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SOUTHERN REGIONAL REVIEW OF GEOARCHAEOLOGY: WINDBLOWN DEPOSITS

Martin Bell and Alex Brown

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Research Department Report 005/2009

Southern Regional Review of Geoarchaeology: Windblown Deposits

Martin Bell and Alex Brown

Summary

This report is concerned with the geoarchaeological potential of loess, coversand and blown sand deposits across Southern Britain. Aeolian sediments are significant because they bury and preserve archaeological sites ranging in date from the Palaeolithic to Second World War, whilst also creating favourable conditions for the preservation of a range of environmental proxies. However, these sedimentary contexts often do not get the attention they deserve.

Each aeolian sediment type is dealt with on a sub-regional basis. Particular emphasis has been placed on the identification of key studies in fields other than archaeology, including geology, sedimentology, quaternary science and soil science. Key conclusions and recommendations highlight the potential of aeolian deposits to provide sequences of environmental and cultural change over a variety of timescales. Such contexts require an interdisciplinary approach to analysis that places aeolian sequences within the wider Pleistocene and Holocene sedimentary and archaeological context. Many aeolian deposits are contained within areas under some form of designated protection, but this often takes little consideration of the presence or importance of Holocene windblown sediments.

The report also highlights the threat to aeolian deposits, particularly within coastal settings, from erosion and development pressure, and the need to monitor, record, and in cases mitigate potential losses to the geoarchaeological record.

Keywords

Geoarchaeology
Geochronology
Optically Stimulated-Luminescence
Burial Environments
Soil/Sediment

Authors' address

Department of Archaeology, School of Human and Environmental Sciences, University of Reading, Whiteknights, PO Box 227, Reading, RG6 6AB.

CONTENTS

1. INTRODUCTION

1.1 The sediments and why they are significant

The vast majority of archaeological finds are contained in a soil or sedimentary context, yet that vital contextual information often does not get the attention it deserves. Hence the need for a geoarchaeological survey to highlight the potential of particular types of deposit and make recommendations for the future. This contribution to the geoarchaeological survey concerns sediments laid down by wind, the so-called aeolian sediments. These are archaeologically significant because they bury and preserve sites extending from the occupation surfaces of Palaeolithic hunter-gatherers to Bronze Age settlements of stone houses and sites connected with the defence of Britain in recent wars. Aeolian sediments also create favourable conditions for the preservation of certain types of environmental evidence such as buried soils, vertebrate remains and molluscs. Although windblown deposits are quite localised in southern Britain today the coastal areas where they are found are disproportionately significant in terms of human settlement and agricultural history. There were also times in the Pleistocene when windblown sediment deposition was much more widespread.

The types of sediment considered here are loess, coversand and dune sand. Loess is a fine grained sediment, predominantly silt, which was transported substantial distances by wind in cold and dry conditions, often around glacial maxima. Coversands are sand grade sediments deflated (ie blown from) from unvegetated surfaces on retreating shorelines, in river valleys or on till plains (Koster 1988). Dune sands are sediments deflated from the beach and laid down along the coast above high tide sometimes a few kilometres inland. In addition to these main types of deposit we also consider local deposition of windblown sediments in heathlands and from arable land. The geographical area covered by this survey is English Heritage's Southern Region, roughly from the Severn to the Thames Estuary but including the 4 northern counties of Gloucestershire, Oxfordshire, Buckinghamshire and Greater London (Figure 10). Occasionally we stray a little beyond those boundaries where sites just outside demonstrate the potential of particular sedimentary contexts. Our aim in the text has been to highlight those sites and sequences which are of greatest established importance. There are other sequences where finds so far have been less significant or where nothing has been found. We have listed all sites, significant and otherwise, in the Appendices and sites are located on maps. Figure 3 shows the distribution of loess and coversands, with the sites listed in Appendix 1. Figure 10 shows the distribution of coastal windblown Holocene sands and those sites are listed in Appendix 2.

Particular emphasis has been placed on the identification of key studies in fields other than archaeology, but which have archaeological implications and relevance not previously considered, for example, in geology, sedimentology, Quaternary science and soil science. Rapid searches were made of published literature in major international, national, and regional journals, regional archaeological syntheses, Geological Survey Memoirs, and key monographs. Searches were made of the main Historic Environment Records and the Archaeological Data Service online ArchSearch (http://ads.ahds.ac.uk). The latter resource includes information from the National Monuments Record, National Trust Sites and Monuments Record, Somerset Historic Environment Record, and Council for British Archaeology Defence of Britain database. In addition, relevant reports of the Ancient Monuments Laboratory and Centre for Archaeology of English Heritage have been highlighted.

Windblown sediments are fine grained and often blanket surfaces, sometimes to significant depth, without directly disturbing them. In this way they preserve *in situ* occupation floors and surfaces of all periods. This property is of particular potential importance in advancing our understanding of the Palaeolithic, a period long dominated by discoveries in river gravels (generally reworked, Wymer 1999) and in cave sediments (Campbell 1977). It is now clear that the best opportunities for finding well-preserved Palaeolithic occupation sites are within fine grained sediment sequences where land surfaces have been buried (Wilkinson 2001) in coastal, riverine and aeolian sediment. The potential of fine grained sediments is especially clear from coastal (not windblown) contexts at Boxgrove, Sussex (Roberts and Parfitt 1999) and recent discoveries at Pakefield, Suffolk and Happisburg, Norfolk (Parfitt *et al* 2005, 2006).

1.2 Formation process issues

Although in many cases aeolian sediments are extremely sensitive preservers of archaeological horizons, there are exceptions and we do need to understand the distinctive formation processes of the sedimentary record in these contexts. Following deposition, poorly vegetated wind blown sediments can be remobilised by deflation, giving rise for instance to blowouts within sand dunes. The fine sediments are blown away leaving a deflation lag of larger particles including artefacts (Butzer 1982, 110). In this way artefacts which were originally deposited on separate surfaces within a dune may come to be associated in a stoney pavement at the base of the deflation feature. In the absence of detailed analytical work we will also encounter uncertainties as to whether fine-grained sediments originally laid down by wind have been subject to reworking by wind, water or colluvial processes. In Pleistocene contexts windblown sediments are also subject to periglacial processes and may be associated with periglacial landforms.

1.3 Dating and correlation

In the case of loess, coversand and terrestrial sediments it is important to establish their relationship to the oxygen isotope stages identified on the basis of deep sea cores (Figure 1) and to the main stages of Pleistocene chronology (Figure 2). It should be stressed at the outset that all correlations with Marine Oxygen Isotope Stages (MOIS) are tentative and provisional. The most important techniques in directly dating deposition of wind blown sediments are Thermoluminescence (TL), and Optically Stimulated Luminescence (OSL) and Infrared Stimulated Luminescence (IRSL) (Aitken 1985, 1992). Thermoluminescence (TL) dating involves the measurement of the light (luminescence) emitted from a sample when heated. The light is produced by the release of electrons trapped within minerals that have accumulated as a result of the continuous radioactive bombardment of a sample. The emitted luminescence of a sample relates to total radiation dose, which is proportional to the age of the sample. The age of the sample can only be calculated by determining the radiation dose rate accumulated per year. This is calculated by comparing the TL signal of the sample resulting from past exposure to radiation with the TL signal produced by exposure to a calibrated laboratory radiation source. Other luminescence dating techniques differ in the light source required to stimulate luminescence.

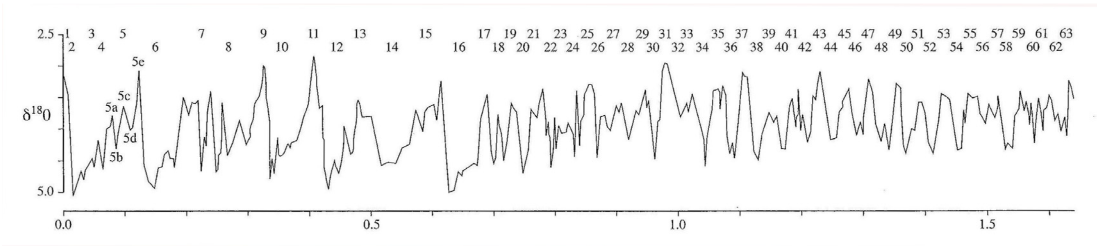

Figure 1: (above) Oxygen isotope record from the Atlantic from Bridgland 1994, compiled from Ruddiman et al 1989

Oxygen isotope stage	Age Ky	British conventional chronology	Climate
1			Warm
	12		
2		DEVENSIAN	Mainly cold
	25		
3			
	50		
4			
	70		
5a - d			
	110		
5e		IPSWICHIAN	Warm
	130		
6		WOLSTONIAN	Cold
	186		
7			Warm
	245		
8			Cold
	303		
9			Warm
	339		
10			Cold
	380		
11		HOXNIAN	Warm
	423		
12		ANGLIAN	Cold
	478		
13		CROMERIAN and earlier	Warm

Figure 2: Simplified table showing correlation between oxygen isotope stages, British Quaternary stages and climate (after Wymer 1999)

Optically Stimulated Luminescence (OSL) utilises visible light, whilst Infrared Stimulated Luminescence (IRSL) requires infrared light. It is important that sample exposure to sunlight is avoided, both in the field and laboratory, as exposure will free all trapped electrons and zero the signal. Errors may also occur in the laboratory associated with calibration of the laboratory radiation source, incomplete zeroing of the luminescence signal in a sediment, or leakage from the electron traps, leading to reduced dating precision (Lowe and Walker 1997; Rapp and Hill 1998).

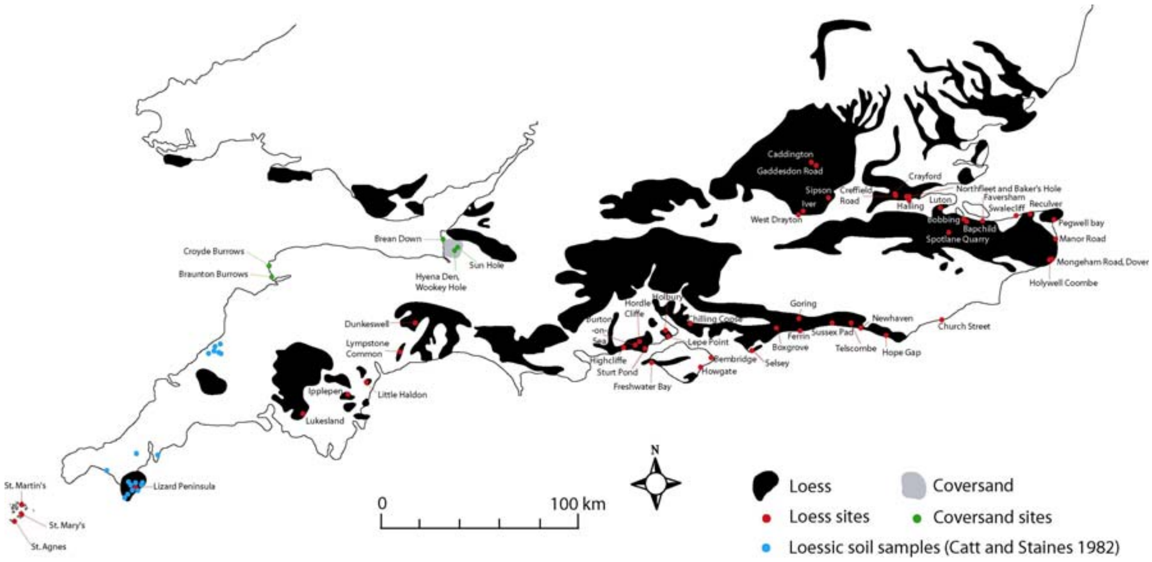

Figure 3: The distribution of loess and coversand in Southern England and with key environmental and archaeological sequences marked (Antoine et al 2003, with additions)

Other relevant dating methods include radiocarbon, 'count from the top', amino acid ratios and biostratigraphy (Lowe and Walker 1997). Not uncommonly in Pleistocene contexts different methods suggest somewhat different dates, often generating a lively debate. Such debates are further complicated by the fact that they sometimes revolve around the interpretation of discoveries made in the nineteenth and early twentieth century. Thus new finds of archaeological material related to loess and coversands which can be stratigraphically recorded and scientifically investigated are of potentially great importance.

2. LOESS

2.1 Characterisation

Loess is a silty windblown sediment transported in periglacial and steppe environments along the margins of the Quaternary ice-sheets (Antoine *et al* 2003). Typically pale yellow or buff in colour, loess largely comprises coarse silts (20-50 μm), with between 15-18% clay, and less than 10% fine sand. Loess is a calcareous sediment with up to 15-18% primary carbonates; however, the thin British loesses have often been subject to decalcification and pedogenesis. Mineralogically, loess is composed primarily of quartz (up to 70%), with feldspar, chlorite, muscovite and glauconite and a heavy mineral component chiefly comprising epidote, hornblende, zircon and tourmaline. Some differences in loess mineralogy have been interpreted as of chronological significance reflecting derivation from glacial deposits (eg outwash or till) of differing origins and compositions (Bridgland 1994, 273). There is a change in loess mineralogy and particle size from south east England towards the south west (Devon and Cornwall). The proportion of chlorite and muscovite increases, whilst the modal particle-size decreases from *c*. 40-45 μm in eastern England to *c*. 25 μm in the South West. This suggests two different sources for loess in southern England (Catt 1978; Catt and Staines 1982; Antoine *et al* 2003).

Where loess is calcareous, land Mollusca may be present but the fauna is a very restricted one: *Pupilla muscorum*, *Trichia hispida* and *Succinidae* sometimes with *Columella columella* and one or two other species all indicative of harsh cold, dry conditions (Evans 1972, 290). Molluscan fauna associated with loess deposits, such as those from Holywell Combe (Preece and Bridgland 1998), Reculver (Preece 1990) and Halling, Kent (Kerney 1971) all indicate a cold sub-arctic environment. When pollen is present this too indicates cold steppe conditions. Palaeobotanical analysis of organic horizons interbedded with head and sealed by sandy loess on the Scilly Isles (Scourse 1991) indicates a similar depositional environment characteristic of the late Devensian.

The general assumption has been that loess was originally widely distributed across southern Britain as a blanket. What remains today is more patchy (Figure 3), surviving as an identifiable stratigraphic unit in areas where the original deposits were thickest in parts of Kent and the Sussex Coastal Plain. It is also present in the soils of chalk and limestone areas which, being permeable, have less stream activity and are likely to have undergone less erosion in the Late Glacial and Holocene. Loess is found in a variety of geomorphic and sedimentary contexts, typically distributed on leeside slopes, valley bottoms, plateaux, sometimes within sinkholes and in Pleistocene landforms such as involutions.

The Geological Survey mapped deposits as 'brickearth' and this is a term widely used in the older literature; such deposits occur widely, for instance, above gravels on Pleistocene terraces of the Thames (Bridgland 1994). The problem is that this term literally describes any sediment suitable for making bricks, not just loess. To avoid confusion the brickearth attribution given to a deposit by earlier investigators is often retained with the result that the term is applied both to (a) sediments the composition and origin of which is totally unknown and (b) sediments which analysis has shown are loess. It is an important prerequisite of future work that the sedimentary and analytical properties of loess-like sediments are fully examined in order to establish whether a sediment is true loess, loess reworked by colluvial, alluvial or periglacial (eg involution) processes, or whether it is sediment of some other origin. In the case of the brickearth covering the gravel terraces of the Thames it is becoming increasingly clear that these deposits are of polygenetic origin with contributions of Devensian and maybe earlier loess, alluvial and colluvial processes. If the sediment is reworked as alluvium there are often laminations and coarser bands present; significant proportions of coarser sediment may also indicate reworking by colluviation and periglacial processes. Micromorphological investigation has proved important in identifying the sediment history of loess and sediments derived from it, particularly the role of pedogenesis. Contained biological evidence frequently provides evidence of reworking, eg the presence of freshwater Mollusca indicating reworked alluvial sediments. Surprisingly, given the stratigraphic and palaeoenvironmental significance of *in situ* loess, analytical investigations of possible loess sediments are not very numerous. One study which succeeded in identifying the *in situ* nature of a loess is north of our research area at Star Lane Southend, Essex (Bridgland 1995, 238). Future investigations need to place greater emphasis on distinguishing *in situ* from reworked loess so that these deposits can play a greater role in stratigraphic correlation and palaeoenvironmental reconstruction, as they do in parts of France (Antoine *et al* 2003; Bridgland 1995).

Weathering and soil formation processes have also post-depositionally altered the characteristics of loess, through decalcification, gleying, alteration of iron-containing minerals, movement of clay and incorporation of humus (Catt 1978). At Pegwell Bay, the upper 1 m of the loess is decalcified as a result of leaching through soil formation. This overlies calcareous loess, and then involution features (Figure 4; Murton *et al* 1998; Clarke *et al* 2007). Where loess deposits are thin they have often been mixed and incorporated in Holocene soils and colluvium (see below 2.6-7).

Figure 4: Pegwell Bay, Kent, loess overlying Pleistocene involutions (photo. M. Bell)

2.2 Distribution

Granulometric and mineralogical analyses of soils and sediments indicate that loess is widespread across southern Britain (eg Catt 1978). Figure 3, based chiefly on research by Catt (1978, 1985), shows the distribution of loess, often mapped as brickearth by the British Geological Survey, where it is the abundant component of the soil, or forms distinct layers within sedimentary sequences. The thickest and most marked loess deposits, reaching up to 4m thick, are found on the Kent Coast at Pegwell Bay (Figure 4; Pitcher *et al* 1954). Distinct loess layers, often no more than 1m thick are found along the Kent coast and on the Sussex Coastal Plain. A thin, discontinuous, but widespread cover of loess can be found across Hampshire (New Forest), Berkshire, Greater London and Hertfordshire, with smaller deposits in south Dorset, Devon, Cornwall and the Mendips. Loess is also present on the Scilly Isles;

here termed Old Man Sandloess (Catt and Staines 1982; Scourse 1986; Ratcliffe and Straker 1996).

2.3 Formation processes

Loess is derived from two primary sources. The thick loess deposits of northern and western China are derived from silts blown from the desert basins of central Asia, whilst the loess of northwest Europe and North America is derived from glacial outwash deposits along the margins of the Quaternary ice-sheets. Glaciers contain significant quantities of sediment accumulated through erosion of the underlying rock and physical weathering under periglacial conditions. Sediment carried away by meltwaters during the retreat of an ice sheet is deposited as outwash plains. These meltwaters often size-sort the sediment, with the finer component carried away by the wind across the barren periglacial landscape and subsequently deposited as a blanket of silty sediment on the lee sides of slopes. The distribution of loess is, therefore, closely related to prevailing wind direction, the location and supply of sediment, as well as the topography of the surrounding landscape. The south-westwards change in modal particle size and mineralogy suggests deposition of loess by north-westerly winds (Antoine *et al* 2003), implying a source in eastern England from the North Sea basin. The differing mineralogy and particle-size of loess in southwest England and the Scilly Isles indicates an alternative source, most probably from glacial outwash deposits in the Irish Sea basin and English Channel (Harrod *et al* 1974; Ratcliffe and Straker 1996). However, although studies on several sites in Cornwall by Catt and Staines (1982) confirmed such an origin for the majority of sites, loess deposits on the Lizard and Towan Beach appear also to include a component derived from weathering of the local granite and slate respectively.

2.4 Dating of loess

In some parts of the world, such as China, loess deposits of enormous thickness occur and are divided up by palaeosol horizons. These sequences provide increasingly important Quaternary palaeoclimatic records (Lowe and Walker 1997). Similarly in eastern Europe thick loess and palaeosol sequences occur and even in Western Europe such sequences are important elements in the Pleistocene stratigraphic succession, for example in parts of France such as the Somme Valley, Normandy and Brittany (Antoine *et al* 2003) and in the Netherlands (Meijs 1985). The loess deposits of Britain are by comparison, thinner, more localised as discrete stratigraphic units, and with so far quite limited evidence for palaeosols separating distinct episodes of loess deposition. Evidence of palaeosols associated with loess sequences is found at Northfleet (Kemp 1995), a soil of Windermere (Bølling-Allerød) interstadial date at Pegwell, North Cliff, Kent (Kerney 1965), from Prospect Park, Heathrow (Rose *et al* 2000) and just outside the study area at Rochford, Essex (Bridgland 1995). Thus there is some possible evidence for hiatuses and pedogenesis in, or on, some British loess sequences.

The development and increasing application of TL and OSL dating techniques to inorganic sediments and soils has enabled more precise dating of loessic deposits (eg, Wintle 1981;

Parks and Rendell 1992; Clarke *et al* 2007). Most identified British loess is dated to the last glacial maximum. However, loess is to be expected in preceding periods of harsh, cold conditions and evidence of this is increasingly being found, albeit with survival localised due to the erosive impact particularly of subsequent cold stages. The accumulated dating evidence, synthesised by Parks and Rendell (1992), has shown there to be three broad phases of loess accumulation. Thermoluminescence dates from four sites (Northfleet, Kent; Sussex Pad and Boxgrove, Sussex, and Holbury, Hampshire) suggest two earlier depositional phases: the first before 170 ka, the second between 50-125 ka (Parks and Rendell 1992).

Reworked loess at Boxgrove, TL dated to between 175.3±19.5 and 229±27.7 ka BP, contained no archaeology, and significantly post-dates the hominid remains by as much as 350,000 years (Roberts and Parfitt 1999). The Boxgrove loess is argued to have originally been blown northwards onto the Downs from exposed, formerly littoral sediments, where it was subsequently moved downslope along with soliflucted chalk and clay-with-flints (Roberts and Parfitt 1999).

Loess at Northfleet, Kent is thermoluminescence dated to 115±12.8, 126.1±12.3 and 153.4±15.9 ka BP, although, this is considered a minimum date (Parks and Rendell 1992), and the Northfleet sequence is now generally considered to be earlier (Wenban-Smith 1995; see below 2.5).

The majority of loess dates to the late Devensian cold stage, (the end of Marine Oxygen Isotope Stage (MOIS) 3 and MOIS 2 between 25-11.5 ka BP) although Clarke *et al* (2007) recently argue, on the basis of new dates from Kent loess, including Pegwell Bay, for two distinct phases of accumulation. The first, dating to the late glacial maximum (23.8±1.3 ka), continues during deglaciation (17.2±1.3 ka), followed by a second phase of accumulation, of a non-calcareous loess (15.0±0.9 ka), associated with the Bølling-Allerød interstadial. On the Scilly Isles, organic horizons interbedded in Head, and overlain by loess, produced radiocarbon dates ranging between 20-35 ka BP (Scourse 1986), similar to dated loess deposits from southern England, supporting a late Devensian date for loess in south-western England.

2.5 Associated archaeological sites

Loess deposits are of special archaeological importance because they may contribute to the creation of exceptional preservation conditions, sealing and preserving more or less *in situ* occupation horizons and because the calcareous nature of loess is conducive to the preservation of vertebrate and molluscan evidence. The most productive investigations of Palaeolithic sites associated with loess in Britain were carried out in the nineteenth century and although some have been subject to limited re-examination in the twentieth century it could be argued that the potential of loess is not sufficiently appreciated today. The following cases illustrate why any Palaeolithic finds associated with possible loess should be regarded as of very high potential. The case is most clearly made by reference to the complex of sites at Northfleet in the Ebbsfleet Valley, Kent of which the most famous is Baker's Hole (Shephard-Thorn and Wymer 1977; Wymer 1968, 1999; Bridgland 1994, Wenban-Smith 1995). From

1883, quarrying led to discovery of many archaeological sites including the richest Levallois site in Britain (Figure 5).

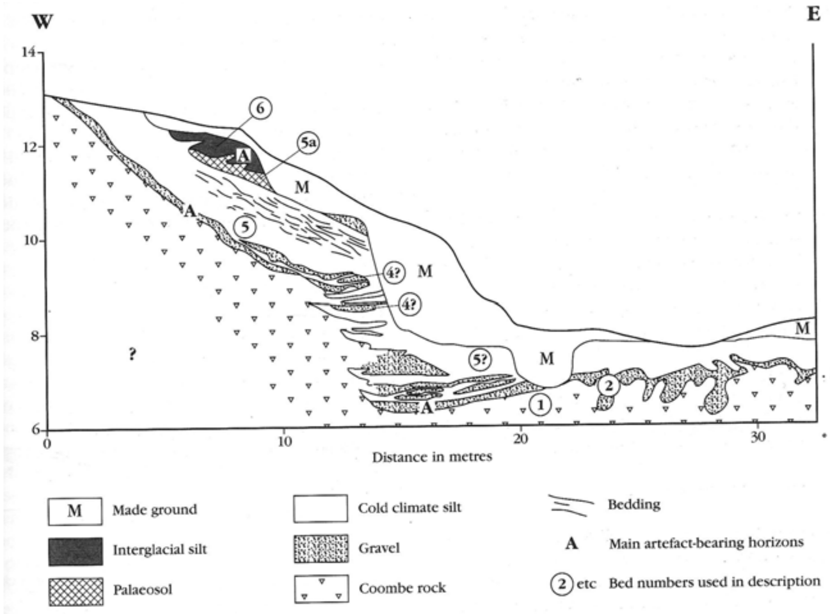

Figure 5: Sediment sequence at Northfleet, Kent from excavations by British Museum showing the relationship between Coombe rock, silts with a loess component and the artefact horizons (from Kerney and Sieveking 1977; Bridgland 1994)

Some artefacts rested on chalk buried by soliflucted Coombe Rock, but most had been subject to some disturbance within Coombe Rock. The Coombe Rock was interleaved with loess the upper units of which contain freshwater Mollusca and have been fluvially reworked. The site is of particular importance because many of the artefacts are sharp and include conjoins, which indicate only limited movement and disturbance. The sediments also produced fauna including mammoth, rhinoceros, Bos, bison, horse and deer, and Mollusca were also preserved in some horizons. Thermoluminescence dates of 115±12.8, 126.1±12.3 and 153.4±15.9 ka BP (Parks and Rendell 1992) are, as noted above (Section 2.4), regarded as minimum dates. In the past Baker's Hole was thought to be of last (Ipswichian) interglacial date (MOIS 5). However, there is vertebrate biostratigraphic evidence indicating an earlier date and the Baker's Hole sequence is now generally considered to date to the end of the cold stage MOIS 8 with some fluvial reworking of aeolian sediments in the subsequent warm stage (MOIS 7). This suggested dating is consistent with results of amino acid ratios in shells. Soil formation within the Northfleet loams which are loess or have a loessic component have been micromorphologically examined. Soil formation is thought to have occurred in MOIS 7 (Kemp 1995).

Of possibly comparable date is Crayford, Kent where an occupation surface including Levallois flakes and handaxes and conjoining artefacts rests on gravel and is overlain by brickearth which also contains a few palaeoliths in mint condition. Mollusc and vertebrate faunas are present in the brickearth (Wymer 1968, 361). The brickearth is thought to contain a loess component but has certainly been fluvially reworked and is overlain by a colluvial component (Bridgland 1994, 249). Biostratigraphic and amino acid ratios indicate the deposits are of MOIS 7 (Wymer 1999, 82).

Similarly at Creffield Road, Acton a rich Levalloisian industry occurs on a buried land surface on gravel and overlain by sandy loam and brickearth, with a few flakes below and in the brickearth (Wymer 1968, 263; 1999). At Bapchild, Sittingbourne there is also a Levallois assemblage with artefacts in sharp condition from soliflucted Coombe Rock with others apparently *in situ* below brickearth which overlay the Coombe Rock (Wymer 1999, 170). At Caddington on the Chilterns in Bedfordshire, there are abundant finds in doline solution features in the chalk where Levalloisian assemblages occur within brickearth which analytical evidence shows is of loessic origin (Smith 1894; Wymer 1999, 175; Catt and Hagen 1978) These deposits have been identified as including both Anglian (MOIS 12) and Wolstonian (MOIS 6?) aeolian contributions (Avery *et al* 1982; Antoine *et al* 2003). These Chiltern sites lie just north-east of the area covered by this review but are mentioned here to draw attention to the potential of solution features to preserve loess and associated Palaeolithic sites.

Loess is also found on the limestone of the Mendips in Somerset (Findlay 1965) and here also the sediments which accumulated in sink hole features at the surface of cave systems appear to contain a significant proportion of loess, although the date of this and whether it is *in situ* or reworked is not known. Tratman *et al* (1971, 245) note that Mousterian occupation at the Hyena Den, Wookey Hole, Somerset was sealed by brickearth, which could be derived from Mendip loess, although again the character and date of this sediment has not been established.

Some of the archaeological sites noted so far in this section comprise Levalloisian material often associated with Acheulean handaxes. Where there is some indication of date the deposits appear most likely to represent the cold stage MOIS 8, when loess deposition is likely to have occurred, and continued into the subsequent warm stage MOIS 7 when some loess appears to have been reworked as alluvium and contains freshwater Mollusca and biota of temperate conditions at some sites such as Northfleet. MOIS 7 has been called the Stanton Harcourt Interglacial (Wymer 1999, 4). If current views on the dating of these archaeological sequences are correct, and if the sediments identified are indeed loess, as analysis on some sites confirms, then this could suggest that loess of pre-Devensian and particularly broadly Wolstonian (MOIS 6-10) date is more extensive in southern England, and certainly more significant archaeologically than has been generally assumed.

Other Palaeolithic finds where indications of date are less secure, but the finds are related to brickearths, thought to be loess, are Luton on the North Downs in Kent where handaxes and debitage occurs below brickearth and Swalecliff, Herne Bay, Kent where handaxes and flints have been found eroding from brickearth (Wymer 1999, 170). Lower Palaeolithic handaxes stratified in loess have been recorded from sites in Kent at Manor Road, Deal, Great

Mongeham Road, Dover (Appendix 1), Mayers Road, Walmer, (http://ads.ahds.ac.uk, NMR NATINV-1086179) and on the Isle of Wight at Howgate Farm (NMR NATINV-1106385).

At Newhaven, Sussex flint artefacts, some of which conjoined to a core, were found in a silt which mineralogically was mainly of loessic origin with a little other sediment probably introduced by involution (Bell 1976). The flints were in Pleistocene landforms comprising stoney clay and silt stripes and a feature originally interpreted as an ice wedge polygon (Figure 6). The limited excavation leaves the nature of this landform equivocal and, in the absence of other polygons in the area the features may represent involutions. However, it should be noted that polygons are associated with loess in late Weichselian Pleniglacial Stadial contexts at Maastricht, Netherlands (van Kolfschoten *et al* 1993). The flints are not typologically distinctive. The sequence was originally interpreted as dating to the main period of loess deposition during the last glacial maximum on the basis that the flints were contained within loess, the mineralogy of which was comparable to the main loess deposits of Sussex. However, the loess, possible involutions and artefacts could relate to an earlier, maybe even pre-Devensian phase of loess deposition which was later subject to involution with underlying soliflucted clay-with-flints and Tertiary derived sediment. Current (autumn 2007) redevelopment plans near this site may provide the opportunity to re-examine its nature.

By far the most extensive surviving loess deposits in Britain are, as already noted, of last glacial maximum date (MOIS 2) and it is to this phase that the Newhaven finds were originally attributed. It is, however, generally considered that Britain was deserted during the last glacial maximum between about 24 ka cal BP and 15 ka cal BP (Housley *et al* 1997; Barton 1997). In South East England Devensian loess is likely to have contributed sediment for reworking during the climatic fluctuations of the Late-glacial and thus perhaps to the sedimentary context of some Upper Palaeolithic sites. On the Scilly Isles there is evidence that loess was also reworked by solifluction under late Devensian peri-glacial conditions (Staines 1986). At Sun Hole Cheddar, Somerset Unit 2 had a high silt content for which wind deposition is inferred. There are Pleistocene fauna and late Upper Palaeolithic artefacts from earlier work at the site but the precise relationship between the artefact bearing horizons and the silts has not yet been established (Collcutt *et al* 1981). Loess contributed to the Allerød soil at Pegwell Bay and may have contributed to soils of that period increasingly being recognised within dry valley sequences of South East England such as the Channel Tunnel and its Rail Link (Preece and Bridgland 1998, 1999; Giorgi and Stafford 2006). Although these Allerød soils are of great palaeoenvironmental and pedogenic importance none has so far produced evidence for human activity (but some contain charcoal). Maybe the downland locations where they are found were not particularly favoured by Upper Palaeolithic communities, but the possibility that these soils could contain well-stratified occupations or activity areas means that any opportunities for investigation should be taken.

The potential of loess sequences for the preservation of Palaeolithic sites is more strongly highlighted by recent discoveries on the mainland of continental Europe than it is by recent British finds. Middle Palaeolithic sites in riverine sediments and loess at Maastricht-Belvédère, Netherlands (Kolfschoten and Roebroeks 1985; Kolfschoten *et al* 1993) relate partly to activity within the type sequence of the Belvédère Interglacial which has TL dates on burnt flint of 250 ka BP and thus is *c* MOIS 7. Excavations in Picardy, France are revealing extensive well-preserved last interglacial soils with evidence of Middle Palaeolithic sites below thick loess of last interglacial date (J-L. Locht pers. comm.).

Figure 6: Pleistocene landform at Newhaven, Sussex,containing loess and mint condition flint flakes. Scale in inches (photo. B. Westley)

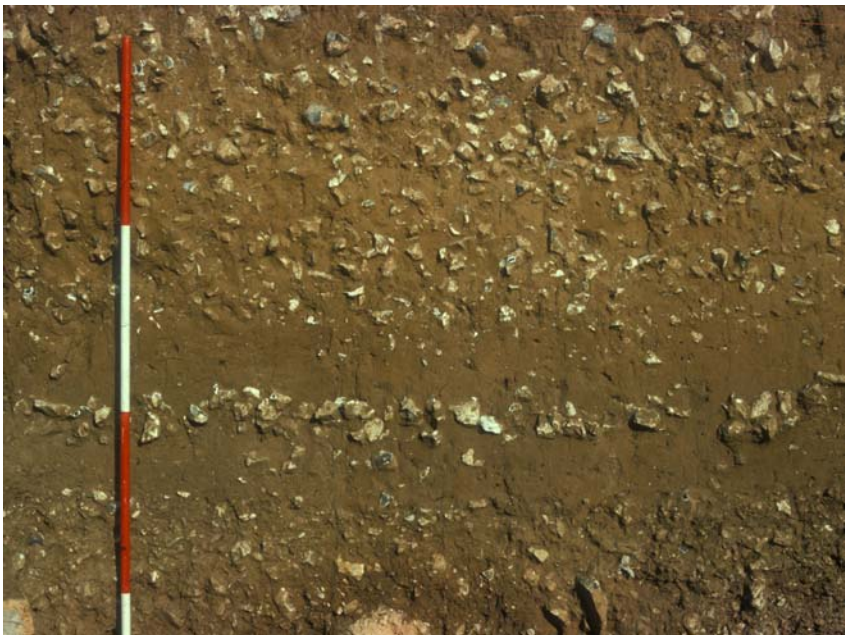

Figure 7: Colluvial sequence at Kiln Combe, Eastbourne, with Beaker occupation in a basal loess rich soils, overlain by a soil of Iron Age date, flinty horizons of the Romano-British period and chalky colluvium of Medieval date (photo. Brenda Westley)

2.6 The significance of loess in the Holocene

The significance of loess soils for past agricultural communities is very evident from the concentration of the earliest Linearbandkeramik (LBK) Neolithic farming sites in Central Europe on loess (Piggott 1965). In Britain the attraction of settlement to soils containing loess has been recognised since a pioneering paper by Wooldridge and Linton (1933). The loess contribution to soils of the chalklands and limestone areas, which would have been more apparent before later prehistoric erosion (see below) may help to explain why many areas of calcareous strata were so favoured for settlement in the Neolithic and subsequent periods of prehistory. Recently a close correspondence has been observed between the distribution of loess and those areas of agriculturally favourable lowland in south east England where extensive ditched land allotment boundaries were laid out on the middle and later Bronze Age (Yates 2007). Significant numbers of archaeological sites of all periods are recorded cutting into loess or loess derived sediments. This reflects the extensive contribution of loess to the soils of southern England, as well as the fertility and attractive nature of loessic soils for settlement and agriculture.

In many areas, loess is identified principally as a component of the modern soil (Catt 1978). Reworked loess typically includes mixed material of more local origin, identified through particle-size and mineralogical analyses (eg, Harrod *et al* 1974; Wintle 1981; Avery *et al* 1982; Catt and Staines 1982: Reynolds and Fisher 1985; Reynolds *et al* 1996; Roberts and Parfitt 1999).

Archaeological surveys relating to the calcareous and other strata in southern England often note the contribution of loess to soils, more often than not this draws on the influential paper of Catt (1978), rather than on any specific analytical investigation of the soil properties and history of the area in question. This tendency to generalisation means we are not yet in a position to quantify the varying contribution of loess to soils in the key archaeological study areas and the effect which subsequent erosion had on soils in those specific areas.

2.7 Erosion of loess in the Holocene

Investigations of chalkland sediment sequences have sometimes produced evidence of distinct loess units. These are often in Holocene subsoils and sometimes within underlying Pleistocene landforms, as at Newhaven and Saltdean, Sussex. Holocene subsoils with high loess content were found in dry valley fills at Kiln Combe, Eastbourne and Chalton, Hampshire (Bell 1981). Loess was also found in the fills of dry valleys investigated in Kent as part of work on the Channel Tunnel and its rail link to London at Holywell Combe, Folkestone (Preece and Bridgland 1998), Whitehill Road, Southfleet and the Nashenden Valley, Rochester (Corcoran 1997, 2000; Giorgi and Stafford 2006). In these and many other valleys it is clear that the erosion of loess made a significant contribution to sequences of Holocene colluvial soil. Within the basal loess-rich buried soil at Kiln Combe, Eastbourne there was a deeply buried Beaker occupation site (Figure 7) and archaeological sites of many periods are frequently stratified within colluvial sequences which also often contain abundant pottery and other artefacts which can be used for dating including establishing the approximate date of loess erosion. At Kiln Combe (Figure 7) the eroded sediments documented the changing soils, from a Bronze Age soil with a high proportion of loess, to a Romano-British soil derived from the erosion of underlying superficial sediments of stoney clay and flint of partly Tertiary derivation, to a Medieval chalky colluvium, since by this time the plough was cutting into underlying chalk (Bell 1983). Understanding the soil history of an area has importance, not only in terms of the changing vegetation and agricultural potential, but also the forms of archaeological evidence (eg bone) or palaeoenvironmental evidence (eg molluscs) which are likely to survive. In some sequences, preservation conditions fluctuated between calcareous and decalcified sometimes several times within a single sequence.

The challenge is quantification of the extent of former loess cover. Favis-Mortlock *et al* (1997) used retrogressive runs of the EPIC soil erosion predictive model, employing South Downs data and assumptions about past environmental conditions to demonstrate that, given known environmental parameters, it is theoretically possible for a thick loess cover to have been eroded from the chalk in the Holocene. Most of the investigations of chalkland dry valley sequences have indeed indicated a loess contribution to Holocene colluvium. At Holywell Combe, colluvium included a *c.* 9 % loessic component (Preece and Bridgland 1998). A loess component has also been noted in colluvium on several CTRL sites (noted above), sites on the South Downs (Bell 1983; 1992) and in Wessex (Allen 1992), Brighton Bypass (Wilkinson *et al* 2002) and the Cranbourne Chase Area (French *et al* forthcoming). Generally speaking the increasing numbers of studies of chalkland dry valley sediments have produced very little evidence of erosion in the Neolithic, but significant colluviation from the Bronze Age makes it probable that it was in this period that much of the remaining loess was removed from the downs. Some studies suggest a significant reduction in arable activity during the Iron Age but settlement and crop growing was again extensive during the Romano-British period. The studies of chalkland valley sediments have not generally revealed anything more than thin loess horizons in the basal Holocene subsoils. Thus, although areas with thicker loess deposits still survive, present evidence would seem to suggest that the loess cover which survived on the chalk into the Holocene may have been somewhat patchy and in most areas is more likely to have been measured in decimetres than metres. Silty surface horizons in the sandy heathland soils of the Weald of Kent and Surrey have been interpreted as of loessic origin (Macphail 1987, 348) and a significant loessic contribution to the silty alluvium, particularly of Boreal date, has been identified in Wealden river valleys by Burrin (1981) and Burrin and Scaife (1984). Further to the west we have already noted the contribution of loess to the Holocene soils and sediments of Mendip and in Devon studies by Harrod *et al* (1974) of silty drift deposits within plateaux and dry valleys, similarly identified a reworked loessic component. Although it has been clear since the work of Catt (1978) that loess makes a contribution to many soils in southern England the proportion of that contribution and of soil change through time remains uncertain. This highlights the need for more investigation of the analytical properties of sediments which may include loess and work on the soil history of landscapes.

3. PROCESSES OF SAND BLOW

Sand particles move by the process of surface creep (moved along the surface by the wind); and saltation where wind is sufficiently strong to pick up grains, transport them for a short distance and then deposit them; and suspension where the transport distance is further (Funk and Reuter 2006). The distance an individual grain will travel is mainly dependent on the size of the grain and wind speed, as well as the specific gravity and surface texture of the particle and soil surface. Dune formation is most likely to occur in periods of strong onshore wind, particularly when reduced sea level, or tidal range, mean that the upper shore dries more frequently, and for longer. Another factor is the occurrence of strong currents driving sand onshore, giving rise to a more gentle shore profile and an abundant sediment supply.

4. PLEISTOCENE DUNE SANDS AND COVERSANDS

Pleistocene dune sands generally overlie a cobble raised beach which in turn is on a wave cut rock platform. The base of the sand deposits often contains marine molluscs and sedimentary structures indicative of marine or sand dune origin. The transition from cobble beach to sand dune is often interpreted as a result of a retreating shoreline creating lower energy conditions and exposing expanses of beach and former marine sand to deflation. Further lowering of sea level resulted in the beach and dune sands grading upwards into coversands which represent deflation under cold dry conditions which resulted in deposition of windblown sediment inland from the contemporary coast. Where they occur close to the coast and contain a significant proportion of marine shell, or where percolating waters from limestone are calcareous, the sands may be cemented by calcium carbonate into a hard sandrock. The Pleistocene coastal sands occupy similar stratigraphic positions overlying raised beaches in many sites in Somerset, Devon and Cornwall and in general the sands seem to relate mainly to the cold and dry conditions of the later Devensian (MOIS 3). However, there is evidence on some sites for generally smaller-scale sand deposition earlier in the Devensian and, as might be expected, during earlier cold stages. No archaeological finds have been identified which are stratified within these coversands and Britain is considered to have been deserted during the last Glacial maximum (Barton 1997). However, since it is clear that there was at least some coversand deposition earlier in the Devensian around times when there is evidence of human activity, and in preceding cold stages, and, since coversand deposition continued into the first part of the Late glacial after people had returned to Britain, the deposits should be seen as of potential archaeological importance. In any case these coversands represent an important marker horizon to which earlier and later artefact horizons may be stratigraphically related.

The most significant site and arguably the most impressive Quaternary sediment sequence in the south west is exposed in the sandcliff at Brean Down (Figure 8; ApSimon *et al* 1961; 2000). This sequence spans the Devensian (MOIS 5 -2; Hunt 1998, 2006). Sediments accumulated against a cliff line which was probably exhumed during successive sea-level highstands. There is no exposure here of a beach at the base of the sequence. The basal sediments are dated to the early Devensian and comprise limestone weathered from the cliff and a significant proportion of blown sand. A bone bed has a vertebrate fauna typical of the transition from MOIS 5/4 and this horizon has a OSL date of 64.87±4.26 ka BP (Lab no: X1468; Currant *et al* 2006). The bone bed produced 3 bones which were originally considered to show evidence of human working (ApSimon *et al* 1961, 130), however, the wear traces are now considered more likely to be the result of erosion by sandblasting, further evidence of aeolian processes at this stage. Overlying this is the main aeolian sediment, an 18m thick sequence of largely stone-free coversand which has OSL dates in the range 60.71 ± 5.5 ka to 47.81±4.47ka BP (Lab nos: X1468, X1467). At the surface of this sand there is evidence of a largely eroded soil which may represent the Lateglacial interstadial, overlain by a breccia of the Lateglacial stadial. Overlying this is the Holocene sequence (Section 5.6.1). The aeolian sequence at Brean is the type site for the Brean Down Member, a Pleistocene stratigraphic division which is also represented on a number of sites in the area (Hunt 1998). Potentially the most significant of these is a complex of caves at Uphill just 2 km

Figure 8: Brean Down sandcliff. The Pleistocene section is to the left, the Holocene section lighter yellow sand, top 5m to right

east of Brean Down. The caves were investigated in the nineteenth century and stratigraphic information is limited (Harrison 1977). Caves 2 and 13 contain sands which might correlate with the Brean sequence. However artefacts are confined to Cave 8. These include a Mousterian assemblage, and early Upper Palaeolithic leaf points which are possibly the latest Neanderthal artefacts in Britain (Jacobi and Pettit 2000). A bone point of Aurignacian type which has recently been dated 28,080±360 BP (OxA-8408) possibly relates to early activity by Anatomically Modern Hominids. Thus the Uphill evidence is of particular cultural significance and may imply that people were in the area during at least part of the period during which the Brean Down Member was deposited. Other sites where the sands of the Brean Down Member are recorded are Middle Hope, Greylake, Yew Tree Farm, Portfield and Kenn (Campbell *et al* 1998; Hunt and Haslett 2006). In the Severn Estuary intertidal

Figure 9: Saunton raised beach with figure pointing at erratic overlain by marine sand and then windblown sand

zone, Allen (1984, 1987) records ice-wedge polygons of probable Devensian date with a sandy and pebbly fill which he attributes (pers. comm.) in part to an aeolian origin.

In Devon coversands are present above raised beaches in Barnstaple Bay at Saunton and Croyde (Campbell *et al* 1998; Gilbert 1996). Amino acid ratios indicate that the raised beaches themselves were reworked at several sea-level highstands (MOIS 9, 7 and 5a). At Saunton massive erratics on the wave cut platform were most probably emplaced by ice rafting (Figure 9). At the base of the overlying sandrock, mollusc fauna and sedimentary structures of cross lamination indicate marine conditions; above this there is evidence of palaeosol formation, land molluscs and sedimentary structures indicating that the sands are of backshore and dune origin laid down in the context of a retreating shore. The marine sands have an OSL date of about 120 ka (MOIS 5e) and coversand about 70 ka, ie MOIS 4. The blown sands are overlain by substantial deposits of stony Head derived from the slopes above the former cliff. Sandrock deposits above raised beaches are also recorded at a number of sites in Cornwall and Devon including Godrevy, Trebetherick Point, Porth Leven, and Hopes Nose, Torquay (Campbell *et al* 1998; Scourse and Furze 1999).

In addition to the coversands of western Britain there are also Pleistocene coversands in eastern Britain derived from deflation of North Sea sands. These are almost entirely further north, eg in East Anglia and Essex, but there are small patches of sand, probably at least partly of windblown origin within Pleistocene landforms in Kent, eg at Grenham Bay and Great Brooksend Farm (Murton *et al* 1998)

5. HOLOCENE COASTAL SAND DUNES

5.1 Introduction

Coastal sand dunes are widely distributed along the southern coast of England (Figure 10). The majority are located in the south-west, with significant concentrations on the north-east coast of Devon, Cornwall, the Isles of Scilly and Kent. Elsewhere, they are more dispersed, although several important areas of windblown sand can be found along the Somerset (eg, Brean and Berrow Flats), east Dorset (eg, Studland Bay) and Hampshire coast. Such areas are significant because, in many cases, traces of extensive buried former land surfaces are sealed beneath, and within, the dunes. Accumulation of blown sands can occur rapidly, preserving a range of archaeological, palaeoenvironmental and geoarchaeological evidence.

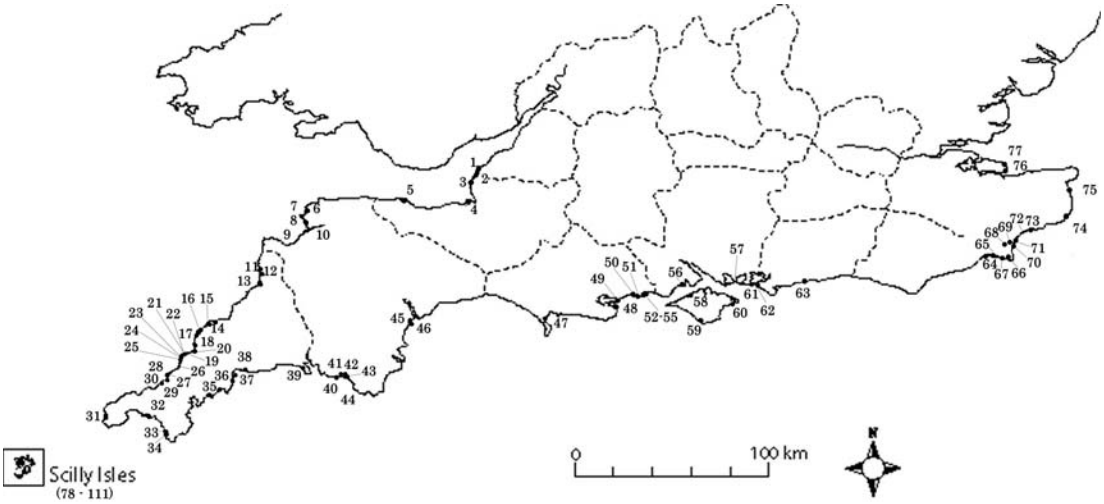

Figure 10: Distribution of sand dunes in southern Britain. For numbered sites see Appendix 2

5.2 Characterisation and processes of coastal dune formation

Sand dunes form in relatively low energy environments where there is a supply of sand grade sediment, ie, particles between 63 μm and 2 mm. Coastal dunes typically comprise medium to fine grained and well sorted to very well sorted sand particles (Pye 1990, 1993). The mean particle-size of 1544 samples from 112 English and Welsh dune systems, analysed by Saye (2003), ranged between 106-125 μm to 550-1000 μm, with dunes in the west tending to be finer and better sorted compared to those along the southern and eastern coasts.

Dunes will form in areas where the bedrock weathers to liberate large quantities of the appropriate size grade. This is not always the product of weathering of local bedrock geology but may include material recycled from earlier dunes, coversands, outwash gravels etc which were formally exposed to seaward at times of lower Pleistocene sea level. Sand deposits, some derived originally from coversands, form extensive blankets in the Bristol Channel, Cornish coast and eastern English Channel (Reynaud *et al* 2003).

Most sand is composed principally of quartz although in the granitic areas of Devon and Cornwall there is a significant proportion of feldspar, giving rise for instance to the markedly white beaches of the Scilly Isles. The mineralogy of dunes provides evidence of the sources or source from which the sand was derived. Dunes often also contain variable proportions of comminuted shell and tiny complete shells and other marine organisms such as calcareous algae, giving rise to calcareous dunes which preserve bones, land Mollusca, etc.

Dunes generally form on gently shelving shorelines where sand deposited by the sea dries out on the upper shore at low tide and onshore wind is sufficiently strong to carry sand particles inland above the tidal limit, where they are dropped by decreasing wind energy or trapped by vegetation. There is much evidence that dune formation is a highly episodic process: phases of sand deposition being separated by phases of stabilisation and soil formation. The stabilisation phases can be of particular archaeological interest because they are often associated with archaeological sites. Beyond the study area there is well documented evidence for the episodic nature of dune blow from the Formby coast of the UK (Huddart 1992), the north-east coast (Wilson *et al* 2001), Northern Ireland (Wilson *et al* 2004) the Netherlands (Jelgersma *et al* 1970) and Denmark (Clemmensen *et al* 2001). The apparent cyclicity of dune formation and stabilisation could be accounted for in various ways. It may reflect the episodic occurrence of extreme events initiating cycles of erosion. It has also been proposed by Tooley (1978) that the cyclical process can be correlated with sea-level change, colder periods with reduced sea-level when water was of lesser volume due to lower temperatures and more water was locked up in land ice. Such episodes he considered saw marked dune blow, particularly the Little Ice Age AD 1550-1850 (Grove 2002). The extensive Younger Dunes of the coastal Netherlands were deposited between AD 1000 and 1600, covering many settlements and fields (Zagwijn 1984). Climate change is well documented from other sources and Wilson *et al* (2004) have recently suggested the possibility of widespread dune formation across northwest Europe during an earlier phases of climatic deterioration (*c.* 1100-400 cal BC), similar to that witnessed during the Little Ice Age. However, it is far from clear if earlier episodes of extensive dune blow were similarly associated with marked climate changes. It is probable that the situation is more complex involving, for instance, a range of factors responsible for marine transgressive and regressive episodes. Resolution of the extent to which local, regional and global factors contribute will be determined in part by whether cycles of dune deposition, erosion and stabilisation are seen to be coeval from region to region. It is beginning to be possible to identify periods of marked sand blow, and as scientific dating is extended these issues will be clarified.

5.3 Topographical context of coastal dunes

Geomorphologically, dunes are of several types, comprising bay, spit, hindshore, nesses, cuspate foreland, climbing dunes and tombolos (Radley 1994). Bay dunes are the most common type, typically forming in the shelter between two headlands, often not including more than a single belt of dunes because of the limited supply of available sediment. Bay dunes are confined largely to the south-west (eg, Harlyn Bay), with none recorded from the south or south-east coast. They vary greatly in scale from the major dune complexes such as those fronting the area from St Ives Bay to Gwithian, and the Somerset Levels, to localised dune bars across the mouths of small valleys, of which there are many examples in Cornwall and Devon. Spit dunes form promontories at the mouth of rivers and estuaries, often backed by reclaimed marshland, and are distributed along the south and south-east coast, except for Northam Burrows on the north-east Devon coast. Hindshore dunes are amongst the largest dune systems, comprising several dune ridges of progressively earlier date encroaching inland (eg, Braunton Burrows), and are only distributed along the western coast of Cornwall. The Camber Sands, East Sussex, and Romney Warren, Kent, are the only two examples in the study area of nesse and cuspate foreland dunes, that form as the result of longshore drift of sediment from two direction at the same time. Climbing dunes are where blown sand has moved progressively up-slope to cover areas tens of metres above the present shore. Sometimes in these situations subsequent coastal erosion has cut a step disconnecting the dunes from direct access to the shoreline which was their original source. These occur in a range of situations where there is sufficient energy for sand to be blown up slope, occurring exclusively in the south-west (Devon and Cornwall), notable examples being on St Mary's, Isles of Scilly and the Perranporth area of Cornwall. The final type, tombolos, are only known on the Isles of Scilly, and are characterised by blown sands connecting two adjacent higher areas of bedrock.

5.4 Dating of coastal sand dunes

The luminescence dating methods have been introduced in Section 1.3. In several cases, dunes are recorded sealing buried soils or peats (eg, Prah Sands, Cornwall), or including interbedded soil 'stasis horizons' with artefacts (eg, Brean Down, Somerset). Radiocarbon dating of organic material from buried soils and/or peats can help to provide age estimates for the formation and cessation of blown sand deposition and intervening hiatus phases. Ideally this should be combined with luminescence dating of associated blown sand deposits (eg, Wilson *et al* 2004).

5.5 Database of coastal sand dune systems and sites

A database of coastal dune systems and associated archaeological sites is included as Appendix 2. Dune systems were identified in the first instance through a systematic study of the British Geological Survey 1:50,000 solid geology and drift deposit maps, Ordnance Survey 1:25,000 Explorer maps and Digimap Carto on-line Ordnance Survey maps between 1:5000 to 1:50:000 scale. This produced a total of 111 areas of coastal windblown sand. All relevant deposits were included, no matter how small. In some cases, larger dune systems have been divided into smaller units where, for example, headlands and river/estuary mouths create natural breaks. The location of these coastal dune systems is illustrated on Figure 10.

Archaeological sites within areas of coastal windblown sediment were initially identified using these maps, combined with investigation of both published and unpublished sources.

The database includes archaeological sites adjacent to blown sands. It Is often not clear if sands have encroached on specific sites and if so whether that was before, or after, the period represented by the archaeological evidence. Such sites are highlighted to identify areas of possible buried archaeology that may be of significant. Also of note in places are exposures of Holocene sediment seaward of dune systems (Figure 11). Where valleys reached the coast they were generally over-deepened at times of low Pleistocene and early Holocene sea level. As sea level rose sediments accumulated within these valleys. Such sequences often include a basal palaeosol, silts of estuarine origin, and phases of peat development alternating with estuarine silts. To seaward dune bars sometimes separate the developing coastal wetland from the sea. The periodic breaching of dune or shingle bars is one of the factors which contributes to the transgressive / regressive cycles documented in coastal wetlands. With sea level rise and erosion the dunes are progressively driven inland exposing Holocene sediments sometimes interleaved with sand layers on the foreshore, as at Brean Down. The peats are often represented by significant submerged forests and intertidal peats, many of which in western Britain either bury or are associated with evidence of Mesolithic or Neolithic activity (Bell forthcoming). The silty and peat facies of coastal sediment sequences are also of great archaeological interest because they sometimes preserve the footprints of people and animals as in the Welsh Severn Estuary and the Formby area of Merseyside. Thus dunes should be seen not in isolation but as part of an associated sequence of coastal sediments within which there is often a range of contexts of archaeological and palaeoenvironmental significance.

The database also includes information on the land use and conservation status of dune systems/sites. This was compiled using Digimap Carto, the Joint Nature Conservation Committee (JNCC) survey of English coastal sand dunes (Radley 1994), and online databases of SAC's, SPA's, RAMSAR's (www.jncc.gov.uk), NNR's and SSSI's (www.english-nature.org.uk/special/sssi, www.english-nature.org.uk/special/nnr). This information is considered significant in terms of the management and identification of any threats to the geoarchaeological resource.

The dune sites are good contexts for the preservation and analysis of land molluscs as the earlier studies of Spencer (1975) and Evans (1979) show. Appendix 3 lists the numbers of land mollusc taxa and shells on four of the dune sites. It illustrates the richness of some of these contexts. A number of the species found in coastal dunes were introduced to Britain in the later Holocene but there are uncertainties as to the dates of introduction which need to be addressed. The main area of potential is in Cornwall and fortunately there is an excellent atlas of the present day land Mollusca of Cornwall and Scilly (Turk *et al* 2001).

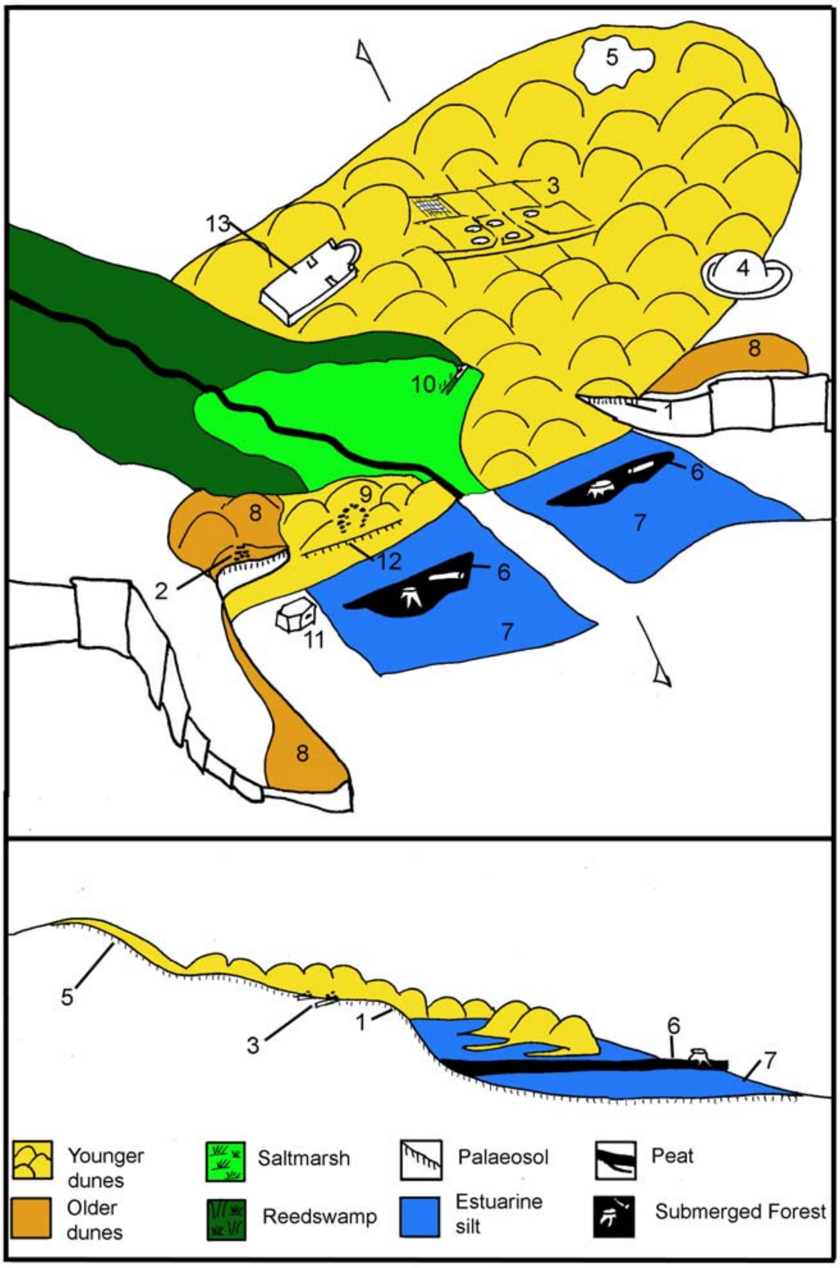

Figure 11: Schematic diagram to illustrate in plan (top) and section (bottom) some of the key contexts in which archaeological and palaeoenvironmental evidence is found in relation to coastal dunes and also some typical relationships between the windblown sands and associated sedimentary contexts. See section 5.6 for explanation of the feature numbers.

The database of 111 coastal dune systems comprises 74 (66%) on mainland southern England, 3 (3%) on the Isle of Wight, and 34 (31%) on the Isles of Scilly. A total of 64 coastal dune systems are wholly or in part under some form of protected status (58%), over half of these (34) located on the Isles of Scilly. The 30 wholly/partly protected coastal dunes on the mainland include 21 SSSI's, nine National Trust Reserves, nine National Nature Reserves, eight Special Areas of Conservation, five RAMSAR's, four Special Protection Areas, two UNESCO Biosphere Reserves, and one Site of Nature Conservation Importance (Camber Sands).

Of those areas of coastal blown sand on the mainland and Isle of Wight, archaeology has been recorded from 45 (60%), of which 20 (44%) have produced prehistoric remains, 9 (20%) have produced Romano-British remains, and 19 (42%) have produced medieval remains. Post-medieval archaeology, largely second world war military emplacements, have been recorded from 15 coastal dunes (33%).

The total number of finds and sites from contexts below or within coastal dunes (Appendix 2) highlights the archaeological significance of such sedimentary contexts. Moreover, a significant proportion of the recorded archaeology has come from sections eroding out along the seaward edge of dunes, although the majority of dunes do appear to be stable (see Saye 2003). However, eroded sections were present at many of the sites visited during the course of this survey, several producing archaeology (see below), emphasising the need to monitor erosion. This is of particular concern given the level of human activity identified from coastal dunes. Many have a recreational function; 21 golf courses were recorded from 19 (25%) dune systems, with some form of building development recorded from 42 (56%). The JNCC survey of English dunes recorded moderate to severe erosion from at least part of 81 of 121 sites survey, the severest concentrated around Cornish dunes (Radley 1994). This should be of concern given the concentration of archaeology recorded particularly on Cornish sites (see below). The impact of recreation activities, particularly from caravan parks is significant. Habitual use of networks of pathways, can cause localised erosion, leading to blowouts amongst dune fields. Many fore-dunes, particularly along the southwest coast, are fronted by beaches frequented by holiday-makers, although marine erosion in these situations is of equal or greater concern.

Marine erosion was recorded by Saye (2003) at 55% of English and Welsh dunes, and at the majority of sites covered by the JNCC survey (Dargie 1993, 1995; Radley 1994), most also including some form of stabilisation work (Radley 1994, table 4, figure 32). Coastal dunes have an important role in flood defence, responding to changes in sea-level, climate and erosion. Shoreline Management Plans (SMP), currently under review, include several policies on coastal defence, outlined by DEFRA (2005), including: i) maintaining existing coastal defences, ii) building new seaward defences, iii) allowing managed realignment of the shoreline, or iv) no active intervention. This recognises that policies promoting long-term erosion or realignment of the coastline will have an inevitable impact on the historic environment, but that each site should be considered individually and balanced against other objectives at a given location (eg, South Foreland to Beachy Head Shoreline Management Plan, 2006; Isle of Grain to South Foreland Shoreline Management Plan, May 2007).

5.6 Archaeology in Holocene coastal dunes

Of the many areas of blown sand in southern England shown in Figure 10 many have evidence of associated archaeological finds and, due to the episodic encroachment of sand, some are among the most well stratified site sequences in England, producing exceptionally well-preserved sites on which there are forms of evidence rarely encountered elsewhere. Figure 11 is a diagrammatic representation of some of the key contexts in which archaeological and palaeoenvironmental evidence occurs in coastal dune systems. It also illustrates some typical relationships with associated sedimentary contexts. The types of site and context are numbered as follows:-
(1) Old land surface below dunes.
(2) Field wall on old land surface below dunes.
(3) Settlement site with huts, trackways, fields and ploughmarks buried by (or within) dunes.
(4) Round barrow partly covered by blown sand.
(5) Flint scatter below (or within) blown sand.
(6) Intertidal submerged forest.
(7) Intertidal exposure of estuarine silts.
(8) Older dunes (sometimes decalcified).
(9) Stone structure within blown sand.
(10) Trackway at wetland edge.
(11) Pillbox originally constructed in dunes.
(12) Old land surface within dune.
(13) Church and deserted medieval settlement within dunes.
(14) Saltmarsh, through time a direct connection between the valley and the sea has often been blocked by a dune bar after which saltmarsh does not extend up valley.
(15) Reed swamp, fen woodland or raised bog, organic sediment accumulation. These organic sediments are replaced in a number of valleys by alluvium.
Archaeological evidence from these sites will be reviewed anticlockwise from the Severn Estuary to the Thames Estuary.

5.6.1 Brean Down and Bridgwater Bay, Somerset

The Severn Estuary upstream from Sand Point is a mud-dominated estuary and wind blown sands are absent. Between Sand Point and Stert the reclaimed wetlands of the Somerset Levels are separated from the sea by a coastal barrier of blown sands. These front Sand Bay and Weston Bay and form a continuous 10 km long dune barrier between Brean Down and the mouth of the Parrett. Parts of this barrier are obscured by housing and holiday development. To seaward of the dunes, erosion exposes peats and Holocene sediment sequences in the intertidal zone at Brean Down (Bell 1990) and Burnham-on-Sea (Druce 1998). Coring transects in the southern Levels (Kidson and Heyworth 1976) and at Brean Down (Bell 1990; 2002) provide evidence for the stratigraphic relationship between the dunes and associated sediments.

At Brean Down, the Pleistocene sequence noted above in Section 4 is overlain by an equally important Holocene sequence which has been the subject of extensive archaeological investigation (Figures 8 and 12). The significance of the sequence was established in a pioneering paper by ApSimon *et al* (1961). In 1983 it became clear that archaeological horizons were under very active erosion when a pair of gold bracelets was revealed; erosion had been exacerbated by construction of a concrete sea-defence wall which had cut into part of the site to the south. Recording and excavation was undertaken (Bell 1990). The sequence comprised an early Holocene palaeosol of Beaker date overlain by a series of blown sands interleaved with colluvium and occupation horizons. Four separate Bronze Age occupations between Beaker and late Bronze Age were identified separated by three episodes when sterile blown sand was deposited and occupation ceased. The site highlights the capacity of blown sand to preserve occupation sequences, structural evidence, microstratigraphic evidence of activity areas revealed by micromorphology, and even very poorly fired, fragile briquetage artefacts which are most unlikely to have survived in a more active pedogenic environment. The calcareous sand preserved bones and molluscs, even egg shell and calcified dog coprolites with evidence of parasitic worms. After Bronze Age activity there was a field wall with evidence of cultivation marks and an early Christian cemetery (Bell 1991). During these periods some sand blow continued but in the post Bronze Age sequence there were only thin aeolian bands and most of the sands had a colluvial component. Following occupation in the sixteenth and seventeenth centuries a dune blow-out truncated part of the stratigraphy.

Test pits and coring showed the Bronze Age site was extensive and accordingly the decision was made to protect it from erosion with stone filled wire baskets and a limestone boulder barrier which was put in place in 1987. In the twenty years since then it has proved effective in stabilising the archaeologically most significant parts of the Holocene section. Since then further test pits and coring have been done in advance of proposed building developments (plans later put on hold; Bell 1991) and sea defence upgrading (Allen and Ritchie 2000). These activities have further documented the relationship between the blown sand and colluvial layers and the peats and silts of the Somerset Levels sequence to the south. At the base of the slope, settlement horizons were separated both by episodes of blown sand deposition and encroachment of silts at the edge of the vast tract of Somerset Levels saltmarsh to the south which is likely to represent the main resource exploited by the site for both grazing and salt extraction. The Brean evidence clearly shows that the sand bar existed from *c.* 4000BP. Given the extent of Pleistocene coversand of the Brean Down Member (4.1) in this area it seems probable that a sandy barrier has existed seaward of the Somerset Levels from at least the mid Holocence. As the rate of sea level rise reduced *c.* 6000 BP the barrier would become established and migrated inland with continuing sea level rise and erosion. Only where it abuts the limestone of Brean Down is early stratigraphy preserved. Much of the bar to the south has probably been reworked by various episodes of deflation. One of these seems to have come close to engulfing the church of St Mary's at Berrow which sits in a hollow surrounded by dunes; medieval and Post-medieval occupation horizons here are stratified in dune sand.

At Minehead windblown sands lies landward of an exposed intertidal sediment sequence including peats which has recently been the subject of palaeoenvironmental investigation (Jones *et al* 2004). The intertidal contexts have produced lithic artefacts in the past but we are not aware of any finds from the blown sand.

5.6.2 Barnstaple / Bideford Bay, Devon

Woolacombe Sands are exposed at the head of the beach and there are also climbing dunes which have been driven up the steep slope of Woolacombe Down. Mesolithic flints and charcoal have been recorded below the sand (Wymer 1977, 60). During our survey only a small area of old land surface overlying angular head was exposed at Mill Rock and this produced a heat fractured flint. North of the stream at Woolacombe a raised beach sits on a shale platform and is overlain by a palaeosol which is covered by blown sands and colluvium (Figure 13). In this deposit struck flints and charcoal were found with traces of a stone structure and late Medieval sherds in a cut feature.

The smaller bay to the south at Croyde also has dunes and there is a significant Mesolithic site on the south slopes of Baggy Point. Here flints occur at the base of sandy colluvium overlying Head and the Pleistocene raised beach complex (Bell 1997).

At the mouth of the Taw / Torridge estuary is the region's most impressive and well-preserved dune system at Braunton Burrows (Figure 14). A midden of the eleventh to twelfth centuries AD has been discovered in a blow-out hollow of the dunes and produced marine and land Mollusca, mammal and fish bone and pottery (Smith *et al* 1983). It is interpreted in terms of transitory gathering or grazing activity, however an earlier record of a Medieval chapel in the dunes suggests the possibility of a settlement. South of the estuary, dunes also occur at Northam Burrows where there is a substantial boulder bar to the south-west at Westward Ho! Seaward of this are important intertidal exposures of Pleistocene and Holocene sediments, particularly the Mesolithic shell midden and submerged forest which have produced a wide range of palaeoenvironmental evidence (Balaam *et al* 1987). Significantly the Coleoptera include species that live on sand dunes implying that in the later Mesolithic the fen wood in which the midden lay was separated from the sea by dunes. There is also a thin veneer of blown sand in places overlying the Pleistocene raised beach at Westward Ho!.

5.6.3 Bude Bay

At both Bude and Widemouth Bay submerged forests are recorded in the intertidal zone (Johnson and David 1982) and were recorded in recent cable laying operations (Cole 2001). At Widemouth, Romano-British finds are recorded from the dunes. We have observed up to 2 m of dunes here with a number of stabilisation horizons. However one context examined contained only marine Mollusca and presumably represents beach sand (Appendix 3).

Figure 12: Brean Down Middle Bronze Age huts of Unit 5b stratified in blown sand

Figure 13: Woolacombe , Devon, showing blown sand and colluvium above Pleistocene raised beach

5.6.4 Padstow / Daymer Bay

In Daymer Bay there is a submerged forest in the intertidal zone, and worked flints, burnt stone and limpets of possible Mesolithic date are recorded near the base of blown sand (Wymer 1977; Johnson and David 1982). During this survey a section was observed on the headland between Daymer Bay on Polzeath (SW 92662 77742) with a buried soil sealed by 2 m of sand within which were stabilisation layers. Near the base of the sand there was a sherd of prehistoric pottery, and scattered mussel and limpet shells; land molluscs were abundant (Appendix 3), including at the base of the sand *Pomatias elegans* which suggests somewhat shaded conditions different from the dune environment of today. Possible Mesolithic flints are also recorded possibly from blown sand above a raised beach at Trebetherick (Wymer 1977).

5.6.5 Harlyn Bay and Constantine Bay

Dunes rising to 30 m now blanket the entire neck of the isthmus between Harlyn Bay and Constantine Bay burying a remarkable multiperiod archaeological landscape (Figure 15). In the valleys behind the dune barrier marshy lacustrine areas with alluvial sediments occur (Selwood *et al* 1998). Four middle Bronze Age urns, some with associated grave goods and in cists, have been found in the cliffs of Harlyn Bay. For two the stratigraphic context is clear: they are associated with an old land surface and predate the overlying blown sand (Crawford 1921; Preston-Jones and Rose 1987). Another unpublished urn has been found more recently in 1990 (J. Nowakowski pers. comm.). Two gold lunulae and a flat axe of early Bronze Age date were found in 1865 (Hencken 1932) within the area shown as dunes on the map although there is no reference to blown sand in the much later accounts of this find (Crawford 1921; Preston-Jones and Rose 1987*).* Beaker sherds are also recorded from a midden in Harlyn Bay. The excavation of a well 200 m from the coast at Harlyn in 1900 led to the discovery and excavation of a cemetery of *c.* 130 Iron Age cist graves on an old land surface below up to 4m of blown sand (Whimster 1977; 1981). A circular building, perhaps a shrine and a midden have been excavated. A radiocarbon date of 3550±90 BP (HAR-1922) has been obtained from charcoal in the old land surface. The graves had been dug from a secondary land surface following initial deposition of blown sand and burials continued into a subsequent phase of sand deposition. Thus the chronology of sand blow at Harlyn is clear: it postdates the middle Bronze Age urn burials and began before the Iron Age burials, the first of which are of the fourth to third centuries BC. The main episode of sand deposition is, however, post Iron Age. Land molluscs from the Iron Age excavations may suggest scrubby vegetation although being hand-picked specimens they are not a representative sample. Subsequent sieving of mollusc samples from a buried soil in the cliff face produced an open country fauna (Evans 1979). There are good exposures of the old land surface in the cliff (Figure 16) and, when we visited the site on 1.8.07, in places up to three stabilisation horizons could be observed and land Mollusca were abundant (Appendix 3). A possible stone wall was observed below the dune on the north side of the bay (Figure 17; SW 8791175485), About 200m west of the stream at SW8770675423 the OLS (Figure 18) was 0.5m thick with an interesting profile: it had a sandy top, then a sandy silt stony horizon and a stone horizon at the base. The unsorted nature of the middle horizon suggested the possibility that the soil had been cultivated, it contained land molluscs (Appendix 3) and limpets.

At Constantine Bay there are extensive dune systems and abundant evidence of Mesolithic flints found by many collectors on coastal footpaths and in systematic fieldwalking of cultivated areas a little inland (Johnson and David 1982). Some of these finds (eg near Constantine Island) are from areas with blown sand, others are from adjacent soils. There are also later prehistoric finds including a hut on Constantine Island (Crawford 1921). Our visit (on 2.8.07) highlighted the continuing potential of Constantine Island and the promontory to its landward. On the north end of the island (SW 85726 75138) a scatter of worked flints (Norman 1977) was observed. The flints appeared to have weathered either from the blown sand or a palaeosol below it, they were associated with heat-fractured stones, mussel and limpet shells (Figure 20). Immediately adjacent was a possible stone cist grave (Figure 19) exposed by erosion below a thin cover of blown sand. This has been independently observed by others (N. Johnson pers. comm. 12.9.07). On the adjoining promontory the shell midden first observed by Crawford (1921) was found to be still exposed in the cliff beside steps to the beach (Figure 21). At the end of the slight promontory there was a fine 2 m section (Figure 22) with a palaeosol at the base, stabilisation layers within the dunes and lines of marine shells which are probably marginal scatters from the midden. Land molluscs were

Figure 14: Braunton Burrows dunes, Barnstaple Bay, seen from the cliffs at Saunton. The Pleistocene raised beach blown sand and Head lies immediately below this cliff on the right

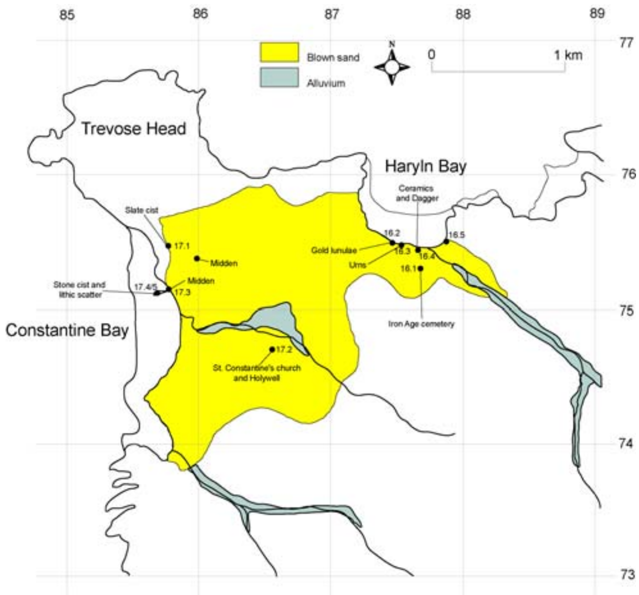

Figure 15: Harlyn and Constantine Bays showing the distribution of blown sands and archaeological sites. For numbered sites see Appendix 2

Figure 16: Harlyn Bay, old land surface overlain by blown sand

Figure 17: Harlyn Bay old land surface with possible wall overlain by blown sand

Figure 18: Harlyn Bay showing thick and partly calcareous old land surface. Scale: pen 14cm

found to be well preserved in the sequence. Crawford (1921) records other middens in the dune area inland of Constantine island and near the medieval St Constantine's church, cemetery and holy well.

Figure 19: Constantine Island, Cornwall. Possible stone burial cist

Figure 20: Constantine Island, Cornwall. Lithic and marine mollusc scatter below blown sand

Figure 21: Constantine Headland, Cornwall. Shell midden within blown sand

Figure 22: Constantine Headland, Cornwall, showing old land surface at the base and stabilisation horizon within the dune

5.6.6 Mawgan Porth

A small valley where the River Menalhyl reaches the sea is fronted by sand dunes and behind this the valley has a fill of Holocene alluvium. A submerged forest is recorded within the Holocene sequence in the intertidal zone (Johnson and David 1982). 55 m from the sea below the blown sand and on a buried soil, a settlement dated ninth to eleventh centuries AD comprising three courtyard house units and a probably associated cemetery, was excavated by Bruce-Mitford (1997) between 1949-54 and by E. Greenfield in 1974. Abandonment of the settlement is thought to have been due to encroaching sand which is interleaved with tumble from building collapse. Because of sand accumulation the buildings were exceptionally preserved in places to a height of 1.5 m. The site was clearly agricultural with animal byres, drains, querns and animal bones, but the date of its excavation means the environmental potential was not explored and it is probable that an associated landscape of fields lies partly buried below the dunes.

5.6.7 Newquay

There appears once to have been a substantial dune system stretching across Fistral Bay between Pentire Point East and Towan Head (Figure 23). This is suggested because from the end of Towan Head there are windblown sediments above rocky cliff well above any available sand source today (Figure 24). Within these sands there is evidence of some stabilisation horizons and marine shells which may be from a midden (SW80015 62547). They have previously been noted seaward of a large Victorian Hotel on Towan Head (Spencer 1975) where the sands are up to 3 m thick with a buried soil at the base and evidence of stabilisation horizons. Land mollusc analysis of the old land surface showed species of shady conditions as well as some indicating more open conditions, demonstrating that even this exposed coastal site was once woodland or scrub; the overlying sands produced a restricted range of open country species (Spencer 1975). With sea level rise the sand has migrated inland and is now covered by the Golf Links in Fistral Bay. Where the sand has blown up slope it has buried an archaeological site recently excavated in advance of a water pipeline in Atlantic Road, Newquay (A. Reynolds pers comm.). There was a little evidence for sandblow here in an Iron Age phase, but a succeeding Romano-British settlement was buried by blown sand, this included buildings, stone walls, possibly intended to prevent sand encroachment, and a buried soil with ploughmarks. It is suggested that the soil may have been partly artificially created for agriculture. The importance of a sand sediment supply in burying and preserving archaeological sites is further highlighted here by the site of Trethellan Farm, a well-preserved Bronze Age settlement of 7 roundhouses dated 2400-1200 Cal BC set in a hollow or terrace beside the Gannel Estuary (Nowakowski 1991). The site was buried first by a possible mudflow, then by colluvial sediment which contained a high proportion of blown sand mobilised by cultivation of the slope above . The main deposition of blown sand on this slope appears to have post-dated the Bronze Age occupation and a later Iron Age cemetery. The sand may derive from either blowing over the crest of the Pentire ridge from Fistral Bay or the Gannel Estuary. The combination of slope processes and blown sand make Trethellan an exceptionally well-preserved settlement preserving a good range of cultural and environmental evidence (soils, micromorphology and seeds). Rather acid soils before sand blow meant that animal bones were few and the land molluscs present appear to post date the prehistoric site and relate to subsequent dune accumulation.

5.6.8 Perran Bay and sands

At Perranporth, where the river meets the sea, a submerged forest has been recorded and, between here and Kelsey Head, extensive tracts of landscape are blanketed by blown sand forming climbing dunes which reach up to 70 m OD (Figure 23). In the first half of the twentieth century areas of dune blowout occurred, and on the old land surface revealed, Harding (1950) recorded many finds of flint artefacts and middens, a hearth and pottery now dated to the middle Bronze Age and Iron Age (Quinnell 2007).

The sands also bury important Medieval and later sites. The earliest of these is a site considered to be of early Medieval origin, the stone St Piran's Oratory an associated cemetery of slab built graves and a midden. This oratory is thought to have been abandoned in the face of sand encroachment and a new church built at St Piran's Church in the late twelfth century AD: that in its turn was threatened by advancing sand even as early as 1281 and in 1804 sand encroachment led to its abandonment. The site has recently been partly excavated (Figure 25; Cole 2007 a and b). Late Bronze Age / early Iron Age pottery has been found in the old land surface, and this level did not include blown sand. Geophysical survey reveals a buried landscape of buildings, field boundaries and cultivation ridges (Substrata 2004). There is also much evidence of post-medieval tin and lead mining in the dunes (Cole 2007a). A mollusc study by Spencer (1975) just north of Perranporth indicated open conditions from the time of the buried soil at the base of the sequence but an increase in shade-loving Zonitidae within the sand suggesting episodic stabilisation which is also indicated by more organic horizons. On the Holywell Dunes which blanket the inland neck of Kelsey Head, Harding (1950) records Iron Age pottery, earthworks and middens buried by the sand.

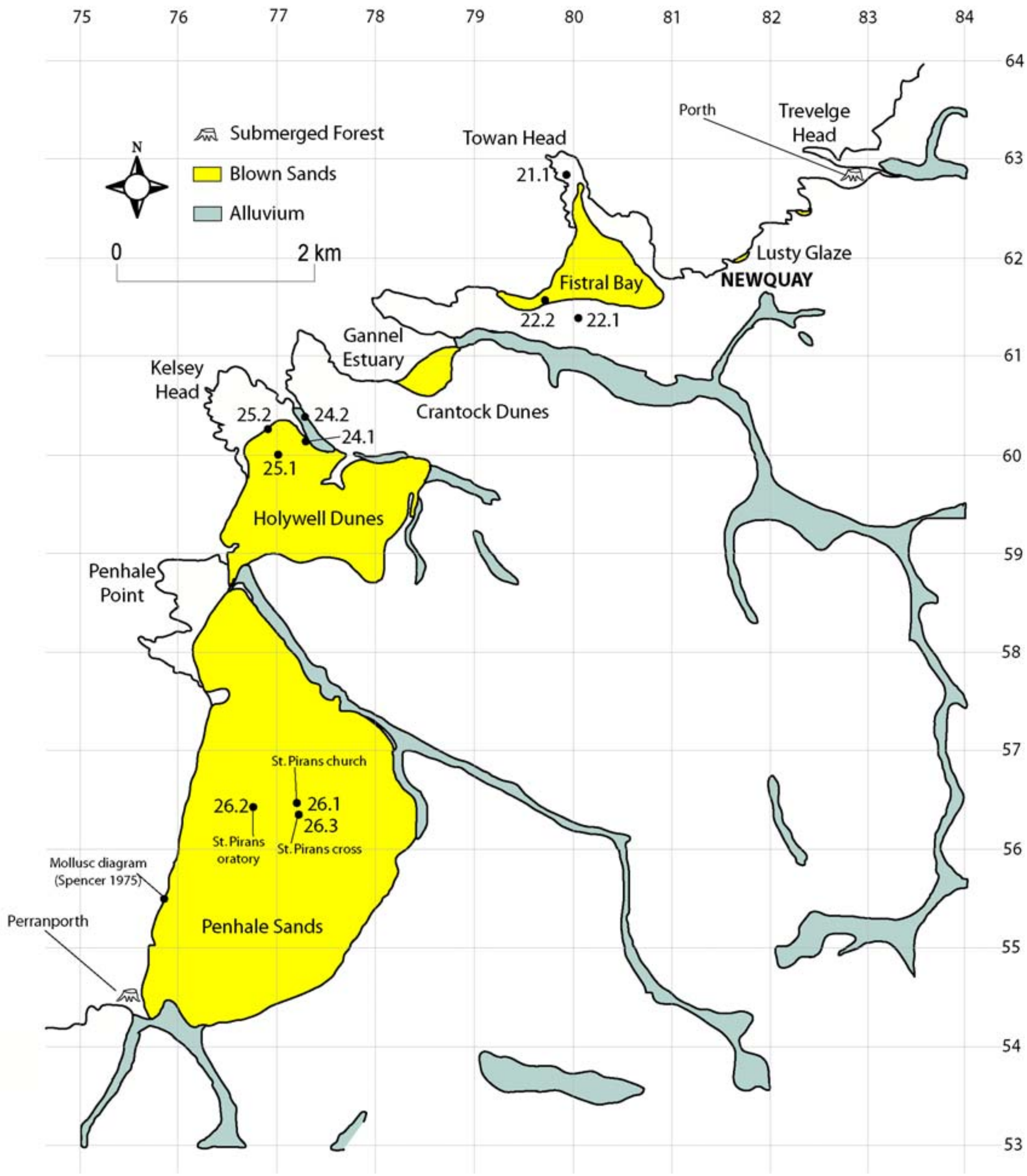

Figure 23: Map showing distribution of sands and archaeological sites in the Towan Head/ Newquay and Penhale Sands/ Perranporth areas. For numbered sites see Appendix 2

Figure 24: Towan Head, Newquay showing old land surface and stabilisation layers within the dune

5.6.9 Gwithian and Godrevy and St Ives Bay

On the eastern side of St Ives Bay between Hayle and Godrevy there is an extensive dune system and where this has climbed up the bedrock of Godrevy the sand buried a major complex of sites at Gwithian (Figure 26; Thomas 1958; Megaw *et al* 1961; Megaw 1976). Assessment and archive reports on those investigations have recently been prepared (Nowakowski 2004, 2005, forthcoming). Many sites were excavated, from Mesolithic flint scatters to Medieval, the most significant being a series of phases of Bronze Age occupations separated by episodes of sand deposition. There were huts and field walls, lynchets, cross ploughmarks and spade marks (Figures 27-8). Artefact scatters and tiny marine molluscs in the soils suggested the use of midden and seaweed as manure. Gwithian shows the quality of the archaeological record which can be preserved on dune sites. A Romano-British site at Godrevy (Fowler 1962) is on the solid geology but is covered with a thin sandy soil which must have a windblown component. Sites are exposed in the cliff at Godrevy again mostly with a thin sand cover and a survey of these has been prepared (Thomas 1995): they include Mesolithic flint scatters, buildings, a seventeenth century fish cellar (Figure 29; Tangye 1991) and a midden. At the time of our visit a possible lynchet was exposed in the cliff face (SW 58083 43006) close to the Romano-British settlement, this had a small quantity of blown sand at its toe (Figure 30). Dune deposits at Godrevy contained abundant land Mollusca (Appendix 3). The twelfth or thirteenth century manor house at Gwithian was abandoned in the seventeenth century because of sand encroachment. Episodes of sand blow at Gwithian can be tentatively dated (pending refinement as a result of current work) to the middle Bronze Age (*c* 1600-1300BC), the late Bronze Age (*c* 1100-800BC), the Romano-British period, the eleventh to twelfth centuries AD and the Post-medieval period.

A coring programme in the former sand quarry immediately south of the site (which is now under conversion to a nature reserve) demonstrated deep sand sequences with evidence of an organic horizon at a depth of 4m in the areas closest to the Bronze Age site (Wessex Archaeology 2002) and thus of palaeoenvironmental potential in understanding the site. At the time of the original excavations there was little systematic environmental sampling. Mollusc analysis was later carried out by Spencer (1975) and from the base of the Bronze Age sequence the landscape was entirely open, medieval samples produced evidence of environments similar to today. In 2005, in tandem with work on the site archive, a small-scale excavation was carried out to obtain a range of environmental samples from the most well-preserved part of the sequence, the proposed investigations included: soil micromorphology, magnetism and phosphates, land and marine Mollusca, plant macrofossils, pollen and bones (Nowakowski *et al* 2006). Work on the archive and the excavation combined have established that there is evidence of Bronze Age cultivation in 5 separate horizons: layers 8, 7, 5, 4 and 3. The molluscs and rather poorly preserved pollen suggest an open environment from the early Bronze Age; there is evidence for greater vegetation cover and scrub, and thus a more stable environment, in the later middle Bronze Age. One of the objectives was to look at the evidence for manuring and establish whether the creation of so-called man-made soils in this area went back to the middle Bronze Age; there is evidence for the prehistoric origins of such practices in Scotland (Guttmann *et al* 2005). Funding has not yet been obtained to proceed to full analysis of the material from this excavation but it is much to be hoped that this will take place since environmental work would very greatly enhance the available archaeological information about this, the most archaeologically significant wind-blown sand site in England.

To the south in the dunes towards Hayle there is an abundance of evidence of post-medieval mining in and around the dunes. Current plans for extensive regeneration and redevelopment at Hayle need to be monitored for the possibility of buried landscapes and sites below the dunes particularly in view of the sensitivity of this landscape as part of the recently designated 'Cornwall and West Devon Mining Landscape' World Heritage Site (DCMS 2005).

Figure 25: St Pirans Church, Perranporth excavated from beneath the dunes

5.6.10 Scilly Isles

The Scilly Isles represent a remarkable drowned landscape of small islands (Figure 31) with stone walls, hut circles and cists below sea-level and in the intertidal zone, attesting to the fact that these once formed part of a larger landmass (Thomas 1985). There are extensive blown sands which in some cases form dry land bars between what would otherwise be separate rocky islands (Barrow 1906). There is a view that once they created more substantial peripheral barriers protecting a central low lying area from inundation. Intertidal peats occur on the inner side of the islands and are dated between the late Mesolithic and the 7th century AD (Ratcliffe and Straker 1996). On St Mary's a sand barrier lies to seaward of the Moors wetland sequence which provides the main record of Scillonian vegetation history with peat formation from 6330±100 BP (HAR-3695). This sequence and the intertidal peats provide clear evidence for former woodland cover on Scilly. Round the coast of Scilly, erosion exposes good sections of the Pleistocene and Holocene stratigraphy and within the latter large numbers of archaeological sites are exposed (Ashbee 1974; Thomas 1985). Being well-stratified and often calcareous with shell sand the sites have a good potential for palaeoenvironmental and palaeoeconomic studies, as assessments on nine eroding sites have shown (Ratcliffe and Straker 1996, 2000). As a generalisation the main blown sand deposits overlie and preserve the archaeological sites. However, at Halangey Porth there was evidence for some sand deposition before occupation. The Bronze Age and early Iron Age settlement of stone houses (Figure 32) surrounded by stone walled fields was abandoned in the face of dune encroachment *c* 2260±90 BP (HAR-1313; Ashbee 1983) and Roman cist graves were

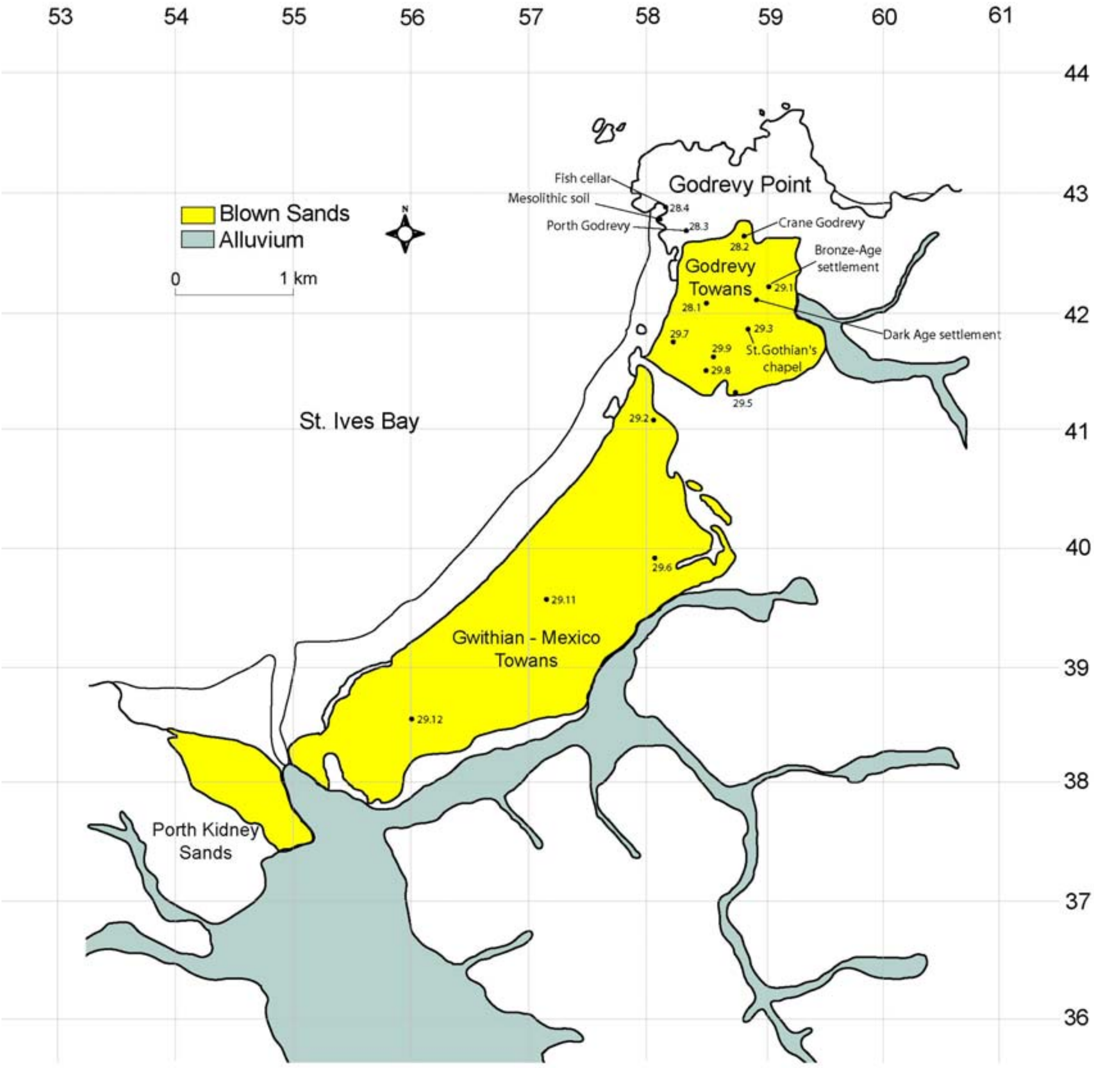

Figure 26: Map showing the distribution of blown sands and key archaeological sites in the Gwithian/ Godrevy area. For numbered sites see Appendix 2

Figure 27: Gwithian excavation 2005 showing base of old land surface and stabilisation surfaces within blown sand. Photo courtesy of J. Nowakowski. Copyright Cornwall County Council

Figure 28: Gwithian excavation 2005 showing cross plough marks at the base of Layer 5. Photo courtesy of J. Nowakowski. Copyright Cornwall County Council

Figure 29: Godrevy Cliffs, colluvium in lynchet with a small amount of blown sand at the toe of lynchet

Figure 30: Godrevy close to a Romano-British settlement, showing colluvium forming a lynchet with a small amount of blown sand at the base

later cut in the blown sand. The settlement moved upslope to Halangey Down (Ashbee 1996) where some structures including the Bants Carn tomb overlay the fields of the earlier settlement. Colluvial sediments, including reworked sand, are associated with these fields and have been the subject of pollen analysis indicating a treeless landscape (Dimbleby *et al* 1981). Nearby, on Bar Point an old land surface with ploughmarks and a field wall dated to the Iron Age (Evans 1983; Macphail 1987) were covered by blown sand *c.* 600-700 AD (Ashbee 1978). The well-preserved settlement of stone houses and middens on Nor Nour began in the middle Bronze Age *c.* 1450 BC and activity continued to *c* 400 AD (Butcher 1978). The sections show some blown sand deposition took place between building phases and the localised nature of Romano-British artefacts suggests that much of the site was by this time buried. An old land surface with pollen evidence for a grazed grassy landscape (Dimbleby *et al* 1981) occurs upslope and this slope and the settlement are covered by blown sands which appear mainly to postdate the occupation. Another middle Bronze Age settlement of stone buildings at Little Bay, St Martin's was associated with an old land surface; colluvial soils had accumulated round the building and the site was covered by 2.5 m of blown sand (Neal 1983).

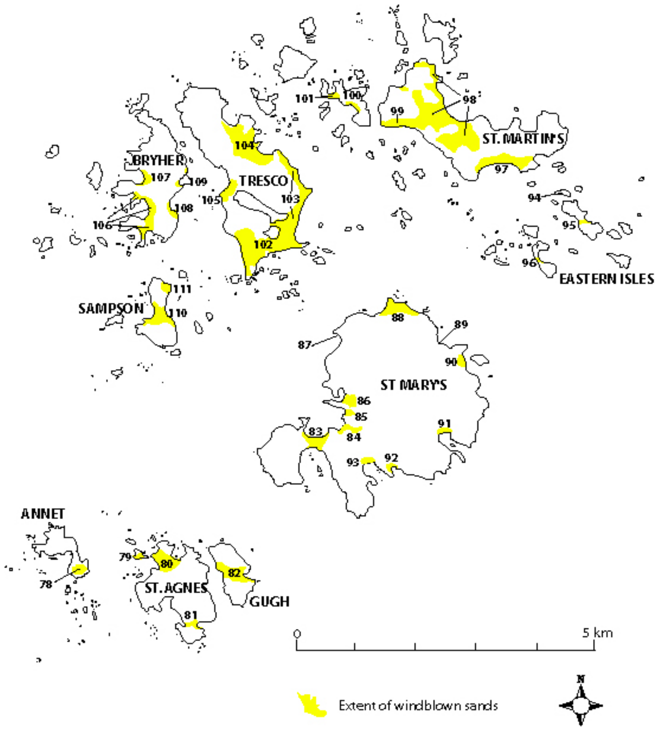

Figure 31: Map showing distribution of blown sand and related archaeological sites on the Scilly isles. For numbered sites see Appendix 2

Figure 32: Halangey Porth, Isles of Scilly. Bronze Age stone structures below vegetated blown sand

Figure 33: Prah Sands showing peaty old land surface overlain by blown sand

Figure 34: Prah Sands old land surface overlain by blown sand

Figure 35: Prah Sands showing a bank and ditch overlain by blown sand. The bottom half of the section shows Pleistocene sediments

Figure 36: Prah Sands possible stone structure overlain by blown sand

Figure 37: Prah Sands pillbox originally erected in dunes, now on the beach as the result of coastal erosion

5.6.11 Mount's Bay

Small rivers discharge into Mount's Bay, their lower reaches separated from the sea by the sweeping curve of a long coastal barrier which is at least partly of dune sand, although now invisible behind the seawalls, coast road, railway, etc. To seaward a submerged forest is exposed and has been observed many times since Leyland's first record in the mid-sixteenth century. This is dated 4278±50BP (Goode and Taylor 1988). Behind the coastal barrier at Chyandour a Holocene peat sequence has been examined (James and Guttman 1992). Peats are also recorded landward of the coastal bar at Marazion Marsh (Goode and Taylor 1988). To the east at Prah Sands a significant Pleistocene sequence was cut into by a Holocene valley; peat formed in this valley and is now exposed on the foreshore (Figure 33) and has been dated 1680±50 BP (Q-2372; Scourse and Kemp 1999). This is overlain by blown sands. When erosion cut into the sequence in 1974 tin ingots were found at the base of the forest bed which at this point is dated 1290±70 BP (Penhallurick 1986). There are also records of flints from the peat, and a midden containing a Beaker sherd in the dunes. At the eastern end of the sands at the time of our visit the cliff exposure revealed an extensive Holocene palaeosol with a bank and ditch (SW 58202 27839) and possible field boundary wall associated with a colluvial sediment (SW 5857227593) all below a cover of blown sand (Figure 34-6). A World War II pillbox now on the beach but originally erected in the dunes above shows the speed at which this coast is eroding (Figure 37).

Figure 38: Gunwalloe - old land surface below blown sand

At Porthleven Sands a coastal barrier which impounds Looe Pool is a mainly shingle bar but apparently with a sand component. Sediments in the pool show evidence of annual laminations from 1815 providing a palaeoenvironmental record which relates to the history of the bar and mining in the landscape (O'Sullivan 1999). To the east at Gunwalloe blown sands are more in evidence and bury a Holocene soil in the cliff section (Figure 38). Early medieval pottery and other artefacts have been found here and there is an early church on the dune edge.

5.6.12 Bigbury Bay and Bantham

Bigbury Bay has an expanse of dunes which at low tide create a bar across to Burgh Island and which constrict the mouth of the Avon River at Bantham. A submerged forest is recorded and there is an old record of a possible dugout canoe, flint artefacts and 'rough buildings' (Winder 1923; Coles 1990). Here dune erosion repeatedly brings to light archaeological finds most notably of an early medieval site with Mediterranean imported amphorae, a bone comb, many bones and other finds. There are also Bronze Age, Iron Age, Roman and medieval artefacts from the dunes (Fox 1955; Silvester 1981; Griffith 1986). Culvert construction in 1982 revealed marsh deposits inland of the dunes, and many stabilisation layers within the dunes, one associated with a hearth which gave dates of 1690±BP (HAR-5775) and 1440±90 BP (HAR-5776); land and marine molluscs were present and bones abundant. There seems to have been a significant settlement on the dunes between about the 5th and 8th centuries AD. Current sea-level related research using Foraminifera has shown a 15m Holocene sediment sequence laid down behind a long established coastal barrier with peat forming from *c.* 4500 BP (Gehrels and Massey pers. comm.)

5.6.13 Poole Bay

Poole Bay is a large shallow embayment extending for *c.* 12 km from Poole Harbour in the west to Hengistbury Head in the east (Figure 39). Several areas of blown sand are distributed along the coastline at Studland Bay, North Haven Point / Sandbanks, Bournemouth, Southbourne, Hengistbury Head, Stanpit Marsh and Sandhills. Studland Bay is the largest of these areas of blown sand, extending for 4 km to the southern edge of the mouth of Poole Harbour. Driver (1933) demonstrated that the dune ridges at Studland Bay date mainly from the 17th century, but are likely to overlie older dune sands. There appears (from the beach) to be a layer of blown sand above a podzol on the top of Tertiary cliffs at Branksome Chine, Bournemouth (Figure 40). If sediment examination confirmed this it would suggest a once extensive dune barrier to seaward of Bournemouth, the precursor of Sandbanks and Studland. Apart from *c.* 20 second world war military emplacements, no other archaeology has been recorded from Studland dunes. No finds have been recorded from blown sands at either Haven Point, Bournemouth, Southbourne, Mudeford Beach or Sandhills. However, a round barrow containing pottery and flint, an amber bead, late Neolithic Grooved Ware pottery and Mesolithic finds are reported from Crouch Hill, Stanpit Marsh. The mound was almost entirely composed of brownish-grey sand (Cunliffe 1987). Although no comment is made on the source of the sand, an aeolian origin should not be discounted (although the sands could be Tertiary). The Ordnance Survey grid reference for Crouch Hill (SZ 1694 9185) lies within the area of blown sands indicated on the British Geological Survey 1:50,000 solid geology and drift map (Sheet 329).

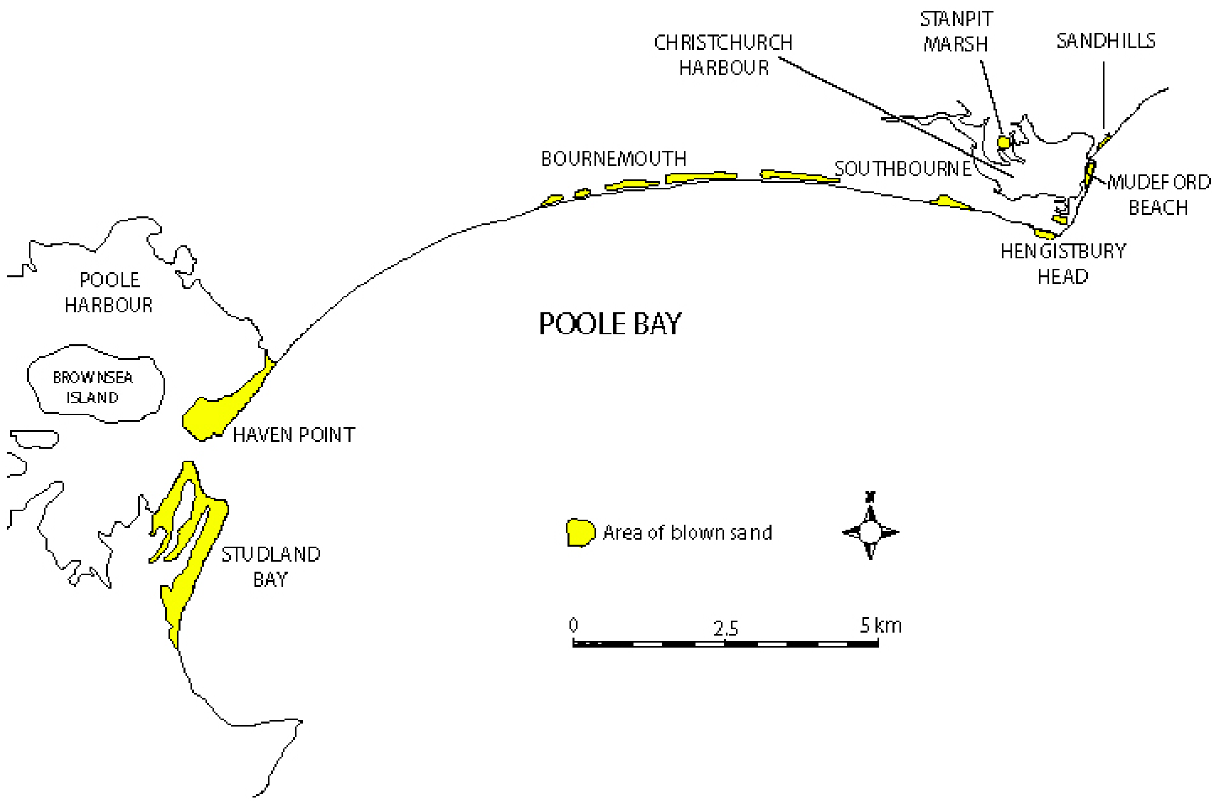

Figure 39: Map showing the distribution of blown sand in Poole Bay

Significant archaeological finds have been reported within and sealed by blown sands at Hengistbury Head, a 2 km long promontory composed of Tertiary sands and clays jutting out into the Solent on the western edge of Christchurch Harbour. The headland contains important late Upper Palaeolithic and Mesolithic occupation sites, a late Iron Age oppidum, and evidence of Romano-British activity (Cunliffe 1987; Barton 1992). Blown sands appear to be derived from the local Tertiary sands, as there is no evidence of dune development on the Headland (Barton 1992). The late Upper Palaeolithic and Mesolithic sites, TL dated to 12,500±1200 BP and 9750±950 BP (average of 6 TL dates) respectively, are both contained within fine sands considered to be aeolian in origin (Mace 1959; Campbell 1977). Particle size analyses of these sands showed a remarkably similar pattern to recent aeolian sediments on the headland, suggesting localised deposition and erosion of sediments by wind deflation (Barton 1992). Attempts to radiocarbon date the late Upper Palaeolithic site produced consistently younger dates suggesting movement of charcoal down the profile as a consequence of bioturbation.

Figure 40: Branksome Chine, Bournemouth, Tertiary Beds overlain by what from the beach appear to be Pleistocene flint gravel, a podsol and the possible blown sand

Further blown sands seal Iron Age and early Romano-British occupation on the northern shore-edge of the headland, reaching a maximum of 1.2 m thickness. These seem to be derived from local sands deposited above and behind a shingle bank. Blown sands of probable medieval date also seal evidence for intensive Iron Age and Romano-British occupation recorded at site 3 (Cunliffe 1987).

Removal of the protective breakwater around Hengistbury Head during the 1800s resulted in significant erosion of the cliff-face, increasing the length of the sand spit to the northwest of the headland (Mudeford Beach), on which extant sand dunes are present. Based on records and maps, this spit appears has gone through several broad phases of accumulation and erosion from the late 1600s, and may, therefore, be comparatively recent in origin. Construction of the groyne at the southern tip of Hengistbury Head in 1938 has also resulted in the formation of a wide beach backed by sand dunes located at the base of the headland (Cunliffe 1987, figures 3.3, 3.10).

5.6.14 Romney Marsh

Romney Marsh is an extensive area of now drained and reclaimed coastal marshland projecting out into Rye Bay, East Sussex and Kent. The Holocene sediments extend to depths of 20 m or more, characterised by widespread deposits of alluvium and middle to late Holocene peat, protected to seaward by the extensive mobile shingle beach of the Dungeness foreland. Amongst some of the deepest sediments are the Midley Sands. Detailed stratigraphic investigations of borehole sequences by Waller *et al* (1988) and Long and Innes (1995) demonstrate that these sands occur widely across the Marsh (Long and Innes 1995, figure 3.1), sealed by blue clay and peat, the latter dating to between *c.* 4800-1500 cal BC. Foraminiferal analysis demonstrates that the Midley Sand was deposited under marine conditions (Waller *et al* 1988). However, these sands are part of a more extensive facies sealing and interleaved with the peat, that rise in height (up to *c.* 3.5 m O.D.), occurring close to, or at, the surface as a series of prominent ridges. This deposit is named after a pronounced exposure, the Midley Church Bank, situated 2 km south of Old Romney. Green (1968) suggested that this formed part of a once more extensive sand spit or sand dune, extending SW-NE across Romney Marsh (Long and Innes 1995, figure 3.1). Although Waller *et al* (1988) argue that the Midley Sand and Midley Church Bank represent the same sedimentary unit, both may have formed under different depositional environments, the former under marine conditions, the latter at least partly aeolian in origin. The south-western end of the Midley Sand lies in proximity to the Broomhill Levels and Camber Sands. Whether they once formed part of a larger relict dune system is uncertain, though Eddison (2000) argues that the Camber Sands began accumulating in the 1800s, significantly post-dating the Midley Sand and Midley Church Bank. Musket shots, modern rifle bullets and shrapnel recorded from erosion features on the Broomhill Levels suggest a similar date for formation to the Camber Sands. However, Bellam (1996) reports the find of a middle Bronze Age pin, unstratified, though apparently eroded from the sands, suggesting that the Broomhill sand and shingle bar may have been in place by 1400-1100 BC, broadly contemporary with the sands of the Midley Church Bank.

The Midley Church Bank is significant, not only because of its potential aeolian origin, but because it is shown in several places to seal remains of Romano-British and Medieval occupation (Appendix 2). At Sandtun, near West Hythe, evidence for Anglo-Saxon settlement (*c.* AD 700-875) was recorded associated with blown sands that begun accumulating on a shingle and sand ridge at the southern side of the Hythe inlet from the 8th century onwards (Gardiner *et al* 2001). Heavily rolled prehistoric and Romano-British pottery was recorded from the shingle-sand beach preserved below the dunes. Saxon occupation took place within the dunes, with evidence for fishing, spindlewhorl manufacture, bone-working and salt-making. Shell middens, large quantities of fish bones, fish hooks, pottery and coins dating from the 690s to 820s AD were recorded. However, industrial scale quarrying of the dunes, building development, and recent experimental crop growing and landscaping, have significantly altered the topography of the dunes, damaging the underlying archaeological deposits. Many of the early finds from the 1940s were also poorly recorded and lack any certain stratigraphic context.

Importantly, the ceramics include a high proportion of continental wares, suggesting the site may have been a landing-place for trading ships. Gardiner *et al* (2001) highlight that a large number of coastal sites on the north and west coast of Ireland and south-west England are similarly located on beaches and dunes, such as Bantham Ham, Dorset (Section 5.6.12). These sites are significant, therefore, in furthering our understanding of the Anglo-Saxon and early medieval economy beyond the more extensively studied urban ports/towns.

Medieval remains covered by sand have also been reported from New Romney. At Fairfield Road, remains of a timber-framed structure dated to *c.* AD 1250-1300 were discovered overlying natural beach sands, subsequently sealed by sand, on top of which foundations for a masonry building of probable 14th-15th century date were recorded. A similar sequence was recorded at Church Road, New Romney, though in neither case is it specified whether the sands are of marine or aeolian origin. However, the 13th and 14th centuries witnessed a series of storms and extensive floods across the Marsh, in particular, those of AD 1250 and 1287-8 (Gross and Butcher 1995). These were followed by recolonisation in the 14th and 15th centuries (Rippon 2002), raising the possibility that the sandy sediments sealing the Fairfield and Church Road sites represent flood rather than wind blown deposits.

Radiocarbon dates from the upper contact of the peat underlying the Midley Church Bank of 2249±48 BP (UB-3581, 400-200 cal BC) and 2762±49 BP (UB-3583, 1020-800 cal BC) suggest that it probably began forming in the Bronze Age, with a later phase of blown sand accumulation in the medieval period suggested by evidence from Dyke Side Farm (8th-9th and 13th/14th century). Long and Innes (1995) emphasise that further study is required to determine whether the Midley Sand is aeolian or water-lain. Even if a water-lain origin were established, it does not preclude the possibility of later aeolian reworking of exposed sands, such as at Sandtun.

5.6.15 Sandwich Bay and Dover

Blown sands are also present on the east Kent coast along Sandwich Bay. Several locations in and around Deal (Appendix 2) record blown sands sealing archaeology, dating from the Neolithic/Bronze Age to the Roman period. These include a Bronze Age cremation sealed by blown sands at TR 375 515, and Neolithic/Bronze Age flint artefacts and Iron Age pottery (*c.* 550-350 BC) beneath the former Royal Marine Barracks. At Northwall Road, Deal, excavation revealed short-lived Iron Age and Romano-British settlement situated on reclaimed land, subsequently inundated by blown sands.

Further traces of Romano-British settlement dating from *c.* AD 50 to *c.* 225 are recorded stratified below, and, in some cases, separated by blown sands at Dickson's Corner, Worth (TR 362 516). These blown sands appear to have accumulated behind a sand spit protecting the Wantsum channel from the sea (Parfitt 2000). Occasional finds of Roman date have previously been made from these blown sands, including a coin of Tetricus (*c.* AD 271)

(Roach-Smith 1882). Test pit surveys within the nearby Sandown region, near Sandwich, also identified sand deposits that appear to have been at least partially reworked by wind action, sealing Iron Age and Romano-British occupation dating to between *c.* 50 BC - AD 80. Any later archaeology may have been destroyed by cultivation (Parfitt 2006).

Blown sands have also been recorded from Dover, south of the Saxon Shore Fort, during excavations in advance of the Dover White Cliffs Experience. Here, a metalled surface outside the shore fort is sealed by a silty loam and in turn by blown sands that in areas reach a maximum of 3.5 m depth. It was concluded that the onset of blown sand deposition was rapid, derived from a local beach or back-barrier environment in the 6th or 7th centuries AD (Wilkinson 1994).

6. NON-COASTAL HOLOCENE AEOLIAN SEDIMENTS

In the partly devegetated and geomorphically unstable conditions at the very beginning of the Holocene it is inherently likely that some aeolian redeposition occurred of coversands and loess and indeed sediments of sand or finer grade deposited by other processes. Localised deposits of this type could provide good conditions for the preservation of transitional upper Palaeolithic / Mesolithic sites, but such conditions are only likely to have obtained for a few centuries at most before an increasing continuous vegetation blanket greatly reduced the possible sources to a few unstable areas, such as perhaps small areas of the floodplains of major rivers. Expanses of devegetated landscape were only created again as a result mainly of human agency. On a very local scale this could have happened at any date, but these conditions will be most prevalent where bare soil resulted from arable agriculture. Deflation of arable soils is today a significant soil erosion factor in the driest parts of eastern England, particularly where agriculture once again exposes Pleistocene coversands to deflation, as for instance north of this study area in the Breckland, Vale of York and Lincolnshire. Such deflation did occur in the past and was responsible for the burial and preservation of important archaeological sites and associated landscapes such as West Stow (West 1985) and Heslerton (Powesland 2003). The soils of the present study area are not today considered to be particularly at risk of wind erosion (Boardman and Evans 2006, Fig 1.33.1). Localised deflation may nonetheless have occurred and some possible prehistoric examples are noted below.

6.1 Mesolithic heathland sites

Dimbleby (1985) discussed a group of sites on the sandy heathland soils of southern England: on the Lower Greensand of the Weald (Iping and Minsted, Sussex, Oakhanger Hampshire); one on the Folkestone Beds (Addington, Kent); and two on the Tertiary Beds of the Hampshire Basin (Longmoor, Hampshire and Winfrith, Dorset). On each of these sites Mesolithic flint horizons occurred on what pollen analysis confirmed was a buried surface below sand. Dimbleby's theory was that in at least some cases the mechanism of burial was wind deposition of the overlying sandy sediments and this may have occurred as a result of environmental disturbance as early as the Mesolithic. Environmental disturbance in the Mesolithic is increasingly attested (Simmons 1996; Bell forthcoming). Greensand sites such as

Oakhanger are extremely rich but remain, as perhaps in the Mesolithic, quite fragile and sensitive environments. The sandy soils are subject to disturbance by footpaths and other activities, which is how most sites were found. Many are today increasingly being actively managed for nature conservation. The formation process of these sites and the chronology of their soil development needs new investigation in particular to help establish whether hiatuses exist within the profiles. A range of palaeoenvironmental techniques should be used to investigate the development of profiles containing artefacts including micromorphology, soil chemistry and particle size. Windblow must certainly have occurred on the heathlands in more recent times when cultivation, heavy grazing, fire, turf cutting and other practices created bare ground. Defoe (1738), writing about the heaths of the Hampshire / Surrey / Berkshire border called them 'sandy deserts where the winds raise the sands'. Today these landscapes, where they survive encroachment by building, are increasingly densely vegetated as grazing pressure has reduced.

6.2 Thames Valley and chalkland sites

Cornwall (1953) examined the fills of Bronze Age ditches on Thames valley terrace gravels at Stanton Harcourt and Cassington in Oxfordshire and identified in the secondary fill of those ditches a stoneless yellow red loam which particle size analysis showed contained high proportions of silt. He found similar sediments with 65% silt in the fill of the Y-holes at Stonehenge. The suggestion was that these sediments were wind blown and indicated a particularly dry climatic episode in the Bronze Age. More recently fine silts of probable aeolian origin have been identified in the Bronze Age ditch fill of Barrow 34 in the Allen Valley, Cranbourne Chase, Dorset (French *et al* forthcoming). One of the difficulties of identifying windblown sediments in archaeological features is that in areas such as the chalk and limestone the soils in any case contain a high proportion of Pleistocene loess. Thus, as in the Mesolithic case in Section 6.2, identification is likely to require a multi-proxy approach using a combination of particle size, sediment micromorphology and associated biological evidence. Such an investigation would be worthwhile since it is relevant to questions of the extent of arable activity during the Bronze Age, its effect on soil properties and the possible effects on land-use history of dry climatic episodes.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Preservation conditions

Windblown sediments are fine grained, can accumulate rapidly, are often subject to limited pedogenic and biological activity after deposition and are frequently calcareous. Thus, they can be responsible for excellent preservation of sites. This will be as true of lithic scatters buried by loess at Northfleet as it is one of the exceptionally preserved Bronze Age sites of Holocene Western Britain. Episodic sand blows preserve key cultural sequences at sites such as Gwithian and Brean Down, the plough- and spade-marks at the former and the preservation of egg shells, dog coprolites etc. at the latter serving to highlight this point.

7.2 Loess deposition phases

The assumption has been that most loess deposition was in the last glacial maximum. Evidence has been presented for several earlier phases of albeit localised loess deposition. Palaeolithic sites appear to be particularly associated with loess laid down in MOIS 6 and 10.

7.3 In situ or redeposited loess

When Palaeolithic artefacts are noted in loess it is often unclear whether the loess is (a) in situ or has been subject to reworking by (b) colluvial or (c) fluvial processes. Any one of these, but especially wind-blown and fluvially redoposited loess, can result in the exceptional preservation of living floors, and if so the sites are of exceptional importance. However, the distinction between the processes (a, b and c) is absolutely critical in terms of associating human activity with environmental conditions. This requires particle size analysis, examination of any associated biological evidence, particularly Mollusca, ostracods etc.

7.4 Coversands

The coversands of Somerset and Mendip represent an important last glacial horizon. The Brean Down evidence shows that aeolian deposition was underway well before the last glacial maximum when Britain appears to have been deserted (Barton 1997). There is thus potential for archaeological finds within coversand sequences. The possible archaeological potential of the early and perhaps late phases of these coversands should be kept in mind and likewise their potential as a marker horizon. This is particularly relevant to current developments in understanding the faunal succession in stages of the Pleistocene where Mendip sites are important (Section 4).

7.5 Contribution of loess to Holocene soils

We have noted (Section 2.6) that general reference is frequently made in the archaeological literature to the former importance of loess and its contribution to Holocene colluvium. Such observations need to be analytically based and quantified particularly now that it is becoming clear that significant spatial differences existed in the soil, vegetation and erosion histories of different areas of the Chalk.

7.6 Dating loess, coversand and dunes

Optically Stimulated Luminescence is becoming increasingly important to our understanding of the chronology of all windblown sediments. In Pleistocene contexts this does not always produce the same result as Amino Acid Racemisation on shells from underlying shore platforms perhaps because there is growing evidence that many of the raised beaches of the South West are multi-generational, ie were reworked during successive sea-level highstands. The comparison between dating techniques requires further exploration. OSL is also a valuable technique in the Holocene in addition to radiocarbon dating and artefact dating. One key thing is to establish the relationship between the horizon being dated and windblown sediment deposition, eg is there actual evidence of sand deposition at the time of the dated event or could the site significantly predate the sediment by which it is buried. Long sediment sequences with archaeology such as Gwithian, Brean Down etc are good contexts for sophisticated radiocarbon accelerator dating programmes using artefacts (eg worked bone) or short-lived biota and Bayesian statistics (Buck 2001) to refine chronology.

7.7 Relationship of dunes to other Holocene sediment sequences

In most cases windblown sands need to be seen, not in isolation, but as part of the Holocene sediment sequences to which they are stratigraphically related. These include buried soils, estuarine silts, intertidal peats, submerged forests and colluvial sediments. At the mouths of coastal valleys these sediment types tend to be interstratified and related to one another in a predictable way as suggested by the hypothetical landscape model in Figure 11. It is the interrelationship between the types of sediment which enables us to reconstruct landscape and environmental change. These relationships are of particular potential importance for dating as for instance where windblown sediments are interleaved with peats behind a coastal bar, thus potentially facilitating the accurate dating of aeolian phases.

7.8 Monitoring coastal exposures

The erosion of coastal sediment sequences is likely to accelerate with projected sea-level rise. Ongoing erosion necessitates recording of eroding archaeological sites. Elsewhere coastal protection work may damage and obscure existing sections, creating the need for assessment. Sites are constantly revealed below and within the Holocene dunes and most of those we visited had some archaeology exposed. Much can be learnt non-destructively from the recording and strategic sampling of exposed sections, as demonstrated by the initial phase of our work in 1983-4 at Brean Down (Bell 1990, 6) and particularly by the recording and strategic sampling on Scilly by Ratcliffe and Straker (1996). The monitoring and recording of exposures is an activity ideally suited to local individuals and archaeological societies. Areas where the concentration of archaeological finds makes conservation and monitoring particularly important are: Brean Down, Harlyn Bay, Constantine Bay, Gwithian, Prah Sands and Bantham.

7.9 Gwithian

Unquestionably this is the most important Holocene windblown sediment site in southern Britain (5.6.9). A project on the archive has been most successfully completed. It is important that the post-excavation work this proposes is taken forward and published in a way that makes the results widely accessible to those working on comparable sites in Britain and abroad. It is particularly important that the targeted and limited programme of scientific and environmental work proposed by Nowakowski et al (2006) is completed. The analysis and publication of this internationally important site will do more than anything else to advance our understanding of coastal windblown sites.

7.10 Palaeoenvironmental research

The sections exposed of old land surfaces and overlying dune sands on many sites are impressive as several of the photographs shown here demonstate. They are ideal contexts for palaeoenvironmental research as the molluscan studies of Spencer (1975) demonstrated. It is surprising that the considerable potential has not been much exploited.

7.11 Sieving programmes

Good preservation of environmental evidence in blown sands means that excavation of sites within them should include appropriate water sieving strategies. The value of this has been demonstrated by work at Trethellan (5.6.7), Brean Down (5.6.1) and smaller scale work on Scilly (5.6.10). Such programmes are particularly important for developing our understanding of coastal agricultural practice through plant macrofossil analysis and evidence of fishing practice through fish bone identification. Sieving programmes will also contribute significantly to other forms of faunal analysis, and in coastal dunes can produce unusual forms of evidence such as coprolites with intestinal parasites, egg shell and charred seaweed as work at Brean Down showed.

7.12 Buried soils

These represent a most valuable and under-utilised resource for research on soil history and the possible effects of cultivation particularly using micromorphology.

7.13 Development threats

25% of the coastal dune sites have golf courses and field observation and air photographs show the significant impact which construction of these has had in some cases. Surprisingly we have not come across evidence of archaeological finds made during construction of courses or of assessments being done in advance of course construction. Despite the fact that these sites are obviously windy none of those we visited currently has a windfarm but this could be a factor in future. Currently the trend is towards offshore marine farms but in some areas that might involve cables and construction across dunes inland. Any such disturbance requires archaeological assessment and a watching brief.

7.14 Historic Environment Records

As Sites and Monument Records evolve into Historic Environment Records (HERs) there is a need to include within them those sedimentary contexts which contain important records of the history of key environments, particularly those which are considered to be of importance for heritage or nature conservation. This includes a large proportion of the windblown sediment sequences considered here. Cornwall has the most important Holocene windblown sediment sequences and its HER is particularly good at recording sites and sediment sequences such as submerged forests of importance. To a significant extent this probably represents the legacy of Gwithian (5.6.9) and other sites noted here.

7.15 Integrated conservation issues

It is notable that many of the loess and coversand sequences of Pleistocene date are protected as Geological Sites of Special Scientific Interest and the justification for this is clearly outlined in the Geological Conservation Reviews on the Quaternary of the Thames (Bridgland 1994) and the Quaternary of South West England (Campbell et al 1998). However, the use of the term Quaternary in these publications is somewhat restricted since there is little or no consideration of the Holocene sediments. The anomaly is particularly evident on sites which have very important Pleistocene and Holocene sediment sequences such as Brean Down and Gwithian / Godrevy where the Geological Conservation Reviews do not discuss the Holocene sediments. A similar point applies to other aspects of conservation; dune landscapes often contain important plant and animal communities and in setting the boundaries and management regimes of these conservation sites there is a need to move from the separate consideration of these various conservation interests to a more integrated approach to heritage and nature conservation, as the current anomalous position of Holocene sediment sequences clearly shows.

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Finds and environmental materials collected during the course of this work have been retained in the Archaeology Department of Reading University.

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APPENDIX A: DATABASE OF LOESS AND COVERSAND SITES

SITE / COUNTY	ARCHAEOLOGY	ENVIRONMENTAL STUDY	DATING	REFERENCE
KENT				
Baker's Hole	X			Wymer 1968, 1999; Bridgland 1994; Wenban-Smith 1995
Bapchild, Sittingbourne	X			Wymer 1999
Bobbing			X	Parks and Rendell 1992
Faversham			X	Parks and Rendell 1992
Great Mongeham	X			ADS NMR_NATINV-1086714
Halling		X		Kerney 1971
Holywell Combe		X		Preece and Bridgland 1998
Luton	X			Wymer 1999
Manor Road	X			ADS NMR_NATINV-1106385
Northfleet	X	X	X	Parks and Rendell 1992; Wenban-Smith 1995
Pegwell Bay		X	X	Pitcher *et al* 1954; Parks and Rendell 1992
Reculver			X	Preece 1990; Parks and Rendell 1992
Spotland Quarry			X	Parks and Rendell 1992
Swalecliff	X			Wymer 1999
GREATER LONDON				
Crayford	X			Wymer 1968
Creffield Road	X			Wymer 1968
SUSSEX				
Boxgrove		X	X	Parks and Rendell 1992
Church Street			X	Parks and Rendell 1992
Ferring			X	Parks and Rendell 1992
Goring			X	Parks and Rendell 1992
Hope Gap			X	Parks and Rendell 1992
Newhaven	X			Bell 1976
Selsey			X	Parks and Rendell 1992
Sussex Pad			X	Parks and Rendell 1992
Telscombe			X	Parks and Rendell 1992
HAMPSHIRE				
Barton-on-Sea			X	Parks and Rendell 1992
Chiling Copse			X	Parks and Rendell 1992
Highcliffe			X	Parks and Rendell 1992
Holbury			X	Parks and Rendell 1992
Hordle Cliff			X	Parks and Rendell 1992

Lepe Point			X	Parks and Rendell 1992
Sturt Point			X	Parks and Rendell 1992
ISLE OF WIGHT				
Bembridge			X	Parks and Rendell 1992
Freshwater Bay			X	Parks and Rendell 1992
Howgate Farm	X		X	Parks and Rendell 1992
DEVON				
Braunton Burrows				
Croyde Burrows				
Dunkeswell		X		Harrod *et al* 1974
Ipplepen		X		Harrod *et al* 1974
Little Haldon		X		Harrod *et al* 1974
Lukesland		X		Harrod *et al* 1974
Lympstone Common		X		Harrod *et al* 1974
CORNWALL				
18 sites		X		Catt and Staines 1982
SOMERSET				
Brean Down	X	X	X	
Hyena Den, Wookey Hole	X			Tratman *et al* 1971
Sun Hole	X			Collcutt *et al* 1981

APPENDIX B: DATABASE OF DUNE SYSTEMS AND ASSOCIATED SITES

Site No.	Site Name	County	NGR	Archaeology	Date Site (S) Dune (D)	Palaeoenvironmental context and studies: LM - land molluscs MM - marine molluscs S - Sediments P - Pollen GP - Geophysics PM - Plant Macrofossils AB - Animal bones F - Fish bones	Conservation Status: NNR, SSSI, National Trust (NT) RAMSAR, SAC, SPA, UNESCO Biosphere Reserve (UNESCO.BR) SNCI (Site of nature conservation importance)	Land Use Eroding (E), Stable (S), Accretional (A) Variable (V)	Nature Conservation (NC), Golf courses (GC), Tourism (T) Building Development (BD), Danger Area (DA) Amenity (A)	Reference (DI – depositors I.D)
1	Sand Bay	Somerset	ST 33/65 -to 31/62			Bay Dune	SSSI, SAC, SPA/RAMSAR* (Severn Estuary)*	S	NC, T, BD	BGS Sheet 279
2	Weston Bay	Somerset	ST 31/62 to 31/58			Bay Dune	SPA/RAMSAR* (Severn Estuary)*	S	T, BD	BGS Sheet 279
3	Berrow Sands	Somerset		↓	↓	Bay Dunes	SSSI, NNR^ (Bridgwater Bay)^ SPA/RAMSAR* (Severn Estuary)*	S	NC, T, BD, GC	BGS Sheet 279
3.1	Brean Down	Somerset	ST 2957 5873	Few Neolithic finds Bronze Age settlement Sub-Roman cemetery 16th century lodge	Beaker to post-medieval (21 14C dates)	M, S, P, PM, coprolites, AB, F	SSSI, NT	NC,		ApSimon *et al* 1961 Bell 1990, Bell 2002, Allen and Ritchie 2000
3.2	Brean, St. Bridget Church	Somerset	ST 2970 5595	Medieval church. Graves cut into alluvium, sealed by blown sands	Medieval or earlier			BD		Dennison 1988
3.3	Berrow, St. Mary;s Church and Yard	Somerset	ST 294 524	(1) Medieval pottery sherds, (2) Brick Floor, both sealed below sand dunes	(1) 14th century AD (2) 1700-1750 AD			BD		Somerset CC HER, DI. 10104
3.4	Berrow Dunes, WW2 coastal defences (x8)	Someset	ST 29 52	Eight pillar boxes, partly covered by blown sand	1940s		SSSI			Somerset CC HER DI. 15470
3.5	Berrow, Rifle Range	Somerset	ST 2930 5211	Rifle range, recorded in 1885 and 1927, now buried under blown sand	19th century?		SSSI			Somerset CC HER DI. 12643
4	Stert	Somerset	ST 24/45, 27/46-46, 28/46				NNR (Bridgwater Bay)	NC, BD		BGS Sheet 279
5	Minehead	Somerset	SS 98/46, 99/45-46, ST 00/44				NNR (Bridgwater Bay)	T, BD, GC		BGS Sheet 278

6	Woolacombe Burrows	Devon	SS 45/41-43, 44/41	↓	↓	Bay Dunes, Climbing dunes↓	NT	NC, T		BGS Sheet 292
6.1	Woolacombe Sands	Devon	SS 452 413 and 454 425	Mesolithic flint scatters	Mesolithic		NT	NC		Grinsell 1970 Wymer 1977
6.2	Woolacombe Sands	Devon	SS 45451 43978	Green glazed pottery from pit in cliff section	Later Medieval					Project Field visit 31 July 2007
6.3	Woolacombe Sands	Devon	SS 45581 43128	Heat fractured flint shatter and flakes recovered from buried soil sealed by blown sands.						Project Field visit 31 July 2007
7	Croyde Burrows	Devon	SS 43/39				SSSI, NT	S	NC, T, BD	BGS Sheet 292
7.1	Croyde Bay	Devon	SS 430 390	30+ pieces of worked flint, provenance uncertain, but NGR located in area of dunes	Mesolithic		SSSI, NT	NC		Wymer 1977
7.2	Croyde Raised Beach	Devon	SS 43/39		Late glacial	Pleistocene cover sands	SSSI, NT	NC		
8	Braunton Burrows	Devon	SS 44/32-37, 45/37, 46/31-37	↓	↓	Open Coast Dunes	UNESCO.BR, NNR, SAC, SSSI	V	NC, T, GC, DA	BGS Sheet 292
8.1	Braunton Burrows	Devon	SS 45 36	Shell midden with medieval pottery, shells, fish and animal remains	Medieval	AB, F, MM	UNESCO.BR, NNR, SAC, SSSI	NC		Smith *et al* 1983
8.2	Saunton Raised Beach						UNESCO.BR, NNR, SAC, SSSI	NC		
8.2	St. Ann's Chapel	Devon	SS 4570 3363	Chapel	Medieval		UNESCO.BR, NNR, SAC, SSSI	NC		EH NMR SS 43 SE 9
9	Northam Burrows	Devon	SS 43-45/30-31			Fringing Dunes	UNESCO.BR, NNR, SAC, SSSI	V	NC, T, GC, A, BD	BGS Sheet 292
10	Instow Sands	Devon	SS 47/30-31			Fringing Dunes		V	BD	BGS Sheet 292
11	Northcott Mouth	Cornwall	SS 203 085			Blown sands within small valley mouth	NT	E	NC, T, A	BGS Sheet 307/8
12	Bude Bay Dunes	Cornwall	SS 20/06-07, 21/06-07			Bay Dunes. Blown sands up to 10 m resting on Head, covered by Bude town and golf course.		S	T, GC, BD, A	BGS Sheet 307/8 Cole 2001
13	Widemouth Sands	Cornwall	SS 19/01-02, 20/01-02			Bay/Climbing Dunes. Holocene Blown sands overlying raised beach LM		E	T	BGS Sheet 322 Freshney 1972
13.1	Widemouth Bay	Cornwall		Roman finds from pit cut into beach sands. Old Land Surface, this layer of	Pottery 2nd century AD					Wood 1965

				cobbles, alluvial deposits and pale buff silty sand, argued to have windblown component.					
14	Daymer Bay, Camel Estuary	Cornwall	SW 92-3/77			Climbing/Fringing Dunes	A	T, BD, GC	BGS Sheet 335/6
14.1	Daymer Bay	Cornwall	SW 92662 77742	2 sherds of coarse pottery from blown sands above buried soil	Prehistoric?				Project Field visit 1 August 2007
14.2	Daymer Bay Trebetherick	Cornwall	SW935780	flints	Mesolithic				Wymer 1977,45
15	St. Minver, Camel Estuary	Cornwall	SW 93/76		Medieval or later				BGS Sheet 335/6
15.1	St. Minver, St. Enodocs church	Cornwall	SW 9315 7723	Originally a Norman cruciform chapel with later additions; cleared of encroaching sand and restored in 1863	Medieval				**ADS Record ID -** NMR_NATINV-430930
15.2	St Minver Sand dunes,	Cornwall	SW 93135 76408	Ancient settlement site shown in middle of dunes (OS map)	?				**OS map (?)**
16	Haryln Bay	Cornwall	SW 87/75			Bay Dunes	S	T, BD	BGS Sheet 335/6
16.1	Haryln Bay	Cornwall	SW 8776 75282	Blown sands sealing Iron Age / Romano British settlement and burial ground.	3550±90 BP (HAR-1192)	Bronze Age C14 dated soil MM and LM	T, BD		Whimster 1977
17	Constantine Bay	Cornwall	SW 86/74-75, 87/75, 88/74-75			Bay Dunes	S	T, BD, GC, A	BGS Sheet 335/6
17.1	Constantine Bay	Cornwall	SW 858 754	60+ pieces of worked flint.	Mesolithic (in area of blown sands)				Wymer 1977
17.2	Constantine Bay	Cornwall		Ruins of Constantine's Church and Holy Well	Medieval				BGS Sheet 335/6
17.3	Constantine Bay	Cornwall	SW 85810 75184	Midden, exposed in cliff, originally recorded by Crawford					Field visit 2 August 2007 Crawford 1921
17.4	Constantine Island, Constantine Bay	Cornwall	SW 858 751	Possible stone cist	?				Field visit 2 August 2007
17.4	Constantine Island, Constantine Bay	Cornwall	SW 858 751	97 worked flint from eroding blown sands	Prehistoric, including possible diagnostic Mesolithic				Field visit 2 August 2007
18	Mawgan Porth	Cornwall	SW 85/67	↓	↓	↓	T, BD		BGS Sheet 346
18.1	Mawgan Porth	Cornwall	SW 8511 6725	Early Medieval Settlement, including Christian cemetery	850-1066 AD				Taylor (ed.) 1997
19	Lusty Glaze	Cornwall	SS 82 62				T, BD		
20	Towan Head,	Cornwall	SS 8025 6032	Buried Soil		LM	BD		BGS Sheet 346

	Newquay									Spencer 1975 Evans 1979
21	Towan Head	Cornwall	SW 800 627	Blown sands on cliff top, most probably remnants of former sand bar between headlands.				T, BD		BGS Sheet 346
21.1	Little Fistral, Towan Head	Cornwall	SW 80077 62768	Possible midden sealed and underlain by colluvium with blown sands	Uncertain			T, BD		Field visit 2 August 2007
22	Fistral Bay	Cornwall	SW 79/61, 80/61-62	↓	↓	Bay/Climbing Dunes. Raised beach and head overlain by Pleistocene and Holocene blown sand		E	T, BD, GC, A	BGS Sheet 346 Reid and Scrivenor 1906
22.1	Trethellen Farm, Newquay	Cornwall	SW 8015 6127	Bronze Age settlement Iron Age cemetery	Bronze Age			BD		Nowakowski 1991 Rose and Preston-Jones 1987
22.2	Atlantic Road, Newquay	Cornwall	SW 80 61	Roman settlement Iron Age pits Plough marks	Iron Age / Romano-British			BD		Reynolds 2000
23	Crantock Dunes	Cornwall	SW 78/60			Bay Dunes	NT	S	T, NC, BD	BGS Sheet 346
24	Porth Joke, West Pentire	Cornwall	SW 59/60				SSSI, NT	NC		OS Map (?)
24.1	Porth Joke	Cornwall	SW 7732 6005	Buried field boundary, possibly within area of blown sands	Prehistoric?		SSSI, NT	NC		OS Map (?) ADS Record ID - NTSMR-NA5605.
24.2	Porth Joke	Cornwall	SW 7720 6048	Find spot of Romano British Rim Sherd at Porth Joke, Cubert, indicated within area of blown sands	Romano British		SSSI, NT	NC		ADS Record ID - NTSMR-NA12912.
25	Holywell Dunes	Cornwall	SW 76/59-60, 77/58-70, 78/58-59			Bay Dunes	SSSI, NT	S	T, NC, GC	
25.1	Holywell Dunes, Kelsey Head	Cornwall	SW 770 601	Find spot of Pottery at Kelsey Head, Cubert, possibly within area of blown sands	Early Medieval/Dark Age, Iron Age, Medieval, prehistoric		SSSI, NT	T, NC		ADS Record ID - NTSMR-NA24970. ADS Record ID - NTSMR-NA529.
25.2	Holywell Dunes, Kelsey Head	Cornwall	SW 7694 6038	Medieval remains at Kelsey Head, Cubert	Medieval to Post Medieval		SSSI, NT	T, NC		ADS Record ID - NTSMR-NA24974.
26	Penhale Sands	Cornwall	SW 76/54-58, 77/54-58, 78/54-58			Bay Dunes	SSSI, SAC	V	T, DA, GC	BGS Sheet 346
26.1	Penhale Sands, St. Piran's Old Church	Cornwall	SW 7720 5646	Medieval Church, graveyard and fields covered in blown sands	10th century AD to 1804 (church moved)	GP (EH)	SSSI, SAC	T, DA, GC		Preston-Jones 1994
26.2	Penhale Sands,	Cornwall	SW 77/56	Medieval chapel	Between 5th-		SSSI, SAC	T, DA, GC		Reid and Scrivenor

	St. Piran's Oratory				7th centuries					1906
26.3	Penhale Sands, St. Piran's Cross	Cornwall	SW 7722 5644	Early Medieval Cross	No later than 10th century AD		SSSI, SAC	T, DA, GC		
26.4	Penhale Sands, St. Piran's	Cornwall		Flint flakes, hammerstone, animal bones	Prehistoric		SSSI, SAC	T, DA, GC		Reid and Scrivenor 1906
27	Porthtowan	Cornwall	SW 68/47-49, 69, 47-49			Bay/Fringing Dunes		S	BD	BGS Sheet 352
27.1	Porthtowan	Cornwall	SW 68/47	Post-medieval mine shafts and associated remains (x9)	Post-medieval					Cornwall Archaeological Unit B.15.0033 EH NMR 1313392
28	Godrevy Towans	Cornwall	SW 58/41, 58/42, 59/41-42			Bay Dunes	SSSI, SAC	S	T, NR, BD	BGS Sheet 351/8
28.1	Godrevy Towans	Cornwall	SW 5862 4216	Lithic implement	Mesolithic					NT SMR 90742*0
29	Gwithian-Mexico Towans	Cornwall	SW 55/38-39, 56/38-39, 57/38-41, 58/39-41			Bay/Climbing Dunes	SSSI, SAC	E	T, NR, BD	BGS Sheet 351/8
29.1	Gwithian	Cornwall	SW 590 423	Bronze Age settlement and field system. Cross ploughing and occupation layer separated and sealed by blown sands	Multi-periods prehistoric	LM, 14C	SSSI, SAC	T, NR, BD		Thomas 1958 Megaw *et al* 1961 Megaw 1976 Nowakowski 1989
29.2	Sandy Lane, Gwithian	Cornwall	SW 58 41	Early medieval Midden (exact location cannot now be pinpointed)			SSSI, SAC	T, NR, BD		Thomas 1964
29.3	St. Gothian's Chapel, Gwithian	Cornwall	SW 58/41	Early medieval chapel covered by blown sands	Early medieval		SSSI, SAC	T, NR, BD		Thomas 1958
29.4	Mining shafts and adit, Upton Towans	Cornwall	SW 57/39, 57/41, 56/39	Post medieval copper, lead, silver and tin mines (x23), some covered by blown sands.	Post-medieval		SSSI, SAC	T, NR, BD		Jones 1999
29.5	Conerton	Cornwall	SW 587 413	Deserted medieval village	1066-1299 AD		SSSI, SAC	T, NR, BD		Thomas 1964 EH NMR SW 54 SE 21
29.6	Upton Barton Farmhouse	Cornwall	SW 5814 3993	Medieval-Post Medieval farmhouse buried by blown sands	c. AD 1620		SSSI, SAC	T, NR, BD		EH NMR SW 53 NE 53
29.7	Gwithian Towan	Cornwall	SW 583 417	Roman Coin of Tetricus	AD 267		SSSI, SAC	T, NR, BD		EH NMR SW 54 SE 15
29.8	Gwithian Towans	Cornwall	SW 585 415	Medieval hut and occupation debris	AD 900-1100		SSSI, SAC	T, NR, BD		EH NMR SW 54 SE 23
29.9	Gwithian Towans	Cornwall	SW 5855 4214	Flint implements	Mesolithic		SSSI, SAC	T, NR, BD		EH NMR SW 54 SE 29
29.10	Gwithian Towans	Cornwall	SW 58 41	Midden, shells and pottery revealed after erosion of sand dunes	Bronze Age					EH NMR SW 54 SE 40
29.11	Gwithian Towans	Cornwall	SW 572 395	Post Medieval Explosives factory	Late 19th AD century					EH NMR SW 53 NE 123

29.12	Gwithian – Mexico Towans (Common Towans)	Cornwall	SW 560305	40+ pieces of worked flint (not indicated specifically as originating from dunes)	Mesolithic					Wymer 1977
29.13	Godrevy-Gwithian Towans	Cornwall	Various	Military emplacements	WW2					Defence of Britain Database CBA
30	Porth Kidney Sands (Lelant Sands)	Cornwall	SW 53/38, 54/38-39			Bay Dunes	SSSI	A	T, GC, BD	BGS Sheet 351/8
30.1	Lelant/Porth Kidney	Cornwall	SW 53-54/38	Pillboxes (x4)	WW2					Defence of Britain database CBA
31	Whitesands Bay, Sennen	Cornwall	SW 35/26, 37/25-26			Bay/Climbing Dunes		E	T	BGS Sheet 351/8
31.1	Sennen, Cove	Cornwall	SW 3621 2799	Pillbox	WW2					Defence of Britain database CBA **ADS Record ID -** CBA_DOB-3294.
32	Praa Sands	Cornwall	SW 57/27, 58/27-28		Roman or later over dated peat	Bay/climbing Dunes	NT	Mostly S	T, BD	BGS Sheet 351/8
32.1	Praa Sands	Cornwall		Tin Ingots found at base of forest layer						Biek 1994
32.2	Praa Sands	Cornwall	SW 57/27	Hearth	Early Medieval					EH NMR 625747
32.3	Praa Sands	Cornwall	SW 58/28	Fragment of beaker	Beaker Period					EH NMR 6165
32.4	Praa Sands	Cornwall	SW 57/27, 57/28	Pillboxes and anti-tank wall	WW2					Defence of Britain database CBA
32.5	Praa Sands	Cornwall	SW 5785 2802	Dunes overlie C14 dated peat	1805±100 BP					Wellin *et al* 1973
32.6	Praa Sands	Cornwall		Possible Palaeolithic living site, hearth, bits of burnt bone…(stated as dubious by Hencken)	?Palaeolithic?					Hencken 1932
32.7	Praa Sands	Cornwall		Flint flake and flint scraper found in peat sealed by blown sands	Prehistoric					SMR ID 164184
32.8	Praa Sands	Cornwall	SW 58202 27839	Ditch and bank section visible in cliff section, associated with agricultural soil with colluvium	Medieval?					Field visit 3 August 2007
33	Gunwalloe, The Towans	Cornwall	SW 66/20			Bay Dunes		V	GC, T, A	
33.1	Carrag-a-Pilez Cliff, The Towans	Cornwall	6624 2019 6630 2026 6628 2024 6626 2021	4 Round barrows shown in area of blown sands, now site of golf course	Bronze Age			S GC, T, A		BGS Sheet 359 ADS Record ID - NTSMR-NA12240, NTSMR-NA25350, NTSMR-NA27256, NTSMR-NA27257
33.2	Gunwalloe Church Cove	Cornwall	6569 2055	Cliff castle and church on edge of dunes	Late Iron Age					
33.3	Gunwalloe, Church Cove	Cornwall	SW 6596 2067	Dark Age Settlement within dunes ?	Early Medieval	LM, PM				Paradine 1981

34	Poldhu/Church Cove, Mullion	Cornwall	SW 66/19			Bay Dunes		V	T	BGS Sheet 359
35	Pendower Beach	Cornwall	SW 897 383 and SW 905 383				NT	NC, T		BGS Sheet 352
35.1	Pendower Beach	Cornwall	SW 8970 3816	Lime Kilns	Post medieval					NTSMR-NA3177
35.2	Pendower Beach	Cornwall		Military emplacements, pimple, pillbox, anti-tank wall	WW2					Defence of Britain database CBA
36	Porthluney Cove	Cornwall	SW 97/41					T		BGS Sheet 353
36.1	Caerhay, Nash House and landscape features	Cornwall	SW 9710 4161	Medieval mansion and chapel, demolished, replaced 1808. Part of landscape maybe impinged on by dunes to the south						NMR_NATINV-429909
36.2	Porthluney Cove	Cornwall	9725 4130	Pillbox, possible in area of dunes	WW2					Defence of Britain database CBA
37	Pentewan	Cornwall	SX 01/46-47					T, BD, Caravan Park covers dune		BGS Sheet 353
37.1	Pentewan	Cornwall	SX 01.46	Pillboxes	WW2					Defence of Britain database CBA
37.2	Pentewan harbour	Cornwall	SX 0193 4720	China clay docks 1826, maybe partly buried by dunes	1826 AD					NMR_NATINV-431098
38	Par Sands	Cornwall	SX 07/53, 08/53			Bay Dunes		A	T, BD	BGS Sheet 353
38.1	Par Harbour	Cornwall	SX 0771 5282	Harbour and China clay working may impinge on area of dunes	1829 AD					NMR_NATINV-431231
39	Tregantle	Cornwall	SX 38/52			Very small 100 m2		T		BGS Sheet 353
40	Challaborough	Devon	SX 64/44					T		BGS Sheet 355
41	Bigbury-on-Sea	Devon	SX 64/43-44, 65/44					T		BGS Sheet 355
42	Cockleridge	Devon	SX 66/44					GC		BGS Sheet 355
43	Bantham	Devon	SX 66/44					T, A, BD		BGS Sheet 355
43.1	Bantham Ham Life Saving Club	Devon	SX 66/44	Early medieval settlement sealed beneath dunes	Early medieval	LM, MM		BD		*Current Archaeology* 178 (2002) *Devon Arch Soc Newletter* 79 (2001) EH NMR 1342622 Griffith 1986 Griffith & Reed 1998 *Devon Archaeological Exploration Society newsletter* 24 (1983) *Archaeology in Devon* 6 (1982-3)
43.2	Bantham / Thurlestone	Devon	SX 663 437	Bronze Age finds Iron Age finds	Bronze Age Iron Age		Scheduled			EH NMR SX 64 SE 4

				Roman artefacts Post-Roman structures (trading post) Sealed beneath sands	AD 400-699 AD 1066-1540 5-7th century AD trading post					
44	Thurlestone (see Bantham)	Devon	SX 67/41-42					T, GC, BD		BGS Sheet 355
45	Dawlish Warren	Devon	SX 98/97-80, 99/79-80			Spit dune	SSSI, NNR, SAC, SPA* (Exe Estuary)	A	NC, T, GC, BD	BGS Sheet 339
45.1	Dawlish	Devon	SX 98/79	Flint implement, Scraper, on dune / saltmarsh edge ?	Palaeolithic		SSSI, NNR, SAC	S, E, NC		ADS Record ID - NMR_NATINV-925985
45.2	Dawlish	Devon	SX 98/79	Neolithic flint scatter	Neolithic		SSSI, NNR, SAC	NC, GC		NMR_NATINV-899692
45.3	Dawlish	Devon	Various	Pillboxes (x4)	WW2		SSSI, NNR, SAC	NC		Defence of Britain database CBA
46	Exmouth, The Maer	Devon	SY 00/80, 01/80					T		BGS Sheet 339
46.1	Danish Fort	Devon	SY 0036 8031	Site of a Danish Fort built in 1001 ?	Medieval					NMR_NATINV-448686
47	Wyke Regis	Dorset	SY 669 765					T, BD		BGS Sheet 341/2
48	Studland Bay	Dorset	SZ 03/83-87, 04/85-88		Dune ridges formed mainly from 17th century AD, but are likely to overlie older dunes	Spit Dunes	SSSI, NNR	S	NC, T, BD	BGS Sheet 342 (East) and part of 343 Driver 1933
48.1	Studland	Dorset	Various	Military installations (x20)	WW2			NC, T, BD		Defence of Britain database CBA
49	North Haven Point / Sandbanks, Poole Harbour	Dorset	SZ 03-04/87		Dunes largely built upon	Spit Dunes		BD, T		BGS Sheet 342 (East) and part of 343
50	Bournemouth	Dorset	SZ 092 909 to 142 913		Five patches of blown sand	Bay Dunes		BD, T		BGS Sheet 342 (East) and part of 343
51	Southbourne	Dorset	SZ 156 909 to 165 907		Located to the west of Hengistbury Head	Bay Dunes				BGS Sheet 342 (East) and part of 343
52	Hengistbury Head	Dorset	SZ 177 905	Late Upper Palaeolithic and Mesolithic flints, Iron Age and Romano-British occupation, sealed by or contained within blown sands.	Late Upper Palaeolithic Mesolithic C14 dates argued to be contaminants		SSSI, NR	NC, T, A		BGS Sheet 342 (East) and part of 343 Campbell 1977
53	Mudeford Beach, Christchurch Harbour	Dorset	SZ 18/90-91		Shingle and Sand ridge extending north from Hengistbury	Spit dune	SSSI (Harbour)	BD, T		BGS Sheet 342 (East) and part of 343

					Head with extant dunes forming from the 17th century AD					
54	Stanpit Marsh, Christchurch Harbour	Dorset	SZ 170 918			Small area of blown sand	SSSI (Harbour), Nature Reserve	NC, T		BGS Sheet 342 (East) and part of 343
54.1	Crouch Hill, Stanpit Marsh, Christchurch harbour	Dorset	SZ 1694 9185	Round barrow, pottery, flint, burnt flint. Find of amber bead and Mesolithic-Bronze Age finds in area of blown sands. Badly damaged by rabbit burrowing	Mesolithic Late Neolithic Early Bronze Age		SSSI (Harbour), Nature Reserve	NC, T		ADS Record ID NMR_NATINV-458662
55	Sandhills	Dorset	SZ 185 918 to 187 921			Small area of blown sand		T, BD Caravan Park		BGS Sheet 342 (East) and part of 343
56	Park Shore to Needs Ore Point	Hampshire	SZ 405 965 to 428 977			Spit Dunes		NC		BGS Sheet 344/5, 330/1
56.1	Park Shore to Needs Ore Point	Hampshire	SZ 409 966	Saltern	Date unknown, origin may be medieval					Hampshire CC HER Site UID 21978
56.2	Park Shore to Needs Ore Point	Hampshire	SZ 4086 9669	Salterns	Dark Age or medieval					Hampshire CC HER Site UID 57681
57	Sinah Common , Hayling Island	Hampshire	SZ 68/99, 69/99-70, 70/98			Spit Dunes		S	BD	BGS Sheet 331
57.1	Sinah Common, Hayling Island South	Hampshire	SZ 69/70	Pillboxes (several)	WW2					Defence of Britain database CBA
57.2	Sinah Common	Hampshire	SZ 692 990	Tank trap	WW2					Hampshire CC HER Site UID 26088
57.3	Sinah Common	Hampshire	SZ 6999 9940	Air raid shelter, anti-aircraft battery, gun emplacement, magazine and military camp	WW2					Hampshire CC HER Site UID 37734
57.4	Sinah Common	Hampshire	SZ 695 992	Bombing decoy	WW2					Hampshire CC HER Site UID 38275
58	Newton Bay	Isle of Wight	SZ 41/91, 42/91				SSSI (Newton Harbour)	NC, T		BGS Sheet 344/5, 330/1
59	Chale Bay	Isle of Wight	SZ 47/77-78, 46/78, 45/78							BGS Sheet 344/5, 330/1
59.1	Chale	Isle of Wight	SZ 485 775	Two sites, 1 in blown sand, 2 in cliff, brickearth. 25+ pieces of worked flint	Mesolithic					Wymer 1977
60	The Duver, St. Helen's	Isle of Wight	SZ 64/88				NT	NC, T		BGS Sheet 331
61	Black Point, Chichester Harbour	W. Sussex	SZ 750 950				SSSI (Chichester Harbour)	NC		BGS Sheet 331
62	East Head,	W. Sussex	SZ 76/98-99,			Spit Dunes	SSSI (Chichester	E	NC,	BGS Sheet 331

	Chichester Harbour		77/98-99				Harbour)		T	
63	Littlehampton	W. Sussex	TQ 01/01-04/01					BD, GC, A, T		BGS Sheet 322
64	Camber Sands	E. Sussex	TQ 98/18, 94/19, 95/18, 96/18		Dunes began accumulating in 1800s AD (Eddison 2000)	Spit Dunes. White (1928) describes the dunes encroaching landward and engulfing buildings	SSSI (Camber Sands and Rye Satlings) SNCI	S	NC, T, GC, A	BGS Sheet 320/1 White 1928 Eddison 2000
64.1	Camber Sands	E. Sussex	TQ 95/18	Machine gun emplacements (x2)	WW2		SSSI, SNCI	NC, T		Defence of Britain database CBA
65	Broomhill Level	E. Sussex	TQ 987 187 to 993 194					T		BGS Sheet 320/1
65.1	Broomhill Level	E. Sussex	TQ 98 18	Bronze Age pin	Middle Bronze Age			T		Bellam 1996
66	Denge Marsh	Kent	TR 04/19, 04/21					BD		BGS Sheet 320/1
67	Bird's Kitchen	Kent	TR 04/22					Golf driving range, T		BGS 305/6
68	Hawthorne Corner	Kent	TR 02/22, 03/23							BGS 305/6
69	New Romney	Kent	TR 05/24, 06/24-25, 07/25					BD		BGS 305/6
69.1	Church Road, New Romney	Kent	TR 0670 2492	Medieval occupation deposits, including clay floor	c. 1475-1550 AD			BD		*Archaeologia Cantiana* 124 (2004), 373
69.2	Fairfield Road, New Romney	Kent	TR 0662 2503	Medieval occupation deposits overlying blown sands Medieval occupation deposits sealed by blown sand Late Medieval structure overlying blown sands	c. 1250-1300 AD 13th century 1500-1525 AD			BD		*Archaeologia Cantiana* 123 (2003), 305
69.3	New Romney gas Pipeline	Kent	TR 065 247	Blown sand containing medieval pottery, overlain by silts, perhaps deposited during well documented flood 1287 AD				BD		*Archaeologia Cantiana* 117 (1997), 322
70	Greatstone-on-Sea	Kent	TR 083 224 to 084 238			Dunes rise c. 5 m above high water mark		BD		BGS 305/6
70.1	Greatstone-on-Sea	Kent	TR 08/23	Coastal artillery battery	WW2			BD		Defence of Britain database CBA
71	Warren Ho	Kent	TR 08/25-26					T		BGS 305/6
72	Dymchurch	Kent	TR 105 295 to 108 303					BD		BGS 305/6
73	West Hythe	Kent	TR 12/33-34					BD		BGS 305/6
73.1	Dyke Side Farm, West Hythe (also referred to	Kent	TR 12/33	Mid-Saxon settlement, including midden, pottery. Known from	7th century AD, possible extending after			BD		*Britannia* 28 (1997), 453 *Medieval Archaeology* 38 (1994), 231

	as ‘Sand Tun’.			Saxon charter. Preserved below blown sands	1066. Midden 8-10th century AD					
73.2	Dyke Side Farm, West Hythe	Kent	TR 1213 3386	Roman finds from underneath blown sands, unstratified	1-5th century			BD		*Archaeologia Cantiana* 124 (2004), 372
74	Dover	Kent	TR 31 41	Area of blown sands to the south of the Saxon shore fort, derived from local aeolian activity in a back-barrier environment				BD		
74.1	Dover Saxon shore fort	Kent	TR 31 41	Blown sands south of Saxon shore fort overlying silty loam sealing metalled surface	6-7th centuries AD.	PS		BD		Wilkinson 1994
75	Sandwich Bay (including Deal)	Kent	TR 37/54-55, 36/55, 35/57-60, 34/58			Open coast Barrier Spit Dunes. Northward growth of the dunes argued to have commenced soon after 5000 BP, as there is Mesolithic and Neolithic occupation of Lydden valley area and Roman remains are recorded below dunes sands north of Deal	NNR, SSSI, SAC	S	T, NC, GCx 3, BD	BGS Sheet 290
75.1	Deal	Kent	TR 375 515	Cremation, cutting brickearth, sealed by blown sands	Bronze Age					*Archaeologia Cantiana* 123 (2003), 302
75.2	East Barracks, Deal	Kent	TR 376 519	Small quantity of prehistoric flints from surface of brickearth and lower sand deposits. Early Iron Age pottery from carbon rich occupation layers interleaved with basal sands	Neolithic / Bronze Age c. 550-350 BC			BD		*Archaeologia Cantiana* 122 (2002), 353
75.3	North Barracks, Deal	Kent	TR 3749 5170	Prehistoric features cut into brickearth, sealed by blown sands	Prehistoric			BD		*Archaeologia Cantiana* 122 (2002), 353
75.4	Blackhorse Wall	Kent	TR 3702 5520	Ditch sealed by 0.8 m of blown sands. Roman coin of Tetricus found opposite Blackhorse Wall	Coin dated *c.* AD 271, ditch date unknown			BD		*Archaeologia Cantiana* 115 (1995), 274 Roach-Smith 1882
75.5	Northwall Road, Deal	Kent	TR 37 53	Excavation revealed short-lived prehistoric and Roman settlement on	Late Iron Age Romano-British			BD		ADS Record ID - EHNMR-1336334. 31/2000 Britannia

				reclaimed land, subsequently inundated by blown sands					
75.6	Dickson's Corner, Worth	Kent	TR 362 516	Roman Occupation sealed below and in cases separated by blown sands	*c.* AD 50 to *c.* 225.			BD	Parfitt 2000
75.7	Sandown, near Sandwich	Kent	TR 34 55	Iron Age and Romano-British occupation sealed by blown sands	*c.* 50 BC-AD 80				Parfitt 2006
75.8	Walmer	Kent	TR 377 507	Roman cremation buried in sand of either marine of blown sand origin	Romano-British				Hoskins *et al* 2005
76	Shell Ness, Isle of Sheppey	Kent	TR 043 676 to 046 696				SSSI (Swale), RAMSAR (Thames Estuary	T, NR	
77	Warden-Leysdown, Isle of Sheppey	Kent	TR 024 717 to 034 707				RAMSAR (Thames Estuary		
78	Annet	Scilly Isles	SV 864 084				RAMSAR, SPA	NC, T	
79	Burnt Island	St. Agnes Scilly Isles	SV 875 086				RAMSAR, SPA	NC, T	
80	The Cove	St. Agnes Scilly Isles	SV 87/08				RAMSAR, SPA	NC, T	
81	Wingeltang Bay	St. Agnes Scilly Isles	SV 883 074				RAMSAR, SPA	NC, T	
82	Gugh	Scilly Isles	SV 88/08, 89/08				RAMSAR, SPA	NC, T	
83	Porth Cressa	St. Mary's Scilly Isles	SV 90/10				RAMSAR, SPA	NC, T	
84	Porth Mellon	St. Mary's Scilly Isles	SV 908 108				RAMSAR, SPA	NC, T	
84.1	Porth Mellon (also see 72.1)	St. Mary's Scilly Isles	SV 909 108	Peat (50 cm) sealed by blown sands	Late Neolithic / Early Bronze Age (no C14)				Scourse 1986
85	Thomas Porth	St. Mary's Scilly Isles	SV 909 111				RAMSAR, SPA	NC, T	
86	Porth Loo	St. Mary's Scilly Isles	SV 909 113				RAMSAR, SPA	NC, T	
87	Halangy Porth	St. Mary's Scilly Isles		Iron Age occupation, including midden, pottery, animal bones, querns, stone structures. Cist grave overlain by blown sands	2260±60 BP (HAR-1313) 2390±50 BP (OxA-4697) 2250±50 BP (OxA-4696)	C14, PM			Ratcliffe and Straker 1996
87.1	Porth Loo (also see 70.1)	St. Mary's Scilly Isles	SV 909 112	Peat (50 cm) sealed by blown sands	Late Neolithic / Early Bronze Age (no C14)				Scourse 1986
88	Bar Point	St. Mary's Scilly Isles	SV 91/12, 92/12				RAMSAR, SPA	NC, T	
88.1	Bar Point	St. Mary's Scilly Isles	SV 915 130	Prehistoric field walls below blown sands	Prehistoric	P (stabilisation horizons in blown sands)			Evans 1983 McPhail 1981
88.2	Innisidgen	St. Mary's Scilly Isles	SV 921 127	Buried soil buried by blown sands	Prehistoric (ascribed date	P			Scourse 1986

					on basis of palaeoecology)				
89	Watermill Cove	St. Mary's Scilly Isles	SV 924 123				RAMSAR, SPA	NC, T	
89.1	Watermill Cove	St. Mary's Scilly Isles	SV 925 123	Blown sands overlying thin layer of breccia and organic layer	33,050± 960/ 860 BP (organic bed 3a) 26,680± 1410/1200 BP (organic bed 3c)	P (organic layer)			Scourse 1986
90	Pellistry Bay	St. Mary's Scilly Isles	SV 927 119				RAMSAR, SPA	NC, T	
91	Porth Hellick	St. Mary's Scilly Isles	SV 925 107				RAMSAR, SPA	NC, T	
	Higher Town Moors	St. Mary's Scilly Isles	SV 925 107 to 921 115	76 cm of peat rests sharply on clean white sand (sub or supra tidal?)	6330± 100 BP (HAR-3695)	P, C14			Scourse 1986
92	Old Town Bay (E)	St. Mary's Scilly Isles	SV 916 102				RAMSAR, SPA	NC, T	
93	Old Town Bay (W)	St. Mary's Scilly Isles	SV 913 103				RAMSAR, SPA	NC, T	
94	Nornour	Scilly Isles	SV 945 148				RAMSAR, SPA	NC, T	
94.1	Nornour	Nornour	SV 944148	Prehistoric, Romano-British settlement. Remains in buried soil sealed by blown sands	C14 (1000 BC – AD 400)	P, C14			Dudley 1967 Butcher 1978
95	Great Ganilly	Scilly Isles	SV 947 144				RAMSAR, SPA	NC, T	
96	Great Authur	Scilly Isles	SV 940 137				RAMSAR, SPA	NC, T	
97	Higher Town Dunes	St. Martin's Scilly Isles	SV 93/15				RAMSAR, SPA	NC, T	
97.1	Par Beach	St. Martin's Scilly Isles	SV 93/15	Five peats buried beneath blown sands, earliest Mesolithic in date, last of late Romano-British / early Medieval date	1570±50 BP (GU-5062, cal AD 390-600)	P, C14			Ratcliffe & Straker 1996
97.2	Par Beach	St. Martin's Scilly Isles	SV 932 153	Iron Age and Roman buildings and burials within intertidal zone. Excavated hut and walling indicated as most probably submerged under extensive sand dunes	3-4th AD century pottery				EH NMR SV 91 NW 1
98	Great Bay Dunes	St. Martin's Scilly Isles	SV 92/16				RAMSAR, SPA, SAC	NC, T	
98.1	Little Bay (part of Great Bay)	St. Martin's Scilly Isles	SV 922 164	Prehistoric Occupation site covered by blown sands	3190±110 BP (HAR-1715) 2780±80 BP (HAR-1726) 3490±100 BP (HAR-4324)	C14, AB			Neal 1983
98.2	Chapel Down	St. Martin's Scilly	SV930 159	Field system visible as	Bronze Age /				EH NMR SV 91 NW

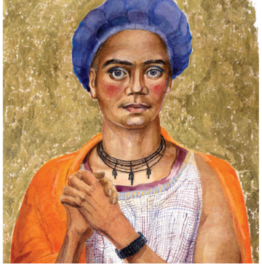
		Isles		scattered ridges covered by blown sand and scrub. Part of larger field system	Iron Age				15
99	Lower Town Dunes	St. Martin's Scilly Isles	SV 9/16				RAMSAR, SPA, SAC	NC, T	
100	Tean (E)	Scilly Isles					RAMSAR, SPA	NC, T	
101	Tean (W)	Scilly Isles					RAMSAR, SPA	NC, T	
102	Appletree Banks	Tresco Scilly Isles	SV 89/13-14				RAMSAR, SPA	NC, T	
102.1	Appletree Bay	Tresco Scilly Isles		Blown sands overlie old land surface, yielding significant numbers of worked flint, possible stone round house					Ratcliffe & Sharpe 1991 (c.f. Ratcliffe & Straker 1996)
103	Pentle Bay	Tresco Scilly Isles	SV 89/14, 90/14				RAMSAR, SPA	NC, T	
103.1	Crab's Lodge	Tresco Scilly Isles	SV 89/14	Blown sands overlain by humic sandy loan (peat)	1480±80 BP (GU5062)	*Note: no indication whether sands are sub or supra tidal.			Ratcliffe & Straker 1996
104	Old Grimsby	Tresco Scilly Isles	SV 89/15, 88/15				RAMSAR, SPA	NC, T	
105	Gimble Porth	Tresco Scilly Isles	SV 88/14				RAMSAR, SPA	NC, T	
106	Stoney to Stinking Porth	Bryher Scilly Isles	SV 875 152				RAMSAR, SPA	NC, T	
107	Popplestone Neck	Bryher Scilly Isles	SV 87/15				RAMSAR, SPA	NC, T	
108	The Brow	Bryher Scilly Isles	SV 881 150				RAMSAR, SPA	NC, T	
109	East Coast Fragments	Bryher Scilly Isles	SV 88/15				RAMSAR, SPA	NC, T	
110	Samson Flats	Samson	SV 87/12				RAMSAR, SPA, SSSI	NC, T	
110.1	East Porth	Samson	SV 87/12	Old land surface exposed below blown sands, including prehistoric walls, pottery, 286 charred cereal grains	3620±70 BP (OxA-3649, 2200-1770 cal BC)	PM, C14			Ratcliffe & Straker 1996
110.2	West Porth	Samson	SV 87/12	Old land surface with late Bronze Age and early Iron Age occupation, sealed by blown sands. Flint, pottery, hut circles. Iron Age pottery in blown sands. Charred cereal grain.	2545±65 BP (OxA-3650) 2525±65 BP (OxA-3651)	PM, C14, AB			Ratcliffe & Straker 1996
111	Bar Point	Samson	SV 878 133				RAMSAR, SPA, SSSI	NC, T	

Conservation and Land Use relate in part or whole of the Dune system or site in question.

NGRs refer to 1km2, 6 figure NGRs centre points of small blown sand deposits

APPENDIX 3 NUMBERS OF LAND SNAIL TAXA AND SHELLS IN VARIOUS CONTEXTS ON FOUR CORNISH DUNE SITES. DATA PROVIDED BY T. WALKER.

Site	Context	Sample sieved	No. taxa	No. shells
Widemouth Bay	'shelly' layer above buried soil	629 g (all sample)	no terrestrial shells	
Daymer Bay	0.30-0.80 cm. above buried soil	2000g	20	661
Harlyn Bay (East)	buried soil	2000g	11	971
Harlyn Bay (West)	0-0.30 cm.	1000g	13	120
Harlyn Bay (West)	0.30-0.40 cm.	1000g	8	270
Harlyn Bay (West)	0.40-0.70 cm.	1000g	6	141
Harlyn Bay (West)	0.70-0.80 cm.	1000g	7	62
Godrevy Towans sand quarry	above buried stabilization layer	1000g	11	742
Godrevy Towans sand scarp	top – stabilization layer	1000g	6	623
Godrevy Towans sand scarp	middle – blown sand	1000g	9	83
Godrevy Towans sand scarp	bottom – stabilization layer	1000g	12	861



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