PLEISTOCENE RAISED BEACHES ON PORTS DOWN, HAMPSHIRE

By Arthur ApSimon, Clive Gamble and Myra Shackley

SUMMARY

Three raised beach exposures on Ports Down between Fareham and Portsmouth, are described. Two of the exposures indicate a transgression reaching *c.*37.5–38.5 m above H.W.M., which is equated with the Goodwood (Sussex) raised beach, for which archaeological evidence suggests a Hoxnian Interglacial age, the third indicates a transgression to *c.*16 m., equated with the Portland raised beach.

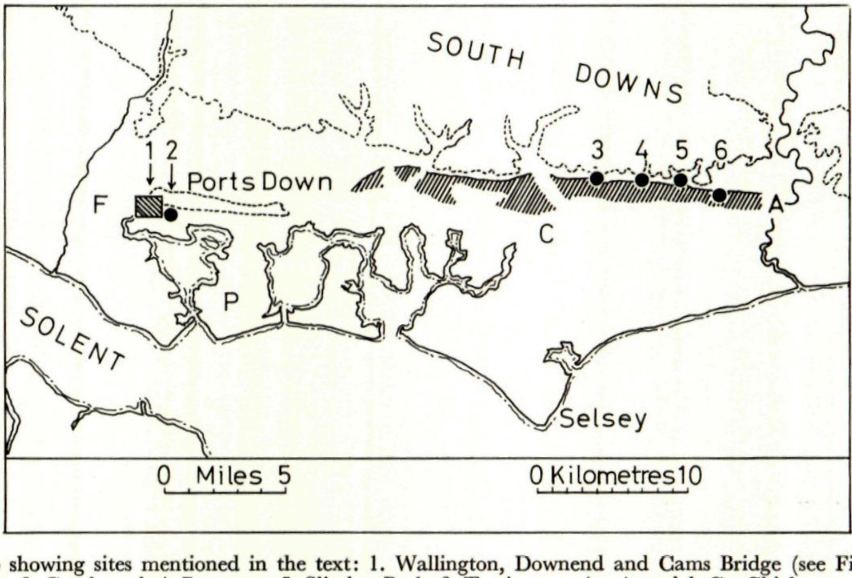

Fig. 1. Map showing sites mentioned in the text: 1. Wallington, Downend and Cams Bridge (see Fig. 3), 2. Red Barns, 3. Goodwood, 4. Boxgrove, 5. Slindon Park, 6. Tortington; A=Arundel, C=Chichester, F=Fareham, P=Portsmouth. //// Goodwood – Ports Down beach, - - - 61m (200 ft) contour.

Prestwich's 'Raised Beach on Portsdown Hill' rediscovered [A.M.A.]

In 1872 Joseph Prestwich, the 'father of the Geological Society', discovered a 'raised beach' deposit on Ports Down between Fareham and Portchester. The site was a pit north of East Cams Wood, later known as Down Coppice, close to the east side of the road

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from East Cams Farm to the Nelson monument, now known as Downend Road. The section in the pit was:

(a) Grey earth and sand with angular and rolled flints

(b) Light coloured laminated sands with seams of shingle 0–2 ft.

(c) Coarse flint shingle, a few whole flints, in light coloured sand 4–6 ft.

(d) Patches of chalk rubble

Prestwich, using an anaeroid barometer, estimated the height of the pit as 125 ft. above sea level, but when his paper was presented it was pointed out (Prestwich 1872, discussion; 1892, 274) that mapping by the Ordnance Survey showed that the whole pit lay below the 100 ft. contour. Osborne White (White 1913, 70) repeated Prestwich's description, noting that the section was no longer well exposed and that there was no evidence for the raised beach marked to the west of the road on the 1" to 1 mile Geological Survey Map (Sheet 310-Fareham, between SU 594067 and 602064).

The pit seen by Prestwich is probably the abandoned pit marked on the OS 6" Map sheet SU 50, 1963, at SU 599064 immediately below the 100 ft. contour and at the west end of a coppice named Cams Coppice on the 1930 edition of the 6" Map. Recently a house was built in the pit and a poorly exposed section in its garden shows shingle.

In 1972 the Downend Chalk Pit (SU 600065) about 100 m north of that seen by Prestwich, was extended southwards, resulting in the exposure in its south face of a section about 120 m long through the raised beach, which is up to 2 m thick, composed of unstratified flint shingle in a clayey gritty matrix. The pebbles are large (up to 15 cm), well rounded, with chatter marks – interlocking arcuate patterns produced by impact in a high energy environment, but without the staining and alteration characteristic of Tertiary pebbles. This shingle reaches a height of 39 m (128 ft.) OD. It rests on a very irregular surface of Upper Chalk with a mean height of about 37.3 m (122.5 ft.) OD, but numerous involutions and solution hollows extend above and below this level and two conspicuous pipes penetrate about 4 m below it. The hollows and pipes are lined with dark reddish brown clay (Munsell 5YR 3/4). When first seen, the southeast corner of the pit showed shingle banked against a steep south-facing slope of chalk rising to about 38.8 m (127 ft.), clearly the remains of the cliff at the back of the storm beach. This cliff must have run nearly east-west at this point, roughly parallel to and a few metres north of the south face of the pit. In the south-west corner of the pit the beach deposits had been removed by the erosion of the shallow valley down which the road runs, but beyond the road a spread of pebbles extends northwestwards across the fields towards the beach deposits found in the cutting made for the M27 motorway east of Fort Wallington.

To the east of the pit, flint pebbles are visible in ploughed fields on a sloping bench at about 35 to 40 m OD, bounded above and below by steeper slopes, which extends for about 500 m to SU 605064 where it is cut by the shallow dry valley down which Cornaway Lane runs. East of this, pipe trenches on the Red Barns, Portchester, housing development showed no signs of the beach, though the presence of occasional flint beach pebbles, in the otherwise pure chalk breccia underlying the Lower Palaeolithic Acheulian workshop site (*atelier de taille*) (SU 609062) at around 31 m OD, excavated in 1975 (ApSimon and Gamble, in preparation) suggests its former presence there. No traces of the raised beach seem to have been reported from further east along the south slope of Ports Down.

Fig. 2. Downend Chalk Pit, south face, showing the Goodwood – Ports Down beach overlying Upper Chalk.
Below: detail showing solution pipe.
(Photos. A. M. ApSimon.)

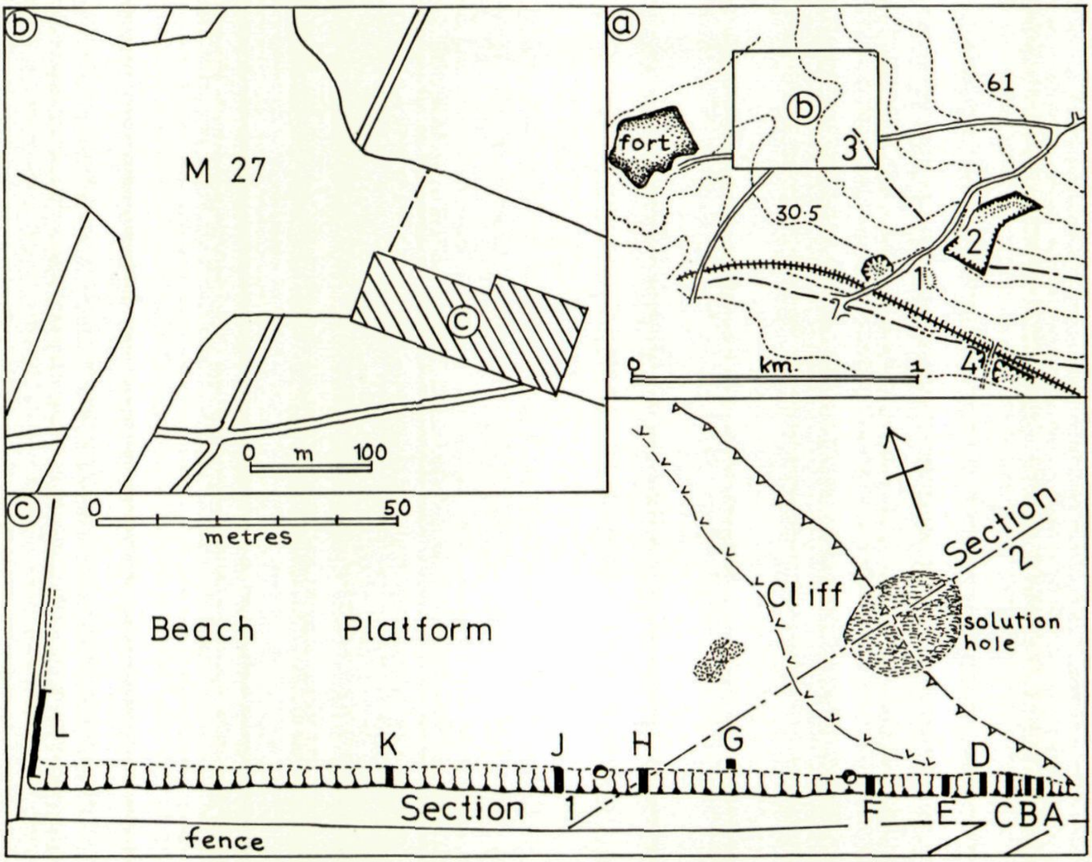

Fig. 3a. Map showing sites on Ports Down near Fort Wallington: 1. Down Coppice pit, 2. Downend Chalk Pit, 3. M 27, Wallington, 4. Cams Bridge. – · – Goodwood – Ports Down shoreline, – · · · – Cams Bridge shoreline.
3b. M 27, Wallington, location plan.
3c. M 27, Wallington, plan of area investigated.
(Based on S.H.A.R.G. plans and on O.S. Maps and Plans, Crown Copyright Reserved).

The Raised Beach near Fort Wallington [A.M.A. and M.L.S.]

This beach deposit was found during excavations in spring-summer 1972 by the South Hants Archaeological Rescue Group (S.H.A.R.G.) on the line of the South Coast Motorway (M27). At this point (SU 596069) the motorway crosses a broad bench cut in the Upper Chalk at about 40 m OD. The bench slopes south-west at about 1°, to the north-east the slope of Ports Down rises at about 2° to 85 m OD. To the north and west the bench is crossed by a shallow dry valley, while on the south it ends in a steeper slope (about 2°) with its upper limit at 30 m (100 ft.) OD.

There is no surface indication of the beach and its presence was suspected only following the discovery of a Mesolithic flint industry in the surface of a sandy layer (Hughes and ApSimon forthcoming). This suspicion was confirmed by digging of a test pit (Figs. 3, 4, 5, G). The subsequent deepening of the

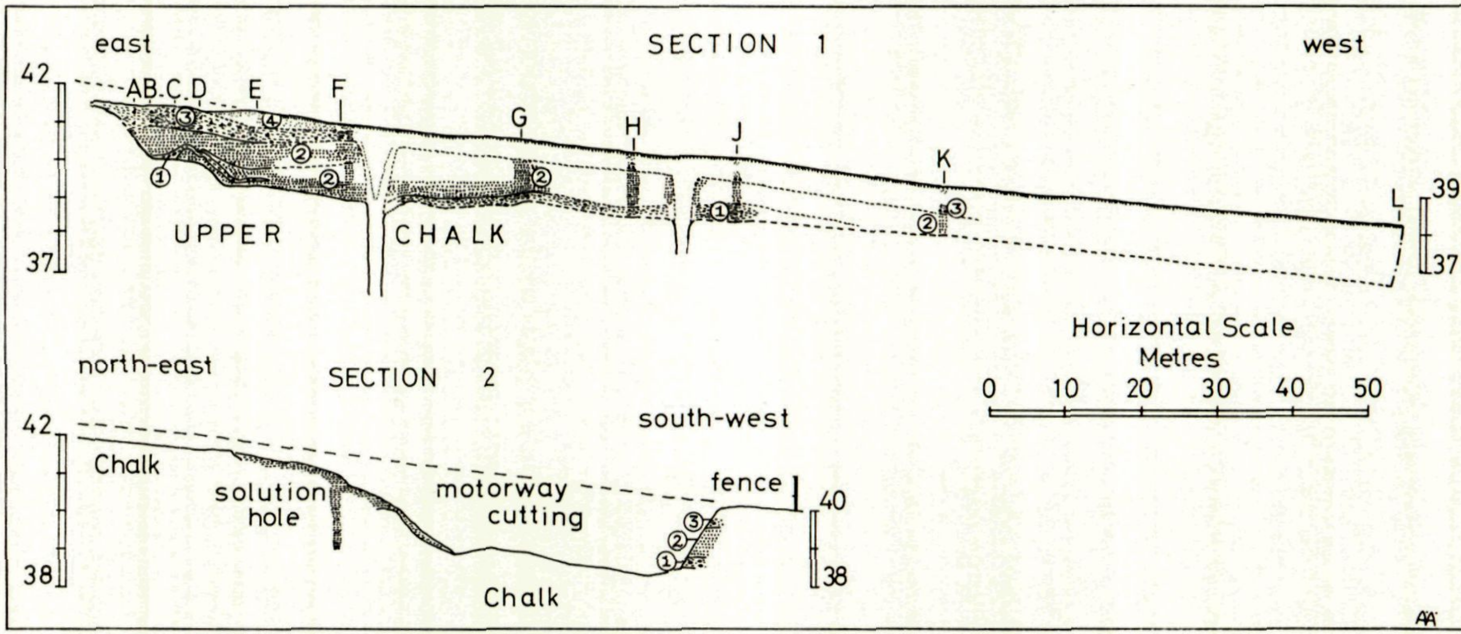

Fig. 4. Wallington raised beach, sections 1 and 2. Vertical scale 5x horizontal scale. Heights in metres AOD.

motorway cutting removed the beach deposits exposing the surface of the Upper Chalk in which the shore platform and the sloping cliff at its inner end were cut. This cliff ran north-west across the line of the cutting for about 100 m beyond which it was cut by the dry valley. The stratification of the deposits was investigated by clearing sections A–K, generally about 1 m wide, along the sloping south face of the cutting and along a temporary north-south face (L) at the west end of the area, and levelled profiles of these faces and along a line at right angles to the cliff were surveyed (Fig. 4).

Stratification

Unit	*Description*	*Thickness* (m)
4.	Brown sandy-loam	0.15–0.45
3.	Grey-brown sandy-clay with broken flints	0.2 –0.7
2.	Yellowish brown sands with current bedding	up to 1.6
1.	Flints in reddish brown clayey matrix	up to 0.4
–	Upper Chalk, top 0.1–0.3 m brecciated	seen to 20

Details (Fig. 5)

Unit 4: The superficial soil was a brown clay where it overlay the chalk, becoming a brown sandy loam with a few white patinated flints where it overlay the beach. Layers E_{10}, F_8, H_5, J_5, K_8; removed from sections A-D.

Unit 3: Dark greyish brown (Munsell 10YR 4/2) clay, becoming more sandy downslope, with generally small (to 5 cm), broken, white patinated weathered flints, sharp transition to layer beneath. Layers A_5, B-C_6, D_8, E_9, F_7, H_4, J_4; not exposed in section K.

Unit 2: upper part *2.4,* generally light brownish grey (Munsell 2.5Y 6/2) compact clayey sand, layers A_4 B_5 C_5 D_7 E_8 F_6; passes down into:

2.3, brown or yellow-brown banded or mottled sand, less clayey, current bedding visible in some sections, two chalk blocks to 15 cm long in A, layers A_3 B_4 C_4 $D_{4,6}$ E_7 F_5 G_8 H_{3b} J_{3b} K_6; passing down into:

2.2, fine yellow (Munsell 2.5Y 8/6), sand, current bedding visible in some sections, base coarser, more ferruginous. G_4 is grey-green, G_6 and K_3 are brown, slightly clayey, layers A_2 B_3 C_3 D_2 $E_{3,5}$ F_3 $F_{3,4,6,7}$ H_{3a} J_{3a} K_4. In G, base is:

2.1, grey sandy gravel, layer G_2.

Unit 2 is generally interbedded with unit 1, directly overlies chalk in A, D and G.

Unit 1: two main divisions, the upper subdivided, upper division:

1.2, B_2 is brown clay, C_2 stiff red clay with lumps of chalk and small pebbles, has split by D into upper subdivision:

1.2₂, D_5 brown stony clay, E_6 with sand as E_7 interbedded, F_7 is brown gritty clay, and lower subdivision:

1.2₁, D_3 is gritty red clay with chalk fragments and flint gravel, E_4 with fresh flint nodules and small well rounded flint pebbles. Lower division:

1.1, E_2 and F_2 are red clay directly on chalk, thickening beyond the solution pipe west of F (Fig. 4,) becomes gritty red clay with numerous fresh flint nodules to 20 cm and occasional small well rounded flint and quartzite pebbles. Except in G rests directly on chalk, layers E_2 F_2 G_5 H_2 J_2 K_2.

The sand, unit 2, reached a maximum height of 40.8 m in B and C, though current bedding was nowhere seen above 40.5m. The sand appeared to wedge out against the rising surface of the chalk between 2 and 5 m east of A (though this area was obscured by vehicle tracks) and to the east of this point the chalk was covered by a brown clayey ploughed layer, with clay and broken flints in deeper pockets.

The surface of the chalk is generally smooth. In D it is covered by a thin *Fe/Mn* pan. The upper 0.1–0.3 m of the chalk is brecciated into angular to sub-angular blocks from 2–5 cm across. Fissures between blocks are filled with clayey (D_1) or yellow (G_1) sand, with occasional small well rounded flint and

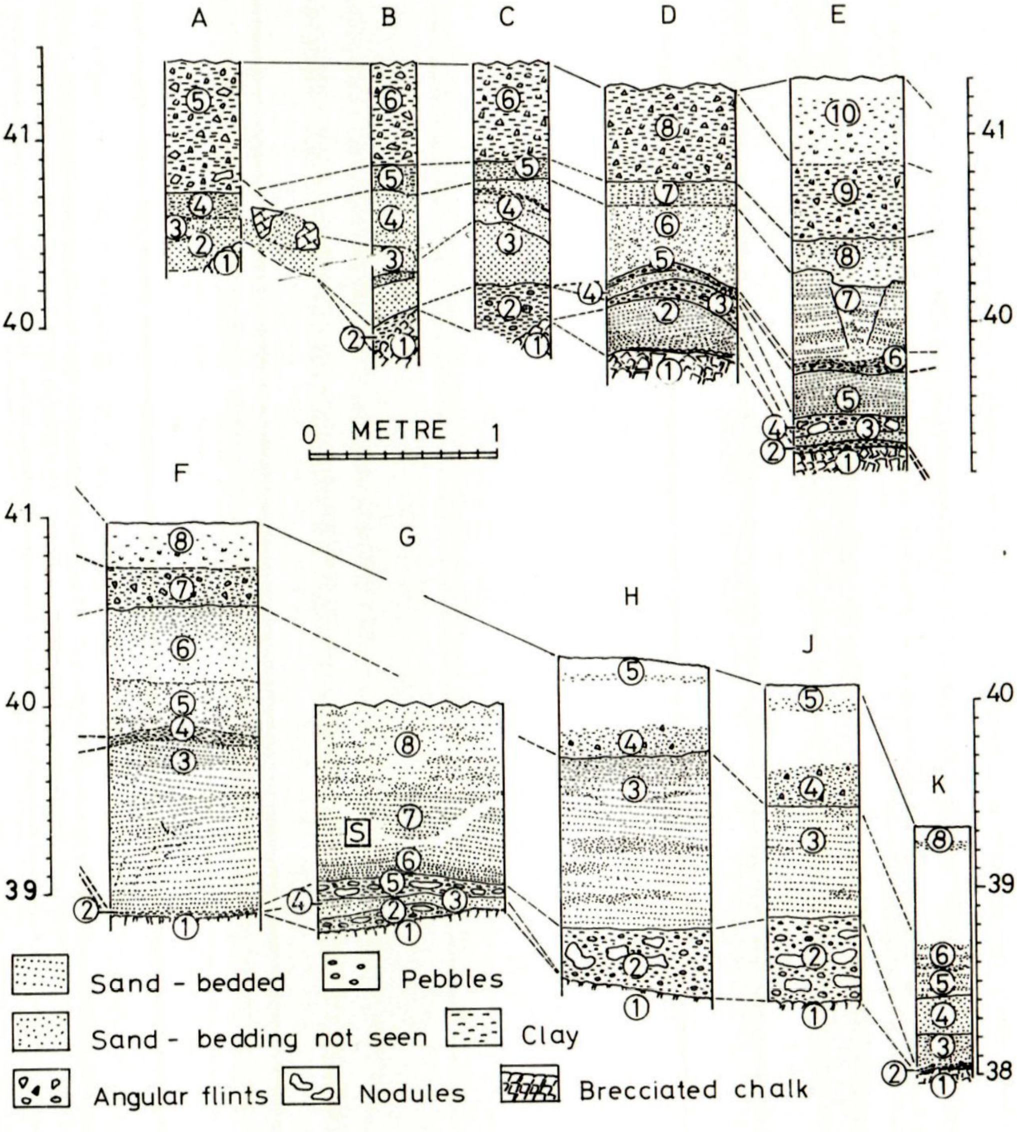

Fig. 5. Wallington raised beach, details from section 1. S=Sample location.

quartzite pebbles. Two solution pipes were seen in section and these had entrained the overlaying layers of units 1 to 3. As at Downend, their sides were lined with up to 5 cm of clay rich in iron and manganese.

In contrast to the sloping south side of the cutting, the north-south section face was vertical so that it was possible to study the run of the layers (Fig. 6). These correspond to the units already distinguished as follows:

Unit 4: L_{7-9}; L_9 is brown sandy loam with a few white patinated flints, L_8 is brown loam, L_7 brown clayey sand with a few flints.

Unit 3: $L_{2,3,4,6}$; L_6 is brown clayey sand with numerous angular, fractured, white patinated flints, mostly small, occasionally up to 20 cm, L_4 is reddish-brown clay loam with scattered flints as L_6, L_3 is brown sandy clay with flints as L_6, L_2 is reddish-brown clay-loam with flints as L_6.

Unit 2: $L_{5,1}$ L_5 is compact reddish brown sand with no visible bedding and with intercalated seams of angular flints, L_1 is reddish yellow sand with chalk blocks.

Unit 1 was absent. Unit 2 and 3 were contorted and wedges and seams of layer L_6 pene-

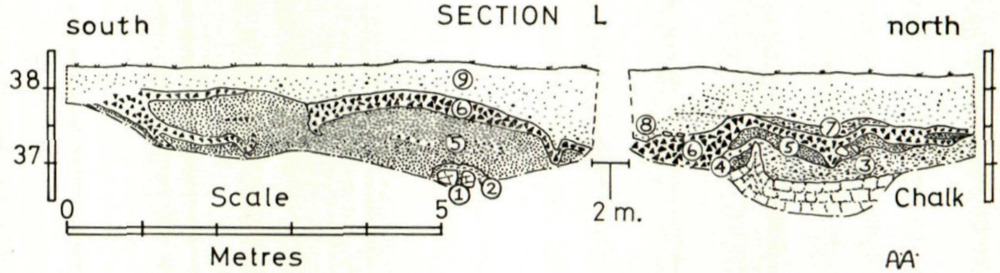

Fig. 6. Wallington raised beach, section L.

trated the sand, L_5. The surface of the chalk also showed signs of disturbance, with blocks and tongues of chalk drawn up into the overlying deposit.

Further down the slope to the west the superficial soil, unit 4, rested directly on the chalk, the intervening deposits having been completely eroded.

The chalk beach platform and cliff

The sections show this rising from about 36.8 m at L to a notch at the foot of the sloping cliff. In section 2 the notch is at about 39 m, in section 1 there are two notches, the lower at 39.3 m and the higher at 40.1 m. The top of the cliff is at about 41.3–5 m OD. In section 2 the cliff is cut by a solution hollow 20 m in diameter. This was lined with a thin layer of iron and manganese rich clay and filled with a yellow-brown sandy clay, proved by digging and auguring to be more than 2 m thick. Prof. F. Hodson reported that the coarse fraction of this clay contains angular chips of flint, indicating the incorporation of chalk residues, though the clay is completely decalcified and no chalk fragments are present. Further solution hollows, up to 9 m in diameter, were seen on the beach platform and these were filled with mainly sandy deposits derived from the overlying layers. The surfaces of the solution holes showed irregular networks of bands of white patinated flints on edge in a sandy clay matrix, similar to unit 3.

As well as those seen in section, at least 40 solution pipes were found when the surface of unit 3 was exposed. These pipes penetrated into the chalk for depths of up to 10–12 metres. They are considered to be of post-Pleistocene age and will be discussed elsewhere in conjunction with the Mesolithic industry from the site (Hughes and ApSimon, forthcoming).

THE CAMS BRIDGE RAISED BEACH, FAREHAM [A.M.A. and C.S.G.]

About 300 m south-south-east of the Downend Chalk Pit the railway line from Portchester to Fareham is crossed by Cams Bridge (SU 601061). The Ordnance Survey 6″ Maps record the development and abandonment of two gravel pits south of the line and on either side of the lane leading to the bridge. The eastern pit is built over, the western pit is disused, and bungalows have been built across its southern side. These are probably the pits '1 mile west of Portchester station' said by White (1913, 34–5) to show 8–10 ft. of ochreous sub-angular gravel, fine and well current-bedded above, coarser and more evenly stratified below, resting on marine sand and covered by 'from a few inches to a few feet' of brown loam. A more detailed section, probably of the west pit, is given by Palmer and Cooke (1923):

1. Brick earth
2. Upper Coombe Rock, unstratified angular gravel
3. Brick earth
4. Lower Coombe Rock, small gravel
5. Raised beach pebbles, chalk with *Pholas* boring
6. Fluviatile sands and pebbles
7. Littoral sands

They refer to the site as Down Coppice, Portsdown (The 6″ Maps, 1911–1942, mark Cams Coppice just north of the railway). In Palmer and Cooke (1930), the site is called Cams Wood Pit and the description is repeated without details or illustration and with 6 omitted. In both papers the deposit is assigned to a 50 ft. (15 m) raised beach.

The west pit was visited in February 1975, when the following sections were noted on the east face:

A. 15–20 m south of the railway fence

	depth (m)
1. Made ground	0–0.6
2. Angular white patinated flints and flint pebbles, generally frost-cracked, fragments in close apposition, clayey-loamy matrix, layer slopes southwards (in north face roughly horizontal, undulating)	0.6–0.75
3. Reddish brown loam, top stoneless, a few small rounded flints near base	0.75–1.15/1.25
4. Flint shingle, generally fine, pebbles lie horizontally	1.15–2,5

B. 30 m south of the fence:

1. Made ground	0–0.7
2. Flint shingle, pebbles up to 15 cm, sub-angular, poorly sorted, unbedded, coarse sand matrix ...	0.7–3.0
A test pit in the floor of the pit about 5 m away proved flint shingle with a little coarse sand to about	3.7

The angles of the pebbles are well rolled and their surfaces bear chatter marks, internally the flint is fresh and without the alteration characteristic of Tertiary pebbles. The suggested correlation between the recorded sections is:

Palmer and Cooke 1923	*ApSimon and Gamble*
2. Upper Coombe Rock	A.2
3. Brick earth	A.3
4. Lower Coombe Rock	A.3
5. Raised beach	A.4, B.2
6,7. Fluviatile and marine sands	Not seen

The bottom of our test pit was at about 15.4 m OD, the top of the shingle at B about 18.4 m OD. North of the pit the ground rises to 30 m OD with a 4° 30′ slope, southwards it falls to the 7.6 m contour with a 1° slope. This change of slope can be traced at the same height eastwards to the foot of the slope (SU 609061–611061) on which the Red Barns palaeolithic sites lie, westwards it can be traced to Downend Farm (SU 591064).

SEDIMENTOLOGY [M.L.S.]

A 500 gm sample of sand was taken from Wallington, unit 2, section G, layer 7, for laboratory analysis. Comparative samples were taken from exposures of supposed raised beach sands at Tortington (Parker's Pit, Slindon) (SU 977073) and Boxgrove Common (Amey's Pit, Eartham) (SU 925083), and from a modern beach at Bembridge, Isle of Wight.

Samples were examined under a binocular microscope, for grain character and fossil inclusions. Randomly selected grains of 60–500 μm in diameter (medium/fine sand) were examined under a scanning electron microscope under magnifications of × 50–1000, allowing observation of the grains in three dimensions. All samples were subjected to detailed particle size analysis. No pre-treatment was required. Results were analysed using a computer programme, compiled from Bork (1970), Kane and Hubert (1963), Pierce and Good (1966), run on the University of Southampton's ICL 1900 computer. This programme calculates the particle size distribution descriptive parameters of Folk and Ward (1957), which are summarized in Table I. Particle size distribution curves are plotted on arithmetic probability paper, and are shown in Fig. 7.

Results

All three Pleistocene sands are yellow in colour (Munsell values: Wallington 2.5Y 8/6, Tortington 2.5Y 8/4, Boxgrove 2.5Y 6/6) and are composed principally of unagglomerated clean quartz grains, rounded and shiny in appearance. No fragments of shell or other inclusions were found. The Wallington sample is indistinguishable from those from Tortington and Boxgrove.

The modern beach sand (Munsell 2.5Y 5/4) contained a higher percentage of heavy minerals, and plentiful shell remains. The appearance of the quartz grains is the same as that of the Pleistocene sands, although they tend to be slightly larger and more agglomerated.

The grain surface textures examined under high magnification generally show patterns of prominent conchoidal-type breakages, with roughened areas of 'blocky' texture. Some areas have a maze of intersecting V-shaped cuts, but this is not common.

None of the three Pleistocene sands contains any material coarser than -2ϕ (4 mm) in diameter. The Wallington and Boxgrove samples have less than 6% of silts and clay, but Tortington has almost 25%. The grain size distribution patterns are similar (Fig. 7), although the high percentage of fine material from Tortington slightly distorts the curve. In all samples the fine sand fraction (3–4ϕ) is the most important. The values of θ_1 (Table I) show the samples to be moderately well sorted. All were negatively skewed and tending towards the leptokurtic (relatively better sorted in the central area than in the tails of the distribution) (Folk and Ward 1957).

The Wallington sample does not differ significantly from either of the other ancient sands, and in its sorting pattern and particle size distribution is similar to the modern beach sand, although finer grained.

TABLE 1 CHARACTERISTICS OF THE SAND SAMPLES

Sample name	*Weight analysed gms.*	*% gravel* > −2.5ø	*% sand* −2.5 — +4ø	*% silt* +4 — +8ø	*Folk and Ward parameters (1957)* M_z	θ_1	Sk_1	Kg
Wallington	560	0.0	94.0	6.0	2.68	1.30	–0.27	1.17
Tortington	410	0.0	73.4	25.6	3.64	0.58	–0.42	1.96
Boxgrove	784	0.0	95.0	5.0	3.02	0.67	–0.70	0.99
Modern beach sand, Bembridge I.O.W.	674	0.0	99.7	0.3	2.06	0.63	–0.37	1.61

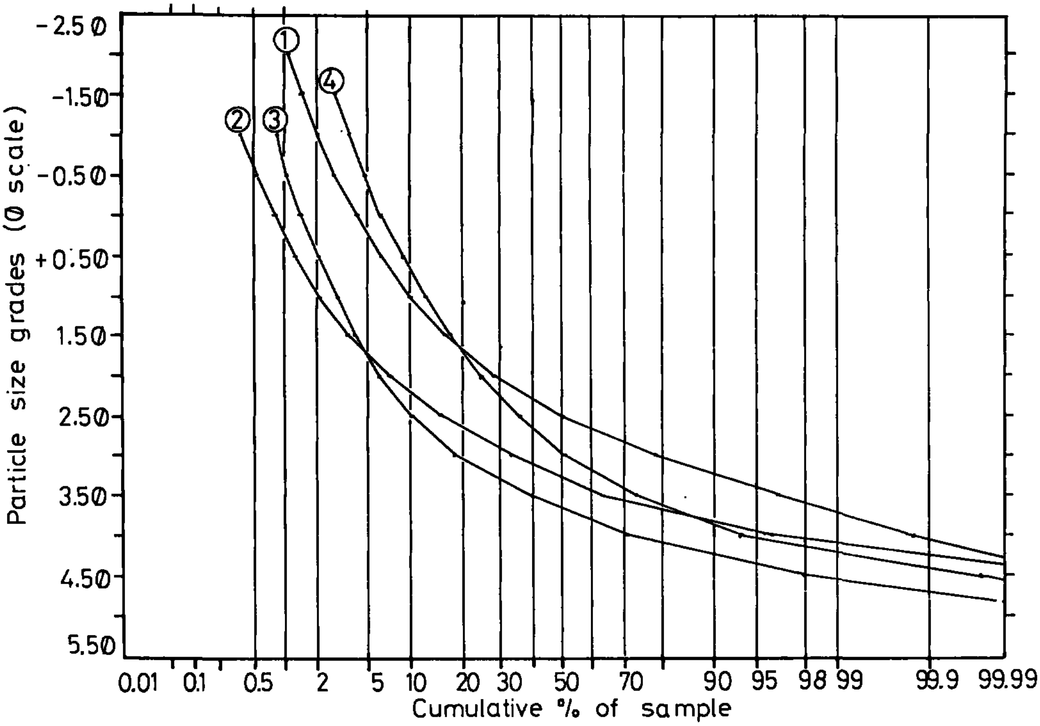

Fig. 7. Cumulative frequency curves of particle size distribution of sand samples from the Goodwood-Ports Down beach (1. Wallington, section 1, layer G7, 2. Boxgrove, 3. Tortington) and from a present day beach (4. Bembridge, Isle of Wight).

Discussion

Sedimentology

Beach sands tend to be well sorted, since they are subjected to constant washing by longshore currents and local sorting by wave oscillations (Inman 1949). They differ from river sands in their abundance of medium/fine grained sand, in the absence of much fine material and in having a negative skewness value (Aseez 1972, Friedman 1961). Friedman concluded that less than 8% of beach sands have a positive skewness value, whereas dune or river sands are predominantly positively skewed. Dune sands tend to have a high silt content (Shepherd and Young 1972) and beach sands a low value for kurtosis due to the local sorting effect (Folk and Ward 1957). Since all three ancient sands conform markedly to the pattern described above, there seems little difficulty in concluding that they are beach sands.

The distribution curves (Fig. 7) show very little material in the 2ϕ fraction. Fuller (1962) notes that the 2ϕ fraction is often missing from sediments deposited in shallow-water environments, suggesting that this size range moves either further onshore or offshore under these conditions. The Wallington, Boxgrove and Tortington sands were therefore most probably deposited under comparatively shallow water with a gentle offshore gradient. The sample locations high up on the beaches account for the presence of material finer than 4ϕ, which was probably wind-transported and derived from the ancient dunes. The modern beach sand is much coarser grained, but this was sampled from the foreshore where the effect of material blown from the dunes was minimal.

The rounded, shiny appearance of the sand grains under the binocular microscope has been taken by some authors as indicative of beach conditions. The conchoidal fractures and blocky appearance under the electron microscope are however thought to result from aeolian abrasion. Wind transport rapidly removes the V-shaped fractures, smooth plateau areas and intersecting to near-parallel grooves characteristic of water-laid sediments (Greenwood 1972). From this it may be concluded that though the Fort Wallington, Tortington and Boxgrove sands are marine beach sands, their upper layers have been modified by wind action following the regression of the sea.

The Downend and Fort Wallington beaches

We believe the Chalk bench at these sites to be a marine wave-cut platform backed by the remains of a cliff. The smoothness of the platform at Wallington suggests that it has not been appreciably lowered by solution. In contrast, the irregularity of the platform at Downend suggests that its original surface has been destroyed by subsequent solution. The sand, unit 2, at Wallington, we interpret (see above) as a beach sand deposited close to high water mark together with some additional wind transported material. The faulting seen in section 1 E probably took place when the sand ceased to be saturated with water. The mottling and banding of the sand has been attributed in the case of similar sands to post-depositional processes (Hodgson 1964). Apart from this and from the partial decalcification which has removed all shell fragments (though some chalk fragments survive), the sand is little altered except in its upper part, unit 2.4, which may have suffered iron depletion and clay enrichment, perhaps through weathering following the regression of the sea.

The shingle at Downend appears to be a storm beach thrown up at high-water mark. Beach sands did occur in Prestwich's section, which was about 100 m to the south and 7 to 8 m lower, implying that this beach has an off-shore gradient about twice as steep as that at Wallington and so will have had a higher energy regime, accounting for the presence of coarse shingle, as compared with the few small pebbles from Wallington.

Unit 1 at Wallington may result from the sludging down over the beach of superficial material from the top of the cliff, mixed with fresh flint nodules and blocks of chalk from the cliff face and pebbles from the beach. The variable and impersistent occurrence of this unit, its duplication and its alternation with decalcified but otherwise little altered sands show that it cannot be the residue of *in-situ* weathering. Though its unsorted character suggests that it was deposited by mass flow, the stones in it were generally horizontal showing that it had not been cryoturbated. The complex interstratification of this with unit 2 suggests variation in conditions of deposition due to minor fluctuation in sea-level. The appearance of undulation in unit 1 may be exaggerated by section 1 being taken obliquely across the beach, but could be accounted for by supposing that this material was deposited during minor regression phases on a beach surface gullied by water draining across it.

Unit 3 we interpret as a slope deposit formed under periglacial conditions. In section L this deposit showed wedges and undulations attributable to frost-heaving – cryoturbation – which also involved the underlying layers. The exposures of this unit in sections A–K were too small to show the presence of cryoturbation structures, but there was no sign of disturbance of the underlying layers. It may be that the chalk cliff protected the back of the beach, whereas between sections F and K the sand was eroded to progressively lower levels. The plane of this erosion, if projected, meets the chalk surface near section L.

The large solution holes in the chalk at Wallington are at least as old as the last glaciation (Devensian) since their fillings showed signs of cryoturbation. The resultant patterns looked in plan rather like stone polygons, but a section through them suggests that the patterns result from cutting horizontally through cryoturbation mounds and hollows formed in them. The formation of the solution pipes may be connected with the presence of permeable beach deposits since they are absent from the 300 m long east face of the Downend pit, where the chalk is covered only by a thin layer of slope deposits. The more aggressive solution of the chalk at Downend may correlate with coarser deposits there as compared with the sand at Wallington.

The Cams Bridge beach

The shingle here (our A_4, B_2) we interpret as a storm beach thrown up at or above high-water mark, which may overlie littoral sands and which is covered by other deposits including a slope deposit (A_2) probably formed under periglacial conditions. Neither the beach platform nor the fossil cliff is exposed, but the latter must lie very close to the north side of the pit. The change of slope here represents a shoreline which can be traced for at least 2 km.

The sea-levels

The height reached by a marine transgression can be estimated by comparing the heights of shoreline elements with their present-day equivalents in the same area. The notch at the back of a beach platform is thought to give a minimum value for high-tide level (So 1965, Wright 1967), while beach deposits give a maximum value since they can be deposited above high tide level. At Wallington the notches suggest a high water mark about 39.5–40 m OD, while the current-bedded sands reach 40.5 m. At present, High Water of Mean Spring Tides in this area reaches about 1.8–2.0 m above OD, so that the Wallington beach suggests a high tide level about 37.5–38.5 m above present day. At Downend the notch may have been a little lower, possibly around 38 m, but this difference can be accounted for by the Downend site being on a headland, whereas Wallington is in a bay. Present-day shore platforms show notches lower on headlands and higher in bays (Wood 1968).

In the case of the East Cams Bridge beach, the height of the notch is unknown, but with shingle reaching about 18 m above OD, high tide level may have been of the order of 16m above present day.

The Ports Down raised beaches, equivalents and dating

East of Ports Down, a continuous terrace on which occur beach deposits similar in character and height to those of Wallington and Downend, can be traced for 26 km between Havant (approx SU 737080) and Arundel, Sussex (Prestwich 1859, Reid 1903, White 1913, Palmer and Cooke 1923, Fowler 1932, Calkin 1935). This has been variously known as the hundred foot, Goodwood or Slindon (Mitchell *et al.* 1973, Table 7, 47) beach. Localities on this beach include Parker's Pit, Tortington and Amey's Pit, Boxgrove, from which the samples of sand shown in this paper to resemble very closely that from Wallington were taken. The Downend and Wallington sites probably represent the extension of this shoreline into the Fareham area. Its westwards extension across the New Forest is probably represented by Everard's '150 ft. stage' with its minor bluff at about 120–130 ft. (36.5–39.6 m) OD (Everard 1954).

No palaeolithic artifacts have been reported from the beaches on Ports Down. Sites in the Chichester-Arundel area have yielded over 300 palaeoliths from the beach (Fowler 1932, Calkin 1935, Dalrymple 1958) including more than 30 handaxes. Most of these are from excavations by J. B. Calkin (1935) in Slindon Park (SU 951084). Two of us (A.M.A. and M.L.S.) have examined a series of implements from these excavations preserved in the British Museum (BM 1935–5–6) (study in preparation). The composition of this series indicates that handaxes were being made on the site, as at Red Barns. Most of the artifacts were made from fresh flint nodules probably obtained from the chalk cliff at the back of the beach, a few were made from beach pebbles. Examination under a stereo-microscope showed that all the artifacts had been rolled in the beach, some only slightly, some more heavily, leaving little doubt that the manufacture of this industry was contemporary with the maximum of the marine transgression. The more finished handaxes can be assigned to the Middle Acheulian and several untwisted ovates are closely comparable to handaxes recovered by Wymer (1974 excavations) from the Hoxnian interglacial lake muds at Hoxne (Wymer 1974). This suggests that the Acheulian industry from Slindon and the Goodwood-Ports Down raised beach are probably also Hoxnian in age.

The Cams Bridge raised beach corresponds in height to the raised beach at Bembridge, Isle of Wight (Chatwin 1960, Fig. 36) and to the well known Portland raised beach (Baden-Powell 1930), which has sometimes been assigned to the Last (Ipswichian) Interglacial (Zeuner 1959, 292) though without any compelling evidence. Both it and the shoreline at 7–8 m found in southern England (Zeuner 1964, 243) and along parts of the northern coast of France, which has also been attributed to the Ipswichian (Eemian) (Sparks and West 1961), are possibly older since there is good evidence from sites on the north coast of Brittany (Giot and Monnier 1973: sites seen by A.M.A., May 1976) to suggest that the 2–4 m shoreline (Zeuner 1964, 243) represents the Eemian transgression.

Conclusions

This paper has presented evidence confirming the marine origin of the Goodwood-Ports Down raised beach and its contemporaneity with a Middle Acheulian industry, as well as supporting its attribution to the Hoxnian Interglacial (Zeuner 1964). This is important since all three points have been doubted recently (Mitchell *et al.* 1973, 47, 52; Kellaway *et al.* 1975, – for critical comments with which we fully agree, see Kidson and Bowen 1976). The Wallington exposure is the first to enable a close estimate to be made of the height reached by the transgression. Our re-examination of the Cams Bridge raised beach confirms the main features of earlier accounts without being able to present evidence of its age.

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Authors: A. M. ApSimon & C. S. Gamble, Department of Archaeology, The University, Southampton SO9 5NH.

Dr. M. L. Shackley, Institute of Archaeology, 35 Beaumont Street, Oxford.