Sedimentary structure of mixed sand and shingle beaches: preservation potential and environmental conditions

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Mixed sand and shingle beaches are highly dynamic features. Where they prograde, they are likely to preserve the surface layer by burial, yielding valuable insights into previous environmental and sedimentological conditions and sediments. This study provides data on the internal structure of a mixed beach in Pevensey Bay on the eastern Channel coast of the UK and links the layers to the period of deposition using topographic data.

The sand and shingle beach at Pevensey Bay extends for ~11km from Eastbourne in the southwest to Bexhill in the northeast. Most of the beach has been artificially nourished in the last few years, but some stretches have remained largely untouched, such as the one shown in Fig 1 where groynes were built as late as the 1952.

Six pits were dug in the beach at around mean high water level (Fig 1) to depths of up to 2.9m, reaching ~0m OD. Samples of 2 to 5kg were taken from the pit walls usually at ≤ 20cm intervals, and later sieved in the laboratory at 1phi intervals. Sediment profiles show that the average grain size (Fig 2), sand content and colour of the gravel and shingle fraction vary significantly with depth. The coarser and finer layers in the lower part of the profiles (below ~1m in Fig 2) show lateral (inter-site) consistency, indicating that the layers formed under the same conditions at the same time at the different sites, and are therefore likely to represent historic beach surfaces. Sites 1-5 also show strong similarities at ~1.9m OD.

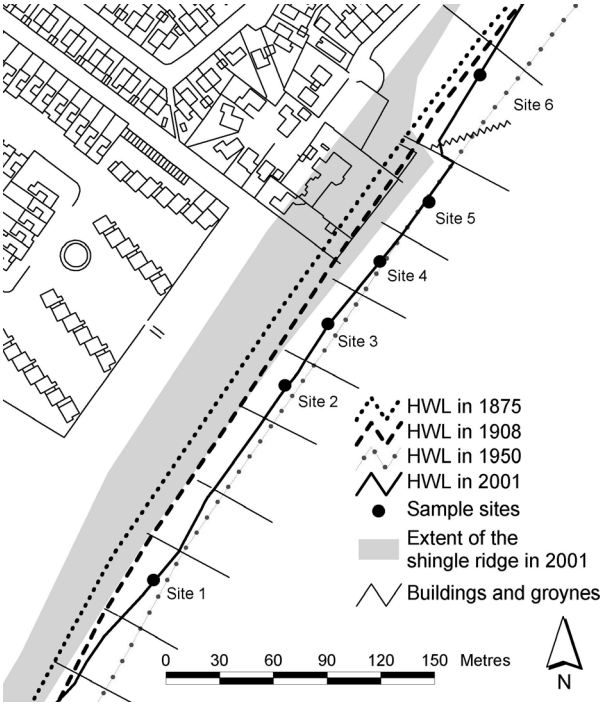

Fig 1: Location of sample pits in relation to historic and present high water lines (HWL).

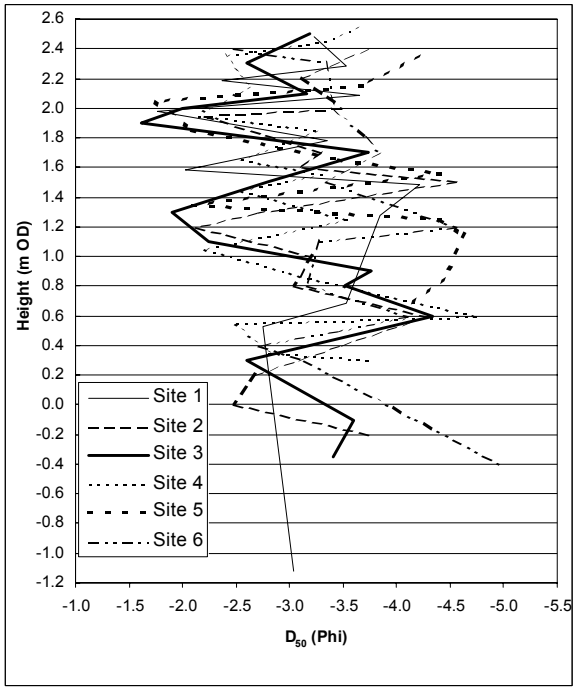

Fig 2: Changes of the D_{50} with depth for all 6 sample sites

Beach profiles obtained from photogrammetric measurements carried out during the Annual Beach Monitoring Survey (ABMS) since 1973 are located close to Sites 1, 3, 5 and 6. Historic profiles were reconstructed from topographic maps based on the position of the High Water Line (HWL, Fig 1), the beach toe and assumptions on beach slope derived from the present beach. For Site 1

these are shown in Fig 3 together with the location and extent of the pit.

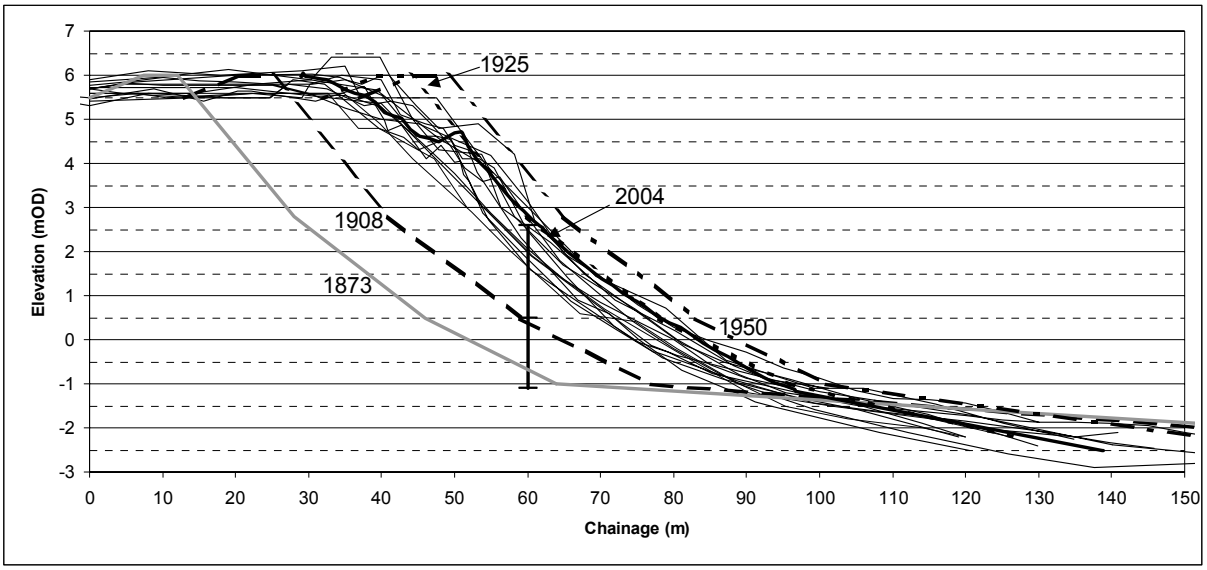

Fig 3: ABMS survey profiles (selection) for the year 1973 to 2001 (thin lines) close to Site 1, beach profiles derived from historic maps (thick lines with years) and a surveyed profile in 2004. The vertical line shows the position and extent of the pit at Site 1.

Beach level fluctuations since 1973 have been small at the pit sites and have only affected the top 1m or so of each pit. Many of the fluctuations shown in Fig 3 are evidently artefacts of the method by which the profiles were compiled, as can be seen by inspection of the left side of the diagram. Here the surface of the beach ridge can be assumed to have been stable over the last decades yet fluctuations of >0.5m in level are recorded. Turning to the evidence of historic maps, major progradation of the beach occurred at all sites between 1873 and 1925 when the HWL reached its present position at Sites 1-5 and slightly landward of its 1950s position at Site 6. Some further advance took place between 1925 and 1950, followed by stability at Sites 1-5, but significant erosion at Site 6.

The evidence therefore suggests that the beach layers found below 1.5mOD at Sites 1-5 have been deposited between the 1870s and 1920s, reflecting in ascending order deposits close to the beach toe and of the beach face. Despite the recent erosion at Site 6, the agreement in the stratigraphic pattern with Sites 2 to 5 for the lower part of the profile would indicate that the beach deposits of that period are still in place. The disagreement in pattern between the sites between ~1 and 1.8m could indicate localised beach level fluctuations possibly resulting from construction of the groyne field. Also, the good agreement of the pattern between Sites 1-5 at ~1.9m could suggest a pulse of relatively fine material, possibly in conjunction with recharge activity updrift in the 1960s.

None of the sediment properties show a general tendency for change with depth, indicating that beach material at the turn of the 19th century was very similar to that of today. Research linking surface sediment size to wave conditions at Pevensey Bay suggest that smaller grain sizes and a decreased sand content are found at the surface during storms while larger particles and an increase in sand content are characteristic of beach recovery under calmer conditions. However, inferring different wave conditions from the patterns found in the stratigraphical record would require caution.

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