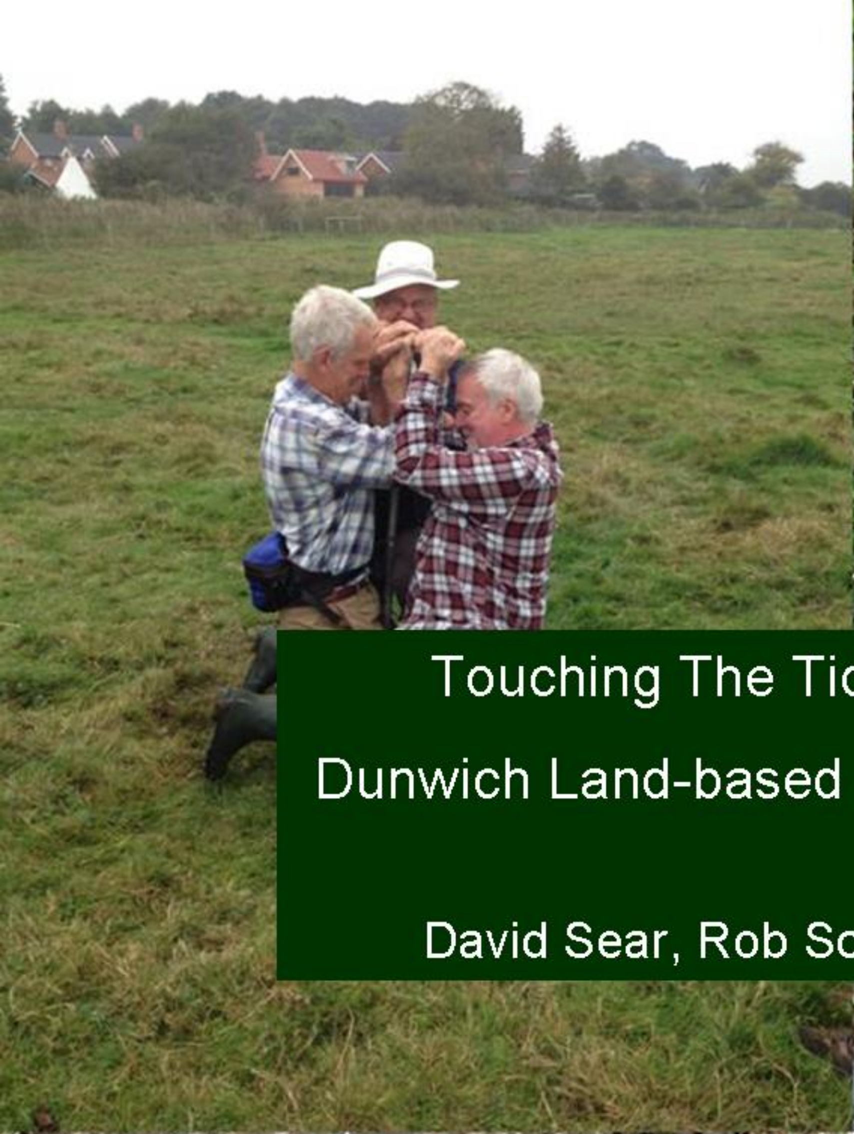

Touching The Tide Project Report

Dunwich Land-based Archaeological report

David Sear, Rob Scaife, Cath Langdon

Touching the Tide
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Touching The Tide

Dunwich Land based Archaeological Survey: 2014-15

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2015

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1.0 Introduction

The fate of the medieval town of Dunwich is well documented (Gardner, 1754; Parker, 1975; Comfort, 1994; Sear et al., 2011; Sear et al., 2012). The precise size of the original town is unknown, but was sufficiently important to have once perhaps have been the seat of the first Bishop of East Anglia, and to have received Royal Charters for a market and a mint (Gardner 1754; Bacon and Bacon 1979, Chant, 1986). In 1086 Dunwich was one of the ten largest towns in England (Comfort, 1994). The wealth of Dunwich was primarily based on sea trade, fishing and ship building; with substantial investment by different religious orders and at times the Crown. Until the middle of the 14th Century, Dunwich was a nationally important seaport. By 1225 it was approximately 1.6km (1 mile) from north to south, with an area similar to the City of London at the same time (Gardner 1754). The town of Dunwich contained up to 18 ecclesiastical buildings, a mint, a large guildhall and several large important houses (Comfort, 1994, Bacon 1979; Chant 1986). By 1242 Dunwich was the largest port in Suffolk with a population estimated to be 5000 at its height, with at least 800 taxable houses, and an area of c.800 acres (Comfort, 1994; Bailey 2007).

The town declined rapidly in the later 13th Century due to blocking of the harbour by extension of a sandy gravel spit during large storms in 1287, and 1328. Sear et al., (2008) suggest that this coincided with a phase of climate change during transition from the Medieval Warm period into the Little Ice Age. Storminess increased in both frequency and magnitude during this period and continued with phases in the later 17th Century and early 18th century, and again at the end o the 19th and start of the 20th centuries. The result of this storm activity was the collapse in shipping trade and income from the market, plus the physical loss of the town and its valuable infrastructure including churches, Friaries and domestic homes. The loss of the market place and town

hall ended the viability of Dunwich as a centre of trade in the late 17th century (Sear et al., 2011).
Whilst much is known about the decline of the town, comparatively little is know about its origins. Many speculate that it was a Roman settlement, and indeed artefacts dating from this period including tiles, have been found. The town was a Saxon settlement but the scale and precise extent of this is uncertain (Sear et al., 2012; Chant 1986). Thus this project represents an attempt to better understand the value of the existing sedimentary archives associated with the town with a view to providing evidence of its origins and history.

2.0 Project Aims

The main aims of the project were:

1. To establish a minimum date for the construction of the town based on dating of sediments at the base of road and defensive ditch deposits exposed in the cliff.

2. To establish an environmental history of the harbour and in particular to determine the sequence and timescales over which it changed from an open estuary to a freshwater marsh and where possible, to identify flood event deposits.

3.0 Site Overview

3.1 Cliff Exposures

The eroding cliffs at Dunwich provided an opportunity to access sections cut through the archaeological horizons within the western extent of the Pales Dyke. This work is vital since these remains are potentially at risk from destruction from cliff retreat (Sear et al., 2012). The land within the Pales Dyke is only 30m wide at the widest point and is likely to be lost within the next 50-100 years. However, it is this exposure in the cliff face that provides an opportunity to access the archaeology without the need for destructive trench digging.

3.2 Objectives

1. To obtain dateable material from the lowest horizon within the Pales dyke defensive ditch and roads. This material to be either organic (bone, plant material or charcoal) for radiocarbon dating or in the absence of dateable organic material, to collect sediment samples from below and within the lowest disturbed sediments for optical luminescence dating.
2. If pottery fragments are evident and accessible without disturbance, then a sample of these will also be recovered.

3. In ALL cases we are only interested in recovering a minimum 1 sample from the lowest (oldest) layers of the exposed roads and Pales Dyke exposures.
4. To obtain dates for each sample and report to Greyfriars Trust and Dunwich Museum.

3.3 Methods

A stipulation of the permission to undertake the Cliff Face sampling given by the Greyfriars and Dunwich Town Trust, was that minimal disturbance was made to the cliff face. This required a method to access and sample the lowest horizons of each site without full cleaning of the whole section. Access to the sediment layers exposed in the cliff were undertaken by climbing up stable vegetated talus (St James Street/Pales Dyke), or by abseiling (Scott's Lane) using a fixed top rope set >10m back from the cliff edge. The cliff edge was protected from the rope by using tarpaulin and wooden boards to distribute the load over the ground adjacent to the cliff edge. On arrival at the base of the section the surveyor identified the lowest of the sections above the undisturbed cliff sediment. In all cases we used naturally exposed sections, but where necessary we carefully cleaned a small section to reveal this lowest horizon.

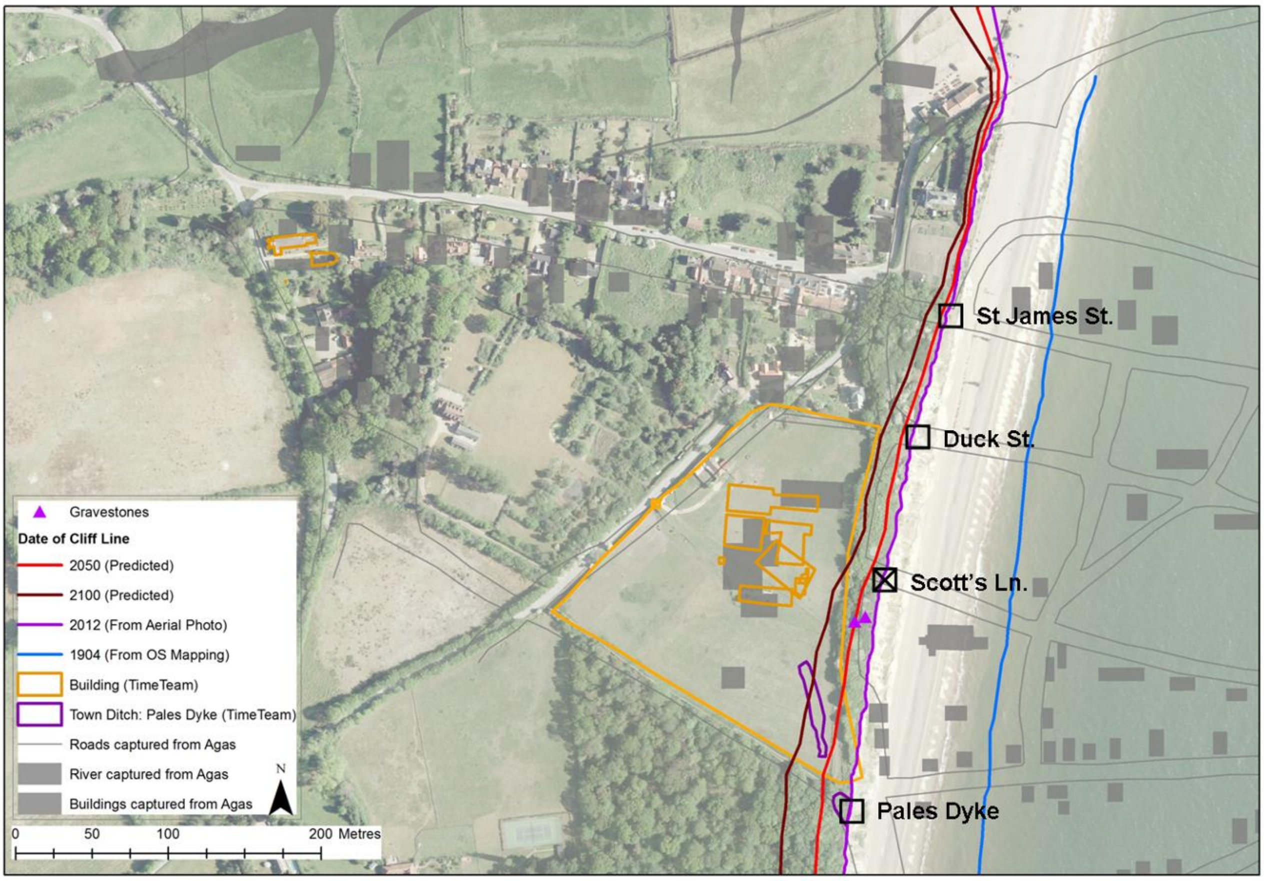


Figure 1: Cliff sites identified for sampling. Note the predicted position of the 2050 – 2100 coastline shows the imminent loss of these sites. Scott's Lane site was not sampled for safety reasons. Samples were taken from the base of St James Street, Duck Street and the Pales Dyke. Base map from Sear et al., (2012).

This minimized disturbance to the cliff face whilst ensuring access to any dateable material exposed at that point. For Radiocarbon and pottery dating we photographed and recovered the exposed fragments/soil, minimizing disturbance to the cliff face.
The sample sites were selected using the digital mapping developed by Sear et al., (2012), and locating the positions where major roads and the town defensive ditch – the Pales Dyke, intersected the 2012 Air photo cliff line (Figure 1).

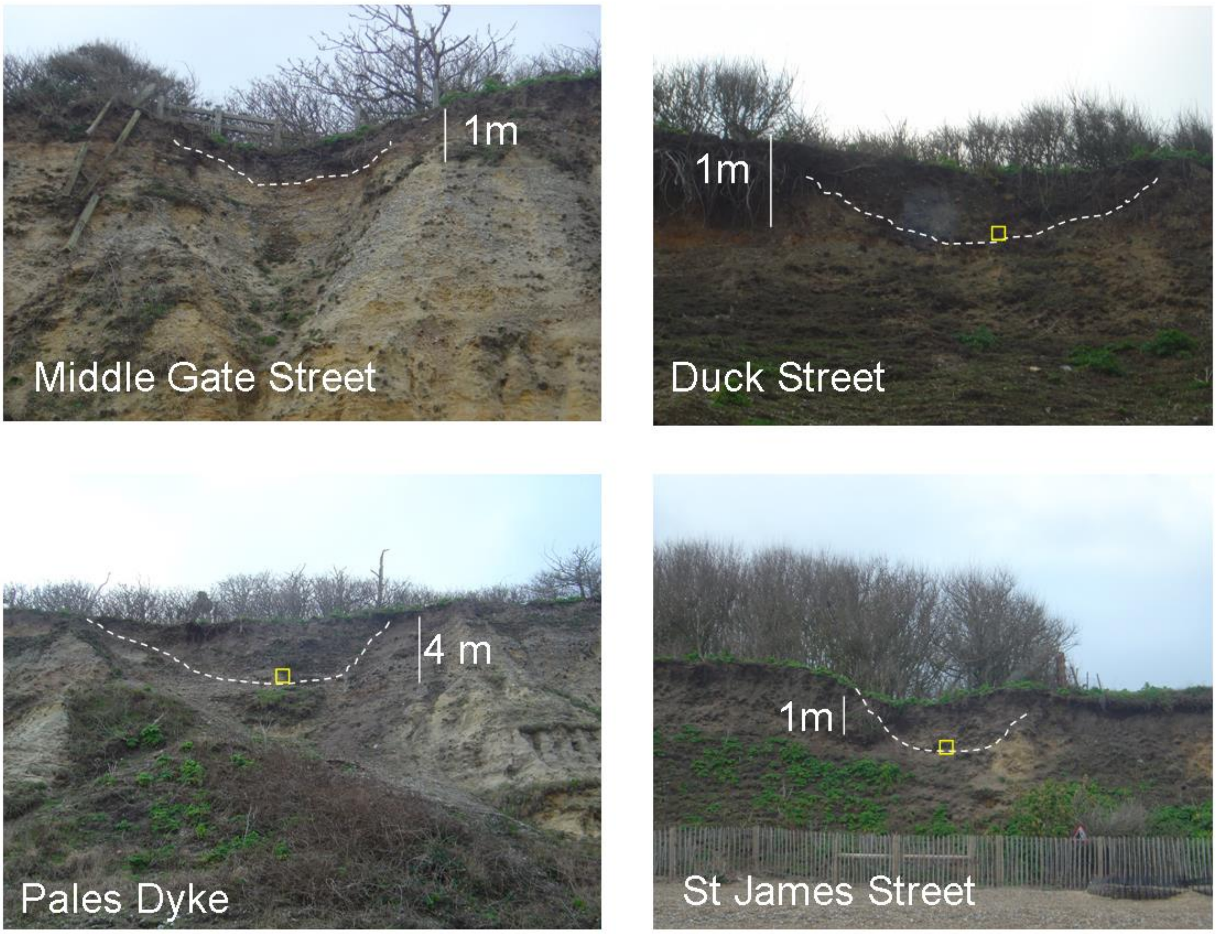


Figure 2: Cliff exposures identified as sampling sites. The lowest horizon above the natural geology of the cliff was sampled (Yellow square). Middle Gate Street was not sampled for safety reasons assessed on the day of survey.

3.4 Geochronology

Three dating methods were considered; 1) dating of any archaeological material found within the sections (e.g. pottery/bone); 2) AMS Radiocarbon dating of charcoal, organic rich sediments and / or plant/bone material; and 3) Optical luminescence dating, which works on the principal that exposure to sunlight 'zeroes' the natural radiation stored over time within the crystal lattice of quartz. Hence the amount of stored radiation (released as luminescence) is a function of time since last exposure to sunlight. It can be used on sediments that are from 300 to 100,000 years BP, and has a 5% accuracy (±50 years on a 1000 year old sample) (see http://crustal.usgs.gov/laboratories/luminescence_dating/what_is_tl.html).

There is the risk that the ditch and road fills were periodically cleaned out or deepened later in their lifetimes. Thus any age is likely to be a minimum date. The purpose of securing dates from a range of sites is to try and maximize the probability of securing a date which reflects the earliest date of construction for the town. In the event, 3 sections were sampled, and two were amenable for AMS bulk radiocarbon dating. One sample from St James Street, contained coal fragments and was therefore unable to be dated. It proved impossible to obtain samples for OSL, due to the presence of pebbles in the layers in or around the location of the dateable layers which prevented recovery of a suitable sample.

In the core samples taken in the floodplain (See section 5 below). Two samples were picked for AMS radiocarbon dating, located at 64cm and 84cm below ground surface in core Dun4. All samples were sent to beta Analytical for dating. Table 1 reports the full dates, and Appendix 1 provides the full Beta reports.

Sample	**Material**	**Conventional Radiocarbon age**	**Calibrated Radiocarbon age**
Pales Dyke TTTDunwichS2 Beta – 397875	Organic sediment (bulk)	2270 ± 30 BP	Cal BC 375 (Cal BP 2325)
Duck Street TTTDunwichS3 Beta - 397876	Organic sediment (bulk)	1310 ± 30 BP	Cal AD 675 (Cal BP 1275)
Core DUN64 Beta-407117	Organic material (bulk)	1620 +/- 30 BP	Cal AD 420 (Cal BP 1530)
Core DUN84 Beta-407118	Plant material (Cannabis Seed)	980 +/- 30 BP	Cal AD 1025 (Cal BP 925)

Table 1: Radiocarbon dates for the cliff sections (TTTDunwichS2;S3) and for the core samples (DUN64;DUN84) collected from the floodplain. Dates are calibrated using Reimer PJ et al. (2013). IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP. Radiocarbon 55(4):1869–1887.

All dates reported are earlier than expected, dating from the middle Iron Age through to late Saxon-early medieval.

4.0 Results

The site was visited on September 5th-7th 2014. A visual survey was made of the cliff top and the location of sections identified and photographed. A GPS (Garmin eTrex 10, horizontal accuracy +/- 2m) survey of the cliff top was then used to find the centre point of each section and checked against a) the GIS mapping, b) the field evidence (relationship to walls, earthworks), and c) stratigraphic evidence in the cliff exposure. Two sites, Middle Gate and Scotts Lane (Fig 1), were considered too dangerous to sample at the time due to evidence of loose and recently eroded sediments that reflected locally active cliff erosion. The remaining sites – Pales Dyke, St James Street and Duck Street were accessed and sections identified for sampling.

At each site the position of the transition from undisturbed geology to disturbed soil and fill were identified visually, and a small 0.3m wide x 0.5m high section cleared for detailed stratigraphic recoding and sampling for dateable materials. The transition was readily identifiable in the form of yellow marine sand exposed in layers along the cliff (Duck Street, St James Street), and a continuous, orange stained layer of sand and marine pebbles (Pale Dyke). The underlying geology is undivided drift, mainly fine-grained buff to brown, locally shelly, micaceous sands, with local rounded flint gravels (BGS 191).

4.1 Pales Dyke

The town of Dunwich was enclosed to the west, south and most probably north by a defensive ditch called the Pales Dyke (Comfort 1994). A defensive ditch and palisade is said to have been present during the regional insurrection led by The earl of Leicester, that threatened Dunwich in 1173 AD. This puts the earliest date for the ditch in the 12th Century. West (1973) reports "the presence of three pieces of Romano-British pottery from the infilling of the ditch are indications of some sort of occupation during that period but allow nothing more", thus suggesting a possible earlier origin for the ditch.

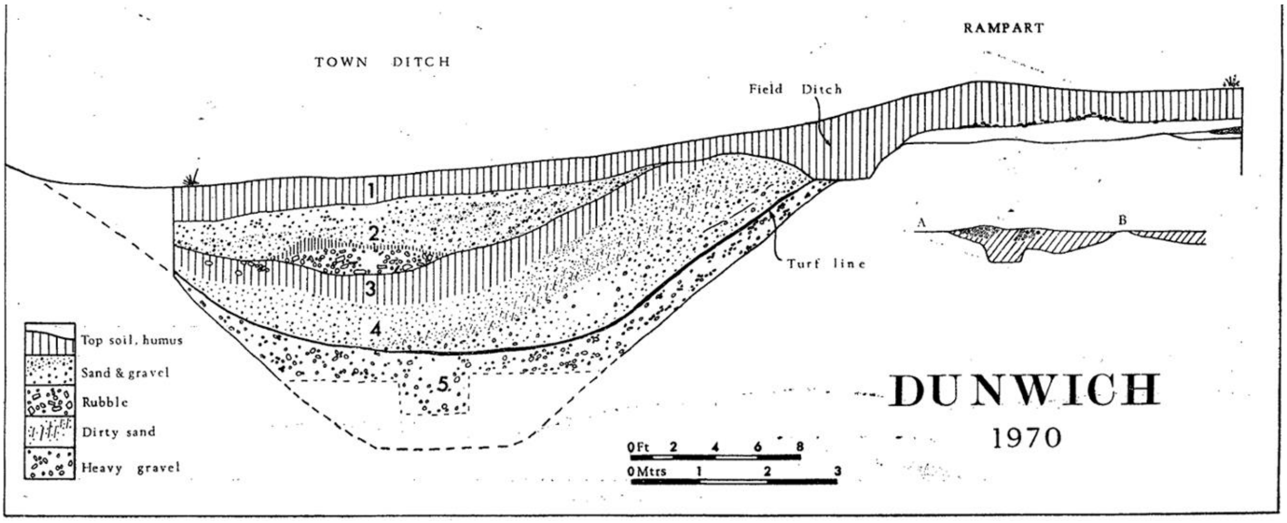
Excavations through the ditch and eastern (inner) rampart were conducted by West in 1970 (West 1973) and by the Time Team in 2011 (Wessex Archaeology 2012). Additional associated excavations of the Temple Mound in 1936 (Spencer 1936) showed that this structure post-dated the ditch and rampart. Similarly Norris (1939) and West (1973) demonstrate that the ditch predates the construction of Greyfriars Friary (c.1290 AD) which accords with documentary accounts (Parker 1976; Comfort 1994).

The West 1970 excavations were conducted at a location similar to that of the current cliff section survey. The section was outside the south and eastern perimeter of Greyfriars Friary. In contrast, the Time Team section was within the eastern perimeter of Greyfriars. Figure 3a shows the stratigraphy of West (1973) section, and Figure 3b the Stratigraphy of the Time Team section (Wessex Archaeology, 2012).

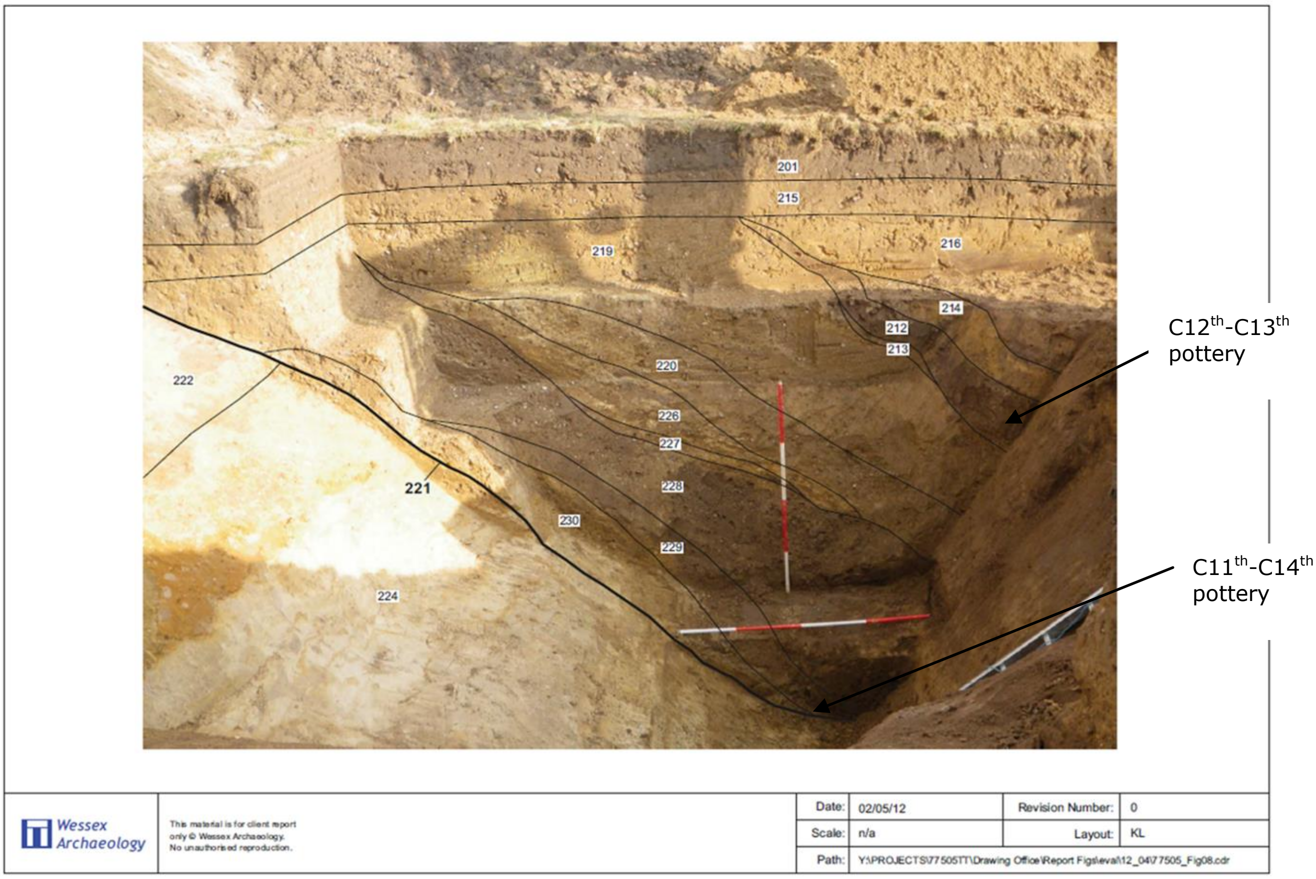
Spencer records the ditch as 10ft (3.05m) deep and 40ft(12.19m)wide. West (1973) records a ditch 15ft (4.57m) deep and 40ft (12.19m) wide, explaining that the lower turf layer in his trench (see boundary between 4 and 5 in Fig Xa) represented the bottom of Spencer's trench. Wessex Archaeology (2012) record broadly similar dimensions as West, at 10m (32ft) wide and 3.7m (12ft) deep.

Stratigraphy is different although broadly similar trends can be seen. The base of the ditch is cut into a Mid orange sand. 5% stone/gravel, subrounded–rounded, <1-2cm gravels (Wessex Archaeology, 2012). Above this is the start of the fill (229-228 in Fig 3b and layer 5 in Fig3a), a layer of Dark brown sandy silt loam. <1% stone, sub-rounded – rounded, <1-2cm, Fairly homogeneous; moderately compact; slightly humic. Wessex Archaeology suggest that this is water-worked inwash containing topsoil which accounts for the humic nature of the sediments. Above this layer are a series of complex infills, including materials associated with the lowering of the eastern rampart, rubble from 19^{th} Century activity in Greyfriars, and humic topsoil. Detailed stratigraphy can be found in Wessex Archaeology (2012) and West (1973).

No dates were produced by the 1970 excavation of West. Time Team provided a tentative estimate based on one small pot sherd which was dated to the 11^{th} - 12^{th} Century, suggesting an early medieval or late Saxon origin.



a)



b)

Figure 3a Section through the Pales Dyke based on the excavations by West (1973). Note the 5ft depth of dark silts sand with gravels overlain by a turf layer. 3b Section through Pales Dyke within the Greyfriars eastern perimeter wall. Gravelly humic silty sand layers 229-228 likely correspond to the layer 5 in West's section. Figures reproduced from West (1973) and Wessex Archaeology (2012).

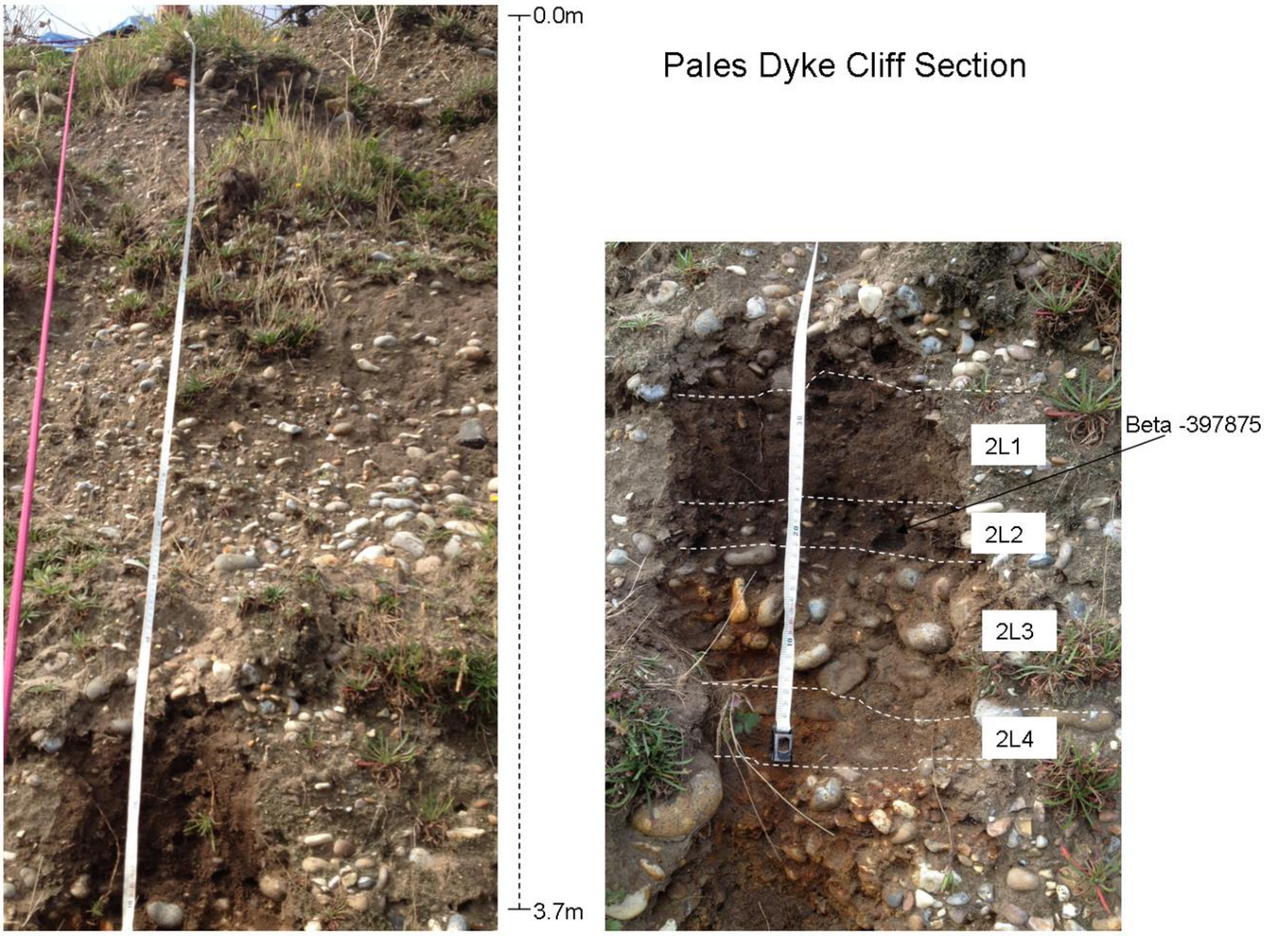


Figure 4: Section through the Pales Dyke bottom sediments. Left shows context for the bottom section. Right shows bottom section with stratigraphic markers and the location of the radiocarbon sample. Details of these are given in Appendix 3.0. 2L3-2L4 is in-situ cliff material.

The 2015 cliff section across the Pales Dyke was located at TM47743 70702 (Figure 1) at an altitude of 27m (Full details in Appendix 3.0). The Bottom of the ditch was identified as a brown silty sand with small matrix supported gravels (<1cm diameter, <5%) with humic organic material. This layer is very similar to 229-228 in Wessex Archaeology and Section 5 in West (1973), although the latter appears to have higher gravel content. Below this layer are two layers of water-worked larger framework supported gravels, with an orange sand matrix. The lower of the two layers (2L4) is indurated and compacted, with iron staining, typical of layers of gravel outcropping in the cliff face. These are interpreted as in-situ geology associated with the undisturbed cliff material. Two samples of humic rich sediment were collected from 2L2 for Radiocarbon analysis. The presence of gravels made the collection of optical Luminescence samples impossible. No evidence of pottery or larger organic remains were evident in the section. Of interest is the exposure of what may be the 19th Century rubble deposit identified by West (1973) in his excavations (see top of left hand panel in Figure 3, and lens of rubble in Figure 4 between layers 2 and 3). Additional work to clean up a complete vertical section to fully contextualise the lower section has been agreed by Greyfriars Trust, and will be conducted later in the summer.

The two samples were returned to the Palaeoecology laboratory at the University of Southampton (PLUS), Department of Geography and Environment for preparation for Radiocarbon dating. Samples were prepared for radiocarbon analysis by careful sorting in a sterile petri dish under a Nikon SMZ1000 stereo microscope. Samples were first cleaned using distilled water and datable material identified and picked out using fine forceps in preparation for pre-treatment and dating. Samples were then sealed in 5ml glass vials and sent off to Beta Analytical for Carbon dating, together with a sealed bulk sample of humic rich sediment. In the event, Beta recommended using the bulk humic sediment as the quantity of picked organic matter was too low after acid treatment, for reliable dating. The specific Beta reports are given in Appendix 1.0, which details the processing and Calibration used in the analysis.

The calibrated bulk organic sediment date for the bottom of the Pales Dyke section (Beta – 397875), is Cal **375 BC** (Cal BP 2325) with a 95% range of 395 BC to 350 BC (Cal BP 2345 to 2300), 295 BC to 230 BC (Cal BP 2245 to 2180) and Cal 220 BC to 210 BC (Cal BP 2170 to 2160). This puts the age of the sediments in the lowest layer of the Pales Dyke within the Middle Iron Age (400 – 100 BC). The sediments, are interpreted as in-washed soil material, and may therefore, reflect erosion of earlier material from within the ditch banks. Thus we are unable to say that this date is a minimum for the construction of the ditch. However, this is also true of the pottery material found in the in-washed soils, and as such the precise date for the Pales Dyke remains inconclusive.

The evidence for the age of the Pales Dyke is conflicting. Looking at the earliest dates, we have historical reference to it in the 12th Century (1173 AD); Thetford ware pottery c. 11th Century (Time Team excavations) and Romano-British (1st-4th Century AD) based on West's excavation notes. The Middle Iron Age date reported in this study, pushes the potential origin back a further 400-800 years. A few Iron Age finds have been recorded in the area around Dunwich, notably a coin in the Westwood marshes to the north, and pottery on the sandy hills adjacent to the Dunwich river crossing (Dymond & Martin, 1989). Iron Age fortifications are rare in east Suffolk, with the nearest located at Burgh, near Woodbridge (Dymond & Martin 1989). If correct, Dunwich would be an early and extensive Iron Age fortified settlement, located adjacent to a port on the Dunwich/Blyth river. Subsequent evidence suggests it existed in the Romano-British period and Saxon period when we know Dunwich was a growing port. It seems most likely that the ditch is earlier than the medieval origins assumed before which is supported in part by the early date for Duck Street (675 AD) and due to evidence of a Middle-Late Saxon retting pit in the marshes adjacent to St James street (485-1025AD).

4.2 Duck Street

Duck Street is shown on the Agas map of 1589 AD, as an eastern spur off the road that ran along the line of the Pales Dyke (Figure 1). Duck Street parallels St James' and Scott's Road, running east into the town centre, to the south of St Peters Church. It was not a major road (c.3.8m wide), and did not puncture the Pales Dyke.

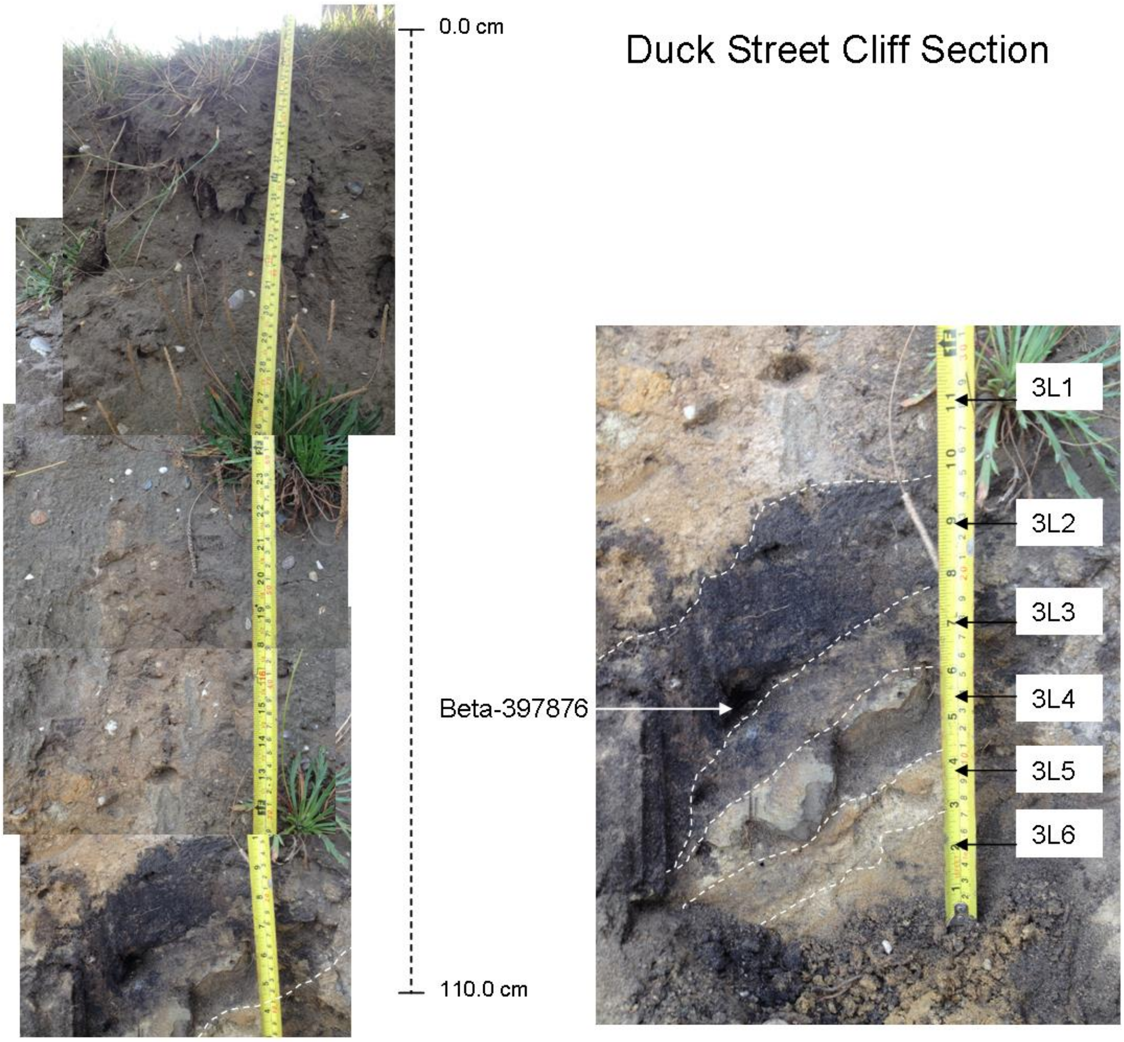


Figure 5: Stratigraphy of the Duck street cliff section. Left shows the context for the section, right shows the stratigraphic layers (details in Appendix 3) at the bottom of the section, including the location of the radiocarbon dated sample. 3L5-3L6 is in-situ cliff material.

The site of Duck street was located visually and by GPS at TM47778 70947. It consisted of a 3.8m wide deeper layer of humic sandy loam topsoil relative to adjacent sections exposed in the cliff (Figure 5). A Section was cleaned at the interface of the undisturbed geology (3L5/6) and the humic sandy loam soil, interpreted to be the bottom of the road section (3L4-1). Of interest is a compact clay rich layer (3L4) at the base of the section which might be an attempt to compact the road surface. Above this layer is a silty-clay with patches of humic rich materials (3L3). These humic rich sediments form a concentrated discrete layer (3L2) from which we took two samples for

Radiocarbon dating. Above this humic rich layer the soil is a sandy loam with small rounded-sub-rounded pebbles. No evidence of a pavement of coarser stones was present.

The two samples were processed following the same procedure as outlined in the Pales Dyke Section above. Organic matter sample size was again too small and so bulk humic rich sediment was used (Table 1; Appendix 1.0).

The calibrated bulk organic sediment date for the bottom of Duck Street cliff section (Beta – 397876), is Cal **675 AD** (Cal BP 1275) with a 95% range of Cal 655 AD to 725 AD (Cal BP 1295 to 1225), Cal 740AD to 770 AD (Cal BP 1210 to 1180). This puts the bottom sediments of the road firmly in the Middle Saxon period (400-1066 AD), during a time when the kingdom of East Anglia had been firmly established and St Felix had established a Bishopric (c.630AD) at Dunmoc (Dymond & Martin 1989). The sediments appear to be discrete representing a local concentration of humic material within the inwashed soil. Thus while the same criticism of the sample (potentially older material washed into the road) can be made, the date does accord with the known presence of a Saxon settlement at Dunwich.

4.3 St James Street

St James Street (TM47804 71037) is clearly visible in the cliff section as a shallow depression aligned with the existing path that occupies the old street. A clear transition exists between the base geology (in this case a yellow sand) and humic brown sandy silt of the in-washed sediment, which includes pebbles and sandy silts with evidence of coal (Figure 6). The latter prevented acquisition of a radiocarbon date from this feature. Thus no date was established for the road which was one of the main thoroughfares into the town. An additional attempt to secure a sample from the section revealed the presence of larger fragments of coal. In the future an attempt should be made to recover more dateable material from this section.

4.4 Summary

The attempts to secure dateable materials from road and Pales Dyke sections have proved successful to a point. Access to some sections is safe and repeatable. It is possible to locate the base of the road and Pales Dyke sections relative to in-situ geology. Furthermore we have demonstrated that it is possible to secure dates based on bulk organic sediments. The main problem with the approach is the limited sections that were permitted to be worked on for reasons of concern for cliff erosion. Similarly, the materials may represent older sediment washed in to a later road/ditch cutting. Cleaning of a wider section would help provide evidence for the origin of the sediment within the road / ditch sections. Similarly, wider cleaning of the section face may reveal in-situ organic material (nuts, plant fragments) that could be more robustly dated (although the criticism would pertain). In the end, we recovered two dates. Both are earlier than hitherto found and support an earlier origin to the town of Dunwich.

Figure 6: St James Street cliff section showing context (left) and detail of the bottom sediment section including stratigraphic layers (details in Appendix 3.0). Location of coal deposit is shown which precluded radiocarbon dating. Section 1L5 is in-situ cliff material.

5.0 The Stratigraphy and Pollen analysis of the Dunwich Marshes: Core 4

5.1 Introduction

Stratigraphical survey of the Dunwich Estuary (Sear, 2015) revealed a number of interesting sediment profiles which have potential for establishing the changing historic environment of Dunwich and estuary, That is, especially pertaining to the local vegetation and land use of the near region and of the history of estuarine development. Multidisciplinary studies are being used comprising detailed description and analysis of the sediments, pollen and diatom analysis and radiocarbon dating, the latter to provide an absolute chronology of marine and brackish water incursions. Subsequently, these palaeodata will be compared and integrated within the historical documentation available for the port of Dunwich. This report presents the first stage of this analysis dealing with the stratigraphy, pollen analysis and vegetation dynamics of the site.

5.2 Core Transects and site

Two core transects were collected over the period 2010-2015. Detailed analysis of Transect Dun2015 and specifically Cores Dun4 and Dun6 were performed under contract for the Touching-the-Tide HLF project. Figure 8 shows the locations of the cores collected as part of an undergraduate dissertation project supervised by Professor David Sear (Wright 2011); only stratigraphic analysis are reproduced for this transect. The mapping shows the location of the core site Dun4, to be positioned in an area of former estuary, most likely salt marsh or grazing marsh. It is likely the site was inundated by salt water at very high tides and from fluvial runoff during rain driven flooding. The location relative to historic Dunwich, shows that the core site was formerly protected by Cock and Hen hills (upwards of 40ft high) and the lower lying ground asociatd with the northwest of the town. This area was stripped of soil and vegetation during the storm of 1740 (Gardner 1754). It is conceivable that some of this material was redeposited over the area of the core site. The position of Core 4 is located west and slightly north of the former enclosure of the Maison Dieu hospital, and north of the main St James Street. It is possible that the area was formerly used to gain access to the Hospital during high tide, when the core site would have been intertidal mudflats.

The site of the 2015 transect and cores Dun4 and Dun 6 are shown in Figure 9 The 1754 sketch reported in Gardner (1754), shows the area around the core site to be freshwater reed bed with adjacent grazing marsh and some (brackish?) pools. In the 1880 photograph, the site is landward of the scene, but the image shows extensive shingle and sand associated with the gravel barrier, and grazing marsh behind. The 1945 Air photo shows the site to be grazing marsh much as it is today. Further details of the 2015 Core transect are given in Appendix 2.

5.3 The stratigraphy

The basic stratigraphy of the Dunwich river estuary is typical of other coastal sediment stacks (Figure 7). At Minsmere, woody peat indicative of freshwater floodplain woodland gives way to blue-grey estuary muds created by a marine transgression around c.3200BP (1250BC), which lasted until c.400BP (1550AD) when freshwater peats again appear, often associated with evidence of higher energy incursions, notable siltyclay and sandy-silt banks (Lloyd et al., 2011). In the Blyth estuary, Brew et al (1992) report the same transgression occurring around c.4300BP, noting that the precise date depends on the development of barriers at the estuary mouth and the availability of clastic material. Thereafter, freshwater peat dominated often associated with Phragmites (common Reed) and where grazed and drained, the top sediments are of partly oxidised peat. Figure 8b shows a transect across the Dunwich river valley, collected by Wright (2011). This clearly shows the estuary mud following an earlier valley form, dipping to a low point near core A1C3, east of the location of the current Dunwich river near A1C4.

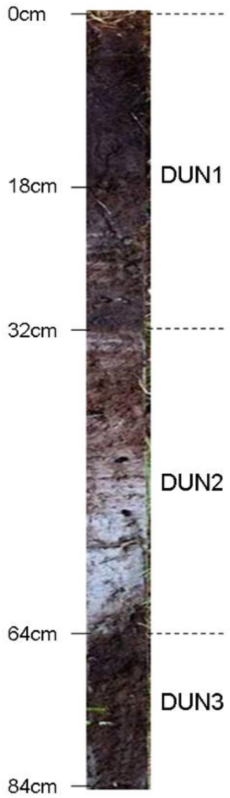
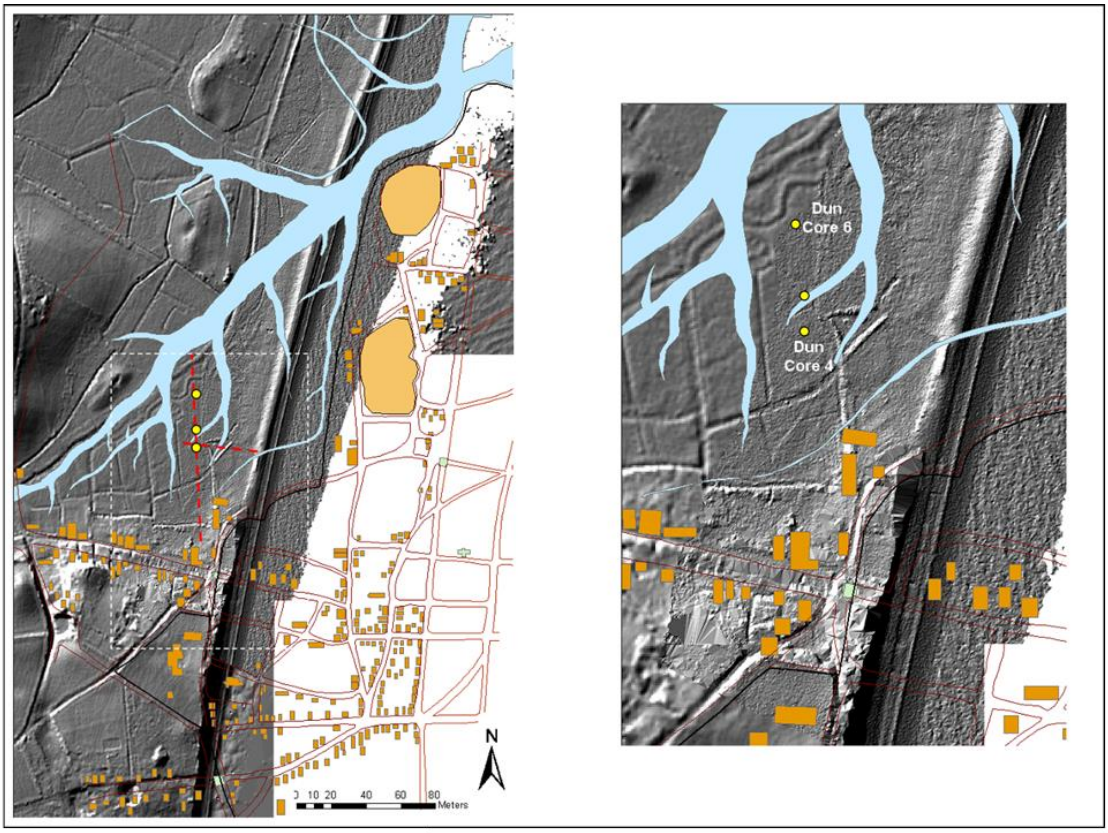


Figure 7: Dun4 Core showing the lower (bottom of figure) organic sediments from the hemp retting pit, overlain with saltmarsh and mudflat sediments (bluey-grey). The laminated organics and silts progress up into a dark humic freshwater marsh horizon at the top of the core (upper part of figure. Sections DUN 1-3 are detailed in Table 3.

The core transect collected in 2015, runs north from the bottom of the gardens located on the north side of St James street, to just south of the Dunwich river. Figure 8b shows the 2m LiDAR elevations dipping rapidly off the sandy-gravel a



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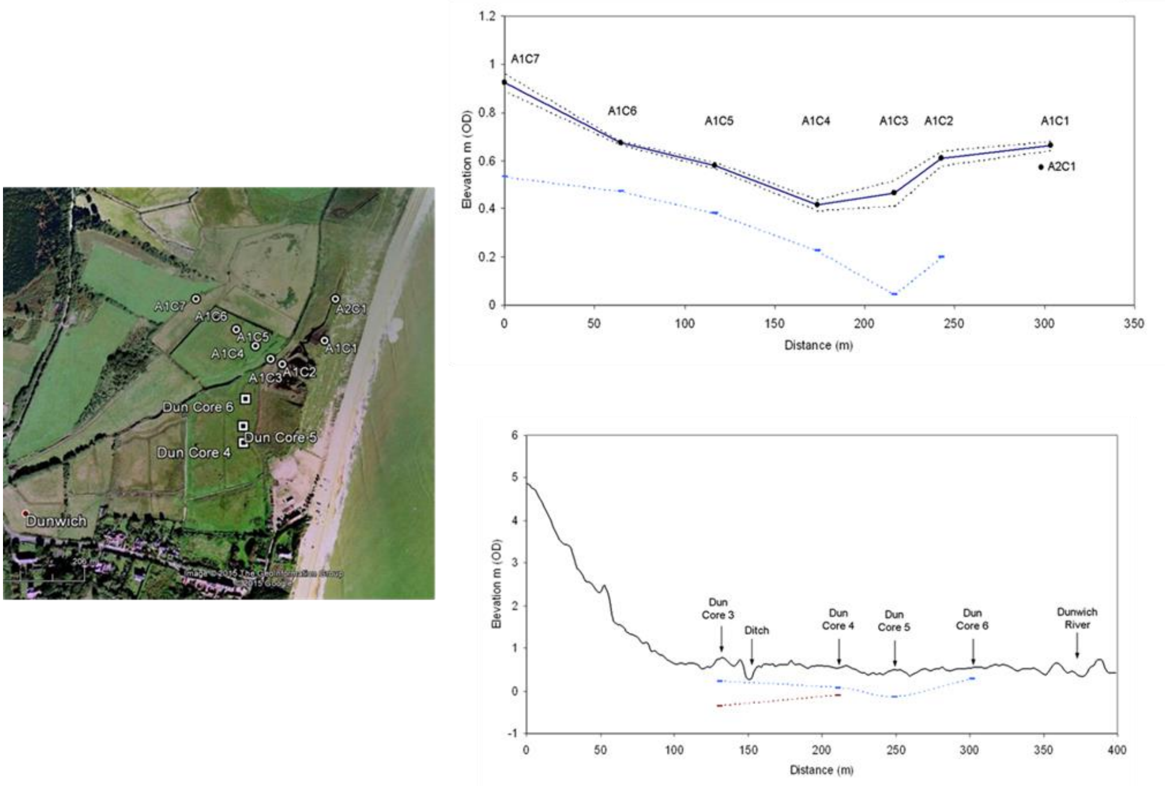


Figure 8: Location of core transects in relation a) in relation to local LiDAR elevation and landscape features from the old town of Dunwich and the current position of the gravel barrier and sea and, b) to a contemporary air photograph of the landscape, and EA LiDAR based elevations. Transect of cores A1C1 – A1C7 cut across the Dunwich river floodplain. Transect Dun4-Dun6 cut north from the margins of the Maison Dieu hospital land towards the Dunwich river.

ridge onto the marches. The top of the estuary blue-grey clay dips towards the Dunwich river with evidence of a shallow channel around Core Dun5. This corresponds with a channel shown on the 1587 Agas map (Figure 8a) and visible on air photos (Figure 8b). Core Dun4 sites on the southern margin of this shallow channel, at a point where the underlying peat surface rises. The estuary blue-grey clay, though not shown in the Figure, pinches out at around 100m north along the transect.

Two cores have been examined in detail (cores 4 and 6) for both stratigraphy and sub-fossil pollen and spores. Core 6 proved to have little pollen and although the stratigraphy has been described this is not discussed here. Core 4 proved to be of greater interest in having a basal organic unit (Figure 7). The profile also produced sufficient pollen and spores to allow construction of a pollen diagram (section 3 below). The stratigraphy of core 4 is described in table 1 below and Figure 7).

Depth metres	**Munsell colour**	**Description**
0.0-0.02	10YR 2/1	Upper rooted humic layer of present marsh community. Matted roots within detrital peat matrix
0.07-0.02	10YR 2/2	Granular/blocky peat. Dark, detrital.
0.17-0.07	10YR 2/2-10YR2/1	Dark detrital peat.
0.20-0.17	10YR 2/2	Sandy silt. Coarse humic. Broadly laminated. Medium to dark brown.
0.21-0.20	Transition	Transition
0.255-0.21	10YR 4/2	Grey/brown, coarsely laminated silt.
0.31-0.255	10YR 2/2	Peat. Fibrous, coarse with occasional sand and small gravel. Some roots.
0.32-0.31		Transition
*c.*0.61.5-0.32	10YR 4/2 to 3/2 with 10YR 5/1	As below but generally paler grey/brown. Coarsely laminated. Pale grey and grey brown laminae. Silt
0.60		Peaty inclusions. Dark.
0.63-0.61.5		Transition
0.86-0.615	10YR 2/1 to 10YR 2/2	Dark brown/black detrital peat. Fibrous.
0.86		Base of profile

Table 2: Sediment stratigraphy of Dunwich Core 4.

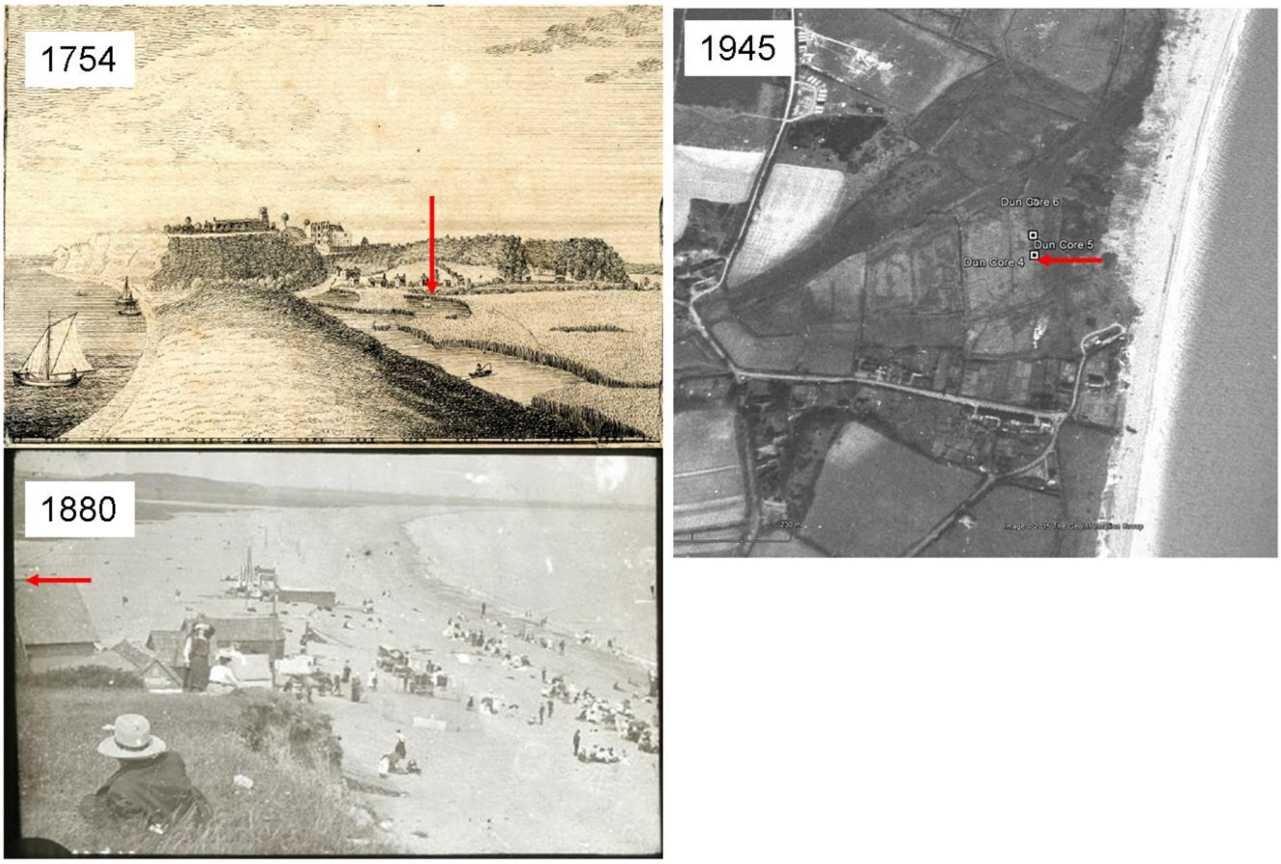


Figure 9: Views of the area around the 2015 core transect, showing evidence of freshwater reed marshes in 1754, clastic overwash in 1880 and grazing marsh in 1945. 1880 photograph is from the Dunwich Museum online collection, The 1754 sketch is from Gardner (1754), and the 1945 aerial photograph is from Google Earth historical imagery, original source being the RAF.

5.4 Pollen analysis of core 4

Pollen cores 4 and 6 were obtained using a large Dutch Gouge corer and have been analysed. The latter, core 6, proved unsatisfactory with only small numbers of pollen found. These traces comprised largely very occasional Chenopodiaceae (goosefoot, orache and samphire) from salt marsh (halophytic) communities, coniferous pollen and re-worked pre-Quaternary palynomorphs. There was insufficient pollen to enable even small assessment style pollen counts. This paucity of pollen is attributed to rapid deposition. Core 4 proved more satisfactory with a basal humic unit overlain by sediment of brackish and marine origin signifying a marine transgressive event.

5.4.1 Pollen method

Samples of 1.5ml volume were processed using standard techniques for the extraction of the sub-fossil pollen and spores (Moore and Webb 1978; Moore *et al.* 1992). The sub-fossil pollen and spores were identified and counted using

Nikon and Olympus biological research microscope. Pollen counts of up to 400 grains of dry land taxa per level was counted (the sum). All spores and pollen of marsh taxa (largely Cyperaceae), fern spores and miscellaneous were also counted for each of the samples analysed. A pollen diagram has been plotted using Tilia and Tilia Graph (figure 10a and 10b). Percentages have been calculated in as follows:

Sum =	% total dry land pollen.
Marsh/aquatic herbs =	% tdlp + sum of marsh/aquatics.
Spores =	% tdlp + sum of spores
Misc. =	% tdlp + sum of misc. taxa.

Taxonomy, in general, follows that of Moore and Webb (1978) modified according to Bennett *et al.* (1994) for pollen types and Stace (1992) for plant descriptions. These procedures were carried out in the Palaeoecology Laboratory of the Department of Geography, University of Southampton.

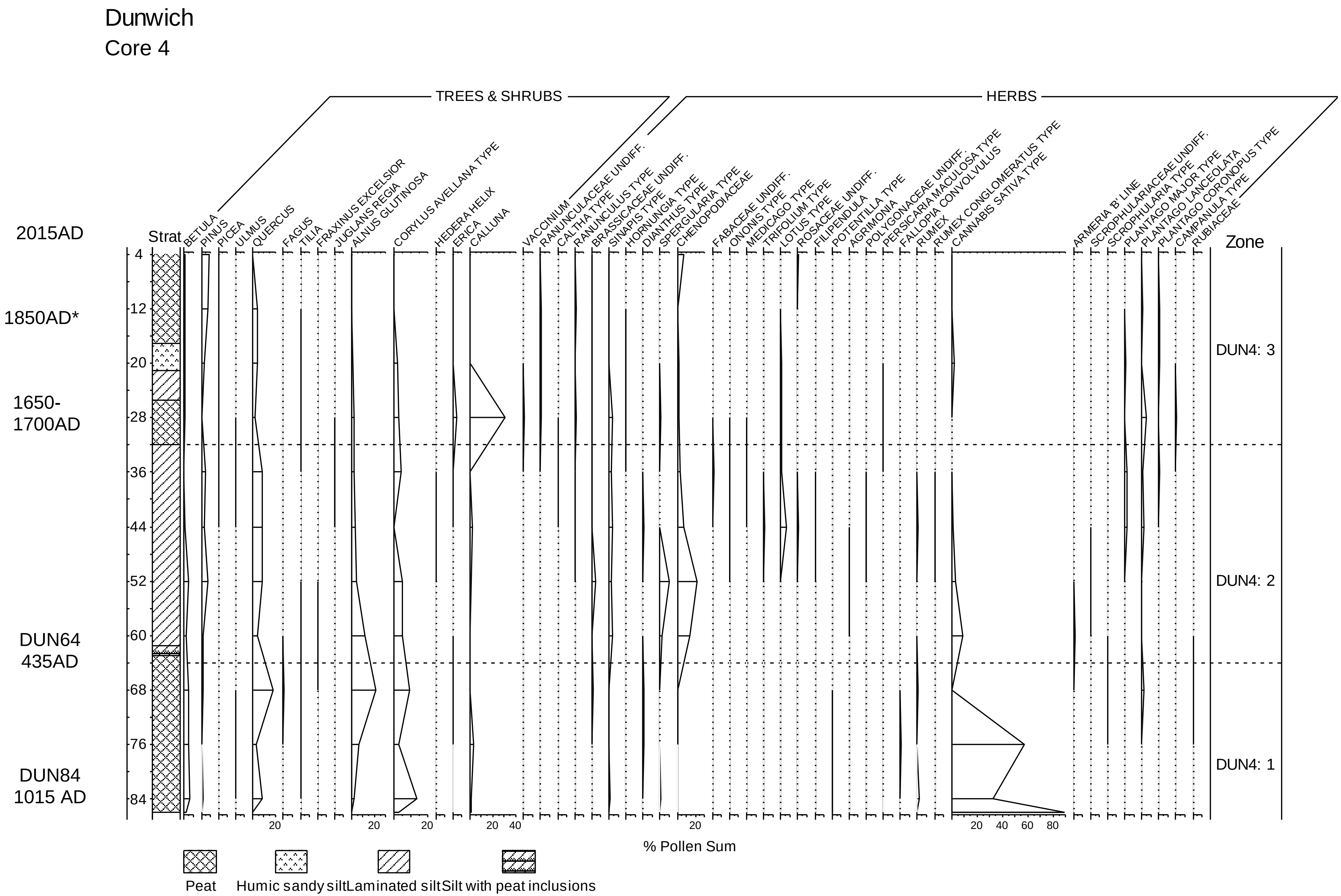
5.4.2 The pollen data

Pollen preservation was found to be variable as might be expected from the contrasting humic sediment at the base of the profile and the more minerogenic, overlying silt and clay of salt marsh and mud flat origin. However, the pollen spectra obtained show interesting and significant changes throughout the *c.*0.9m of sediment. These changes have been described as local pollen assemblage zone DUN4: 1-3 from the base of the profile at 0.90m upward. These are defined and described in table 3 below and shown graphically in Figure 10.

Local Pollen Assemblage Zone	***Palynological characteristics***
l.p.a..z DUN4: 3 4cm to 32cm Poaceae-Lactucoideae	DUN4: 3 is delimited by increasing values of Poaceae and Lactucoideae, the latter peaks to 40% at 12cm. Arboreal and shrubs comprise *Betula* (to 10%), *Quercus* (6%), *Tilia* (1-2%), *Alnus* (1-2%) and *Corylus avellana* type (declining 3-1%). *Pinus* increases (10% at top of profile) and *Picea* is present. Dwarf shrubs include *Calluna* (peak to 40%) and *Erica* (3%) These peak at 28cm and subsequently decline. Herbs are dominant and include Chenopodiaceae (3% at 4cm), *Cereal* type, *Cannabis sativa* (<3%), *Cirsium* and *Bidens* type. Other herbs sporadically present at <2% include *Lotus* type, *Persicaria maculosa* type and *Anthemis* type. Marsh taxa are important and dominated by Cyperaceae (to 39%) with small numbers of *Typha/Sparganium* type and *Potamogeton* type. Fern spores decline markedly in comparison to the previous

	zones with a reduction of *Pteridium aquilinum.* Pre-Quaternary palynomorphs are present at reduced levels.
l.p.a.z. DUN4: 2 32-64cm Chenopodiaceae-Poaceae	This zone is delimited by increasing values of Chenopodiaceae (to 20% at 52cm). There is a corresponding increase of *Spergularia* (to 9%). Herbs are dominant with Poaceae (peak to 58%) most important. Other herbs include *Cereal* type, *Ranunculus* type, Lactucoideae, *Bidens* type. *Medicago* and *Lotus* type (small peak at 44cm). *Cannabis sativa* type remains present but at considerably lower levels than in DUN4: 1. Tree pollen values remain at low levels. *Quercus* which remains (*c.* 10%). *Alnus* (10% to <5%) declines whilst *Corylus avellana* also reduces throughout the zone. Other trees and shrubs include *Betula* (to 6%) and *Pinus* (8%) and occasional *Picea* (top of zone), *Ulmus* and *Juglans regia*. Marsh taxa comprise Cyperaceae with increasing values (peak to 40% at top of zone), *Caltha* type, and *Potamogeton* type (peak to *c.*20%) at 60cm. Ferns comprise *Dryopteris* type declining throughout whilst *Pteridium aquilinum* and *Polypodium vulgare* are also present in small numbers. Pre-Quaternary pollen palynomorphs peak to high values (50% Sum + Misc.)at 52cm.
l.p.a.z. DUN4: 1 64 -86cm *Cannabis sativa*	This basal zone is characterised by extremely high values of *Cannabis sativa* (hemp) pollen (to 90% at 86cm and 60% at 76cm). Values subsequently decline markedly at the end of the zone and no *Cannabis sativa* is present at 68cm. Tree and shrub pollen includes *Betula* (<5%), *Quercus* (<10%) and *Corylus avellana* type (to 15% at 84cm). Dwarf shrubs include *Calluna* (to 5%). Poaceae are present at values of *c*. 20% at 84cm increasing to *c.* 30% by the end of the zone. Other herb pollen taxa include occasional Brassicaceae, Chenopodiaceae (top of zone), *Potentilla* type, *Rumex Cirsium* and Lactucoideae. Cyperaceae (sedge) is present to a maximum of 20% at 84cm with occasional *Typha latifolia* and *Typha angustifolia/Sparganium* type. Ferns comprise significant *Dryopteris* (to 40%) with some *Pteridium aquilinum* (6%) and *Osmunda regalis* (occasional at top of zone)

Table 3: Pollen zonation of Dunwich Core 4.


Dunwich
Core 4
TREES & SHRUBS
HERBS
Strat
BETULA
PINUS
PICEA
ULMUS
QUERCUS
FAGUS
TILIA
FRAXINUS EXCELSIOR
JUGLANS REGIA
ALNUS GLUTINOSA
CORYLUS AVELLANA TYPE
HEDERA HELIX
ERICA
CALLUNA
VACCINIUM
RANUNCULACEAE UNDIFF.
CALTHA TYPE
RANUNCULUS TYPE
BRASSICACEAE UNDIFF.
SINAPIS TYPE
HORNUNGIA TYPE
DIANTHUS TYPE
SPERGULARIA TYPE
CHENOPODIACEAE
FABACEAE UNDIFF.
ONONIS TYPE
MEDICAGO TYPE
TRIFOLIUM TYPE
LOTUS TYPE
ROSACEAE UNDIFF.
FILIPENDULA
POTENTILLA TYPE
AGRIMONIA
POLYGONACEAE UNDIFF.
PERSICARIA MACULOSA TYPE
FALLOPIA CONVOLVULUS
RUMEX
RUMEX CONGLOMERATUS TYPE
CANNABIS SATIVA TYPE
ARMERIA 'B' LINE
SCROPHULARIACEAE UNDIFF.
SCROPHULARIA TYPE
PLANTAGO MAJOR TYPE
PLANTAGO LANCEOLATA
PLANTAGO CORONOPUS TYPE
CAMPANULA TYPE
RUBIACEAE
Zone
2015AD
1850AD*
1650-
1700AD
DUN64
435AD
DUN84
1015 AD
4
12
20
28
36
44
52
60
68
76
84
DUN4: 3
DUN4: 2
DUN4: 1
20
20
20
20
40
20
20
40
60
80
% Pollen Sum
Peat
Humic sandy silt
Laminated silt
Silt with peat inclusions

Dunwich Cont.

Core 4

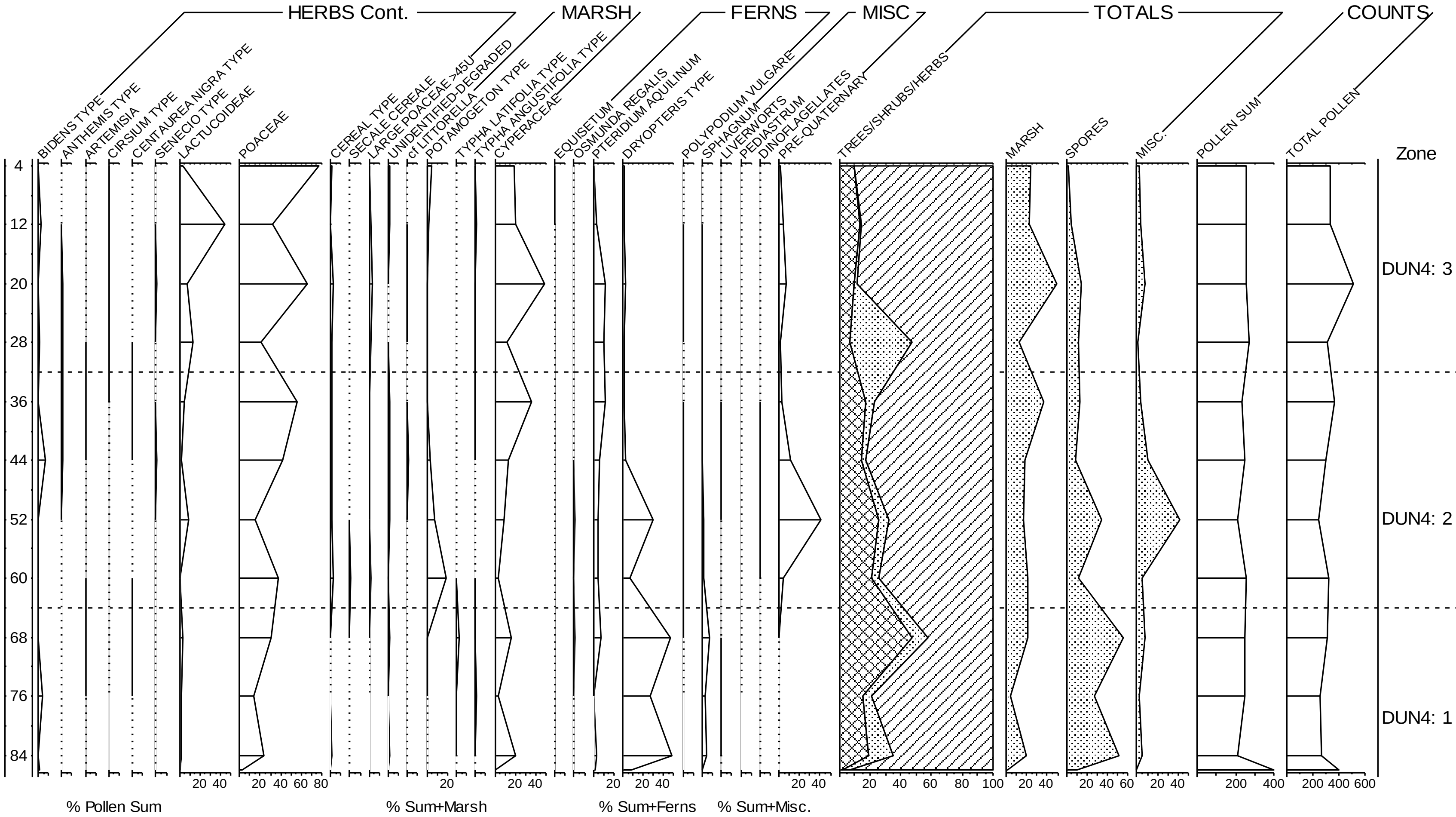


Figure 10: Pollen diagram for the Dun-Core 4 showing vegetation changes associated with environmental transitions from terrestrial cannabis rich peat, through saltmarsh and tidal mudflats into reed swamp and grazing pasture at the top of the core. The chronology of the core profile is provided by 2 Radiocarbon dates, DUN84 and DUN 64, and the rise of Pine and Spruce pollen towards the top of the core that provide a chronomarker of c.1650-1700AD.The top of the core at 0cm is live vegetation and dates to the current century. The date at 1850AD is based on an SCP profile from Rollo (2012) constructed from a core located close to Dun6.

5.4.3 The vegetation and environment

Given the historic date/age of the sediment profile, that is spanning perhaps the last millennium (1025AD (95%1015-1150AD)), it is not surprising that the overall character of the vegetation landscape was one of openness with open agricultural habitats in evidence. There is, however, a background of woodland and tree growth also represented in this otherwise agrarian landscape.

The pollen data can be viewed in terms of the on-site vegetation and other wetland vegetation which was fluvially transported to the site and pollen representing the surrounding area of the site and in some cases from more regional sources. These aspects are discussed.

The on-site (autochthonous) elements: The changing sediment character and overall stratigraphy reflect the environment of deposition and thus, the character of the vegetation and vegetation communities which colonised the site. As a result of the stratigraphical variations, the taphonomy is complex.

The site of Core 4 proved interesting having a basal, peat/organic unit (c. 0.60cm to the base at 0.8m. Such basal units tend to be of late middle to late Bronze Age date throughout southern and Eastern England and developed in response to rising sea level and subsequent transgression. Here, however, the organic unit is of historic date (385-1150AD 95% extremes) and appears to have been a pond which was subsequently inundated sometime after c.1050AD. As described below, this wet depression was also interesting proving to have been a hemp (*Cannabis sativa* L.) processing site. This was substantiated by the presence of *Cannabis* achenes in these level (see below). Pollen (l.p.a.z. DUN4: 1) indicates that this depression or pond supported a grass-sedge fen. There is surprisingly little evidence of freshwater aquatic macrophytes and this may be due to polluted water through hemp processing. Occasional cysts of freshwater *Pediastrum* were however, recorded in this basal pollen zone.

At 0.64m (Date unknown but after c.1100AD) there was a significant change of environment with change to minerogenic sediment with a horizon of reworked, transitional peat and sediment. The peat containing elements of pollen from l.p.a.z. 1 (mainly *Cannabis sativa*). This was clearly a brackish or marine transgressive event which resulted in the formation of salt marsh and mud flat on and nearby the site. L.p.a.z DUN4: 2 contains much palynological evidence for such habitats with strong representation of halophytes which include especially, Chenopodiaceae (goosefoot, orache and samphire), *Spergula* (spurrey), *Armeria* (thrift and/or sea lavender) and *Potamogeton* type. The latter taxon include both pond weed and sea arrow grass and it is the latter which was probably part of the halophytic/salt marsh habitat. With this transgression, the change to mineral sediment also demonstrates the erosion and transport of earlier sediment containing geological palynomorphs. High values of these at *c.* 0.52m indicate that the site was mud flat at this time. During this zone/phase, deposition was stable with the accretion of blue-grey sediment of typical salt marsh origin.

Towards the top of l.p.a.z. 2, there is evidence of declining importance of salt marsh and a recursion to a more freshwater habitat. From c. 0.44m, sedge pollen (Cyperaceae) start to become important replacing the Chenopodiaceae and Potamogeton/Triglochin pollen which otherwise characterise this zone. Increases of Lactucoideae (dandelion types from the dry-land zone) and the on-site sedges characterise l.p.a.z. 3 which shows a change to a more freshwater fen with sedges and other reed swamp elements (bulrush) or a flood plain habitat. Stratigraphically, this was also a phase of less stability with alternating peat, humic silt and sand lenses. The latter may be associated with flood events.

The dry-land, terrestrial zone: The most interesting and important aspect of this profile is the dominance of hemp (*Cannabis sativa*) pollen in the basal organic sediment of l.p.a.z. 1. Such high pollen values are rare and only occur where cultivation and processing has taken place or from specific circumstances where pollen analysis has been carried out on rope/cordage or from ships caulking (Scaife pers comm.). Here, it appears that this site from which this core was obtained was used for retting to obtain fibre for rope making. This is not unprecedented in East Anglia being discussed by Godwin (1967a, 1967b) and subsequently by Bradshaw *et al*. 1982. Traditionally, hemp crop was left in ponds and wet ditches for some weeks or months adjacent to places of cultivation to separate the bast fibres. This was clearly the case at this site. This would have been especially important for rope production in Dunwich and most probably for maritime use. Palynologically, the pollen is indeterminable from hop pollen (*Humulus lupulus*) in sub-fossil state; the morphology is similar due to close botanical relationship. Here, achenes (seeds) of hemp were also found and radiocarbon dated (Table 1, Appendix 1.0). Hemp was an especially important crop to the extent that edicts especially by Henry VIII to ensure fibre for rope making to support the English fleets. Thus, it is clear that fields adjacent to this sample site were used for cultivation at this time (1025BP) and the adjacent wetland used for retting of fibre. This was the non-toxic variety!

The substantial numbers of pollen mask the background and more regional vegetation components. However, during this phase and in the overlying zones/levels, the pollen data show a typical late historic environment. That is, mixed arable and pasture and some retained woodland. Oak and hazel were the principal woodland components and this probably represents remaining managed, coppice with standards, woodland also of use for shipbuilding and other more domestic uses (building timbers, hurdles and wattle). Small pollen numbers of ash (*Fraxinus*), lime (*Tilia*) and beech (*Fagus*) are from occasional local growth. These taxa are markedly under represented in pollen spectra (Andersen 1970, 1973). There is a single record of walnut (*Juglans regia*) which attest to a post Roman date.

Agriculture: Apart from the hemp cultivation discussed, the herb pollen spectra show predominantly pasture with some cereal elements. The latter are, however, less well-represented in pollen assemblages unless in very close proximity to sampling. Grass pollen is dominant throughout and although a proportion will have derived from the on-site vegetation, along with ribwort plantain (*Plantago lanceolata*) and other herb this suggests stronger pastoral land use in the nearby region.

Pine pollen is present throughout the profile. In l.p.a.z. DUN4: 2, this may be attributed to the typical over representation in fluvial, especially marine sediment due to the buoyancy of the saccate pollen. However, the expansion in l.p.a.z. DUN4: 3 there is an increase of pine and also the presence of spruce. The latter is non-native and along with pine these represent plantation. The pine rise from c. 1650-1700 is seen in many pollen diagrams of the recent historic period (Long *et al.* 1999) and is attributed initially to planting of exotic conifers in parks and gardens after popularity resulting from John Evelyn's treatise *Sylva.* Subsequently, pine also increases in importance from forestry plantation. The pollen is anemophilous and is of regional rather than local origin.

5.5 Summary

Marsh sediments contain a record spanning the full history of Dunwich. Our research has demonstrated that these sediments can be used to reconstruct regional and local changes in land cover, and from these infer periods of environmental change and potentially industry within the immediate vicinity. Moreover, the presence of distinct higher energy sediment layers of silt and sands offer the possibility that the sediments also record periods or discrete events resulting from coastal storms. The analysis of core Dun4, is nationally of interest as it contains strong evidence of only the third UK example of a retting pit for the production of hemp fibres used in rope and sail making. The association with a major international port makes this highly likely. The period of retting appears to continue from early Saxon to early medieval, before a major marine transgression, perhaps associated with storm action around the 13^{th}-14^{th} century, resulted in a change to salt marsh and mudflat environments at the site. This phase of estuarine habitat continued until c.1600, when freshwater marsh again occupied the site. This phase was interrupted by a period of episodic higher energy deposition (silt-clay laminations, culminating in a major event recorded as a sandy-silt layer. This layer is also seen in the Core sample recovered by Rollo (2012) some 20m north of Dun4. Preliminary evaluation strongly points towards the storm event of 1740, which Gardner (1754), records as washing across the adjacent land seaward of the core, stripping the soil and vegetation, and depositing it landward. The presence of calluna and other heath pollen may represent this stripped soil and vegetation. The environment at the core site stabilised, and returns to freshwater peat representative of the current reed beds and grazing marsh. This accords with Gardner's (1754) sketch, which shows the site to be dominated by reed beds and small pools of open (fresh-brackish?) water.

5.6 Further Research

Having established a chronology and environmental context for the sediment profile at DUN-4, additional analysis is warranted. During summer 2015, an undergraduate dissertation student will undertake sand grain analysis through the profile to identify periods of increased sand deposition that may correlate with individual storms or periods of increased storm activity. Additional diatom analysis may be undertaken to confirm the rate of change from terrestrial to marine and back to terrestrial habitat. This will permit correlation with the historical documented change in the harbour at Dunwich. Additional samples will be picked for Radiocarbon dating at 62cm to establish an age for the marine transgression, at 32cm to establish the date of the return to freshwater marsh conditions, and at 17cm to establish a minimum age for the flood event/period recorded in the organic sandy silt sediments. If resources permit, we will also check for Spheroidal Carbonaceous Particles (SCP's) – the product of high temperature combustion, to provide dates post 1850AD (Rose and Appleby, 2005). Rollo (2012) and Wright (2011) both identified SCP's within the top 15 cm of cores recovered from close to the present Core.

6.0 Conclusion

The research reported supports several conclusions;

- The sediment deposits in and adjacent to Dunwich provide a valuable additional source of historical evidence that shed light on the industry, environmental change and chronology of the site

- Additional research effort should be targeted at the road and Pales Dyke before those features WITHIN the town boundary are lost to the sea, which Sear et al (2012) project will occur within 50-80 years.

- The dates obtained for this project strongly point towards an early (Saxon) settlement, with evidence that the Pales Dyke ditch may have had earlier origins in the Iron Age. The existence of a retting pit with materials dating from the 5th – 11th century, a road dated to the 7th century all support the presence of a port at Dunwich in the Saxon period.

- The pollen data show a typical late historic environment. That is, mixed arable and pasture and some retained woodland with oak and hazel as the principal woodland components.

- Marsh sediments have been shown to provide a history of environmental change that reveals incursion by the sea into the area of retting after c. 1100AD, and transition back to freshwater reed marsh around 1600 AD although confirmation of that date is awaiting a radiocarbon date. There is evidence of storm activity associated with the early 18th Century, and evidence for the 1740 storm. The transition from freshwater retting pit to marine saltmarsh and estuary mud is rapid and possible rests from storms breaching a gravel barrier/spit. The transition to freshwater marsh is more gradual, punctuated by a short marine incursion before storm events overwash the area and freshwater conditions dominate thereafter.

- We have achieved the two main aims of the project although additional analysis is required to fully understand the environmental archive in the marsh core.

7.0 References

Andersen, S.T. 1970 'The relative pollen productivity and pollen representation of north European trees and correction factors for tree pollen spectra'. ***Danmarks Geologiske Undersogelse*** R.II. 96,1-99.

Andersen, S.Th. 1973 'The differential pollen productivity of trees and its significance for the interpretation of a pollen diagram from a forested region pp.109-115. In Birks, H.J.B and West, R.G. ***Quaternary Plant Ecology.*** Blackwell, Oxford.

Bacon, J. & Bacon.S.R., 1979 **The search for Dunwich City under the Sea**, Segment Publications, Colchester.

Bacon, S.R., 1979 Underwater Exploration at Dunwich, **International Journal of Nautical Archaeology**, 3, 2, 314 – 318.

Bailey, M. 2007 **Medieval Suffolk: An economic and social hi**story, 1200 – 1500. Boydell Press, Woodbridge, 338p.

Bennett, K.D., Whittington, G. and Edwards, K.J. 1994 'Recent plant nomenclatural changes and pollen morphology in the British Isles'. ***Quaternary Newsletter.*** 73, 1-6.

Bradshaw, R.H.W., Coxon, P., Greig. J.R.A. and Hall, A.R. 1981 'New fossil evidence for the past cultivation and processing of hemp (*Cannabis sativa* L.) in Eastern England. ***New Phytologist*** 89 (3) 503-510.

Chant, K., 1986 **The history of Dunwich**, 2nd Edition, Dunwich Museum, 20pp.

Comfort, N., 1994 **The Lost City of Dunwich**, Terence Dalton Ltd., Lavenham, Suffolk.

Dymond, D. & Martin, E. 1989 **An Historical Atlas of Suffolk**, 3rd Edition, Suffolk County Council, Lavenham press, Lavenham, Suffolk, 224p.

Gardner, T. 1754 **An historical account of Dunwich, ….Blithburgh, … Southwold, … with remarks on some places contiguous thereto**, London, 291p.

Godwin, H. 1967a 'The ancient cultivation of hemp'. ***Antiquity*** 41, 42

Godwin, H. 1967b 'Pollen analytic evidence for the cultivation of *Cannabis* in England' ***Review Palaeobotany and Palynology*** 4, 71.

Long, A.J., Scaife, R.G and Edwards, R.J. 1999 'Pine pollen in intertidal sediments from Poole Harbour, UK; implications for late-Holocene sediment accretion rates and sea-level rise'***. Quaternary International*** 55, 3-16.

Moore, P.D. and J.A. Webb. 1978 ***An Illustrated Guide to Pollen Analysis***. London: Hodder and Stoughton.

Moore, P.D., J.A., Webb and M.E. Collinson. 1991 ***Pollen Analysis.*** Second edition. Oxford: Blackwell Scientific.

Parker, R., 1975, **Men of Dunwich**, Dunwich Reading Room Trust, 272pp.

Rollo, I. 2012. Identification of past storm events in the back barrier marsh at Dunwich (Suffolk, England) using a sand grain analysis, **Unpublished Undergraduate BSc dissertation**, School of Geography, University of Southampton, 61p.

Rose, N. L. and Appleby, P. G. 2005 'Regional applications of lake sediment dating by spheroidal carbonaceous particle analysis I: United Kingdom' ***Journal of Palaeolmnology***, 34, pp 349-361

Sear, D.A., Bacon,S.R., Murdock, A.P., Donaghue, G., Baggaley, P., Sera, C., and Lebas, T.P., 2011, Cartographic, geophysical and diver surveys of the medieval town site at Dunwich, Suffolk, England. **International Journal of Nautical Archaeology**, 40; 1, 113-132.

Sear, D.A., Bacon,S.R., Murdock, A.P., Donaghue, G., Lebas, T.P., 2008, Dunwich 2008 Project Report to Esmée Fairbairn Foundation, English Heritage & Dunwich Museum Trust, **Unpublished GeoData Report No. UC1064**, 58p.

Stace, C. 1991 ***New flora of the British Isles*. ** Cambridge: Cambridge University Press.

West, S.E., 1973 The excavation of Dunwich town defences, 1970 (with a note by N. Scarfe)' **Proceedings of the Suffolk Institute of Archaeology and History** Vol32 pt1 p25-37

Wright, Y. 2011 Does the influx of large sediment particles within the cores taken at Dunwich, Suffolk correspond to historical records of storm events?, **Unpublished Undergraduate BSc dissertation**, School of Geography, University of Southampton, 61p.

Wessex Archaeology 2012 **Dunwich Suffolk: Archaeological assessment and results**, Wessex Archaeology Report No. 77505, Wessex Archaeology, Salisbury, 43p.

Appendix 1.0: Beta Analytical Radiocarbon Dating Reports

See accompanying .pdf Reports

Appendix 2.0: Cliff Section Stratigraphy (see Figures 4-6).

SITE	Dunwich
CLIENT	Touching The Tide Project
CONTACT	Bill Jenman
FIELD STAFF	Professor David Sear, Dr Hal Voepel
LOCATION	Site 1: St James Street Cliff Exposure
POSITION	TM47804 71037
ALTITUDE	16m
SITE TYPE	Exposed section through cliffs
PURPOSE	Collection of material for dating bottom/construction of feature
STRATIGRAPHY	Depths below ground surface in centre of St James St exposure
1L1	152 cm - Light Brown soil , Sa/Si <60% rounded pebbles
1L2	160 cm - Brown soil Sa/Pebbles <40% rounded pebbles
1L3	161 cm - Dark Orange/Black Sand
1L4	173 cm - Orange yellow sandy gravel, <30% rounded pebbles
1L5	173+ cm -Yellow/Orange Sand Natural Geology

SITE	Dunwich
CLIENT	Touching The Tide Project
CONTACT	Bill Jenman
FIELD STAFF	Professor David Sear, Dr Hal Voepel
LOCATION	Site 2: Pales Dyke Cliff Exposure
POSITION	TM47743 70702
ALTITUDE	27m
SITE TYPE	Exposed section through cliffs
PURPOSE	Collection of material for dating bottom/construction of feature
STRATIGRAPHY	Depth below ground surface in Pales Dyke
2L1	395 cm - Brown sandy soil few stones
1L2	403 cm - Dark organic rich sand layer
2L3	410 cm - Yellow grange sand with large gravels - rounded
2L4	430 cm - Indurated orange sandy gravel. Gravels rounded.

SITE	Dunwich
CLIENT	Touching The Tide Project
CONTACT	Bill Jenman
FIELD STAFF	Professor David Sear, Dr Hal Voepel
LOCATION	Site 3: Duck/King Street Cliff Exposure
POSITION	TM47778 70947
ALTITUDE	29m
SITE TYPE	Exposed section through cliffs
PURPOSE	Collection of material for dating bottom/construction of feature
STRATIGRAPHY	Depth below ground surface centre of King/Duck St
3L1	87 cm - Brown sandy soil with isolated <5% flints - sub-rounded
3L2	96 cm - Dark organic black sand
3L3	99 cm - Light brown andy silt with dark organic/burnt patches
3L4	103 cm - Grey/brown compacted clay/silt, no gravels
3L5	110 cm - Yellow orange sandy clay (natural geology?)
3L6	110+cm - Yellow sand (natural geology) no gravels