PALAEO-ENVIRONMENTAL STUDY AREA P4

VENTNOR UNDERCLIFF -PALAEO-ENVIRONMENTAL OVERVIEW, ISLE OF WIGHT, UK

Plate P4 ***Ventnor Undercliff Landslide complex, Isle of Wight***

AN ASSESSMENT OF THE ARCHAEOLOGICAL AND PALAEO-ENVIRONMENTAL EVIDENCE FOR GROUND MOVEMENT AND COASTAL CHANGE IN THE ISLE OF WIGHT UNDERCLIFF

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1. LOCATION

The Undercliff is to be found on the southern coast of the Isle of Wight (Plate P4) where it borders a range of chalk hills which rise to a maximum height of 240m. Lying at the foot of an inland cliff, this is a coastal strip with a sheltered micro-environment nurturing a range of lusitanian and sub-tropic plants which are highly unusual in British latitudes. Since the mid-19th century these special climatic qualities have attracted human settlement which has been responsible for the growth of the resort town of Ventnor.

1.1 The geophysical location

The Undercliff of the Isle of Wight is an ancient landslide complex which is still subject to ground movement. It is set at the base of an land-locked cliff on the south coast of the island where it occupies a total area of 700 hectares. The complex is 12 km long and from its seaward toe to its rear cliff or scarp it is approximately 0.5km. The matrix of the landslide complex is composed of consolidated rubble trains, debris lobes and massive back-tilted terrain blocks.

Most of these features are interspersed with Holocene colluvium and are blanketed by a mantle of landslide debris. The inland boundary of the Undercliff is mostly marked by a high sandstone scarp where large blocks of the Upper Greensand bedrock have been detached from a high bench during an event of primary failure. This material has since subsided and settled towards the sea.. West of Ventnor this primary detachment has given the scarp a vertical cliff face. The town of Ventnor rests at the foot of a more graduated scarp which breaches the bench of Upper Greensand and penetrates the Chalk. This anomaly coincides with the truncated course of a deep chalk combe which drains the high chalk ridge known as Boniface Down. East of the Ventnor and Bonchurch, the vertical cliff-line re-assumes in an area known the Landslip.

1.2 Coastal description

The toe of the Undercliff landslide complex comprises a rocky cliff-line where a consolidated matrix of slipped boulders and colluvium has become subject to wave attack. The variable quality of landslide matrix and the presence of massive dislodged blocks has produced a series of small headlands and embayments. The Isle of Wight coast Shoreline Management Plan identifies the seaboard of the Undercliff as a single 'coastal process unit' which can be divided into six individual 'management units' (Halcrow 1997). East of Bonchurch the sparsely inhabited coastline of Luccombe Bay and Dunnose has been designated management unit VEN1. Much of this sparsely populated sector of the coastline is still covered by semi-natural deciduous woodland and it is subject to a policy of 'no action except monitoring'. Here, a steeply graded sea-cliff is susceptible to frequent mudslides and falls. As a consequence the beach is littered with fallen boulders which have come to settle on a bare wave-cut platform.

From Bonchurch to Steephill the matrix of the landslide complex is more stable where it is exposed on the coast of management unit VEN2. On this segment of coast a modest sand and shingle beach has developed at the foot of a shallow and inclined cliff-line. The beach is sustained by a series of wooden groynes while the foot of the cliff is defended either by lengths of hard seawall or by armoured sections where the foot has been reinforced with an artificial rock toe. Behind theses defended frontages the main population of the Undercliff has grown with the development of Ventnor since the mid 19th century. Since the introduction of these defences much of the inclined cliff-line has become colonised with natural vegetation which is a clear sign of current stability. Occasional interruptions have, nevertheless, occurred where slips have been assisted by integral weaknesses within the landslip matrix.

West of Flowers Brook and Steephill Cove, the face of the inclined cliff-line loses it vegetation where a policy of 'no action except monitoring' allows active wave-attack to proceed. This is unit VEN3 where an eroding cliff composed of consolidated landslide rubble has produced a series of coastal platforms or boulder reefs. These are to be found at sea-level where they are occasionally interrupted by small shingle embayments. This eroding cliff-line includes the sea frontage of the village of St Lawrence which currently lies some 200-300m inland. The natural degradation of these cliffs is a contributory element in a long-shore movement of sediment which feeds the resort strandline of Ventnor.

West of Binnel Point. unit VEN4 embraces Binnel Bay (Plate P4a), a large embayment which coincides with two on-shore areas where ground-movement and instability are particularly high (behaviour zones 9 and 10). Here a similar policy of 'no action' also applies.

West of Binnel Bay a smaller embayment at Reeth Bay is subject to a policy of 'holding the line'. This policy highlights that the risk of ground movement is greater than the preceding units and the threat to human settlement has increased where the zone of potential movement approaches close to the village of 'Crab Niton'. West of Reeth Bay the coastline assumes a convex course where it rounds St Catherines Point. Here, in unit VEN6, a policy of 'do nothing' has been adopted. On this section the cliff-line re-assumes its characteristic inclined profile rising to a common height of 8-10m. Behind the cliff the surface of the landslide complex acquires an unusual flatness which seems to have been well suited to human settlement in the past The retreat of this cliff has left a variety of archaeological features truncated in the cliff-face.

In the final section of the Undercliff the main failure line, marked inland by the Upper Greensand cliff, can be traced for a further 1.3km as far a Blackgang. Below the cliff a complex of highly unstable lobes, blocks and mudslides are subject to regular and some occasional catastrophic movements. This is the most dynamic section of the entire Undercliff.

On the shoreline these soft materials are susceptible wave attack after they have subsided to form a soft debris bench. The orientation of the shoreline changes at St Catherines Point to face in a south-westerly direction. By virtue of this change in orientation the final section of the Undercliff shoreline is classed for shoreline management purposes as part of unit FRE1.

2. MODERN HUMAN GEOGRAPHY

The present population of the Undercliff comprises some 12,000 persons. Since the mid 19th century the population has been centred on Ventnor, a resort town with its origins essentially tied to the arrival of the railway in 1857. Ventnor differs from most southern English resort towns by the nature of its unusual micro-climate. Its modest beach has not matched the attractions of larger seaside resorts yet its climate and unusual setting secured the growth of the town during the later 19th and early 20th centuries. A number of fine 19th century villas and mansions are scattered throughout the landslide complex. An additional boost to the population of the Undercliff occurred during and after the 1960's when the Isle of Wight Structure Plan released additional areas for urban development in the pleasant wooded environs of Ventnor, Bonchurch and St Lawrence. Prudently, the Unitary Development Plan for the Isle of Wight recognises the difficulties posed by the landslide complex and future development is restricted in this area to no more than 100 hectares.

2.1 Regional authority

The Undercliff lies within the jurisdiction of the Isle of Wight Council, an English county and unitary authority which also has powers as a designated a coastal protection authority. Government funding for coastal protection is provided by MAFF and is allocated in accordance with a regionally conceived coastal protection policy supported by a Shoreline Management Plan. The first Coastal Zone Management Plan for the South Wight was assembled by the Isle of Wight Council in 1995-6 and was a pioneer and exemplar of its type. A national policy for such plans was implemented in 1995 and the first full plan for the Island was compiled in 1996.

2.2 Designations

For development control purposes the designation of Heritage Coast has been assigned to the whole of the Undercliff west of Ventnor. This portion of the Isle of Wight is also an Area of Outstanding Natural Beauty. Both are nationally assigned designations. Within the Undercliff national designations have also been applied to sections of the landslide complex at Blackgang-St Catherines and the Landslip at Bonchurch. At these locations Sites of Special Scientific Interest have been identified.

3. CONTEMPORARY PROBLEMS OF COASTAL EROSION AND GROUND SLOPE MOVEMENT

Problems of ground movement in the Undercliff were first recognised in 1816 by Professor Thomas Webster who recognised significant landslides east of Bonchurch, in the an area now known as the Landslip. The first of these movements was noted in 1810 while others followed in December 1818 and November 1839. Since the 1970's the Undercliff landslide complex has been very intensively studied. These studies have focussed upon the nature of landslide behaviour at this site; methods of reducing landslide hazards by means of engineering works; monitoring ground behaviour; developing suitable planning controls and guiding development away from unsuitable locations. In 1988 a study of ground movement in Ventnor was commissioned by the Dept of the Environment with three specific objectives.

- Determining the nature and extent of landslides
- Understanding the past behaviour of separate parts of the Undercliff
- Formulating a range of management strategies to reduce the impact of future movements

It is in pursuit of the second of these objectives that archaeological and palaeo-environmental investigations in the Undercliff have a particular role to play. The LIFE study demonstrates that archaeological and palaeo-environmental evidence can help to fix the long term timetable in which coastal erosion and ground movement events are proceeding in the Undercliff. There are also issues of episodic causation and periodicity to be resolved and here, too, the palaeo-environmental evidence has much to offer.

Problems of coastal erosion in the Undercliff have been appraised in the Isle of Wight Shoreline Management Plan of 1997. The plan recognised that the coastline is entirely composed of disturbed landslipped material but it nevertheless proposed six individual management prescriptions for differing sections of this coastline. At the eastern end of the Undercliff, in the area known as the Landslip (Ventnor 1), active landsliding had been observed since 1810. Here a policy of 'no action' was proposed. For the coastal frontage of Bonchurch and Ventnor (Ventnor 2), high property values led to a the policy, a prescription of 'holding the line'. On the coast of St Lawrence and Binnel Bay (Ventnor 3 & 4) the policy was 'no action' while at Niton, where occupied properties lie close to the coast, the prescription proposed to hold the line. Finally, in the region of St Catherines Point, a policy of 'do nothing' was proposed for an area with high natural and historic environmental assets but a very low population density.

The basis for sub-division of the coast is an understanding of coastal processes, the natural and the human environment. In general, the entire coastline of the Undercliff is geomorphologically similar and the division into the six coastal management units has been dictated more by economic values rather than natural distinctions. Of greater interest to the LIFE programme are relationships between the ground behaviour zones and past or transfixed patterns of human settlement. The archaeological and palaeo-environmental evidence concealed within some of these behavioural zones provides an independent means of assessing the chronology and severity of past slope movement.

4. KNOWN HISTORY AND ARCHAEOLOGY

4.1 Foci of past human settlement in the Undercliff

Prior to its 'discovery' in the early 19th century the Undercliff accommodated a sparse population during the historic period. Modest medieval churches at St Lawrence and Bonchurch served small communities with a subsistence based mostly upon fishing. The lack of enlargement or embellishment of these churches attests a long history of sparse human activity prior to the arrival of Victorian developers and entrepreneurs. The recent discovery of a putative Christian cemetery at Flower's Brook, Ventnor suggests that a third centre of population in the Undercliff may have been lost to landslide or coastal erosion in Late Saxon or Early Medieval times.

The three medieval settlements at Bonchurch; Ventnor/Flowers Brook and St Lawrence were probably supplemented by a fourth community which was apparently sited in the neighbourhood of St Catherines Point. This last location can make no claim to a medieval church or cemetery other than through its place-name. Nevertheless, archaeological evidence tumbling from its eroding cliff-lines show that past inhabitants had amassed their kitchen residues into a number of medieval middens while living at this spot. Moreover, the flat and agriculturally attractive cliff-top terrain at St Catherines still displays areas of abandoned ridge and furrow fields which are generally synonymous with successful medieval settlements (Sites 2063, 3370, 3371, 3374-6, 3378). Elsewhere in the Isle of Wight the association of old ridge and furrow fields with notable manorial or parochial settlements is strikingly clear. It is significant that where these fields have

otherwise survived in the Undercliff they are to be found adjoining the medieval settlements at Flowers Brook (site3447) and St Lawrence (site 33960).

The settlements at Bonchurch, Flowers Brook and St Lawrence were all readily supplied with drinking water from springs and streams issuing from the landslide surface. At St Catherines the water supply seems to have been less prolific yet there is a small spring which now lies close to the cliff edge near the lighthouse. The incidence of historic settlement and water-sources in the Undercliff can claim great antiquity. At Bonchurch Early Bronze activity is attested by the finding of Beaker pottery not far from the stream (site 760). At Flowers Brook an Early Bronze Age cremation urn was found within 100m of the stream, at Steephill, while a substantial hoard of some 30 Later Bronze Age axes lay within 200m of the same stream. Both of these finds are indicative of established settlement in the 2nd and 1st millennia BC.

At St Lawrence Neolithic or Early Bronze Age flint debitage was found on the southern margin of the village (site 1853) while a Later Bronze Age axe (find 671) was found just east of the medieval church. Later occupation at St Lawrence, in Iron Age times, is attested by a prestigious warrior burial found some 500m west of the church while other less well-dated burial of prehistoric type have been found in the same vicinity (site 695). At Flowers Brook a very similar pattern of continuity is intimated by the presence of strewn Late Iron Age pottery in the old estate of Steephill Castle (sites 769 and 770). At St Catherines Point the evidence of prehistoric occupation is prolific in the cliff-face close to the Lighthouse spring and it includes Beaker pottery and midden deposits of Iron Age and Roman date. A series of ditches truncated by the cliff offer evidence of a more substantial nature during the Roman period when tiles from a stone building were eventually discarded on this site (site 2063).

The sum of this evidence points to a long and repetitive pattern of human occupation in the Undercliff where settlement seems to have been naturally drawn to four specific locations. A sparsity of notable archaeological finds outside these four foci reinforces the are for continuity yet there remain two exceptions which deserve further attention. The first is to be found at Binnel Bay where Bronze Age and Iron Age middens found near the shore attest notable activity at this spot. The presence of these sites can be readily explained by the course of the Old Park stream which enters the sea at this point and appears to be a long established source of freshwater.

4.2 The location of Roman communities within the Undercliff

The earliest archaeological discoveries date from Victorian times when building activities were proceeding in and around Ventnor. A significant discovery was the unearthing of a Romano-British skeleton in 1849. This was found in a context which was perceived to represent accidental death in a catastrophic rock fall (Dunning 1951) There are hints that a notable population may have occupied the Undercliff in late Iron Age and early Roman times. A prestigious Iron Age warrior burial found at St Lawrence indicates that the Undercliff community of the 1st century BC was apparently one of some considerable status (Stead 1969). A Celtic stone head found at the eastern end of Undercliff, at Luccombe, adds further status to the population of this area (Sherwin 1938; Tomalin 1987).

By the first century AD occupation in the Undercliff seems to have been centred on at least two focal points. At Ventnor human activity developed around Flowers Brook and Undercliff Gardens where large strews of pottery were left including some imported products such as terra nigra vessels from Gaul. The nature of this site has not been scientifically investigated and much is now overlain by modern houses. At the western end of the Undercliff, at St Catherine's Point a late Iron Age community was responsible for the construction of one or more ditched enclosures. These were sited on a flat stabilised surface of the landslide complex overlooking the sea. The nature of the St Catherines's settlement is not adequately understood for it has only been observed when sections of the prehistoric ditch have been exposed in fresh cliff-falls. The items recovered from this site suggest sustained occupation from the 1st century BC until the 4th century AD. It is probably safe to assume that much of this settlement has since been lost to coastal erosion.

5. ARCHAEOLOGICAL AND PALAEO-ENVIRONMENTAL STUDIES AND POTENTIAL

5.1 Background to the archaeological and palaeo-environmental studies

Prior to 1994 the archaeology of the Undercliff have received little attention. A summary of its archaeological sites based upon the County Sites and Monuments Record was produced for South Wight Borough Council in that year and this had given a theoretical regard to the problems of coastal erosion. A second desk-top review was integrated into the Shoreline Management Plan of 1997 when a total of 61sites was noted within the Undercliff. A problem readily recognised in both of these studies was the old and invalidated quality of the sites recorded in the County Sites and Monuments Record. Many of these entries referred to archaeological evidence uncovered in Victorian times when scientific knowledge of the subject was very poor.

Within the span of the current LIFE project a new field audit of Island's coastal archaeological resources was conducted. In the Undercliff fieldwork was directed to an area which might be affected by coastal erosion during the next 75. The Shoreline Management Plan for this area generally predicted that, without defences, the sea would advance between 20 and 225 metres into the toe of the landslide complex. The theoretical limit of this advance was defined by a `benefits line' within which a rapid archaeological field audit was conducted. This audit confirmed the presence of 121 archaeological sites, 21 historic buildings, 9 listed buildings and 5 historic parks or planned landscapes. However the course of the benefits line through the landslide complex enclosed only the area which was deemed to be vulnerable to coastal erosion during the next 75 years. This definition did not include the total area which was potentially subject to landsliding or slope instability. To the encompass this larger area it was necessary to carry the boundary of the coastal study area to the base of the inland cliff. This embraced a further 64 known archaeological sites bringing the total number of known sites on the landslide surface to 184.

During the LIFE study it was not possible to make field inspections of the full array of known archaeological and palaeo-environmental sites throughout the landslide complex. Nevertheless, by reviewing the nature and context of the full array for the very first time a number of valuable observation could be made.

5.2 The application of archaeological evidence to the dating of the primary landslide event or 'main failure'

The dating of the present landslide complex has been attributed to a major compound failure in the Cretaceous clays and sandstones, an episode set sometime within the Late Quaternary (Hutchinson 1987, 132). The date of this event has not been fixed by absolute means yet given that a population of some 12,000 people is now settled on the landslide surface it is clearly important to know the length of time over while the matrix of displaced material throughout the Undercliff has been able to settle. The archaeological data-base for the Undercliff is of some help here for it identifies four findspots where very early flint tools, or `palaeoliths', attest the presence human groups in the location which is now occupied by the Undercliff. These activities must be placed well back within the Ice Age and they are represented by findspots which are sparsely but broadly dispersed across the landslide surface.

On the shoreline below High Port, in east Ventnor, two Lower Palaeolithic implements were found in 1921 (find 706). Retained by their finders neither of these items can now be traced but their descriptions are sufficient to indicated that these were core tools of the Acheulian tradition and that one was a hand-axe of ovate form while the other was, seemingly, a pointed type. The first was described as ochreous while the second was described as 'rolled'. A visit to the find-spot in 1923 found some evidence to suggest these items were derived from a recent fall of gravel. A visit to the site by Frank Basford in 1999, after the coastline had been altered by coastal defence works, could find no trace of this putative Pleistocene deposit.

At Reeth Bay in coastal unit VEN5 another Acheulian flint hand-axe was found on the shore of the Undercliff. This seems to have been derived either from the matrix or the surface of a zone of active landsliding (Moore et al 1995, 47, fig 11). The shoreline management plan for this coastal unit predicts further severe ground movement within the next 70 years and for this reason the benefits line of the plan makes a deep inland sweep of 0.4km bringing the future shoreline close to rear scarp or main failure line of the Undercliff. Given the active nature of ground movement in this zone, it seems highly unlikely that this palaeolith could have reached the beach from any other source other than a context which was contained within the matrix of the active landslide.

The fourth palaeolith to be recovered from the Undercliff is in generally fresh condition showing little evidence of subsequent disturbance or wear (Basford 1980, vii fig 1). It comes from what appears to be an incontestible Pleistocene context on the surface of the landslide complex at a location close to 'The Orchard' in the coastal management unit VEN4. This axe was reported by Mrs Etherington in 1977 who found the item in a gateway between two fields. This findspot is situated near the junction of two behavioural zones where an area of intermittent active ancient landslides gives way to an area of actively degrading ancient landslides which lead down to the sea. The former zone is characterised by imperceptible ground movement in the past with infrequent periods of accelerated movement involving the opening of pressure cracks. This, arguably, is a context in which a Pleistocene deposit containing evidence of past human activity might retain its integrity. The more southerly behavioural zone appears to present a process in which Pleistocene artifacts such as the Reeth Bay hand-axe might be carried downslope to the dynamic environment of the modern beach.

It is unfortunate that a history of weak and inconsistent archaeological curatorship has allowed these particularly important discoveries to evade the scientific enquiry they deserve. Despite these impediments, two helpful postulations can be made. The collective evidence presented by the Undercliff palaeoliths indicates that a common style or 'tradition' of flint workmanship is present. This is a phenomenon which embraces a vast timescale within the Pleistocene period. On a raised beach at Boxgrove in West Sussex, similar core tools of the Acheulian tradition have been dated around 500,000 BP. This is a date which is impractically old for the for the formation of the Undercliff. Assemblages of Mousterian tools 'of the Acheulian tradition' offer an upper limit for the production of these core-tool hand-axes. A highly appropriate example comes from Pan Pit in the Medina valley of the Isle of Wight and this can be attributed to an event which is probably no later than circa 30, 000 years BP. While the Pan Pit assemblage exemplifies the finale of hand-axe production there is good reason to suspect that the Undercliff implements were probably manufactured some considerable time before this event. Mousterian hand-axes of the Acheulian tradition are normally smaller and broader than the specimen recovered by Mrs Etherington at The Orchards and this suggests that we should extend the possible date of the main Undercliff failure further back into the Pleistocene to a time when larger Acheulian axes were in common use.

Writing in 1985 Hutchinson, Chandler and Bromhead first postulated an event in the Ipswichian inter-glacial period when a precursor to Undercliff landslide complex might be formed in a position off-shore from the present site. This proposal would certainly be compatible with the production of appropriate Acheulian hand-axes and it would also accord with a climate and sea-level which was not greatly dissimilar from that of today. This proposal of 1985 envisaged a precursive event in an interglacial period which ended some 110,000 years ago but it also acknowledged that a subsequent and substantial fall in sea-level during the Devensian glaciation could allow a continued process of landsliding and settling to take place at a time when this land-surface would be free from marine influence. Unfortunately the archaeology of hand-axe production between 110,000 and 30,000 years BP is poorly understood.

An alternative explanation for the Undercliff palaeoliths could be derivation from a high-level gravel deposit set on the Southern Chalk Range which lies immediately north of landslide complex. If palaeolithic implements were lodged in such deposits their arrival in the Undercliff landslide complex could occur at any time during or after the Pleistocene period. A recent re-appraisal of the Lower Palaeolithic sites in southern Britain has recognised that high-level

Palaeolithic assemblages are present on the Isle of Wight; the most notable being that at Bleakdown which rests at some 80m OD (Wymer 1999, 111). Gravel deposits are also present on the Southern Chalk Range overlooking Ventnor but these are much higher and older deposits which are perched at c.125m OD on Rew Down and at c.230m OD on Boniface Down. Classified as 'angular flint gravel' these are highly oxidised and gellifracted flints which are generally considered to be of Pliocene age. There has never been any indication that these deposits contain Palaeolithic material and they can offer no credible source for the Pleistocene artifacts found in the Undercliff.

While there is clearly an outstanding need to examine the critical contexts in which the palaeoliths have been found, the archaeological evidence has already shed a revealing light on the fundamental question of how old is the Undercliff landslide complex? If no more than one of the four findspots represents a contemporary or near-contemporary deposit we are bound to conclude that the main failure is in excess of c. 30,000 years old. Just how long the excess might be should be resolved by site-specific investigations which are integral with the future coastal protection and landslide management programmes. The archaeological and palaeo-environmental evidence assembled in the LIFE review of this topic demonstrates that the age of the main geological failure of the Undercliff should be increased by at least a factor of 100%

6. IDENTIFYING AND DATING LANDSLIDE BEHAVIOUR SUBSEQUENT TO THE MAIN FAILURE IN THE UNDERCLIFF

6.1 Late Glacial precipitation, seepage erosion, groundwater levels and thermal effects on the rearward wall of the Undercliff

After primary failure had occurred along the inland margin of the Undercliff its seems that this event was eventually succeeded by a least two other significant processes. Secondary falls or 'topples' have occurred from the main rearward cliff from time to time and one of these was experienced at Gore Cliff in1928. Hutchinson et al (1989) observe that falls of this type are preceded by the opening of vertical vents or joints and that forward movement and collapse was assisted by seepage erosion and the softening of the foundation stratum of Gault Clay. The periodicity of these events has never been established although the same writers observe that frost wedging may have a role to play.

Periods of differential or intensified seepage certainly deserve further attention when we consider the history of the rearward wall or scarp of the Undercliff. A very important climatic trigger is posed in the Late Glacial period when the relief of permafrost at the close of the Pleistocene allowed joint-expansion and the release of a particularly high and formerly frozen water table. At Blackgang, high embayments and old spring hollows are to be found in the Chalk range to the rear of the landslide complex and although these are now dry abandoned we can reasonably accept them as being products of the Late Glacial watertable and a precursor of the drainage system which was later to form Blackgang Chine. This history is generally confirmed at the southern foot of Week Down where a chalk combe, since cut by the platform of a sports-ground, contains a buried soil of Late Glacial date (Preece pers comm). At Blackgang the discovery of an undisturbed Early Bronze Age round house in the floor of a chalk embayment confirms that high-level outflowing had permanently ceased above 150m OD by opening of the 2nd millennium BC.

At Ventnor we find that the high and dry combe on southerly face of Boniface Down has fulfilled a similar drainage function while operating on a much larger scale. Here, we should not overlook the fact that, below the mouth of the combe, the landslide complex of the Undercliff changes its morphology to become a series of multi-rotational slides. It seems that these features may have been triggered by both coastal erosion and seepage erosion and high groundwater pressures centred on the catchment of the combe and that these events seem best attributed to the Late Glacial period. The resulting slides have since come to accommodate the town of Ventnor. Not only do these slides show the highest levels of current ground movement (up to 100mm pa) but they also accommodate the greatest concentration of recorded landslides since recording began in 1800 (Moore et al 1995,10-14 figs 1 & 2).

Previous studies of the Undercliff have concluded that a major factor influencing the renewal of movements in certain slips has been high ground-water pressure, overall steepness of profile and the depth and nature of the principal slip surfaces Hutchinson et al (1985. 8). The LIFE review of the archaeological and palaeo-environmental evidence indicates that these processes should be viewed more critically within the ambit of climatic events during the past 10,000 years while also recognising that the outcome of events during the Late Glacial period have virtually predetermined the ground behaviour regime which now controls the sustainability of Ventnor town.

6.2 Marine erosion and renewed sliding of the landslide complex

The second process to affect the ground behaviour within the matrix of the Undercliff landslide complex has been marine erosion (Hutchinson et al 1985, 4). While sea-level was substantially lower during the last, or Devensian, glaciation the shoreline was far removed from the Undercliff. From the late Glacial Period onwards the level of the sea began to rise, reaching it's most rapid advance with the onset of the Atlantic warm phase around 5000 BC. These changes allowed wave-attack to commence on some of the large terrain blocks which had been moved forward by translational movement during the primary failure event.

Borehole data gathered and analysed by Hutchinson (1985) suggest that early marine attack in the western Undercliff at was responsible for the formation of a sea-cliff rising from a sea platform cut at a level of - 7m OD. Comparison with other sea-level data in the region would favour such action occurring around 5,000 BC. Wave attack on this particular face was abruptly terminated when a second episode of landsliding took place. This secondary event was responsible for a massive outflow of disturbed rock and soil covering the old sea cliff and burying the old sea platform beneath a debris apron some 35 metres thick.

It is uncertain whether this apron of debris was formed during a single or cumulative event but in two instances this and a similar deposit has been found to contain material suitable for dating. At St Catherines Point two small tree trunks were found entombed deep within a large flow of ancient consolidated landslide debris. These trees yielded dates of 2540 + 40 BC and 2010 + 50 BC.

Some 2.5km to the east of St Catherines, at Binnel Point, a Neolithic soil horizon had developed in the consolidated debris flow and this could be dated by charcoal at 2530 + 100 BC (Preece 1986). This site showed that some human groups were active in the Undercliff at this time and that elm and alder trees were currently being burnt at a location where large dislodged boulders were still protruding from the landslide surface. Samples of contemporary terrestrial mollusca recovered from this ancient soil was dominated by *Carychium tridentatum* and *Discus rotundus*, both indicative of a shaded environment. This strongly complemented the evidence offered by the charcoal that the landslide surface was well populated with trees. Further confirmation was provided by skeletal evidence of red deer (*Cervus elaphas*), red squirrel *(Sciurus vulgaris.L*) and dormouse (*Muscardinus avellanarius*). However, the presence of the land snail *Pomatias elegens* also suggested that broken ground available in which this species might burrow. Such an environment could be readily produced by the inroads of Late Neolithic or Early Bronze Age agriculture.

A question that should be posed at this point is whether human interference with the natural environment in this sector of the Undercliff was sufficient to trigger major landslides in the western Undercliff during the late 3rd or early 2nd millennium BC. Some 2.5km west of the Undercliff, on the present cliff-top at Walpen, a contemporary soil containing Beaker pottery has been found buried beneath some 5m of static sand-dune (site 2650). The overwhelming of this Early Bronze Age land-surface by a massive wind-born deposits suggests that a deliberate process of major de-afforestation or *landnam* may have been underway at this time and that this human activity precipitated wide-scale erosion on this section of the Isle of Wight coast.

Translated to the nearby Undercliff, such de-afforestation could impose catastrophic effects on moisture retention and ground drainage on the landslide surface. This is a scenario which might be readily argued for the processes which occurred at St Catherine's Point. An alternative argument might consider that a strong south-westerly fetch prevailing around 2500-2000 BC had brought wave attack to the western toe of the landslide complex at St Catherine's Point and that landslide events were triggered at this time. Marine attack is an acknowledged stimulating mechanism for landslide movement (Hutchinson 1985), yet given this explanation it would be difficult to explain why the same incidence of slides has not been sustained at St Catherine's Point up to present times.

A particularly valuable aspect of the LIFE archaeological review has been the appraisal of archaeological sites on the surface of the secondary slip at St Catherine's Point. While the trees contained within the slip matrix offer an absolute date of 20210 + 40 BC, human occupation on the surface of the same debris apron had certainly been established within the time-frame 2000-1600 BC because a pit containing Beaker pottery of this period has been discovered in just such a position during the LIFE programme. This evidence indicates that the major secondary landslide event at Catherines Point can be confidently attributed to the close of the 3rd millennium BC while human colonisation had commenced on the surface of the new debris apron during the early 2nd millennium BC.

6.3 The recognition of major land-loss from the rear scarp at Gore Cliff

At Gore Cliff valuable evidence has been recovered from a colluvial deposit found in a cliff-edge position overlooking the Blackgang landslide system. A palaeo-environmental study at this site examined a profuse accumulation of snail shells which had come to rest in a series of hill-washed soils (Preece 1976). Many of the snail species are naturally restricted to particular and sensitive environments and this means that a statistical analysis can lead to a reconstruction the past character of the cliff-top.

The most striking conclusion of this study was the realisation that the snails and their soils had arrived on the site from the higher land situated to the south-west. This is an area which is now lost to the cliff-edge and the highly active landslide complex which now lies beyond. The changing types and numbers of snail shells revealed a progression from a shaded environment to an open landscape. The latter was apparently the product of human intervention and associated prehistoric agriculture. Within this chalky hill-wash lay a Roman bronze brooch of the 2nd century AD; its presence clearly demonstrating that the lost hill of Gore was still in existence at that time.

Due to the depth of this hill-wash, some 2m, there could be little doubt that a very significant compound failure had occurred at Gore in the Roman or post-Roman period and that during this event a very substantial portion of land had been lost. However, the land-slipped surface below Gore Cliff now shows no evidence of a large detached land block which could attest to the translational movement and removal of this hill. This confirms that coastal erosion at the western end of the Undercliff has been far more dynamic and effective in removing debris aprons and detached land blocks of this size. This action seems to be attributable to the high fetch and prevailing winds which attack this sector of the Isle of Wight coast while leaving the remainder of the Undercliff in a position of relative calm.

6.4 Detecting the size of past communities within the landslide area

The location and the size of the medieval churches at Bonchurch and St Lawrence has offered a means of assessing the demography of the past human population settled upon the surface of the landslide complex. It has been noted that both churches display a particularly modest building history with little enlargement or embellishment ever taking place. Indeed the church at Bonchurch is noted for its simple and charmingly bijou 12th century plan and an external appearance which has changed very little since the 13th century. The history of this community stems from a pre-Conquest settlement held in the time of Edward the Confessor by *Estan* of Earl Godwin. The Domesday survey of AD 1086 records a manorial holding of considerable

wealth and this has been attributed to access to extensive grazing on the chalk downs above the rim of the Undercliff (Page, 1912, 155-6).

At St Lawrence a slightly different history can be detected. This community is not recorded in Domesday and there is no documentary mention until the 13th century. The church apparently dates from this time and it is even smaller than that of Bonchurch. Indeed, prior to its enlargement in 1842 it was cited as the smallest church in England (Page 1912, 193-195). Like Bonchurch, the history of this community confirms the presence of no more than a sparse population within the Undercliff prior to the late 19th century.

Archaeological evidence draws attention to two other historic communities in the Undercliff. The first lies at the extreme eastern end of the landslide complex at Luccombe. An early medieval settlement was detected here when archaeological material was disturbed by a number of ground movement events occurring between1923 and 1931 (Sherwin & Dunning 1937). Although this site was only summarily investigated the array of material from the midden suggests that no occupation took place at this spot after the 12th century. This abrupt termination might be attributable to ground slope movement at that time. It is also notable that this location lies zone 1 of the Undercliff where landslide activity is particularly prevalent (Moore et al 1995, fig 11). It should not be overlooked however that the same location is also subject to notable coastal erosion and it was this process which was responsible for the final loss of the midden site in 1931.

At Flowers Brook on the western perimeter of Ventnor town, recent archaeological investigations have revealed a putative early Christian cemetery on a site recently developed as a water pumping station. The precise date of the cemetery has yet to be confirmed but there seems little doubt that this must represent the presence of settlement of late Saxon or Early medieval date and that this community is well removed from the two known medieval churches in the Undercliff. The Flowers Brook cemetery lies very close to edge of the modern sea-cliff and it is quite possible that the cemetery belonged to a church and community which has been lost to coastal erosion. An intriguing possibility is that following coastal erosion or ground movement at this location, the community may have relocated at St Lawrence where the church was not built until the 13th century.

6.5 Archaeology and the risk assessment of property

At Binnel Bay and St Catherines Point radiocarbon assays were able to fix the date of a massive landslide event which had occurred around the close of the 5th millennium BC. After this event archaeological evidence from Bronze Age, Iron Age and Roman features intimates that no significant movement subsequently took place. This principle of examining archaeological sites for the long term assessment of round behaviour is theoretically applicable to other areas of the Undercliff including the urban area of Ventnor It is unfortunate that most of these sites in Ventnor are known to us only as isolated artefacts or poorly investigated deposits which have mostly been unearthed before 1900. Despite these shortcomings the archaeology of Ventnor shows some promise in identifying areas of relative stability. At Undercliff Gardens (site 770) extensive strews of Late Iron Age and Roman pottery are to be found in an area now well populated by houses and bungalows constructed during the 1960's. The context of this material has not been fully investigated although a recent evaluation of a potential development plot suggests that the pottery sherds were deposited in hillwash on an old landslide scarp. Here, it seems that the accretion of soil had slowed to a very slow accumulation by the close of the Roman period. This scarp surface is situated in a very large compound slide which contains large dislodged and settled blocks of Greensand (Moore et al 1995). The archaeological evidence suggests that no ground movement or colluviation has taken place on the surface of this slide for the past 1700 years and that the siting of this section of the urban estate is on land with a demonstrable history of stability.

Another archaeological site of interest to the ground movement problem is to be found in a higher sector of the town at Gills Cliff Road (site 732) This area is located at the foot of a very

steep scarp in an area of multi-rotational sliding. Excavations at this site uncovered the floor of a small hut which had been occupied during the immediate pre-Roman period *c.* AD 10-43. Excavation showed that the floor of this site had been cut back into a chalky hillwash and although the site seemed to have been occupied for no more than two or three decades it had been overwhelmed on one occasion by a further flow of hillwash before occupation was resumed. The faunal remains from the site included ox sheep and pig, all animals capable of overgrazing an area which could become subject to overgrazing and erosion. The evidence from this site shows that hillwashes were active during occupation in the 1st century AD yet after this date further soil movement was minimal. Although this site occupied a central position in a major multiple rotational landslip the archaeological evidence showed that the only discernable movement of soil had occurred some 2000 years ago and that this was of a minor and possibly seasonal process which was probably humanly induced.

6.6 The assessment of archaeological sites pertinent to the study of coastal erosion and ground slope movement

Prior to the inception of the LIFE project no appraisal had been made of archaeological information pertinent to the history of coastal erosion and ground slope movement in the Undercliff. The rapid field audit of coastal archaeological sites improved the fund of raw knowledge by adding some 24 new sites within the benefits zone of this coastline. Unfortunately the field audit also found that 27 of the known sites in the Sites and Monument Record could not be found on the ground, a further 28 were subject to coastal erosion, 2 had been completely destroyed and one was subject to damage by ploughing. This left just 44 sites in undamaged condition.

No project design for the scientific evaluation or investigation of archaeological sites has been prepared for the Undercliff although two criteria might guide a future approach. There is a need to retrieve and evaluate archaeological material which is subject to coastal erosion. Some relatively simple work of this type has already been carried out at St Catherines Point and Binnel Bay and this has provided valuable dating evidence giving a terminus post quem for the major ground slope movements in behaviour zones 9 and 11. This approach should certainly be applied to the behaviour zone 5 in Ventnor town where high property values are influenced by the threat of ground slope movement. Here the archaeological evidence is capable of demonstrating the length of time over which conditions of stability have been sustained. Where past slope movement has taken place the archaeological evidence is also capable of indicating which areas have moved whilst still retaining their integrity.

A further practical application of the archaeological resource concerns the dating and incidence of sites in differing areas of ground behaviour. At St Catherines Point the evidence is particularly helpful. The present sea cliff at this location reveals a deep homogeneous deposit of landslide debris containing transported tree trunks which can be dated to the late 5th millennium BC. Cut into the top of this debris surface was a small pit containing Early Bronze Age Beaker pottery attributable to the close of the 3rd millennium BC. The same cliff-line is cut by silted ditches of the late Iron Age and Roman periods while the plateau-like surface of this section of the landslide complex is occupied by a rectilinear earthwork and unbroken ridge and furrow earthworks of the medieval period. The sum of this evidence attest a major landslide event in the 5th millennium BC followed by no other significant movement at least since circa 2,000 BC. The broad area of ridge and furrow confirms that the general area of flat topography has remained unchanged at least since medieval times, while the Roman and Bronze Age evidence suggests that these conditions of stability may have been sustained for a much longer period.

7. THE SCORING OF ARCHAEOLOGICAL SITES PERTINENT TO THE STUDY OF GROUND SLOPE MOVEMENT AND COASTAL CHANGE

7.1 The refining of the sample

A total of 121 archaeological and palaeo-environmental sites in the Undercliff were identified by means of the Isle of Wight Sites and Monuments Record and the 1999 Coastal Audit. A desk-top review of these sites identified 37 which could offer a significant contribution to the objectives of the LIFE project (Appendix P4.1). This preliminary sorting allowed the exclusion of SMR entries for street furniture, 20th century military installations, historic parks and gardens, memorials, historic buildings and other sites all of which could offer no ready contribution to the study of ground movement or coastal erosion processes.

7.2 The higher-ranking scores

The highest scores achieved in the analysis were those for the midden deposits at Ventnor (site745) and St Catherines Point (site3388). Both secured a score of 9 based on their perceived palaeo-environmental value. Marine mollusca in these middens potentially offered information on the past coastal environment and this was confirmed at site 3388 at St Catherine's Point were the occurrence of the winkle Monodonta lineata and the limpet Patella asperum signified a change in sea temperature and shoreline character since Roman times. This evidence allowed high scores for both environmental change and specific coastal change. By virtue of their position on top of a landslide surface both sites also scored one point for chronological significance despite the fact that no radiocarbon samples had so far been obtained. The middens were recognised to be a rich source of Roman cultural material and for this reason they both secured two points for their potential cultural amenity value. Neither of these sites secured a score for visual amenity.

Five sites achieved a score off 8 points. In the village of St Lawrence the medieval church (site768) and a manorial building (site 764) both reached this level with the help of bonus scores for visual amenity. These sites also scored 2 for their potential chronological value, it being acknowledged that both buildings could contain wooden beams suitable for dendro-chronology. It was also observed that both structures were sited on a landslide surface where the survival of a medieval building had a particular chronological significance. It was also acknowledged that both buildings were set in environs where midden or occupation debris could readily survive below-ground. For this reason a score of 2 points was awarded for potential environmental evidence. It should be noted that these two sites were seen to be of significant value to the study of the ground slope movement but could offer no ready value to the study of coastal change.

At St Catherine's Point, midden sites were valued for their potential contribution to both coastal change and slope movement. These included an Iron Age midden (235) and three medieval middens (sites 231, 712 & 3390) all of which were sited on the surface of a large debris apron. These sites were perceived to offer values very similar to midden 3388 which had scored high on the proven palaeo-environmental significance of its marine mollusca.

7.3 Lower scores bound by group significance

A scatter of extant upstanding field monument sites at St Catherines Point was represented by SMR entries 2063, 3370, 3371, 3374, 3375, 3376 and 3393. All were features of a similar type and their values were enhanced by a particular group significance. These were ridge and furrow field systems of suspected medieval date. Their values had been boosted by a score of 2 for cultural value and a bonus of 2 for visual amenity. Despite enhancement under these headings, the other scoring criteria for these sites were worthy of special note.

The presence of the field systems on top of a landslide surface won a chronology score of 1 point while their siting at this particular location in the Undercliff was considered to be a highly important indicator of a lost medieval settlement. The loss of this community was further implied by the way in which some of the field systems had bee truncated by the present cliff-line. Importance was attached to the relationship of this lost community to other medieval populations in the Undercliff and this was perceived to reflect past changes in settlement patterns induced by landslide events and coastal erosion. While field systems of this type were a relatively common phenomenon, the significance of this particular location won a full score of 3 for its inference for coastal change. Very similar values were accorded to another ridge and

furrow system, at Flowers Brook, Ventnor (site 3447). This site also claimed an enhanced group significance when it was viewed in conjunction with the demographic significance of a nearby ancient cemetery (site 2149).

Within the environs of Ventnor town a score of 7 points was assigned to old evidence of Roman remains at Castle Road. Here, an opportunity for new evaluation was clearly required in the environs of site 742. This site reflected a general need to re-examine a number of other low-scoring Roman sites which were located within in an area where the history of past ground-behaviour and human settlement was particularly relevant to the modern built environment of the town. Here there was clearly a group significance to these sites which outweighed their individual scores. This indicated that there was an implicit need to monitor and examine the spaces between the individually noted findspots.

This problem of recognising group significance was repeated at site 769 at Undercliff Gardens on the edge of the Steephill housing estate. Here a strew of Iron Age pottery had conveyed useful stratigraphic evidence relating to ground movement history. Viewed with adjacent pottery from site 770 on the estate this offered an indication that a much larger body of archaeological evidence was probably still un-investigated nearby. The finding of a hoard of Late Bronze Age axes in the same vicinity (site 739) also implied that evidence of protracted prehistoric occupation might be stratified in the slope deposits which had apparently accrued at this spot.

Sites scoring 5 points in this appraisal amounted to seven. Four of these could claim some additional group significance, all being further findspots of poorly recorded Roman material within the town of Ventnor (sites 732, 744, 747, 756 and 757). Further evidence, comprising Roman burials found in the town could offer a score of no more than 3 points at sites 743 and 746. These served to enhance a case for a higher group value for Roman sites within the town; implying that increased archaeological monitoring and vigilance is required.

In St Lawrence village the discovery of an Iron Age warrior burial at site 699 and some contemporary iron currency bars at site 672 presented another case of group significance. These two sites implied that human habitation had long been sustained on the surface of this particular behavioural unit of the landslide complex. This case was reinforced by nearby sites 671 and 1439 which claimed lower scores yet extended the potential time range human settlement back into the Bronze Age.

A further ancient feature at St Lawrence tended to consolidate the case for enhanced group significance for sites set within the environs of the village. This was an ancient well or spring which was perceived to indicate a potential focus for historic or prehistoric settlement (site 676). This feature gained a score of 7 points assisted by the presence of an 18th century brick structure which ranked as a visual amenity. The more significant scores for this site took account of a waterlogged and anaerobic environment which was suspected below-ground. This was perceived to present notable potential for the survival of palaeo-environmental evidence such as mollusc and plant remains which, in this context, could be preserved in calciferous deposits or tufas. Such deposits are to be found at certain calcium-rich springs and they are known to be present within the Undercliff where disturbed encrustations have been occasionally exposed by coastal erosion. Preece (1979) has demonstrated the biostratigraphical value of these deposits in an example studied at Totland.

7.4 Scoring the findspots of palaeolithic artifacts

The discovery of palaeolithic implements in the Undercliff was considered to be crucial to the overall dating of the main geological failure which was responsible for the genesis of the landslide complex. The lost or obscured coastal site (706) at High Port scored 8 points gaining full scores of 3 for its potential contribution to both environmental change and specific coastal change. These score arose from the fact the original museum report of 1923 had recorded a gravel deposit as the perceived source of the find. A value of 1 was awarded for the relative chronological value of the present evidence although it was realised that if the gravel deposit could be relocated, further dating evidence might be forthcoming.

At site 690 at the 'Orchard' a second Palaeolithic find-spot secured a lower and provisional score of 6. It was felt that no score could be awarded for potential environmental value until a new field inspection secured more reliable details. At High Port the recorded presence of a high level gravel deposit secured a score of 3 for evidence of coastal change but without validation the Orchard site could score no more than 2 in this category. After the loss of the High Port artifacts only a written record of weak cultural value remained and this could secure a score of no more than1 point for cultural amenity. In contrast the Orchards find was known to survive and due to its antiquity and rarity it merited a cultural amenity value of 2.

The last find-spot for a palaeolith in the Undercliff lay on the shore of Reeth Bay (site 594). The location of this find in actively re-sorted beach material denied it significance for sea-level or palaeo-environmental studies. Its presence at the seaward foot an active landslide nevertheless merited a score of 2 point for its potential value to the study of landslide effects on coastal change. The presence of this palaeolith within the footprint of the coastal landslide complex was sufficient to merit a chronology value of 1 because the presence of any Pleistocene artifact in this context presented profound implications for the dating of the entire landslide system.

7.5 Scoring a related site set outside the landslide complex

The last score of note is an award of just 3 points for the discovery of ancient human remains in the floor of Boniface combe (site 750). These finds were made during the construction of a railway cutting in the 19th century and geomorphologically they lie outside the footprint of the landslide complex. The modest score accorded to this site may well under-estimate its importance. It has been observed elsewhere in this LIFE study that this high and dry chalk valley may once have predetermined the present configuration of the Ventnor landslide behavioural units. The present writer provisionally attributes this event to the release of high-level groundwater during the Late Glacial period. Given the poor account of the discovery of these remains it is impossible to predict the potential value of further archaeological and palaeo-environmental material contained within the floor of this combe. Based only on known information, the present score may well be a serious under-estimation of a sediment archive which may elucidate much of the history of the ground-movement which now affects the town.

7.6 Assessments of condition, fragility and threat

Questions of condition and fragility were considered in the analysis. The condition of 58% of the selected sites remained unknown, many of these being early discoveries now concealed beneath the built environment of Ventnor town. A further 11% failed to show any evidence on the surface of the ground when inspected during the 1999 coastal audit. Confirmed destruction accounted for just 8% of the sites while 13% were considered to be extant or partially extant visible monuments. Only 8% of the sites were observed to be actively eroding but this figure became less re-assuring when the issues of fragility and threat were considered.

Observations on fragility found that 59% of the sites could not be assessed and in many of these instances prior destruction could be suspected. In 23% of the sites fragility was not considered to be a threat to future sustainability. In 13% of the sites however, fragility was rated at a level of two points while in a further 5% the full score of 3 points was applied. Estimates of fragility did not necessarily encompass the dormant threat of coastal erosion which might activated within the benefits line of the undefended coastal management units. This threat was however considered in the descriptive observations on each site.

8. CURRENT APPROACH TO IDENTIFICATION AND PROTECTION OF THE ARCHAEOLOGICAL RESOURCE

All of 184 known sites in the Undercliff landslide complex are recorded in the County Sites and Monuments Record and this has offered them a limited degree of protection. Unfortunately the measure of protection, promoted by Central Government planning policy advice (PPG 16) only applies to those potentially destructive processes which happen to be subject to control under

the Town and Country Planning Acts of England and Wales. At Flowers Brook, a significant archaeological site was subject to threat by the installation of water pumping facilities which were exempt from Planning controls. Under the Water Act Southern Water recognised a duty of regard for archaeological remains and this enabled pre-emptive excavations and scientific recording to be carried out following guidance given by the Isle of Wight County Archaeological Unit. This investigation, yet to be completed, is offering an important insight into the past population of the landslide area.

Notably destructive to the archaeology of Undercliff are the natural processes of ground slope movement and coastal erosion. No on-going programme of monitoring and recording is in operation to meet these threats and their accruing losses. The information gained from the coastal erosion sites at St Catherine's Point and Binnel Bay demonstrate just how valuable some of these sites can be in reconstructing the timetable of natural changes which are affecting the Undercliff community.

There is a high potential for the recovery of palaeo-environmental evidence of the past character of the landslide complex. Small localised wetlands within the Undercliff have never been palynologically investigated yet these offer an opportunity to establish or confirm the presence of areas of long term stability. An assessment of potential pollen archives is an objective which must be fulfilled before to the history of a the individual ground behaviour zones is finalised.

9. CURRENT APPROACH TO IDENTIFICATION AND PROTECTION OF THE PALAEO-ENVIRONMENTAL RESOURCE

No protective measures are accorded to known or potential sites of palaeo-environmental value in the environs of the Undercliff. A site of demonstrable value to the present study has been the hillwash deposit and terrestrial mollusca assemblage at Gore Cliff (Preece 1980). Another is a late glacial palaeosol exposed by mechanical earth-removal at Ventnor football ground. In Park Avenue, to the east of Flowers Brook, a notable deposit of peat was exposed by pipe-laying operations in 1999 and this offered the potential of examining the long term history of environmental stability and change at a point where the behaviour of the landslide complex is of direct practical concern to the urban population of Ventnor. Unfortunately, where no statutory obligations are extended to the protection or recording of non-cultural deposits, disturbance or removal of sediment archive such as these have not been mitigated by scientific investigation and recording. A similar lack of monitoring, palaeo-environmental investigation and analysis has occurred where geo-technic boreholes have been cut for engineering purposes in the landslide surface of the Undercliff. Fortunately some voluntary deposition of cores and core-logs has taken place but there remains a need for a co-ordinated strategy linked to a sound research framework. Work by Hutchinson (1987) clearly demonstrates the value of borehole logging and there is clearly a need to a local infrastucture which is capable of monitoring all significant invasive activities which breach the surface of the ancient landslide system.

10. SUCCESSES AND PROBLEMS IDENTIFIED BY THE LIFE PROJECT

The Isle of Wight Shoreline Management Plan prepared in 1997 has provided a clear policy for coastal defence in the Undercliff while a series of commissioned surveys inaugurated by the former South Wight Borough Council have identified the mechanical processes and behavioural units which make up the landslide complex. The commissioned surveys include a Planning Guidance Map which is of particular value to builders, developers and property owners. Where lacunas in knowledge remain they concern uncertainties over the long-term pattern of ground behaviour and whether landslide events in the Undercliff are driven by cyclical processes which may affect the future.

A certain amount of compartmentalised thinking still impedes a clear overview of the Undercliff problem. In the past an artificial distinction drawn by central Government provided funding for research and prevention of land-loss due to coastal erosion but excluded funding for land-loss due on-shore ground movement. In the context of the Undercliff such a distinction was impractical and it can impede the formulation of a fully integrated research design. More recently there has been increasing recognition of the need to integrate the study of coastal processes and ground stability as part of the design of new coastal protection schemes.

From an archaeological standpoint coastal defence policy has concentrated attention upon sea-defence works at Bonchurch and Ventnor while advocating a 'do nothing' policy in the region of St Catherines Point. The soft eroding cliff-line of the latter coastal unit contains the largest known resource of geo-archaeological and palaeo-environmental evidence pertinent to the overall understanding of the nature, scale and pace of coastal and slope changes in the Undercliff. This problem of omission has been partly led by a lack of flexibility in the fourfold MAFF-approved prescriptions for coastal defence. This lack of sufficient flexibility has also been recognised elsewhere in the Solent study area, where consultants have produced a Shoreline Management Plan for Chichester Harbour. New guidelines being considered by MAFF may increase flexibility in the future.

In the case of the Undercliff, it is necessary to take an over-arching view of the research strategies which are necessary to establish the nature, scale and pace of coastal and ground-movement processes which control the future of the entire geomorphological unit. The danger of a compartmentalised approach is exemplified in management prescription for unit VEN6 at St Catherine Point. Here, a policy of 'do nothing' has overlooked the archive of past landslide and coastal-change information which is locked up in the archaeological and palaeo-environmental deposits which are now subject to cliff erosion at this location. A prescription of managed retreat at St Catherines would permit the scientific examination of archaeo-environmental evidence at this location while adding to the understanding of the landslide complex. The value of these cliff-line archaeological sites was well summarised in volume 1 of the Shoreline Management Plan but the need to interrogate these resources was not carried into the implementation proposals contained in volume 2.

Palaeo-environmental sites pertinent to the long term history of ground behaviour in the Undercliff and indeed elsewhere have been virtually overlooked in Shoreline Management Plans. Given the unresolved questions concerning periodicity of ground movement events and the role of climatic and environmental changes, there remains a need to identify sediment archives within landslide complexes such as the Undercliff which are capable of retaining pollen and palaeo-molluscan evidence of past vegetational changes.

A practical problem identified in the LIFE study of the area has been a lack of appropriate record-keeping, archiving and monitoring in an area where records of past human activity and natural events are vital to the management of a landslide area. Record-keeping for the archaeological or cultural resource was well organised and maintained to a national set standard, an achievement which could be attributed to the central Government inducements and the issuing of specific guidance for *Sites and Monuments Records* (RCHME XXX). Nevertheless, where archaeological or geo-archaeological resources might be disturbed or damaged in the landslide complex provisions for site monitoring were patchy and could only be enforced where issues of Planning consent arose. As a statutory undertaker the Isle of Wight Council could make no in-house provision for the archaeological monitoring of trench-cutting and ground disturbance without imperiling a budget plan which was critically scrutinised by Central government. This was particularly regrettable in Ventnor town where there was a particular need to retrieve datable evidence concerning the long-term history of ground behaviour in a vulnerable urban setting. Similarly, no planned provision had been made for the regular archaeological monitoring of the coast, despite the weak nature of the cliff-line and the loss of potentially important sites to destruction by wave action. This omission was not one of awareness but a lack of funding and justification with Central Government's revenue support procedures.

Where palaeo-environmental evidence was sought for the long term history of ground behaviour provisions for data-capture were particularly weak. Government guidance on 'Planning and Archaeology' (EH 1990) had not included palaeo-environmental deposits or sediment archives and this had meant that no prospection surveys had been carried out to locate these resources. Similarly, no effective mechanisms were in place to assess or protect them. Where geotechnical boreholes had been sunk, the retention of cores and record-logs was patchy and no planned provision was usually made for the analysis of palaeo-environmental horizons intercepted by the core. These omissions arise from a lack of appropriate statutory instructions to local authorities and the lack of technical directive from the Council of Europe.

11. SOCIAL INCLUSION AND COMMUNITY INVOLVEMENT

Substantial effort has been by the Isle of Wight Council in promoting knowledge and understanding of coastal processes and ground movement in the special area of the Undercliff. The Shoreline Management Plan of 1997 was accompanied by press releases and an information leaflet presenting the shoreline management options.

The Council's Coastal Visitors' Centre, sited at Ventnor, plays a key role in promoting local understanding of the issues of coastal erosion and ground movement. Particularly valuable is the day to day availability of coastal studies staff and the staff of the County Archaeological and Historic Environment Service. Both of these services are able to actively promote and sustain local interest in the palaeogeography of the Undercliff. It is by this means that the loss of sites to natural and humanly-induced destructive processes is mitigated. It should be observed however that the public service roles of these two sections is not specifically recognised in Central Government's annual assessment of Local Government expenditure (SSA). This places these services under perpetual threat of reduction, curtailment or ineffectuality.

12. KEY ISSUES

1. Ventnor and the Undercliff are a clear demonstration that incremental and long-term problems will arise where human settlement is allowed to develop on an eroding coast which is also a major landslide complex. New development on this scale would be most unlikely for both technical and environmental reasons.

2. The presence of undisturbed and datable archaeological evidence can help to differentiate between areas of varying risk within the landslide complex and this information should be used as part of future landslide investigations wherever possible.

3. While geotechnical studies have identified most of the structural components of the Undercliff there has remained an outstanding need to date the primary failure which has pre-set the timetable for all subsequent events. The appraisal of archaeological and palaeo-environmental evidence should establish an extended ground-change chronology which can provide wisdom of hindsight over past events and developing trends. In the case of the Undercliff this has at least doubled the timescale previously proposed for the development of secondary landslide processes.

4. Prior to the inception of the LIFE project the dating of secondary landslide events within the Undercliff had been largely restricted to the very short timespan offered by historical records. The application of archaeological and palaeo-environmental studies has extended the ground-change chronology from a cramped historical vision of 200 years to a a fuller perspective of 10,000 years. This expansion has also outlined a number of significant events and changes during this period and it proffers a case for research which can extend the chronology beyond 30,000 years.

5. There has remained an outstanding need to fix the date of subsequent ground movements in the individual behavioural zones of this landslide complex. The present

study has shown that undisturbed archaeological remains on the surface of landslide behavioural zones can fix the date by which major secondary slides and debris aprons have occurred. Palaeo-environmental evidence contained within the matrix of a landslide deposit can also provide a date before or by which slope movement has occurred.

6. The Undercliff demonstrates that management plans and development plans are most effective when they encompass a research programme which provides a clear overview of the physiography and the human and environmental history of each behavioural zone or shoreline management unit.

7. A cost-benefit approach driven principally by property values or immediate perceptions of human need is not conducive to a sustainable shoreline management strategy. The purview of shoreline management units in the Isle of Wight Undercliff demonstrates the implementation of government policy 'to protect life and property'. The palaeo-environmental and archaeological resources which contribute to the overall understanding of the entire coastal process unit including Ventnor. Threatened archaeological and palaeo-environmental features such as those at St Catherine's Point exemplified this issue by offering a key to the understanding of the ground-change chronology throughout the entire landslide complex. The application of a do nothing coastal management policy can be detrimental and inappropriate where 'intangible' geo-archaeological and palaeo-environment resources within the prescribed management unit hold scientific potential which is applicable to the other management units or the whole coastal process unit or cell.

8. This case-study demonstrates that there is a need for a broadness of vision which can embrace pertinent field evidence which may lie outside the boundary of a shoreline management unit or landslide management zone. This vision should also embrace evidence which may be held within the domain of other or allied environmental sciences. In this case the colluvial deposits at Gore Cliff show that a shoreline management plan should be sufficient flexible to admit whatever archaeological and palaeo-environmental sites can elucidate the nature, scale and pace of long-term changes which are taking place throughout the entire coastal process unit.

9. While the defining of coastal cells and process units on the UK coastline has been highly beneficial to shoreline management, prescriptions for action have been less perceptive of the need to understand the long-term timetables of local coastal change. This is because present management action on the shoreline has been largely focussed upon the engineering requirements of individual management units while neglecting the need to acquire a balanced chronological perspective of the evolving changes which are taking place throughout the whole process unit or the coastal cell. This situation has now been recognised by the government which is commissioning a national geomorphological study. However the full potential of palaeo-environmental expertise is yet to be recognised.

10. This LIFE project has provided a first step towards understanding the full palaeo-environmental history of this landslide complex. Further questions of climatic change and periodicity remain to be resolved. There is a need to consider global climatic triggering factors and field evidence which may be dispersed across several national boundaries. For this purpose the European Commission's framework for research, liaison and data-exchange in this field is invaluable.

11. Erratic site monitoring and the unsustainable loss of non-renewable archaeological and palaeo-environmental archives has impeded the construction of a full Holocene ground-change chronology in a region where coastal processes and ground-movement events are dictating natural change. Support for the essential functions of monitoring, sample-retrieval and scientific analyses in regions vulnerable to coastal and ground-movement changes are currently ad hoc or project-based. These arrangements cannot guarantee long-term consistency and they are inappropriate for sustained measurement and scientific re-appraisal. Enhancement by Local Authorities of Sites and Monuments

Records and Environmental Records is a promising means of advancing monitoring and resolving problems . Nevertheless, a statutory mandate is required to ensure that investigations and analyses are maintained with equal vigour and compared and synthesised to a common European standard.

12. An 'ad hoc' response to collection and preservation of cultural items pertinent to earth science and palaeo-environmental studies has occurred in the past. This has denied adequate appraisal of past settlement and the ground-behaviour history of the town. Conversely, the chance reporting of a single palaeolithic artifact (from the 'Orchard') has transformed scientific calculations of the age of the entire landslide complex. The idiosyncratic loss or retention of critical evidence such as this demonstrates that there is need to sustain consistent curatorial care of the common European palaeo-enviromental heritage and to ensure long-term security of archaeological material and records which will can facilitate future re-examination and re-appraisal.

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Plate P4a ***Binnel Point, Ventnor Undercliff Landslide complex, Isle of Wight. Coastal erosion has exposed important palaeo-environmental evidence***