EVALUATION OF PALAEOLITHIC DEPOSITS AT PURFLEET, ESSEX

Martin Bates¹, George Lambrick², Ken Welsh², and Mark White³ with a contribution by Rob Scaife⁴.

¹Department of Archaeology, University of Wales, Lampeter, Ceredigion, SA48 7ED. ²Oxford Archaeological Unit, Janus House, Osney mead, Oxford, OX2 OES. ³McDonald Institute for Archaeological Research, University of Cambridge, Downing Street, Cambridge, CB2 3ER. ⁴Heyside, Dodpits Corner, Newbridge, Isle of Wight, PO14 OTN

INTRODUCTION
There are particular difficulties in assessing areas of Palaeolithic archaeology. Structural features such as pits and ditches will not be present; deposits containing archaeological remains are entirely natural and likely to be deeply buried; understanding often complex natural depositional processes is critical to assessing the context and significance of any archaeological remains; actual evidence for human activity can be limited, relying heavily on recognition of relevant artifacts or worked bone; the often sparse occurrence and relatively small size of such remains on the one hand and the depth of sediments on the other make the scale and method of sampling sediments a critical factor. This paper describes an approach to assessing Pleistocene deposits known to contain Palaeolithic remains at Purfleet, which may have scope for wider application and further development and adaptation.

The Oxford Archaeological Unit (OAU) undertook a two stage archaeological evaluation during July, August and September 1995, on behalf of Union Railways Ltd (URL) on land at the former Esso oil depot immediately to the south of the Purfleet Bypass, Purfleet, Thurrock, Essex (Fig. 1). The evaluation formed part of a programme of archaeological investigation along the line of the Channel Tunnel Rail Link (hereafter CTRL), the aim of which was to appraise the impact of the construction of the new railway upon the cultural heritage. This paper is a shortened version of the evaluation report prepared for Union Railways (URL 1996). We would like to thank Union Railways Ltd for permission to publish this paper; the opinions expressed are those of the authors.

Pleistocene deposits within the Purfleet area have been extensively quarried, allowing scientific and archaeological investigations to be carried out on them. The southern edge of a former course of the Thames crosses the evaluation site, and previous studies have shown that Palaeolithic artefacts are most densely distributed towards the southern edge of the Pleistocene deposits.

Geology
Sediments within the study area at Purfleet consist of fluvial sands and gravels deposited during the Middle Pleistocene. These deposits are part of the Corbets Tey Gravel (Bridgland 1994; Gibbard 1994) and are considered to have been deposited by either the Thames or the north bank Thames tributary, the Mar Dyke. Previous work in the area (Bridgland 1994) has demonstrated that these sediments thin to the east and wedge-out against a rise in the chalk at the eastern end of the study area. Although sediments previously described in the Esso Pit (Bridgland 1994) and the Botany Pit (Wymer 1968) appear to lack fossiliferous material work in Bluelands and Greenlands Pits (Snelling 1975; Palmer 1975; Hollin 1977) recovered extensive remains of small and large vertebrates, molluscs and foraminifera and ostracoda. To the west younger, lower lying sediments of the Mucking Gravel have been mapped as a thin strip immediately above the Holocene alluvium.  

ARCHAEOLOGICAL BACKGROUND
Palaeolithic
The archaeological evidence consists of flint artefacts and palaeo-environmental remains recovered from Pleistocene geological deposits. These deposits consist of a sequence of stratified clays, silts, sands and gravels of predominantly fluvial origin that thin towards the north-facing chalk slope to the south of the Mar Dyke.

Palaeolithic flint artefacts were collected by Snelling from Botany Pit (TQ 556785) in 1961. This flint industry has been attributed as 'Proto-Levalloisian' and dates to between 200,000 and 300,000 years ago. Snelling recovered this assemblage from a deposit of gravel resting on chalk bedrock at approximately 12 m OD (Wymer 1968, 312-313).

More detailed investigations of these deposits were carried out less than 1 km to the east by Palmer in the late 1960s at Greenlands Quarry (TQ 566785) and Bluelands Quarry (TQ 570787). Palaeolithic artefacts were recovered from fluvial sediments in both quarries (Palmer 1975, 1-13). These artefacts occurred in three distinct bands of gravel within the Pleistocene sequence. The artefacts from each gravel band have been attributed to, respectively: the Levalloisian industry (Gravel 1), the Clactonian and Acheulean industries (Gravel 2) and the Clactonian industry (Gravel 3).
Figure 1: Site location plan showing distribution of Pleistocene sand and gravels and the transect line of boreholes drilled during the GSF site investigation.
Palmer identified these gravel-bands within a deep sequence of Pleistocene deposits filling what was considered to be the middle of a channel of the Mar Dyke. At this point the base of the channel was cut into chalk bedrock at 6.7 m OD, and the top of the Pleistocene sequence occurred at 13.75 m OD. In between the gravel-bands 3 and 2, between 2 and 1, and over gravel-band 1, are complex sequences of clays, silts and sands. The lower clays and silts (between gravel-bands 3 and 2) have been shown to contain both mollusc shells and pollen.

A recent re-examination of the Botany and Esso pits by David Bridgland as part of a geological study of the CTRL (URL 1993) suggested that Palaeolithic artefacts are most strongly distributed towards the southern edge of the Pleistocene deposits where these are banked against the chalk anticline.

**Mesolithic and Neolithic**

Archaeological remains from these periods have been discovered at several locations in the area. At the west end of Greenlands Quarry (TQ 56407850) pottery (possibly Neolithic), flint artefacts (Mesolithic/Neolithic) and two possible postholes (unattributed) were found in the top metre of the deposits exposed in the quarry section. A prolific Mesolithic flint industry was also recovered from the topmost part of the section at the north-east corner of Greenlands Quarry (TQ 56857853). An assemblage of over 300 flint artefacts, including flakes and a polished axe of likely Mesolithic and/or Neolithic date, was recovered from the topsoil at Beacon Hill (TQ 557782) during an archaeological salvage operation after the destruction of the hilltop by quarrying in 1969 (Caldwell 1971, 58).

**Bronze Age**

The only unambiguous location of Bronze Age archaeological remains is at the top of Beacon Hill (TQ 557782), where a Bronze Age cinerary urn was recovered during the 1969 archaeological salvage operation (Caldwell 1971, 58).

**Iron Age and Roman**

Isolated finds attributed to the Roman and/or Iron Age periods have regularly been found in the upper parts of the old quarry faces around Botany Pit.

**AIMS**

The Written Scheme of Investigation (URL 1995) outlined thirteen principal aims for the evaluation, as follows:

- To assess the sedimentological character, and horizontal and vertical extent of affected Pleistocene/Palaeolithic deposits.
- To assess the vertical and lateral distribution of Palaeolithic artefacts within the Pleistocene levels.
- To examine the Pleistocene/Palaeolithic levels to the depth of impact from construction works by means of boreholes and by test pits.
- To assess the potential of the Pleistocene/Palaeolithic and other deposits for artefactual and environmental remains.
- To assess the relationship of Palaeolithic archaeological deposits, including artefacts and ecofacts, to the Pleistocene lithostratigraphic and sedimentary sequence.
- To determine the potential for post-Palaeolithic archaeological deposits and, if such deposits are defined, to assess their date, character, extent, quality and condition.
- To relate all archaeological deposits found to other discoveries in the locality.
- To critically review the local, regional, national and (where relevant) international significance of such archaeological deposits as are revealed.
- To contribute towards proposals for mitigation of impact on such archaeological deposits as are revealed and/or can be predicted from the evaluation evidence.
- To make a full graphic, photographic and written record of the evaluation.
- To communicate the results of the evaluation to the client (and through them to the statutory consultees) in the form of a suitably illustrated report which shall be lodged with the County Sites and Monuments Record within one year of the end of fieldwork.
- To prepare an archive of the evaluation project, to be deposited in an approved museum within a timescale to be agreed with the County Archaeologist, taking due account of the potential for further fieldwork.
- To deposit the finds with the archive (subject to the agreement of the landowner and, where relevant, any decisions under Treasure Trove law).
METHOD

General Approach
In order to evaluate the thick and deeply buried Pleistocene deposits, a staged approach to the evaluation was devised. The first stage of work took the form of a borehole investigation, carried out by the Geoarchaeological Service Facility (GSF) of the Institute of Archaeology, University College London at the request of the Oxford Archaeological Unit. A series of boreholes were drilled using a shell and auger percussion drill rig to recover undisturbed core samples (see Fig. 2). The aim of this exercise was to provide an assessment of the general profile and character of the lithostratigraphy in order to determine the sedimentary depositional sequence and to refine the siting of the test pits excavated during the second stage of evaluation.

The second stage of work involved the excavation of a series of test pits (see Fig. 2), primarily for the recovery of artefacts and ecofacts, to provide larger bulk samples of sediments, and to provide an opportunity for examination of the depositional sequence in situ.

The Borehole Investigation
A shell and auger percussion drill rig was used to drill an array of 10 boreholes along the proposed CTRL route corridor (Figure 2). In all cases, irrespective of apparent depth of Pleistocene sediments, boreholes were drilled to 10.0 m depth from the surface to ensure that bedrock had been penetrated.

Individual boreholes were recorded in detail during drilling. Where possible U4/U100 cores were recovered. Recovery quality varied both down profile and across the site. Dense ground within the gravels precluded the use of U4/U100 cores in certain parts of the sequence. Elsewhere the extremely unconsolidated nature of the sands resulted in U4/U100 cores falling apart on extraction from the ground. Where sampling using U4/U100 cores was not possible open shelling of the hole was undertaken and sediments logged and taken as bulk samples. Where possible cores were extruded using an hydraulic core extruder. Where sample cores were overcompacted due to the nature of the sediment cores were cut open longitudinally.

Extruded cores were split and individual halves retained in split plastic piping or the split U4/U100s. Both core halves were cleaned carefully using a knife or scalpel and the cleaned faces examined. One half of the core was selected for detailed study and photography.

Individual cores were subsequently described in detail using standard sedimentological terminology to describe colour, composition, bedding and grain sizes. In addition other features, such as the presence of clay coatings on clasts and sand grains, zones of reddening, blocky structure to the sediment and trace fossils indicative of plant rooting/bioturbation (possibly indicating pedogenic activity and/or the presence of a buried landsurface) were actively sought.

Considerable emphasis was placed on the recognition of i) incipient pedostratigraphic features and ii) stratigraphies containing bioassemblages. When it became clear at an early stage in the bulk processing that faunal material were not present within the cores, extra attention and resources were allocated to other avenues of identifying incipient pedogenesis. For this reason a previously untried route to this objective - using reddened clay coatings on quartz sand grains as a criterion identifiable by Scanning Electron Microscopy (SEM) - was deployed on a small number of selected samples.

The Test Pit Investigation
Four test pits were excavated under the direction of Ken Welsh, using a mechanical excavator equipped with a 0.9 m wide ditching bucket. All the test pits were 4 m long and 1.7 m wide in order to accommodate a trench-box shoring system once a depth of 1.2 m had been reached. The trench-box was lowered in stages as each test pit was excavated. This technique ensured that disturbance of the deposit was minimised (compared with stepped trenching) while also ensuring that at least the short end-sections of each test pit were open to observation. One section in each test pit was drawn at a scale of 1:20. In test pits ARC2001TP, ARC2002TP, and ARC2003TP, the end face of the test pit was felt to be representative of the deposits as a whole. In ARC2004TP, with more complex stratigraphy, it proved possible to draw the long face as a cumulative section by cleaning and recording the side of the trench each time it was exposed before the trench box was lowered (Fig. 3).
Figure 2: Test pit and location plan.
A resident engineer was on site at all times to advise on and monitor the safety aspects of the excavation. Test pit ARC2002aTP was resited after made ground was encountered in its initial position, and the final test pit, ARC2002TP, was excavated through unconsolidated sediments.

The test pit locations were determined on the following basis. Test pit ARC 2001 TP was excavated between boreholes ARC 0007 SA and ARC 0008 SA, which broadly identified the south east margin of the Pleistocene channel deposits, in the area that had been reported in previous studies as containing the majority of the artefacts.

Test pit ARC2002 TP was excavated between boreholes ARC 0009 SA and ARC 0011 SA where the greatest sequence complexity had been noted.

Test pit ARC2003 TP between boreholes ARC0012 SA and ARC0013 SA to investigate a single thick gravel accumulation observed in these boreholes and in ARC0015SA, which differed from the sedimentary units recorded in the remaining boreholes.

The position of the final test pit, ARC2004 TP, was located on the basis of the emergent results of the other test pits to the south-east of ARC2001 TP, to investigate further the margin of the Pleistocene sediments on the line of the Chalk 'cliff'.

Figure 3: South-west facing section of test pit ARC2004 TP.

SUMMARY OF RESULTS

General Stratigraphic Sequence
The evaluation indicated that the stratigraphic sequences observed fall into three separate spatial groups (Figure 4). Group 1 consists of the deposits observed in boreholes ARC0012 SA, ARC0013 SA, and ARC0015.
Figure 4: Summarised stratigraphy along the route corridor based on selected boreholes.
SA and test pits ARC2001 TP and ARC2002 TP. A sequence of coarse fluvial sands and gravels was overlain by well-bedded sands and silts with occasional thin gravel beds. These were interpreted as fluvial deposits grading vertically into channel margin or overbank floodplain deposits. There was some indication of episodes of pedogenesis and therefore of potential palaeo-landsurfaces. The upper part of the sequences in ARC0009 SA and ARC 0011 SA consisted of chalky silt or gravel. These are probably colluvial or solifluction deposits.

Group 3 consists of the deposits recorded in boreholes ARC0006 SA, ARC0007 SA, and ARC0010 SA, at the eastern end of the site. Test pit ARC2004 TP can probably also be included in this group. Chalk bedrock was overlain by a very thin bed of fluvial sand or gravel. This was in turn overlain by a chalk-rich sediment, interpreted as colluvial or solifluction deposits.

ARC2001 TP did not locate the chalk ‘cliff’. However, the rockhead was 1.5 m higher than in the adjacent borehole ARC0008 SA. The sediments present were well-bedded and would be suitable for palaeo-current determinations. Flint artefacts were recovered from all the spits except spit 7. Several flint flakes were present in the well-bedded, Pleistocene deposits in the lower part of the sequence. Their relatively sharp condition indicates that they had not moved far from their point of origin. The upper deposits produced the majority of the flint artefacts, although this material was undiagnostic, it differed in character from the material in the lower levels of the sequence, and two small sherds pottery, recovered from spits 1 and 2, indicate a late prehistoric date.

It was difficult to record the deposits in ARC2002 TP due to the unconsolidated nature of the sediments and the full depth of the sequence was not ascertained. However, the lower part of the recorded sequence seemed to confirm the nature of the sequence as recorded in ARC0011 SA. A single flint flake was recovered from the lower sequence but was in a rolled condition and undiagnostic. The upper deposits produced a greater number of flint artefacts and a few small sherds of pottery. The later deposits were possibly colluvial in origin.

ARC2003 TP demonstrated that the coarse sands and gravels recorded in this area were in fact well-bedded and suitable for palaeo-current determinations. A small number (7) of flint flakes were recovered from the lower spits, all in a rolled condition. The upper part of the sequence also produced a small quantity of flint, including two cores, which can probably be assigned to the later prehistoric period. Again, the later deposits were possibly colluvial in origin.

ARC2004 TP revealed a chalky basal sediment (context 407), possibly a colluvial or solifluction deposit. The lower part of 407 appeared to consist of mixed chalky rubble with pockets of sandy material filling hollows in the chalk bedrock. The majority of the Lower Palaeolithic artefacts came from this deposit. They were generally in fairly sharp condition, suggesting that they had not moved far from their point of origin. The Pleistocene deposits were truncated by a large ditch-like feature (context 410) filled with brown sandy silt (contexts 404 and 408), of which 404 produced two sherds of pottery of Late Bronze Age or Early Iron Age date (full report by A Barclay in URL 1996).

LITHICS

Introduction
A collection of 130 humanly worked flints and 10 pieces of unworked burnt flint were recovered during the course of the evaluation. Two general series are evident, which can be separated primarily on the basis of stratigraphic position and on the association of burnt flint and pottery with the upper series. It is not possible to give absolute numbers for each series, as the nature of the extraction often crossed natural stratigraphic units. In some cases therefore, elements from both series have become mixed within the same spit and it was decided too hazardous to separate them purely on the basis of staining and patination. As a result, only those pieces from unmixed contexts will be discussed below.

The upper series is numerically diminutive and clearly of later prehistoric origin. It was considered to be of only minor importance to the aims of the evaluation and is not discussed here. The lower series was of greater consequence for the purposes of the evaluation, and arguably also of greatest archaeological importance. The presence of two bifaces, together with the general characteristics of this series, strongly indicates an Earlier Palaeolithic date for this collection.

THE EARLIER PALAEOLITHIC FLINT ASSEMBLAGE
This assemblage was recovered from the lower stratigraphic units (revealed by spits 4-7) in test pit ARC2001 TP and ARC2004 TP, but may be absent from the deposits encountered in test pits ARC2002 TP and ARC2003 TP. A small proportion of the collection was found within the bedded gravels and silts of ARC2001 TP although the greatest concentration, by far, was found in the chalky slope debris and small solution hollows in the Chalk in ARC2004 TP. The material recovered by hand from the solution hollows proved to be in fresher condition than
the remainder of the assemblage. It is possible that these pieces have not been subjected to the mass movement suffered by the artefacts from the chalky colluvium, hinting that primary flint scatters may have once been present and providing hope of finding less disturbed concentrations outside the area examined. In general, the collection is mildly patinated, in fairly sharp condition and is stained. The colour of the staining ranges from buff to dark red-brown; this is likely to reflect very localised sedimentary conditions only. The series consists of cores, flakes and two bifaces, with one possible biface roughout (Table 1); no flake tools were recovered.

Table 1: Artefacts recovered from spits 4-7 in ARC2001 TP and ARC 2004 TP

<table>
<thead>
<tr>
<th>Trench</th>
<th>Spitz (25 cm)</th>
<th>Flakes/blades</th>
<th>Cores</th>
<th>Bifaces/roughouts</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARC2001TP</td>
<td>4</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>2</td>
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<td>2</td>
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<td>6</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
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<td></td>
<td>7</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>ARC2004TP</td>
<td>4</td>
<td>24</td>
<td>2</td>
<td>2</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>11</td>
<td>2</td>
<td>-</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>6</td>
<td>1</td>
<td>-</td>
<td>7</td>
</tr>
<tr>
<td>Totals</td>
<td>-</td>
<td>50</td>
<td>3</td>
<td>3</td>
<td>56</td>
</tr>
</tbody>
</table>

The two bifaces and the possible biface roughout were all recovered from test pit ARC2004 TP. The nature of the excavation makes it impossible to associate the bifaces directly with any stratigraphic unit, or to determine the precise nature of their association with the larger flake element. The presence of a small number of biface thinning flakes, however, may allow the assumption that the bifaces were made near or at the site. The bifaces have been manufactured using the soft hammer knapping technique and are in fresh condition; as are the associated soft-hammer flakes.

The first biface recovered is a complete, sub-cordiform type (Wymer 1968; Type G) 120 mm in length (Fig. 5). Working is restricted to the tip of the piece and the butt is mostly unworked. The small number of apparent removals at the butt are considered to have been produced by machine, and correspond with a series of fresh scars at the tip. It would appear that the piece was entrained by the digger bucket and turned over, thus removing pseudo-flakes from both the tip and butt. The cortex remaining on the artefact reveals that the original nodule was thin and narrow, and that the shape of the biface may simply have followed the form of the raw material.

A second biface is represented by a broken butt. The tip is missing and the nature of the break suggests that it may have broken during manufacture (Pl. 1). This feature, known as end-shocking, usually results from inadequate support of the biface during manufacture. The possible biface roughout recovered shows some evidence for thinning the piece but the poor angles and the general shape seem to have defeated the knapper. This piece is slightly more abraded than the other implements.

The cores have only been lightly reduced showing direct evidence of six, nine and 12 removals respectively; all retain areas of original cortex. Three reduction strategies have been used – single, parallel and alternate flaking (cf. Ashton 1992) – although it must be stressed that these are universal techniques of core reduction and are of minimal cultural significance (see below).

The majority of the flakes show features associated with hard hammer percussors. The dorsal patterns on the flakes, ranging from one to five scars, show previous removals originating from the distal, proximal and lateral positions. A number exhibit relit core edges with removals from the proximal and lateral margins. The flakes, therefore also indicate the use of several common reduction strategies, with the frequent rotation of the cores in the pursuit of good flaking angles. The flakes are often fairly large (mean length from spits 4-6, ARC2004 TP = 57 mm) and exhibit a wide range of residual dorsal cortex, from 0-100%. The latter might provide evidence that all stages of core reduction from initial decortication are present at the site. Some of the flakes may represent the initial hard-hammer roughing out stage of biface production.

**RAW MATERIALS**

The raw material used to produce these artefacts exhibit a cortex entirely consistent with that observed on flint taken from the Chalk at Purfleet. This is a black flint with a thin white chalky cortex. The material appears to have been of good quality, with fine flaking properties, although today much of the flint present in the Chalk is badly frost shattered. Two artefacts were made on Bullhead flint, which forms bands at the base of the Thanet Sand and is widespread in river deposits of the Lower Thames. These factors suggest that the raw materials used are those immediately available in the locality.

**INDUSTRIAL AFFINITIES AND DATING**

The key question surrounding these finds is whether elements supporting the cultural succession of Clactonian, Acheulean and Levalloisian, apparently present in the nearby Bluelands and Greenland's Pits (Wymer 1985; Palmer 1975; Hollin 1977) can be discerned at Esso Pit.
Although nothing which could be confidently termed Levallois was found, the presence of bifaces and thinning flakes allows the designation of at least one part of the Esso Pit material to the Acheulean.

![Figure 5: Biface hand axes (top) and flakes (bottom) from ARC2004TP.](image)

In general, the nature of the assemblage recovered would appear to fit Wymer's (1985) contention that a mixture of two Lower Palaeolithic industries is represented in some of the deposits at Purfleet — Clactonian (ie the flakes and cores) and Acheulean (the biface element) — although there are no reasons at present for dividing the material in this manner. Core reduction of the type present at Purfleet is now widely recognised as an integral part of the Acheulean (McNabb 1992; McNabb and Ashton 1992; Ashton et al. 1994). It is, of course, possible that a succession of industrial variants is present, as at Swanscombe, Kent, but this hypothesis is untestable given the context of the material. Even if *in situ* material was present the fact that this was an evaluation requiring certain logistical methods of recovery effectively precluded the possibility of tracing any potential cultural succession through the sequence.

Moreover, while the artefact assemblage does provide a general indication of the age of the site, it is definitely Earlier Palaeolithic, it cannot be used to assign a specific date. Acheulean bifaces are found throughout southeastern Britain in deposits ranging from 500 to 125kyr. Moreover, biface typology is of no value in assigning relative age (*cf.* Wymer 1991 *inter alia*). However, the nature of the industry is entirely consistent with Bridgland’s
(1994) proposed correlation with Oxygen Isotope Stage 9 (c. 300 kyr).

CONCLUSIONS
The condition of the Palaeolithic artefacts indicate that whilst not in situ, they have not moved very far from their point of origin. The use of local raw materials, and the presence of all stages of both core reduction and biface manufacture also indicates that a fairly integral assemblage is represented.

A simple comparison of finds from the four test pits shows that the density of artefacts greatly diminishes away from the chalk banks of the palaeochannel towards the centre of the channel itself. This plainly indicates that human activity was taking place on the edge of the channel, and that primary knapping scatters have been swept up into a mass movement deposit and simply carried downslope. This suggests that more or less primary scatters may survive landwards of the current test pits. The quantity of material recovered from ARC2004 TP, in very small volume of sediment, indicates the extreme richness of the site. However, the fact that the material was recovered during an evaluation using machine-excavated spits, with the majority coming from a mass-movement deposit, means that a more detailed examination of the site is required before anything more concrete can be said regarding the interpretative significance of the Esso Pit finds.

POLLEN ANALYSIS, by Rob Scaife
Two pollen samples were examined of which only one produced sufficient numbers of pollen grains to enable identification and pollen counting. The methods and results of this assessment were reported in detail in the original evaluation report (URL 1996). The pollen spectrum obtained was clearly dominated by pollen of trees of mixed deciduous woodland. This is typical of temperate interglacial character. From a single sample it is not possible to correlate this assemblage with other interglacial sequences from the lower Thames of eastern England as a whole. The possibility of contamination has been considered but the condition of the pollen and the presence of pollen from aquatic species makes it seem likely that the pollen does in fact represent sub-fossil pollen preserved in fluvially laid sediments.

CONCLUSIONS

Pleistocene
The evaluation produced a transect through the fluvial deposits and feather edge of the Corbets Tey Gravels, and identified an artefact-rich, slope wash or solifluction deposit close to the line of the chalk ‘cliff’. Unfortunately, it was not possible to relate this deposit to the fluvial deposits due to the presence of a large, later prehistoric feature.

The laminated and bedded silts, sand and clays seen in borehole group I and in ARC2001 TP had similarities with deposits recorded in Bluelands and Greenlands Quarries, where they produced mollusca, ostracods and pollen, and in the Botany and Esso Pits, where, like this sequence, the deposits were without fossils. The accepted model development of the Thames fluvial sequences (Bridgland 1994, 17-19) indicates that these deposits were laid down in interglacial, floodplain conditions. However, a discrepancy exists in that this sequence had previously been recorded at a height of about 10.6 m OD, compared to between about 14.5 m and 17.5 m OD in the assessment area. However, since the silts, sands and clays observed in the nearby exposures are overlain unconformably by sands and gravels, it is possible that the deposits recorded here represent a later part of the same interglacial sequence which has been eroded elsewhere.

Samples from the Pleistocene deposits did not produce faunal remains. However, the pollen spectrum recovered from the lower, interbedded silts in ARC2001 TP showed a temperate (interglacial) environment, dominated by trees of mixed deciduous woodland, consistent with the environment of deposition suggested by Bridgland (1994).

The dating of interglacial deposits at Purfleet is uncertain - Bridgland (1994, 225-228) correlates this interglacial with Oxygen Isotope Stage 9, suggesting an age of about 300,000 BP (mid-Saalian Stage). However, Gibbard (1994) suggests that the interglacial sediments represent part of the later, Ipswichian stage. In the absence of molluscan material suitable for amino acid geochronological determinations, other dating techniques such as Electron Spin Resonance and Thermoluminescence would need to be considered.

The form of the chalk ‘cliff’ was not clearly revealed, but the fluvial sediments thin out against rising chalk bedrock in the south-eastern part of the site, suggesting that the ‘cliff’ is fairly low relief in character and complicated by solifluction or slope wash deposits.

Archaeological material was recovered from all of the test pits but that recovered from the lower parts of ARC2002 TP and ARC 2003 TP was heavily rolled and re-worked. While not specifically diagnostic as Palaeolithic material, its stratigraphic position made this likely. In ARC2001 TP, a number of flint flakes, in fairly sharp
condition, were recovered from the lower silt units. In ARC2004 TP, the majority of the flint was recovered from the chalk-rich solifluction or slope wash deposit overlying chalk bedrock, and from hollows within the bedrock, again in good condition. The condition of the artefacts suggested that they had not moved very far, indicating that in situ deposits may exist locally, either on the margin of the floodplain deposits, or to the south of the chalk 'cliff'. This association of archaeological material with the 'cliff' line is in accord with the situation recorded in other exposures at Purfleet, for example, in the sands and gravels banked against the chalk 'cliff' at Botany Pit (Wymer, 1968, 312-313 and 1985, 313) - some of which was associated with chalky solifluction deposits.

The worked flint from ARC2004 TP is considered to belong to the Acheulean techno-complex, on the basis of the two bifaces, a possible roughout, and a small number of biface manufacturing flakes recovered from the chalk-rich deposit in ARC2004 TP (see Pl.1). In addition, there were several cores and hard hammer flakes, of Clactonian character. This accords with material recovered from Bluelands and Greenlands Quarries from the basal gravel underlying the laminated silts, and from a gravel band overlying it. The possibility therefore exists that more than one Palaeolithic industry is represented by this material, as suggested by Wymer (1985), though on this occasion no material attributable to the Levalloisian industry was recovered, and the cores and flakes, which would perhaps previously been called of Clactonian aspect, could simply be an integral part of the Acheulean material with which it was found.

The evaluation confirmed that significant quantities of Palaeolithic flint artefacts occur within the Pleistocene deposits affected by the CTRL at Purfleet. Their fresh condition, together with the evidence of flint working and the range of implements and waste material present, reinforces the significance of the assemblage. Although there was no direct evidence for in situ material from trenches 2001TP and 2004TP, it had only travelled a short distance and the possibility of in situ deposits cannot be ruled out. The pollen confirms that there was at least some potential for palaeo-environmental reconstruction, which could be coupled with further, detailed sedimentary analyses to shed light on the depositional conditions. The absence of molluscs and small bones and the very poor preservation of one of the pollen samples indicated that there is unlikely to be a continuous sequence of palaeo-environmental evidence of all types. However, the absence of molluscs and bones in these boreholes and test pits does not mean that there will not be pockets or more extensive localised sequences of rich deposits within the CTRL corridor in the vicinity of the chalk 'cliff'.

The possibility that the basal sequence in ARC2001 TP may represent temperate interglacial deposits of later date than observed elsewhere at Purfleet gives this particular area a potential added significance which is not applicable to other parts of the Purfleet complex as currently understood. However, further investigations would be needed to confirm this.

Later Prehistoric

Although the investigation was specifically designed to assess the Pleistocene and associated Palaeolithic deposits, two later prehistoric features were recorded, in ARC2002 TP and ARC2004 TP. The large, ditch-like, feature in ARC2004 TP produced pottery of Late Bronze Age or Early Iron Age date and both features produced undiagnostic flint flakes. These upper deposits were interpreted as colluvial deposits and may correspond with similar deposits recorded at Greenlands Quarry (Gibbard 1994, 74).

SIGNIFICANCE OF THE DEPOSITS

General Considerations

The significance of archaeological remains in Britain are normally judged by reference to the Secretary of State's non-statutory criteria for the scheduling of Ancient Monuments (eg as set out in DoE Planning Policy Guidance Note 16) and for the purposes of their Monuments Protection Programme, English Heritage have added two additional criteria (amenity and conservation value) which are used for the purpose of considering management issues. There is no standard guidance for how the criteria should be applied to 'open' Palaeolithic sites (ie natural sedimentary deposits containing Palaeolithic artefacts rather than more specific confined sites such as caves and rock shelters). These open sites do not readily fit within the definition of an ancient monument to which the criteria apply.

A further important issue, which to some extent overcomes the limits of the concept of archaeological remains as 'monuments' is that modern attitudes to the investigation of Palaeolithic archaeology are fully integrated into multidisciplinary studies of Pleistocene sedimentary and environmental sequences. As such the approach overlaps considerably with the geological and scientific interest of deposits whose importance (as in this case) may be recognised through the designation of Sites of Special Scientific Interest (SSSI's) under a different body of legislation. The Scheduled Monument criteria were based on the concepts already established for the designation of SSSI's, and so while they are different, the two approaches do at least provide a parallel framework for assessing the
scientific importance of an area of interest.

**Table 2: Assessment of the significance of the deposits**

<table>
<thead>
<tr>
<th></th>
<th>Whole Deposit</th>
<th>Evaluation Area</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Survival/ Condition</strong></td>
<td>Significant parts of the deposit have been quarried away in the past leaving about 27% intact (cf. URL 1994, Vol 4 Figure B4). The sedimentary sequence survives well where not disturbed. In places there is a good range of biological palaeoenvironmental evidence, but its survival appears to be patchy. By virtue of the depth of the deposits they are relatively stable. In the vicinity of open faces there could be some deterioration of preserved pollen, though this has not been documented. Palaeolithic artefacts within the deposit are often very fresh though no in situ working floors or occupation areas have yet been identified.</td>
<td>The survival of Pleistocene deposits within the CTRL corridor is similar to the general situation, except that the area of greatest interest for palaeolithic archaeology along the gravel/ chalk interface is apparently largely undisturbed, except for the limited effects of a probably later prehistoric ditch.</td>
</tr>
<tr>
<td><strong>Period</strong></td>
<td>Clactonian, Acheulian and Levalloisian artefacts reflecting the chronological development of flint working technology have been found in stratigraphic sequence, but dating deposits on the basis of artefacts relies partly on the absence of technologically later types, which may not be significant. On the basis of amino acid dating of molluscan remains and correlation of geological stratigraphies within the region the sequence is considered to belong to Oxygen Isotope Stages 10-9. There is no absolute dating for the sequence.</td>
<td>The presence of Acheulian type flintwork is consistent with the general period of the deposits. There are some differences in the height of the deposits which make precise correlation with the stratigraphy elsewhere difficult though the sequence is generally consistent with previous observations. Direct dating of the sequence may be difficult.</td>
</tr>
<tr>
<td><strong>Rarity</strong></td>
<td>Pleistocene deposits with a known abundance of fresh artefacts, demonstrable palaeoenvironmental evidence and possibly a stratigraphic sequence of technological types are very rare on a national scale. In this respect the complex is also very rare within the Thames sequence and in particular is an unusually rich and complex sequence for the particular stages of the Thames valley development represented here.</td>
<td>As for the general deposit with regard to the presence of fresh artefacts; the deposits investigated appear to have less potential for palaeoenvironmental evidence and stratigraphic sequencing which would diminish their rarity value if generally applicable to the deposits affected by the CTRL, but pockets of good preservation could well exist which were not encountered by this investigation.</td>
</tr>
<tr>
<td><strong>Fragility/ Vulnerability</strong></td>
<td>Apart from the CTRL there are some pressures from development in the area, though it is not designated for further mineral extraction. The designation of part of the area as an SSSI provides some protection.</td>
<td>Significant vulnerability to CTRL proposals as the railway will be in cutting through the full depth of the deposits.</td>
</tr>
<tr>
<td><strong>Diversity</strong></td>
<td>The deposits incorporate a variety of depositional environments and ancient topographical features no longer visible on the surface. In places there is a good range of other (biological) palaeoenvironmental evidence. Palaeolithic artefacts have been found in significant numbers in several widely separated parts of the deposit and at different levels within it. A range of later material has come from the area, though it is not clear what surviving in situ archaeology might be present.</td>
<td>As for the general deposit, but the stratigraphic sequence appears to be somewhat less diverse and the absence of molluscan and faunal remains suggests that the evidence from this particular area may be somewhat less diverse. However pockets of better preservation could survive which were not encountered in the limited sample of the area investigated.</td>
</tr>
<tr>
<td><strong>Documentation</strong></td>
<td>The Pleistocene sequence at Purfleet has received much attention in recent years and with the results from this investigation is one of the best documented palaeolithic sites of this type in Britain.</td>
<td>This report provides the bulk of the documentation for the CTRL corridor though finds from the immediately adjacent areas such as the Essso Pit are also relevant.</td>
</tr>
</tbody>
</table>
The Purfleet deposits have significant group value because of their key position in relation to other deposits of major significance in the Lower Thames valley such as Ebbsfleet, and how the comparative geological stratigraphy and archaeology between such sites is crucial to understanding the development of Pleistocene geomorphology and palaeolithic archaeology in the region (Bridgland 1994)

The deposits within the CTRL corridor have substantial group value as part of the general Purfleet deposits, and thereby as a contribution to wider understanding of the development of the Thames sequence and early human activity in the region. They have specific group value in that there are differences in the height of deposits which cannot be accounted for on the basis of the results of this investigation but could be of wider significance in interpreting the sequence as a whole.

The Purfleet deposits have very significant archaeological potential. It is only in recent years as a result of small scale systematic observation that the deposits are beginning to be understood. There is potential for the survival of in situ palaeolithic archaeology and for a significant range of good sedimentary and biological palaeoenvironmental evidence which has not yet been fully exploited. There is significant potential for testing and greatly refining present understanding of the spatial development and patterning of the ancient topography and associated palaeolithic activity which could have much wider implications for palaeolithic archaeology. There is significant potential for clarifying the human use of the site in the Holocene which at present is very poorly understood but could be of significance relative to more thoroughly investigated areas in this part of the Thames valley.

As for the general deposit and as above regarding the height of deposits within the CTRL corridor compared to other parts of the Purfleet sequence. The potential for good biological evidence as revealed by the investigation reported here is more limited than elsewhere in the Purfleet deposits, but patches of better preservation might exist.

The Purfleet sequence has significant conservation value in relation to geological and geomorphological deposits, but is not of significant ecological interest.

The CTRL corridor traverses an integral part of the overall Purfleet complex, which has now been shown not to be significantly disturbed as previously suspected. While the potential interest of this area would be somewhat diminished if the apparent lack of molluscan and faunal remains proved to be general, the possibility of such remains being well preserved in pockets of suitable deposits cannot be excluded. The potential interest of the area is enhanced by the possible existence of a later prehistoric site of some significance. The CTRL corridor is part of a complex of national importance.

The Purfleet Pleistocene and Palaeolithic Complex

Despite the difficulties of using the non-statutory scheduled monument criteria for this type of site explained above, it was an aim of the evaluation to judge the significance of the area affected by the CTRL within the context of the whole Pleistocene deposit at Purfleet. For the purposes of this assessment OAU used the criteria at two levels; first for the whole of the Purfleet Pleistocene gravel and chalk head deposits east of the present Mar Dyke through which the CTRL will pass; and secondly for the specific CTRL corridor investigated by this evaluation. This assessment is set out in Table 2.

It is concluded that the CTRL corridor is an area that forms an integral part of a complex of national importance for its Pleistocene and Palaeolithic interest. Within the length of corridor examined it seems clear that the areas of greatest potential are the general area of the chalk ‘cliff’ and in particular the solification deposits which are most productive of flint artefacts, the finer fluvial sediments which have greatest potential for biological remains, and the areas in the fluvial sands and gravels with signs of incipient pedogenesis which are among the sedimentary contexts which might produce in situ traces of Palaeolithic activity. While actual in situ remains have not been identified here or elsewhere within the deposits at Purfleet, the freshness of the flintwork and the presence of potentially suitable sedimentary contexts leaves this as a possibility.

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Methodological Considerations
The approach adopted for this evaluation was developed to deal with the specific circumstances of the site, in both geological and archaeological terms and with respect to logistical requirements. The work was specifically designed to build on a good level of pre-existing knowledge of the area and was in itself staged so as to incorporate an iterative process of using feedback from the initial stages of work to inform the detailed application of the later parts of the strategy.

The key factors influencing the design of the evaluation were the assumptions based on the stratigraphic information regarding environments of deposition. The approach used here worked well because the stratigraphic profile was a relatively simple 'terrace cross-section' which was already understood in general terms, and because Palaeolithic artefacts are locally abundant at the site.

Where stratigraphic sequences are less well known or significantly more complex than at Purfleet this approach would need larger and more complex arrays of boreholes, possibly at closer sampling intervals. Likewise more and/or larger test pits might be needed, especially where artefacts are sparse and the location of any concentrations less predictable. Where access to test pits is precluded because of a high water table or potential contamination in a confined space, the method would be restricted but could be adapted to achieve most of the objectives. The aspect, which perhaps deserves most further consideration, is how to improve the stratigraphic integrity of the finds recovery without unduly compromising the cost effectiveness of the approach.

Overall we believe that the approach developed at Purfleet to the evaluation of moderately deep Pleistocene deposits with Palaeolithic archaeology was sufficiently successful to deserve wider application and further development as a means of dealing with this particularly intractable aspect of archaeological evaluation. It is encouraging that it has already been recommended for other evaluations in the Purfleet area and elsewhere.

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