observation Point 9).

Valleys

There are three types of river in Gower. There are normal fluvial valleys, such as that of the Morlais river which flows along a vale in the Coal Measures of north eastern Gower. Secondly, several valleys originated as normal valleys but subsequently developed 'karstic' features, as can be seen in the Llethryd (Observation Point 7) and Bishopston valleys (Observation Point 18). Smaller 'blind' valleys can be seen from the roadside at Nicholaston (Observation Point 8), and completely dry valleys, locally called 'slades', occur frequently along the south coast. The third type of valley was produced by glacial meltwater during the Pleistocene and is now occupied by a small 'misfit' stream, as for example in the Clyne Valley (Observation Point 3).

Coasts

The broad pattern of the south Gower coast is determined by a series of pitching folds in the Carboniferous Limestones, which result in anticlinal headlands with cliffs and synclinal bays with sandy beaches. After the rough shape of Gower was determined by faulting, only a narrow wave-cut platform has been produced at the foot of the present cliffs. Contemporary marine activity is restricted to a limited zone at the foot of the 60-80 m 'cliffs' (Observation Points 14, 15, 16).

Higher sea levels during the Pleistocene left behind beach deposits cemented with calcium carbonate, which are called 'raised beaches'. Although beaches and their platforms have been eroded since their formation, their mode of origin is indicated by the rounded shingle and shells they contain (Observation Point 16). Three of these beach levels were identified by George (1933).

During periods of glacial activity and correspondingly low sea levels, outwash material was laid down on the floor of the Bristol Channel. As sea level rose again sand was moved with the advancing coastline until it came lie at or near the heads of the bays. Where topographic conditions were suitable, the sand was blown inland during the period from the 13th to the 16th centuries, by extra stormy weather conditions (Observation Points 12, 13, 17, 20).

On the north coast of the peninsula the cliffs descend into marshlands of the Burry Estuary. There the vegetation and geomorphology can be seen to be closely inter-related (Observation Point 6). The marshes have accumulated in the shelter of Whiteford Point, a shingle ridge which possibly originated as a glacial moraine, subsequently covered by a sand dune complex.

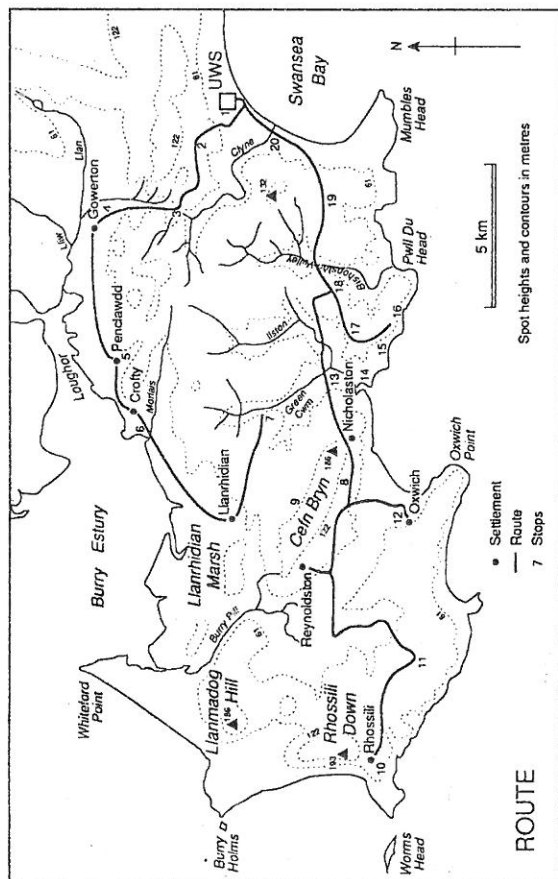
The total area of the Burry Estuary downstream from Pontardulais bridge is 45 km². There are eight areas of marshland, three of which are semi-estuarine and lie upstream of Loughor Bridge. The true estuarine areas include Pendlawdd, Llanrhidian and Landimore marshes and Morfa Bacas, south east of Llanelli.

Although apparently level, the marshes have been shown to have a gradient of 1 in 240, with small breaks of slopes or 'micro-cliffs' which delimit the sandflats of the estuary, the middle marsh and the upper marsh. Dominant vegetation associations have been shown to occur in four zones.

- 1 On the sandflats of the estuary *Spartina* has effectively replaced *Salicornia* as the primary colonizer. The soil is a raw sandy gley soil.
 - 2 Between 3.3 m and 4.1 m above OD, an extensive sward of *Puccinellia maritima* occurs; this too is being invaded by *Spartina*. The soils are classified as Calcareous Alluvial gley soils.
 - 3 Between 4.1 m and 4.8 m above OD, the grass *Festuca stolonifera* can be seen only on the higher interfluvies between creeks. Its distribution is related closely to the micro-relief of the marsh surface.
 - 4 On the landward edge of the marsh, flushing by fresh water from higher lands keeps out the salt water and reduces pH values so that soils become acid and vegetation is dominated by *Juncus maritima*.
- Sedimentation in the Burry Estuary results largely from redistribution of fluvio-glacial deposits, plus sand and shell fragments from the sea floor. Old maps show many different channels in the estuary, but in the 19th century training walls were built to control the flow of the river Loughor. These increased scour and helped to provide a navigational channel to Llanelli, but reduced scour and favoured sedimentation on the southern side. Sedimentation was further enhanced by the introduction of *Spartina* in 1935.

At Spring tides, 1,400, million cubic metres of sea water enter and leave the estuary twice daily, dropping to 1,040, million cubic metres at Neap tides. As there is only a small fresh water input by the river, the flushing time is effectively one tidal cycle.

Thus the physical geography of Gower can be described simply under the three headings of surfaces, valleys and coasts. When glacial and periglacial activity is superimposed on these three basic elements a clear and comprehensible picture of the peninsula is obtained.



SECTION 2 - POINTS TO BE OBSERVED

1 Singleton Park (629 922)

- (a) From Singleton Park, looking north east, can be seen the Pennant Sandstone (Middle Coal Measures) escarpment of Townhill on which the West Giamorgan Institute of Higher Education Buildings are conspicuous. These sandstones which dip northwards at 30° form part of the southern limb of the South Wales coalfield syncline, and include some thin coal seams.
- (b) Within the Park the Coal Measures are covered with fluvio-glacial sands mantled by a finer-textured cover loam. The undulating topography results from a combination of coarse fan-like deposits, the mode of deposition, and subsequent erosion. The cover loam was deposited later and then soliflucted into the hollows, leaving only a thin layer on the crests of the undulations. Peat accumulated in one enclosed hollow further west in Sketty Park, the analysis of which revealed deposits dating back to Pollen Zone 1, 14,000 BP, in the Late Glacial.
- (c) South of Singleton Abbey, an area of low-lying ground frequently floods especially during winter. This is a dune slack, lying behind the coastal dunes on which the Mumbles road and former railways were built. In the College grounds the dunes have been wooded for ornamental purposes and some have been cleared and levelled for car parks.
- (d) On the foreshore, the dunes and the old railway embankment, form the landward edge of a sandy beach which inclines down to the imperceptible slope of the floor of Swansea Bay. At the foot of the beach slope there are several exposures of the 'submerged forest', peaty deposits with *in situ* birch roots underlain by a strongly gleyed clay. The deposit is a relic of a woodland developed on low-lying and poorly drained land formerly behind the dunes.

Eastwards, Kilvey Hill (193 m) can be seen to dominate the town of Swansea. To the west, the higher ground of Mayals and Boarspit lie on the Millstone Grit, which is between 500 m and 600 m in thickness. Mumbles to the south-west is situated alongside an anticline of the Carboniferous Limestone which projects into Swansea Bay. The Carboniferous Limestone increases in thickness westwards from 900 m at Mumbles to 1500 m at Rhossili. It is dolomitized and all the major fossil zones (KZCSD) are present.

2 Hendrefoilan - Killay (607 930) Looking northwards along Wimmerfield Drive, the escarpment formed by the Pennant Sandstones can be seen rising above the modern housing and Hendrefoilan House. The Penlan coal seam crops out at the foot of the steepest part of the scarp face. The eastern extremity of the Penclawdd seam was worked in Oichfa Woods, south of the main road.

3 Dunvant (594 937) A narrow winding valley cuts through the Pennant Sandstone escarpment at Dunvant. The Clyne river enters this valley from the western side, north of the escarpment and flows southwards to Swansea Bay. The north end of the valley has no stream in it. Although there is a lack of strong positive evidence, such as deposits and associated indications of direction of water flow, the valley has the character of a sub glacial meltwater channel.

North of the gap excellent sections of the Pennant Sandstones, dipping northwards at 45°, can be seen in old quarries. In addition to the stone quarries, Dunvant had a brickworks and coal mines in the past.

4 Gowerdon - Gorseinon Lowland The lowland of the valleys of the river Llan and Lliw is extensively mantled with glacial drift. It is thought that the curious drainage pattern here was initiated by stream courses around stagnant ice, at the close of the last period of glaciation.

South of the River Llan, several valleys coincide with the strike of the softer shales, but like the Dunvant Gap, appear to have been deepened by glacial meltwaters.

West of Gowerdon to the north of the B4295 road, extensive marshes can be observed where the estuary widens into the Burry Inlet. Evidence of several former small coal mines can be seen to the south of the road.

5 Penclawdd (546 958) Once a small port, coal mining and metal smelting village, Penclawdd is now better known for its cockles, and there is a large dump of shells, raising the level of the land on the north side of the main road.

West of the village, at Dalton's Point, observe the extensive cover of *Spartina anglica* (Cord grass) growing on the marsh. This plant was introduced to the Burry Inlet in 1935 when some was planted in the lee of Whiteford Point. Since then it has spread rapidly and actively encourages sedimentation, thus raising the level of the marsh.

6 Llanrhidian Marsh (South-west of Crofty 525 945) Leave the main road (B4395) and walk 300 m down the lane to the marsh for a general view of Burry Inlet, the estuary of the Loughor river. The low glacial gravel mound of Salthouse Point can be seen to the east, extending into the estuary. On the opposite shore, the gravel banks of Carreg-fach and Carreg-ddu support the sandspit and alluvial complex of Penrhyn Gwyn. It has been suggested that these features are the remains of a recessional moraine deposited by a valley glacier which formerly occupied the Loughor valley. In the distance to the west, the sand dune complex of Whiteford Point is developed over another gravel deposit reworked by the sea, possibly the remnants of the terminal moraine of the valley glacier.

On the downland side of the marsh, fossil cliffs of Flandrian age are preserved on the Carboniferous Limestone west of Llanrhidian, with more subdued forms of sandstones and shales of the Millstone Grit and Coal Measures. Ice scouring during the last glaciation (Late Devensian) was probably responsible for the removal of weathered debris from these slopes.

The marsh is drained by creeks which vary in depth from the small rills to major channels. Along the edges of most creeks, slumping results in a stepped appearance which, in smaller creeks, can cause a bridge or tunnel to form. Where complete blockage occurs, sinuous salt pans are formed. Other salt pans with a more circular shape are thought to have a similar origin but then to develop their circular shape as their banks collapse. These salt pans dry between spring tides and their floors develop good examples of polygonal cracking. Their high salinity inhibits recolonization by marsh plants other than *Salicornia*.

Preferential deposition of sand or silty material occurs adjacent to creeks, with the finer material and organic residues carried to areas distant from the creeks. This results in a "creek-ridge" landform as described by Dutch soil scientists. Creek ridges become apparent when the marsh is drained and the finer interfluvial sediments shrink more than the coarser materials of the creek banks. These textural differences can be seen on Llanrhidian Marsh, but as drainage has not taken place, there is no vertical expression of the creek ridges.

7 Llethryd (531 912) The Llethryd stream rises on Forest Common, a drift-covered area with strongly acid gley soils on the northern side of the B4271 road. The stream passes beneath the road and enters a swallow-hole about 200 m to the south at the foot of a wooded slope. For 2 km from this swallow-hole, the stream passes underground, to emerge at the Parkmill resurgence (539 897). The dry valley, called Green Cwm, is interesting for the two pre-historic monuments which can be seen on the walk down the valley.

Cathole Cave (537 900) This contained evidence of occupation by prehistoric man which with animal remains are now in the British Museum. These date from the Upper Palaeolithic age, between 14,000 and 10,000 BP.

Giant's Grave (537 898) A chambered long barrow of Neolithic age dated approximately 4,500 BP. The two dozen human skeletons found on excavation in 1869, are now in the University Museum, Oxford.

8 Nicholaston (51 88) There are several examples of small streams draining from Cefn Bryn, which disappear into pot-holes on the north side of the A4118 road.

9 Cefn Bryn (491 900) Cefn Bryn is a thrust-faulted anticlinal ridge of Devonian sandstones and conglomerates, which rises to 186 m at its eastern end, but is only 158 m where the road reaches the summit. Extensive views in all directions include the Burry Inlet to the north and Oxwich Bay to the south. Rhossili Down (193 m) and Llanmadoc Down (186 m) can be seen to the west and are similar in structure to Cefn Bryn. All the hills are thought to be remnants of The 600ft Surface (183 m) formed by marine abrasion during the Pliocene or early Pleistocene, but they might possibly be land surfaces exhumed from beneath Triassic deposits which formerly covered the area.

In the distance to the east, the low escarpment of the Millstone Grit rocks can be seen, with remnants of the intermediate surface at 120 m. More impressive is the view to the south, with extensive remnants of the surface. This lower surface is developed over strongly folded Carboniferous Limestones. The pattern of folding can be observed in the shape of the coast. Oxwich Bay (and further west Port Eynon Bay) is developed where a syncline occurs and Oxwich Point (and Port Eynon Point) are both anticlinal in structure.

The slopes of Cefn Bryn all have the appearance of having undergone strong solifluction during a periglacial climate. Involutions can be observed in quarry sections and frost cracks

have been seen in the floor of the soil pits. This means that the landscape has a smooth flowing outline with few rock outcrops.

Strongly acid soils are widespread and areas of poor drainage prevalent. Thus the most extensive soils on the commonland are brown podzolic soils (usually under bracken) on better drained areas and stagnohumic gley soils in low-lying situations. Podzols occur on the hill crest only where they can be seen in the quarry (495 898) and further east towards Penmaen.

Commonland There are 3388 ha of commonland in 35 different tracts in Gower. The commons were an integral part of the farming system and their use was (and still is) governed by common rights, attached to a farm, cottage or land held by a commoner. The rights of common are six in number: pasturage, pannage (foraging by pigs), estovers (taking of undergrowth and small branches for fuel or fencing), turbary (cutting of peat), piscary (fishing) and soil (removal of gravel or stone). Public access is not of right, except on Clyne Common which happens to lie within the boundary of the City of Swansea (see Observation Point 9).

Arthur's Stone (Maen Ceti) (490 905) A 24 tonne conglomerate capstone overlies a chambered tomb of Neolithic age (4,500 BP). The conglomerate contains brown clay-ironstone, coal fragments and traces of fossil plants which do not occur in local Devonian conglomerates. This evidence suggests the origin of the capstone as an erratic, derived from the north crop of the South Wales Coalfield Millstone Grit and brought to Gower by glacial action.

Three other prehistoric relics are visible from Cefn Bryn. Cliffor Top (505 925) is situated on the escarpment of the Millstone Grit east of Llanrhidian at 118 m. A 1st century AD Iron Age hill fort covering 3 ha, The Bulwark (443 927), lies on the eastern end of Llanmadoc Down at 150 m, and is a large Iron Age enclosure with complex banks and ditches. Hardingdown (435 907) also has four Iron Age enclosures.

10 Rhossili (416 881) Situated at the southern end of Rhossili Down, the small village of Rhossili also gives its name to the 6 km of beach at the western end of the Gower peninsula. Just beyond the hotel, the beach below can be seen to be backed by a low cliff and bench at the foot of the Down. The bench has all the appearance of a raised beach, but it is not. Examination of the material from which it is formed, shows it to have originated as a solifluction deposit from Rhossili Down which has been trimmed by the sea. Similar solifluction beaches occur at the foot of the limestone cliffs south of Slade and at Oxwich (4985).

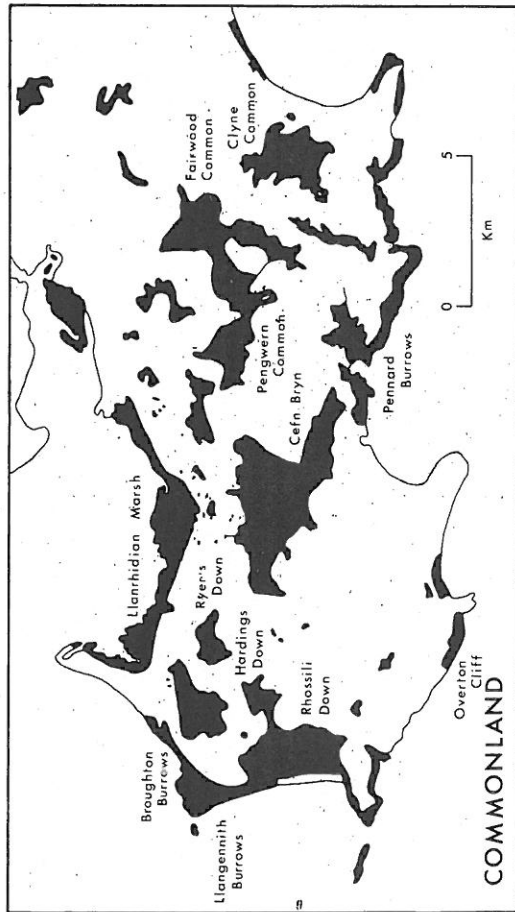
In the distance the small anticlinal island of Burry Holms can be seen, with the sand dune complex of Llanguenith Burrows to the east.

A short climb onto the southern end of Rhossili Down gives a view of the village and its open field or 'viel'. This survival from the Medieval system of farming, can be seen to be laid out in strip fields, averaging 0.6 ha and separated by baulks or landshares.

Worms Head, beyond the open field and cliffland, is another anticlinal island of Carboniferous Limestone.

11 Pilton Green (446 871) A footpath leads to the Paviland Caves, of which Goats Hole was probably the richest of British caves for archaeological finds. In 1823 Dean Buckland found the 'Red Lady', now in the University Museum, Oxford. It turned out to be a male skeleton, covered with red ochre and subsequently dated to 18,500 BP. Over 800 stone implements were found together with the remains of many animals. These included horse, bear, ox, mammoth, woolly rhinoceros, Irish elk, wolf and reindeer, ie a cold fauna, which corresponds to the maximum of the late Devensian glaciation.

12 Oxwich Bay (501 865) Compares with Swansea Bay, with similar flat sandy beach, dunes and low-lying land behind the dunes. In this case, though, the freshwater (brackish) marshes were once landscaped but were allowed to revert to nature following storm damage.



They are of considerable interest to biologists and birdwatchers, but are under fairly severe pressure by holiday-makers. Alignment of the dune system is on an ESE - WNW direction and the shape of the dunes suggests that the winds from the ESE are most important. Where vegetation cover is broken, blow-outs occur of the U-shaped dunes and erosion of the sand takes place. The amount of sand decreases westwards, as does the height of the dunes; however, the maximum recreational use of the area is also in the west, so any further erosion adjacent to the car park will cause deterioration of the dunes, and reduce the amenity value. Some attempts have been made to stabilize the remaining dunes by planting marram grass, erecting brushwood barriers to trap sand and fencing to keep out people.

13 Pennard Pill (54 88) Follow the footpath from Parkmill, noting the angular course of the liston Brook, which probably relates to the underlying faulting pattern in the limestone. Tidal conditions can be seen in the stream shortly after emerging from the woodland, and sand dunes become increasingly evident. Erosion caused by visitor pressure (especially on horseback), can be clearly seen on dunes and alongside the stream.

At the head of the bay behind a low beach ridge composed mainly of limestone fragments, a small salt marsh has developed (538 883). On the opposite shore, sand dunes on the beach have been greatly reduced by erosion during the last few years. After crossing the beach ridge, a good example can be seen of cemented scree composed of angular limestone fragments and sand held together by a calcareous cement.

14 Three Cliff Bay (53 87) If tidal conditions permit, pass through the natural arch out into Three Cliff Bay. Cross the floor of the bay and ascend the cliff at the eastern extremity, where there are remnants of a raised beach platform, with poor examples of raised beach material cemented to the cliff about 10 m above sea level.

15 West Cliff Pennard (54 87) From the cliff top, view below a narrow, wave-cut rock platform, in which the bedding planes of the limestone show clearly at low tide. Note also the bedding in the slopes above the active cliff in the view to the east, toward Pwlldu Head, which shows some overfolding.

16 Fox Hole, Southgate (554 872) Known also as Heatherslade Bay, this small inlet contains two of the three raised beach levels identified by T.N. George. At the foot of the low cliff, cut in solifluction material at the end of the little valley or slade, an elevated wave-cut platform can be seen developed on the Carboniferous Limestone. On this wave-cut platform is preserved the "Patella" beach, composed of sand, rounded limestone fragments, and fossils of the gastropod *Patella vulgata*, held together by a calcareous cement.

At low tide conditions, the lower Heatherslade beach can be seen on the wave-cut platform over which the sea is working at the present time. Although much eroded, it is possible to see that this is a fossil beach similar to the one above, thus it is apparent that sea level since the beach was deposited, has changed and has returned to approximately its former level. The lower beach contains a greater number of drift erratics. This suggests that it was formed at the time of the late Devensian re-advance, when solifluction could have brought drift material over the cliff to be incorporated with the local limestone fragments on the beach.

Minchin Hole Cave (554 868) A succession of fossil beach materials and cave earths have been preserved in Minchin Hole, Pennard. The importance of these deposits lies in their relationship to the raised beaches and the implications this has for the climatic succession of the late Devensian. The sequence is as follows:

- 1 Inner and Outer Talus - angular limestone blocks which included aeolian material in the outer talus can be seen as fragments adhering to the walls near the cave mouth and overlain by a thick stalagmite floor at the back of the cave.



Photo 1 Common land on the eastern slope of Rhossili Down.

- 2 The "Neritoides beach" - a pinkish sand containing small gastropods is overlain by an earthy cave breccia. Towards the rear of the cave these two merge and it is suggested this deposit accumulated at a time of falling sea level and is not strictly a beach. The brown earthy breccia contains abundant mammalian and bird remains including those of narrow-nosed rhinoceros, horse, elephant, red and fallow deer, pig, lion, spotted hyena, red fox, bank vole, field vole and northern vole. This fauna is of an interglacial character.
- 3 The 'Patella Beach' - a rise in sea level caused a cut into the lower cave earth. A storm beach deposit consisting of a mixture of boulders, shingle and sand and shell fragments (especially the limpet *Patella*) was deposited.
- 4 Lower red cave earth - angular limestone fragments in a red clayey matrix containing remains of *Microtus oeconomus* (northern vole). A lower sea level is inferred, otherwise it would have been washed away.
- 5 Inner beach - grey beach sand on a wave-smoothed rock floor.

The implications of these deposits are not fully understood, although it would appear that the cave earths represent cold periods and the beach deposits periods of high sea level. The mammalian remains in the lower cave earth are incorporated into red palaeosol material washed into the cave. They are indicative of warm conditions which were followed by colder conditions which produced the angular limestone fragments lying above. Most of the outer talus cone that formerly blocked the cave entrance has been removed by erosion.

17 Pennard Burrows (551 883) A view across the golf course laid out on Pennard Burrows. This large extent of dunes was blown inland during the 14th, 15th and early 16th centuries. It is recorded that because of the sand tenants had their rent reduced in 1478 and in 1517 the church was excused its royal levy. The church was eventually abandoned during the 1520s in favour of the new site 2 km further east. Climatic records also indicate increased storminess from AD 1200 continuing until the 18th century.

18 Bishopston Brook (577 896) The Bishopston Brook is crossed just south of the point where it passes underground under normal conditions of flow. Like Green Cwm, referred to earlier (Observation Point 7), it flows underground, through caves along joints and bedding planes in the limestone, for 1.5 km, before returning to the floor of the valley as a surface stream. Some old lead mines are recorded in the Bishopston valley but their production was small and they were worked for only short periods in the 19th century. The limestone quarry is the only one still in operation in Gower.

19 Clyne Common After leaving Bishopston, the route along the B4436 crosses the urban common of Clyne. The commoners have fenced the northern side of the road to control stock and improve grazing, leaving the southern side ungrazed. Much of the common is covered with boulder clay. Where small escarpments of Coal Measures sandstones protrude through, they support brown podzolic soils. Elsewhere brown earths occur on freely drained areas and stagnohumic clay soils form in hollows. The northern part of the common approximates to The 400ft Surface (121 m).

20 Blackpill to University College The sand dunes which line Swansea Bay here attain a height of about 10 m and a width of 200-300 m. The land behind the dunes was infilled to make the Ashley Road playing fields, behind which can be seen the old degraded cliff line formed at the maximum extent of the Flandrian transgression.

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