Northfleet (Ebbsfleet Valley): Baker's Hole Complex

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Highlights

This locality exposes a complex sequence of predominantly fine-grained sediments, probably representing a mixture of fluvial, colluvial and aeolian deposition in a tributary valley of the Lower Thames. The deposits have yielded sporadic mammalian and molluscan remains, mostly of species with cold affinities, but one level in particular suggests interglacial conditions. The rich 'Levallois industry' that occurs in the lower part of the sequence makes Northfleet the most significant Levallois site in Britain.

Introduction

Pleistocene deposits in the Northfleet district constitute the most famous and most prolific source of Levallois artefacts in Britain. These sediments are not of mainstream Thames origin, however, but belong to the tributary Ebbsfleet valley. For this reason, their relation to the Thames terrace system has been difficult to determine, despite the abundance of archaeological evidence they have yielded. The sediments, which comprise a series of gravels, sands and silts overlying a substantial sheet of soliflucted Chalk (coombe rock), have generally been correlated with the '50 ft' or 'Middle Terrace' of the main river (Smith, 1923; Burchell, 1933, 1934a, 1936a). The sediments above the coombe rock are often referred to as the 'Ebbsfleet Channel' deposits, a name first used by Burchell (1936a, 1936b). The fact that many of the huge numbers of Palaeolithic flakes from Northfleet were made using the Levallois technique (see Chapter 1) has long been recognized (Spurrell, 1883a; Smith, 1911; Dewey, 1932).

Three separate remnants of the Ebbsfleet deposits are included in the GCR site (Figure 4.34). The stratigraphical relations of these to one another and to the earliest sections at Baker's Hole are imperfectly known. The Baker's Hole site, described in the early years of this century (Abbott, 1911; Smith, 1911), has only been relocated in recent years, having previously been regarded by many authors as entirely quarried away. Although never used by the owners of the site, the name Baker's Hole has consistently been cited in the archaeological and geological literature since 1911. A local legend attributes the name to a drunkard called Baker who perished by falling into the pit (Abbott, 1911). This name was applied by King and Oakley (1936) to the interval during which the periglacial deposits at the base of the Northfleet sequence were supposedly deposited, their 'Baker's Hole or Main Coombe Rock Stage'. The site has also been described under the names Southfleet Pit' and 'New Barn Pit'. Chalk extraction at Northfleet has now ceased and the surviving remnants of the Ebbsfleet sediments within the GCR site are to be incorporated in a large-scale restoration scheme in such a way that useful exposures and a reserve of deposits for future investigation both remain.

Description

The occurrence of Palaeolithic artefacts in the Ebbsfleet valley at Northfleet was first reported by Spurrell (1883a, 1883b), although it is uncertain precisely where his observations were made. In the early years of this century new quarrying led to the discovery nearby of the celebrated Baker's Hole site, detailed descriptions being provided by Abbott (1911), Smith (1911) and Dewey (1932), the last including an illustration of the stratigraphy (see (Figure 4.35) and (Figure 4.36). Smith (1911) described Palaeolithic implements and fossils from an accumulation of coombe rock likened, by Reid (in Smith, 1911), to that of the South Downs. The fossils included teeth and bones of elephant, horse, rhinoceros and deer. Few could be identified to species level because of their fragmentary nature and weathered state, but teeth of *Mammuthus primigenius* and *Dicerorhinus hemitoechus* were recognized, together with antler fragments of *Cervus elaphus.*

Dewey (1930, p. 148) described the Baker's Hole site as 'a working floor … lying under masses of unassorted chalk and flint rubble'. He also observed that there were gravel and sand-filled channels cut into the upper surface of the coombe rock, in which mammoth tusks occurred (Dewey, 1930, 1932). These basal deposits were overlain by gravel and sand, the latter cross-bedded, then 'loam' and brickearth (Figure 4.35). Spurrell (1883b), however, had referred to the artefacts lying on a 'kind of beach', which led Roe (1981) to question whether the industry might be associated with a fluvial deposit that pre-dates the coombe rock. It seems likely, however, that Spurrell's observations were made in the vicinity of the site later studied by Burchell (see below), so that the 'beach' to which he referred was probably a gravel forming part of the infill of the Ebbsfleet Channel.

Burchell (1933) described a series of gravels and 'brickearths' in the Ebbsfleet valley, overlying a 'bench' cut into the coombe rock and underlying Chalk at 7.5 m O.D. (Burchell, 1933; (Figure 4.37)). The stratigraphical sequence here, equivalent to that represented in part of the GCR site, was pieced together over a lengthy period of observation (Burchell, 1933, 1935a, 1935b, 1936a, 1936b, 1936c, 1954, 1957; Boswell, 1940; Zeuner, 1945, 1946, 1954; Kerney and Sieveking, 1977). It can be summarized as follows (few indications of thickness have been recorded, perhaps because of variability in different parts of the channel; see (Figure 4.37)):

12.	'Trail' — as bed 9 (formerly undifferentiated from 9).
11.	Sandy 'fluvial brickearth'.
10.	'*Cailloutis*' (thin gravel bed), yielding Levallois artefacts.
9.	'Trail': gravelly 'loam' with rafts of coombe rock. Published descriptions and illustrations suggest that this bed (and possibly bed 7) were cryoturbated.
8.	Silt, aeolian/colluvial (brickearth). This yielded *Pupilla muscorum.* Its upper part was decalcified and devoid of shells. Bands of ferruginous staining were observed near the top.
7.	Upper coombe rock, with derived artefacts and land snails.
6.	Freshwater silt, fossiliferous (temperate■climate). This bed contains *Corbicula fluminalis* (see, however, below), amongst remains of 40 species of terrestrial, marsh and freshwater Mollusca (see below), as well as mammoth, giant deer, horse and indeterminate rhinoceros.
5a.	Buried soil developed in the top of bed 5.
5.	Silt (brickearth). This is interbedded with numerous minor lobes of 'coombe rock' and/or gravel. It contains *Pupilla muscorum, VallIonia costata* (Müller) and *Limax* sp., the last two from the lower part of the bed only. Descriptions and photographic records of sections excavated by the British Museum in 1969 reveal clear indications of aqueous bedding. These records also suggest interdigitation with (or incision through) beds 2 and 4. A total thickness of over 6 m is indicated (see (Figure 4.37)). An assemblage of small vertebrates is also recorded from this bed (Carreck, 1972; see below).
4.	Gravel, with remains of woolly rhinoceros, mammoth and horse, together with artefacts (concentrated in 4a?). This is probably the higher-level gravel recorded in the British Museum sections (Figure 4.37). If so, its separation from 2 is unclear in the absence of bed 3, all evidence of which appears to have been removed by quarrying. Reworked Palaeogene shells and flint pebbles occur in this bed (Carreck, 1972).

4a.	Palaeolithic horizon at the base of bed 4, with a mixture of hand-axes, cores and flakes, including Clactonian and Levallois types (unabraded and unpatinated). These are accompanied by remains of mammoth, woolly rhinoceros and horse (Burchell, 1936a).
3.	Sand, fossiliferous, yielding *Bithynia tentaculata.* Not seen in British Museum excavations? Carreck (1972), citing unpublished sources, also listed shells of *Anion* sp. and *Limax marginatus* (Müller), as well as giant deer and a number of small mammals. The latter were listed as *Arvicola abbotti, Microtus* sp. and *Clethrionomys* sp.
2.	Coarse gravel, cryoturbated into or filling scour/solution hollows in the top of bed 1. Built up to >2 m at the edge of the channel, where it is interbedded with lenses of coombe rock and appears to interdigitate with the lower part of 5 (see (Figure 4.37)).
1.	Main Coombe Rock, thought to be equivalent to that at the Baker's Hole site. The working floor at Baker's Hole was at the base of this deposit (Figure 4.35).
	Frost-shattered Chalk.

In his early reports, Burchell took the gravel that appears above as bed 4 to mark the base of the Ebbsfleet sequence. Later excavations (Burchell, 1936a) revealed additional beds below this (2 and 3) and showed that the channel had been eroded prior to the deposition of the basal coombe rock (bed 1). The latter formerly occupied the channel, but was largely removed by erosion before its denuded remnant was covered with coarse gravel (bed 2). This gravel was in turn overlain by a fossiliferous sand (bed 3), above which another gravel (bed 4) was observed, from which unabraded hand-axes, amongst other types of artefact, were recovered (Burchell, 1936a, 1936b; see above). Burchell (1935a) also recorded small-mammal remains from bed 4 (4a?). The latter record has been supplemented in recent years from material placed by Burchell in the British Museum, so that the full microtine assemblage from the site as a whole is as follows: *Clethrionomys glareolus* (Schreber); a form transitional between *Microtus arvalis* (Pallas) and *M. agrestis* (*L.*)*; M. anglicus* (Hinton); *M. nivalis* (*Martins*)*; Arvicola cantiana* (Carreck, 1972; Sutcliffe and Kowalski, 1976). Whether all these taxa were present in bed 4/4a is uncertain; Burchell (1936a) also recorded a 'microtine fauna' from bed 3, but gave no details. Carreck (1972) recorded different elements from the above assemblage in beds 3, 4 and 5. Bed 4 also yielded a large Palaeolithic assemblage, listed by Burchell (1933) as: (1) much-rolled Clactonian and Acheulian artefacts, derived from earlier deposits, (2) less-abraded Levallois specimens, washed from the adjacent coombe rock, and (3) unrolled Levallois artefacts of a later type, some with marked Aurignacian (Upper Palaeolithic) characteristics.

Both Burchell and Zeuner interpreted the basal gravels and sands (beds 2–4) as fluviatile, but Kerney and Sieveking (1977) attributed them to solifluction. Detailed records and photographs of the British Museum sections show bedding structures in bed 5 that suggest the supply of silt from the valley side. Once in the channel this silt, of apparent loessic origin (see below), probably joined the sediment load of the Ebbsfleet, so that fluvial silt was deposited away from the margins of the channel. These records also raise questions about the stratigraphical significance of beds 1–4 and of Burchell's interpretation of the sequence of erosional and depositional events. It appears that the sections revealed the edge of a channel cut into frost shattered and soliflucted Chalk, filled by a gravel lag followed by fluviatile silts, the latter interdigitating with further lobes of gravel and coombe rock near the sides of the channel. A widening of the channel was followed by the formation of a later, more widespread gravel lag, which continues over the lower sequence in the deeper part of the channel. This may be the later gravel described by Burchell (bed 4). However, without the fossiliferous bed 3, it is impossible to distinguish beds 2 and 4 amongst a succession of gravels that interdigitate with the silt of bed 5 (Figure 4.37).

The upper part of the sequence (beds 5 and above), predominantly silts (brickearth) with land snails, was deposited over a wider area than the lower channel deposits. From these later sediments Burchell (1933) obtained artefacts that he classified as Upper Mousterian, Aurignacian and Solutrian (it is difficult to relate these finds to the beds described above, which were not recognized at that time). The surviving brickearth (bed 5) has a particle-size distribution and mineralogical characteristics that suggest that it is predominantly of loessic origin, although with additional sand and gravel material (J.A. Catt and A.H. Weir, pers. comm.).

Continued excavations at Northfleet allowed Burchell (1935a) to observe that a previously unrecognized higher spread of coombe rock (bed 7), containing derived artefacts, occurred within this predominantly loessic (fluvially redeposited?) sequence. The recognition of this and other subordinate beds of coombe rock within the higher part of this succession led to the widespread use of the term 'Main Coombe Rock' for the deposit first described (bed 1). Burchell (1936c) recognized an additional fluviatile cycle at the top of the sequence, within what was formerly recognized as 'trail', thus adding beds 10–12. These additional beds were not recognized by Zeuner (1945, 1946, 1954, 1959).

Burchell originally recorded only the snail *Pupilla muscorum* from the brickearth sequence, which led him to conclude that a cold climate was represented (Burchell, 1935a).

However, later collecting revealed the presence of additional species within the silt (see above, bed 5) and, more importantly, led to the recognition of a temperate-climate bed (bed 6) (Zeuner, 1945, 1946, 1954, 1959; Burchell, 1954, 1957). This produced a rich molluscan fauna numbering some nine freshwater and 16 terrestrial species (Burchell, 1957); amongst the former *Corbicula fluminalis* and amongst the latter *Discus rotundatus* (Müller) were regarded by Burchell as particularly indicative of a climate at least as warm as at present. Carreck (1972) considered the record of *C. fluminalis* to be dubious. Another species listed by Burchell that is important as an interglacial indicator is *Azeca goodalli* (Férussac) (R.C. Preece, pers. comm.). Bed 6 also yielded bones and/or teeth of *Megaloceros giganteus* (giant deer), *Equus ferus* (horse), *Mammuthus primigenius* (mammoth) and rhinoceros, together with an assemblage of pointed hand-axes, classified by Burchell (1957) as Micoquian (see, however, Roe, 1981).

Burchell described a change in the molluscan fauna in the upper part of Bed 6 to a much more restricted assemblage, which, he believed, heralded the return of cold conditions prior to the formation of the immediately overlying (upper) coombe rock (bed 7). Beneath the temperate-climate silt a zone of weathering has been recognized at the top of bed 5 (Zeuner, 1945, 1946, 1954, 1955, 1958, 1959; Dalrymple, 1958; Catt, 1979; Kemp, 1984, 1991; (Figure 4.37)).

The precise locations of the Baker's Hole section and of exposures studied at later dates have been subjects of considerable debate, largely because of the imperfect records made at the time. Wymer (1968) placed the original locality approximately 0.8 km to the south-east of the GCR site. Roe (1968b), on the other hand, cited a location 0.3 km to the west of the latter. Carreck (1972) considered Smith's Baker's Hole site to have been *c.* 200 m to the south-east of the surviving sections, at around TQ 614 738. A recent detailed study of early publications and of notes and maps preserved with the Palaeolithic collections in the British Museum has led to the confirmation of Carreck's location (Wenban-Smith, 1990, and pers. comm.). It is possible that remnants of this important sequence survive beneath the bed of a disused tramway (Figure 4.34), thought to be located within 20 m of the faces originally studied by Smith (1911), records of which have recently been discovered in the Natural History Museum (F.F. Wenban-Smith, pers. comm.; (Figure 4.36)). The sections studied by Burchell in the 1930s are thought to have been close to the present GCR Section B (Carreck, 1972; (Figure 4.34)).

The remnants of Burchell's Ebbsfleet channel site were reinvestigated by the British Museum in 1969. This work remains largely unpublished, but a short note appeared in 1977, coinciding with a visit to the site by INQUA (Kerney and Sieveking, 1977). A section included in that report largely confirmed the earlier descriptions, although showing numerous interdigitations between the coombe rock and the Ebbsfleet loams (Figure 4.37). The site had unfortunately been damaged by this time by the removal of the highest deposits (the top of bed 6 and all higher beds had been entirely quarried away by that time), and by tipping against the old faces. The occurrence of Levallois artefacts and a cold mammalian fauna in the basal gravels (bed 4?) was confirmed (Kerney and Sieveking, 1977), the palaeoliths corresponding typologically with Smith's (1911) Baker's Hole industry.

All that now remains of Burchell's Ebbsfleet valley locality are two residual islands and a linear face trending NNW–SSE (see (Figure 4.34)). These show Chalk overlain by coombe rock, into which the Ebbsfleet deposits are channelled. One of the islands (B, (Figure 4.34)) was excavated by the British Museum in the late 1960s (Kerney and Sieveking, 1977) and found to show the edge of the fluvial deposits, banked against coombe rock and Chalk (Figure 4.37). This may possibly be close to the area studied by Spurrell (1883a, 1883b), before the Baker's Hole site was discovered (Carreck, 1972; (Figure 4.34)). The other island (C, (Figure 4.34)), shows a predominantly colluvial sequence, but without the channel edge being visible (Carreck, 1972; F.F. Wenban-Smith, pers. comm.). The linear face further to the north (A, (Figure 4.34)) has also been investigated by Carreck (1972) and the British Museum (Kerney and Sieveking, 1977). The sequence in this section, overlying Chalk and coombe rock at *c.* 9 m O.D., comprises waterlain gravels and silts capped by sandy loessic or colluvial/loessic deposits (Figure 4.38). These deposits have yet to be directly related to Burchell's section, but the waterlain silts have yielded freshwater molluscs, land snails and mammals indicative of a temperate climate and an open habitat. The molluscan assemblage is dominated by aquatic gastropods, particularly *Lymnaea truncatula, L. peregra* and *Anisus leucostoma* (M.P. Kerney, pers. comm.). This assemblage differs markedly from that in the temperate silt (bed 6) in section B, but contains no stratigraphically diagnostic species.. It appears to represent stagnant swampy conditions rather than a typical fluviatile environment, as is signified by the fauna from bed 6. The contrast between the temperate-climate shelly beds in sections A and B may indicate a difference in facies rather than in age. The altitude of the two deposits is closely com parable (*c.* 11 m, section A; *c.* 12 m, section B), which suggests, if both can be confirmed as part of fluviatile sequences, that they may be of similar ages or even lateral equivalents. It is important to establish whether this is the case; if so, the deposits overlying the temperate-climate shelly silt in section A might equate with the higher part of Burchell's sequence, now removed by quarrying from the area of section B.

According to Carreck (1972), a record by Burchell (1935b, p. 330) of 25 molluscan taxa, from 'between Swanscombe and Northfleet', is an early reference to bed 6 in section B. Dominated by *Trichia hispida,* this assemblage was interpreted by Burchell as indicating a climate at least as warm as that at present. However, he provided no details of the location from which this fauna came and did not refer back to this earlier report in 1957. Furthermore, not all the species in the earlier list are present in the later one (Burchell, 1957). There are also some similarities between the unprovenanced assemblage and that obtained from section A; it is therefore possible that the 1935 assemblage is transitional between the two recorded later. I t remains to be demonstrated whether all these molluscan records are from a single, variable bed within the Northfleet sequence.

Polished facets on bone fragments and flints from the temperate-climate silts in section A were interpreted by Kerney and Sieveking (1977) as possible human artefacts. Carreck (1972) had previously recorded polished flints and bone fragments from the surviving sediments at Northfleet (not just from section A). He had concluded, however, that these resulted from natural processes. Carreck did record a right ilium of horse from section A, from a stratigraphical level that places it later than the temperate-climate shelly bed, that showed signs of having been cut. He regarded this as the best candidate for a bone artefact from his own collection, but stressed the need for an assessment of the material obtained from the British Museum excavations. This assessment is still awaited.

The deposits overlying the temperate-climate sediments in section A have particle-size and mineralogical characteristics conforming with a loessic origin, but differ in their mineralogy from bed 5 in section B (J.A. Catt and A.H. Weir, pers. comm.; see below).

Interpretation

Abbott (1911) observed the association at Baker's Hole of a depression scoured into the Chalk with brecciation of the bedrock, festooning of the Pleistocene beds, deformation of these strata with slickensides along highly inclined slip-surfaces, together with a general mixing of fossils, archaeological relics and Pleistocene deposits. This led him to suggest that the movement of a heavy frozen mass passing from higher to lower ground had occurred. Of the various early explanations of coombe rock formation, this is one of the closest to the modern interpretation of such deposits as the result of mass-movement (solifluction).

Reid (in Smith, 1911) regarded the coombe rock at Baker's Hole as the product of rainwash derived from chalk slopes, the surfaces of which were partly frozen, during a period of intense cold. Bromehead (in Dewey *et al.,* 1924) suggested that the deposit was laid down by torrents of water produced by summer thaw, likening this to modern processes in

Siberia. Similar ideas of torrential deposition of the Baker's Hole deposits were proposed by Jessop (1930). Dewey (1930) was the first to attribute the Main Coombe Rock to mass-movement associated with permafrost conditions, although he regarded the inundation of the working floor as a sudden and catastrophic event.

Interpretation of Palaeolithic assemblages

The importance of the Ebbsfleet valley as a source of unusual and distinctive Palaeolithic material was recognized at an early date. Spurrell (1883a, 1883b) noted the great variety of size, shape and freshness of artefacts from Northfleet and was clearly aware of the method of their manufacture (he gave (1883a) an accurate description of what was later to be termed the Levallois technique). Smith (1911) likened the industry at Baker's Hole to that from Le Moustier in the Dordogne but, although he mentioned that Levallois flakes occurred, the latter term was first applied to the assemblage as a whole by Dewey (1932).

Abbott (1911) repeatedly visited the site from 1892 and recovered implements and 'clebitage' of the typical Northfleet type. Following an expansion of quarrying in 1907, large numbers of worked flints were collected by J. Cross; these formed the majority of the implements described by Abbott, who suggested the names 'Prestwichian' and 'Ebbsfleetian' to describe the industries represented at Baker's Hole, terms that did not receive widespread acceptance.

Smith (1911) considered that a small proportion of the Palaeolithic assemblage from Baker's Hole was derived from the earlier '100 ft Terrace' (Boyn Hill/Orsett Heath) deposits, through which the Ebbsfleet valley was eroded prior to the formation of the coombe rock. At least 99% of the palaeoliths were of a distinctive type, however, and were taken by Smith to represent the indigenous Baker's Hole industry. These consisted of flakes and cores, unrolled and usually unpatinated, which were classified by Smith as of 'Le Moustier' type. He concluded that this material represented the debris of a working floor that had been inundated by deposition of the coombe rock.

Burchell (1931) described the industry from the Baker's Hole working floor as Early Mousterian, with Levallois in parentheses. He later considered the unabraded Palaeolithic material collected from the gravels and silts overlying the coombe rock to represent a distinctive later industry, which he classified as 'Levallois D', recognizing certain Aurignacian (Upper Palaeolithic) characteristics in this assemblage (Burchell, 1933). In this paper (1933), he classified the industry from the Main Coombe Rock (bed 1) as 'Levallois B', believing it to post-date the industry from the Upper Loam at Swanscombe, which he classified as 'Levallois A' (see above, Swanscombe). Burchell believed there to be a typological succession of Levallois industries that could be related to terrace stratigraphy in the Lower Thames. He later described unrolled and unpatinated hand-axes from the junction between beds 3 and 4, regarding these as contemporaneous with the Levallois industry, a similar association having been recorded in the Somme valley (Burchell, 1936a, 1936b).

Correlation

The early workers were impressed by the similarity between the coombe rock at Baker's Hole and that on the Sussex coast (see Reid, in Smith, 1911). The occurrence of narrow-nosed rhinoceros *Dicerorhinus bemitoechus* at Baker's Hole was somewhat problematic, since the Sussex coombe rock, the palaeontology of which is otherwise similar, contains the woolly rhinoceros *Coelodonta antiquitatis. Smith* (1911) argued that the solitary tooth of *D. hemitoechus* on which the identification was based might have been derived from earlier deposits, along with a small proportion of the palaeoliths. This is certainly a possibility, since *D. hemitoechus* occurs in the Swanscombe sediments, which cap higher ground to the west of the Ebbsfleet valley (see above, Swanscombe).

Newton (in Smith, 1911) likened the restricted mammalian fauna at Baker's Hole to those from the 'Middle Terrace' of the Thames at Grays and Ilford (see above, Globe Pit and Aveley). Bromehead (in Dewey *et al.,* 1924) considered that the coombe rock (bed 1) had been deposited during the period of erosion that followed the deposition of the 'Middle (Taplow) Terrace' deposits of the Lower Thames, thus supporting Newton's correlation. Dewey (1932) correlated the cold period during which the coombe rock was deposited with the second of the two East Anglian glaciations recognized at that time, which would seem to imply a Saalian age. A similar correlation was proposed by Burchell (1931). Breuil (1932a, 1934) also assigned the Main Coombe Rock to the Riss (glacial) Stage (= Saalian) and interpreted the artefacts as 'early Levallois'. He regarded the deposits as earlier than, or contemporaneous with, the nearby Crayford sediments, now ascribed to the late Saalian Mucking Formation (see above, Lion Pit), which also yield Levallois artefacts.

Burchell (1933) disagreed with Bromehead's interpretation of the Main Coombe Rock as a post-Taplow Terrace' accumulation, pointing out that coombe rock had never been found overlying this terrace; instead he suggested that the gravels and 'brickearths' that he had observed in the Ebbsfleet valley, cut into the Main Coombe Rock (Figure 4.37), were probably of Taplow' ('50 ft Series') affinities. Burchell likened his 'Levallois D' artefact assemblage from the Ebbsfleet deposits to the industry at Crayford (see above, Lion Pit), thus concurring with Breuil, and claimed support for this view from the fact that both sets of deposits yield *Coelodonta antiquitatis.* He also considered that a comparable sequence of brickearth overlying coombe rock could be observed to the north of the Thames in the Grays area, an apparent reference to the sediments at West Thurrock (see above, Lion Pit).

In their well-known synthesis of Pleistocene deposits in the Thames valley, King and Oakley (1936) proposed two new stage names that relied heavily on evidence from the Northfleet area. The first was the ill-defined, possibly multiple, 'pre-Coombe Rock Erosion Stage(s)'. To this King and Oakley attributed the cutting of the various 'benches' recognized beneath Taplow terrace deposits in the Thames valley, the erosion and infilling of the Wansunt 'channel' (Dartford Heath — see above, Wansunt Pit) and the occupation of the Levallois working site at Baker's Hole. They also proposed a 'Baker's Hole or Main Coombe Rock Stage', which they correlated with the 'Little Eastern glaciation' (Saalian Stage). They believed that the coombe rock covering the Baker's Hole working floor was emplaced and subsequently dissected by the Ebbsfleet during this 'stage' and attributed the Ebbsfleet Channel deposits to the succeeding 'Taplow Stage', thus agreeing with Burchell rather than Bromehead. They also followed Burchell (1936c) in placing the uppermost part of the Ebbsfleet Channel sequence (beds 10 and 11) in their 'Ponders End or Upper Floodplain Terrace No 1 Stage', suggesting that the uppermost silt bed (11) had more the nature of hillwash than fluviatile alluvium. This last statement was disputed by Burchell (1936a), who claimed that, despite its steeply sloping base (from +15 m to –3 m O.D.), this bed contained sedimentary evidence for a fluvial origin.

Zeuner (1945), summarizing the Ebbsfleet sequence, interpreted the predominant silts as loessic deposits, citing the results of mechanical analyses. This view has received recent support from Catt (1977, 1978, pers. comm.; see below). Zeuner (1945, 1955) also described a weathering horizon at the top of bed 5, immediately beneath the temperate-climate silt (bed 6), that showed intense rubification, indicative of an interglacial climate. Catt (1979), however, observed that the reddened horizon contains less illuvial clay than would be expected in a typical interglacial soil. Kemp (1984, 1991) has recently confirmed Catt's observation; he noted that a number of pedogenic features can be recognized, not only in the reddened zone, but also more extensively within bed 5. Kemp considered the surviving material to represent only the basal part of a truncated soil profile, perhaps below the main levels of clay illuviation. He refuted Zeuner's claim that the Northfleet buried soil is strongly developed.

Zeuner (1945) correlated the aggradation (to *c.* 12 m O.D.) of the fluviatile temperate-climate deposits in Burchell's section with his 'Late Monastirian' sea level. He considered that this high-sea-level phase occurred around 125,000 years BP, which would imply correlation with the Ipswichian Stage (*sensu* Trafalgar Square). However, he noted that the sediments at the Baker's Hole site were aggraded to *c.* 16 m O.D., which he thought sufficient to suggest a correlation with the earlier 'Main Monastirian' sea level, which he dated at *c.* 150,000 years BP. He attributed both these high-sea-level phases to the 'last interglacial'; however, the last-mentioned date would now be considered to fall late within the Saalian Stage and to equate with the Oxygen Isotope Stage 6 cold episode (Table 1.1).

Examination by Oakley of the Palaeolithic assemblage collected by Spurrell from North-fleet led Oakley and King (1945) to express misgivings about their earlier correlation of the Baker's Hole coombe rock with the Saalian (King and Oakley, 1936). They decided, in collaboration with A.D. Lacaille, that the typology of the Baker's Hole assemblage placed it later within the 'Levalloisian' than had previously been thought. Oakley and King (1945) concluded that if the Baker's Hole industry, buried by the Main Coombe Rock, was 'late Levalloisian', the aforementioned bed must be post-Saalian. However, Breuil (1947) suggested that local variation in cultural development was responsible for this apparent anomaly and that the Baker's Hole industry, although similar to the 'Early Upper Levallois' in France, was in fact of 'Lower Levallois' (Saalian) age. He thought that a possible reason for such diachronism in the archaeological record was the southward migration of Palaeolithic Man from England in response to climatic deterioration, introducing more advanced techniques, developed in England, into the French sequence at higher stratigraphical levels.

Tester (1958) concurred with Breuil, pointing out that the Main Coombe Rock, if not Rissian (Saalian), would have to be considered of Würm (Devensian) age, which would imply a 'last glacial' age for the Taplow Terrace and leave a large hiatus between this and the (Hoxnian) Boyn Hill Terrace. Tester suggested that the character of the Baker's Hole industry resulted in part from the unusual abundance of excellent flint that was available following the pre-Main Coombe Rock downcutting. This allowed the extravagant Levallois technique to be used, there being no need to conserve raw material. This suggestion by Tester pre-empted modern interpretations, which recognize the availability of raw material as a major influence on the use of the Levallois technique and no longer consider it possible to recognize an evolutionary sequence within the Levallois assemblages from the Lower Thames (Roe, 1981).

In his later work, Burchell (1957) suggested a direct correlation between the temperate-climate silt (bed 6) in the Ebbsfleet succession and the similar '*Corbicula* bed' at Crayford (see above, Lion Pit). The temperate-climate sediments at Northfleet were attributed by Kerney and Sieveking (1977) to the Ipswichian Stage, mainly on the basis of their elevation, since they contain no pollen or stratigraphically significant fauna. However, Stuart (in Sutcliffe and Kowalski, 1976) noted that teeth of the vole *Arvicola cantiana* from the Burchell collection were of early type, implying (according to Sutcliffe and Kowalski) a pre-Ipswichian (*sensu* Trafalgar Square) age. The occurrence of *C. fluminalis* may provide support for this view, since this species is now regarded by some authorities as having been absent from Britain during the Ipswichian Stage (*sensu* Trafalgar Square) (see Chapter 2, Stanton Harcourt and Magdalen Grove). Note, however, that the occurrence of *C. fluminalis* at Northfleet requires confirmation. Carreck (1972) noted that reworked fragments of a Palaeogene *Corbicula* species are common in the Ebbsfleet sediments. Unfortunately, amino acid analyses of shells from North-fleet, which might provide a further indication of their age, have yet to be carried out (see, however, note at end of Interpretation section).

Care must be exercised in applying the new stratigraphical scheme for the Lower Thames terraces, presented in this volume, to the Ebbsfleet deposits, as they occur in a tributary valley, in which steeper gradients might be expected. However, the elevation of the waterlain sediments, between 7.5 m and 12 m O.D., suggests an association with the Taplow/ Mucking Formation of the main river. This would confirm a correlation of the Northfleet sediments with the Taplow aggradation, as advocated by Burchell and others, but not with the deposits mapped as 'Taplow' in the Lower Thames (these are older; see above, Purfleet and Globe Pit), a fact that may have led to the dispute between Burchell and Bromehead (see above). This interpretation implies a correlation of the temperate-climate bed at Northfleet with the various interglacial deposits within the Mucking Formation of the main valley, such as those at Aveley and West Thurrock. Although regarded by many previous authors as being of Ipswichian age, these have been interpreted in this volume as representative of an undefined post-Hoxnian/pre-Ipswichian temperate interval, the equivalent of Oxygen Isotope Stage 7 (see above, Lion Pit and Aveley). The underlying fluviatile and aeolian beds at Northfleet can therefore be ascribed to Oxygen Isotope Stage 8, whereas the sediments above the temperate-climate silt probably date from Stage 6. This interpretation receives support from the association, at other sites in the Lower Thames, of sediments ascribed to Stage 8 with Levallois artefacts (see above, Purfleet and Lion Pit). The evidence from Northfleet may therefore help to reinforce the view that the recognition of this technique within the British Palaeolithic record may be of considerable stratigraphical significance.

The thermoluminescence dating technique has recently been applied to the Northfleet deposits (Parks and Rendell, 1988), sediments having been sampled from section A (H.M. Rendell, pers. comm.). These range between 149,200 and 115,600 years BP, results that would seem to point to a younger age than that suggested above. However, Parks and Rendell emphasized that, because of problems encountered in using this technique to date pre-Devensian sediments, these should be regarded as 'minimum age estimates' (the implications of these dates cannot in any case be determined until full stratigraphical details are published).

Mineralogical analyses of the loess-derived sediments exposed in both sections A and B (Figure 4.37) and (Figure 4.38) by J.A. Catt and A.H. Weir (pers. comm.) provide further clues to the possible age of the Northfleet sequence. By determining the relative proportions of non-opaque heavy-mineral species in the silt and fine-sand size ranges, it has been shown that Devensian loesses, which are common throughout south ern and eastern Britain, have a characteristic suite of such minerals, strongly dominated by epidote (Catt *et al.,* 1971, 1974; Eden, 1980; Bridgland, 1983a). The fluvially bedded silt (bed 5) below the temperate-climate horizon in section B was found to have significantly different mineralogical characteristics; for example, it contains less epidote, amphiboles and rutile than typical Devensian loess, but more zircon, tourmaline and kyanite. Bed 5 also contains a rare brown and green spinel, which has not been reported in Devensian loessic deposits. Whether these differences result from genuine distinctions between loesses of different ages (which would be of considerable stratigraphical value), or whether they reflect the addition of silt-grade material from other sources into the Ebbsfleet deposits, remains uncertain. However, J.A. Catt and A.H. Weir (pers. comm.) have observed similar heavy-mineral distributions in pre-Eemian loess in Belgium. They have found that the Ebbsfleet silt (bed 5) also resembles this pre-Eemian loess in its clay mineralogy; both are composed mainly of smectite, illite and kaolinite. Devensian loess at Pegwell Bay, Kent (Weir *et al.,* 1971), has a quite different clay mineralogy in that it also contains significant proportions of vermiculite.

Catt and Weir have also found that the suite of heavy minerals in the temperate-climate sediments in section A at Northfleet resembles that in the pre-'*Corbicula* bed' silt (bed 5) in section B and in the Belgian pre-Eemian loess. The clay mineralogy confirms this affinity, which suggests that reworking of sediment from the underlying silt into the temperate-climate deposit has occurred. The brickearth that overlies the temperate-climate silts in section A has a similar clay mineralogy to the other sediments at Northfleet, but its heavy-mineral assemblage has considerably more epidote and less zircon. Although these differences mean that this upper brickearth has a mineral content closer to Devensian loess than any other bed at Northfleet, its composition remains transitional; in fact it resembles the pre-temperate silt (bed 5) more closely than it resembles Devensian loess. These results indicate that, if this upper brickearth is primarily of loessic origin (as its particle-size distribution suggests), either it too is of pre-Devensian age or it has largely been reworked from the older silt (bed 5).

Summary

The complex site at Northfleet is of considerable importance to British Quaternary stratigraphy. It represents the most significant occurrence of Palaeolithic material in Britain showing the use of the Levallois technique. Past researchers have probably read more into the Palaeolithic sequence at this site than can be supported by more rigorous assessment, but knowledge and understanding of the Levallois technique as represented in Britain is heavily dependent on evidence from this locality.

Important evidence for dating the industry and for reconstructing the palaeoenvironment that prevailed when the deposits were laid down is provided by the fossiliferous parts of the Northfleet sequence. The succession represents an important phase in the fluvial history of the Lower Thames region, one in which the presence of Palaeolithic Man was significant. It is probable that a previously unrecognized temperate episode, intermediate between the Hoxnian and Ipswichian Stages of the traditional chronology, is recorded by part of the Ebbsfleet sediments. These temperate-climate sediments have been widely attributed to the Ipswichian, but according to the new Lower Thames stratigraphical scheme, adopted in this volume, they are believed to correlate with Oxygen Isotope Stage 7 (intra-Saalian). This implies broad correlation with sediments of the main Lower Thames at Ilford (Uphall Pit), Aveley, West Thurrock and Crayford (Table 1.1).

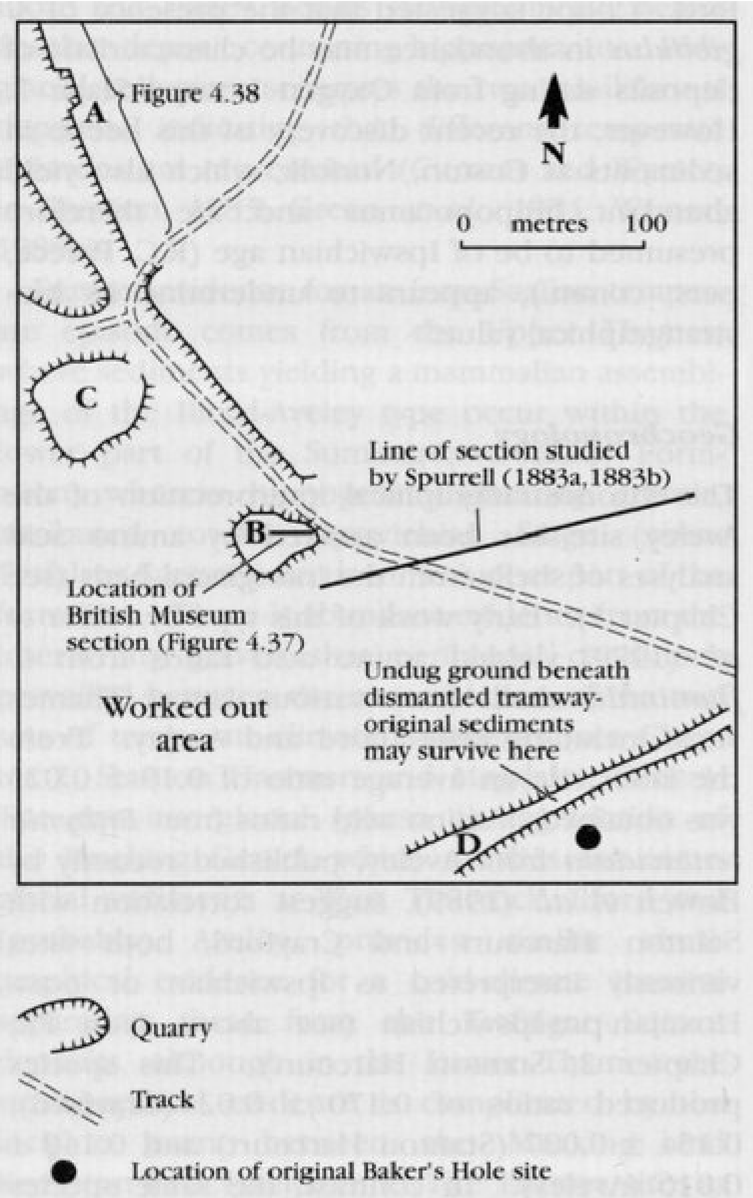
Note: since writing this report, amino acid ratios have been obtained from shells of *Lymnaea peregra* from section A. Three sets of analyses yielded similar results, giving the following mean ratios: 0.177 ± 0.020 (n = 5); 0.188 ± 0.022 (n = 5); 0.169 ± 0.038 (n = 8) (D.Q. Bowen and F.F. Wenban-Smith, pers. comm.). These results strongly support the arguments given above for a Stage 7 age for the temperate-climate deposits at Northfleet.

Conclusions

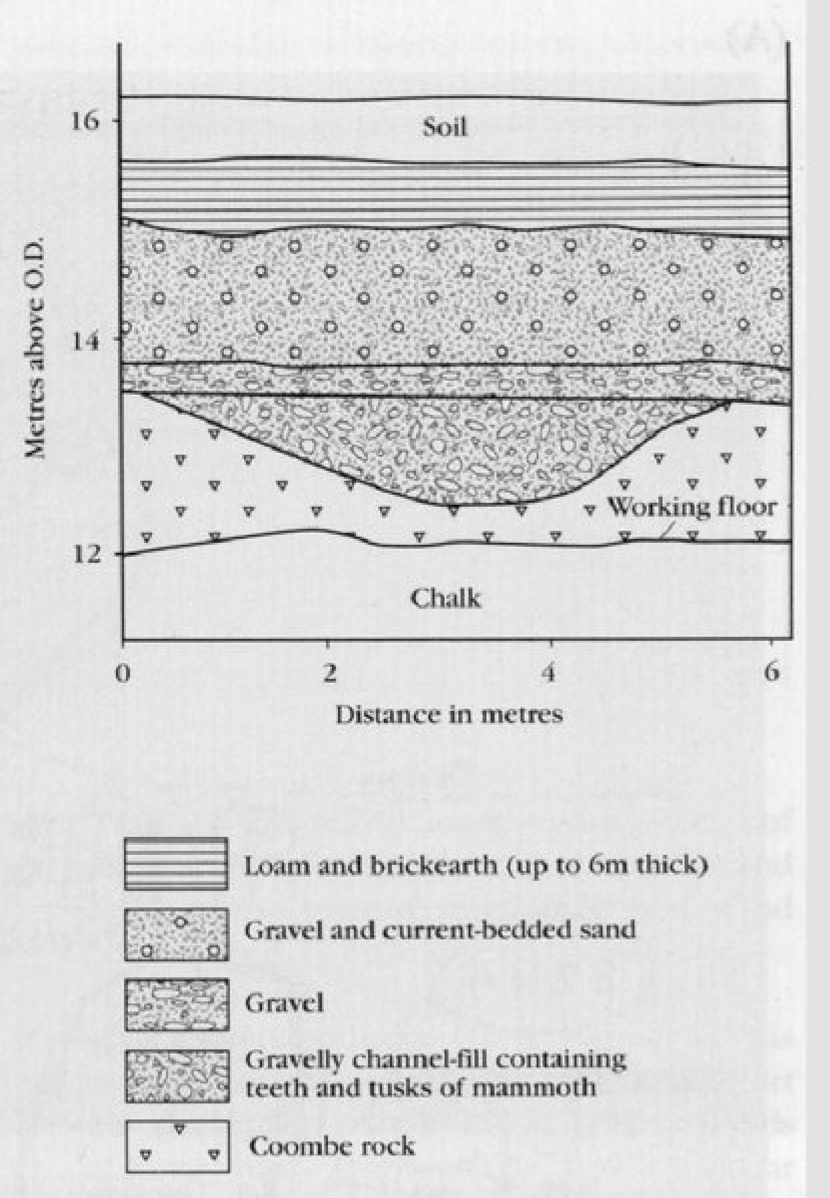
The Northfleet site records the deposition of sediments in an old channel of the Ebbsfleet, a tributary of the main River Thames. The sequence here is largely of cold-climate origin, commencing with a basal 'coombe rock', a deposit formed by the accumulation of Chalk debris as a result of slope movement under periglacial conditions. At the bottom of this deposit, at the original Baker's Hole site, a Stone Age working area was discovered. The flint debris of this working site, some of which could be fitted back together, showed the use of a technique known as 'Levallois'. Indeed, Baker's Hole is the most important Levallois site in Britain. A complex sequence of gravel, sand and silt overlies the basal coombe rock and has produced further Levallois material, as well as occasional mammalian bones and teeth and snail shells, all suggestive of cold conditions. Other types of flint artefacts have also been recovered. Silty material at two locations (at least) within the Baker's Hole complex has yielded shells of temperate-climate molluscs, implying that a warm episode is represented within the predominantly cold Northfleet sequence. Traces of soil formation in the earlier sediments beneath this bed seem to confirm that temperate conditions prevailed and that there was a brief break in sedimentation at this time. This deposit was overlain by further cold-climate sediments, now mostly quarried away, which showed evidence of frost action during periods of intense cold.

There is little information from which to date either the temperate episode represented at Northfleet or the important artefact-bearing sediments that make up the lower part of the sequence. Comparison with the terrace sequence in the adjacent Lower Thames valley, however, suggests that the deposits are of mid- to late Saalian age and that the temperate episode probably equates with Stage 7 of the deep-sea record — about 200,000 years BP.

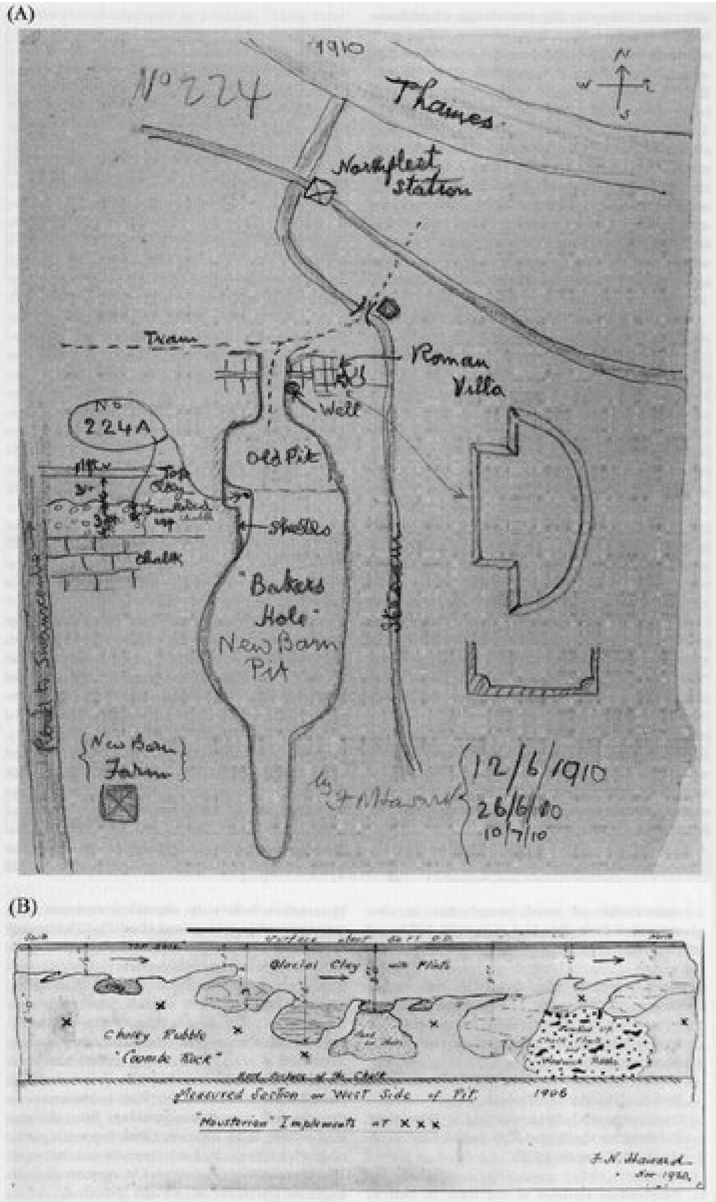
References



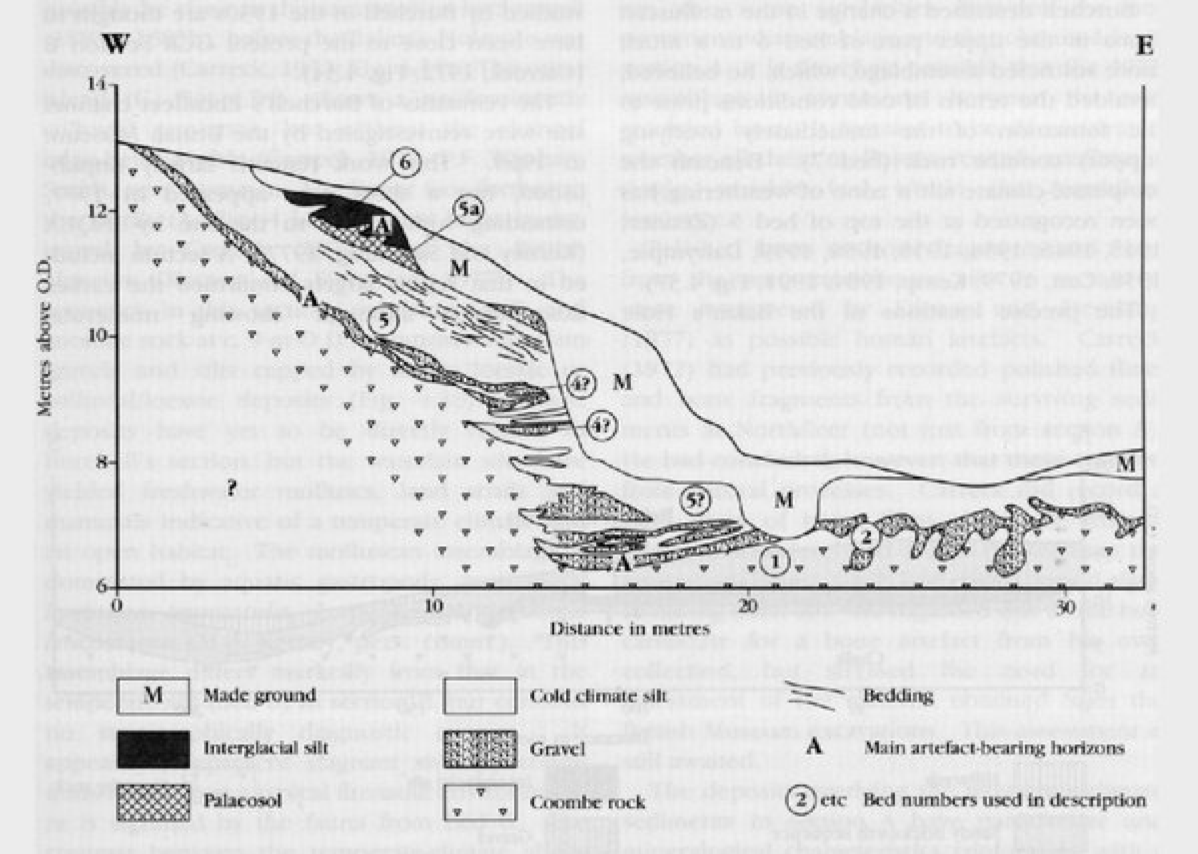
(Figure 4.34) Plan of the surviving remnants of the Baker's Hole Complex, Northfleet. A—C are the three parts of the GCR site. Updated information regarding the location of the original Baker's Hole site (and the possibility that sediments related to this survive at D) has been supplied by F.F. Wenban-Smith (pers. comm.).



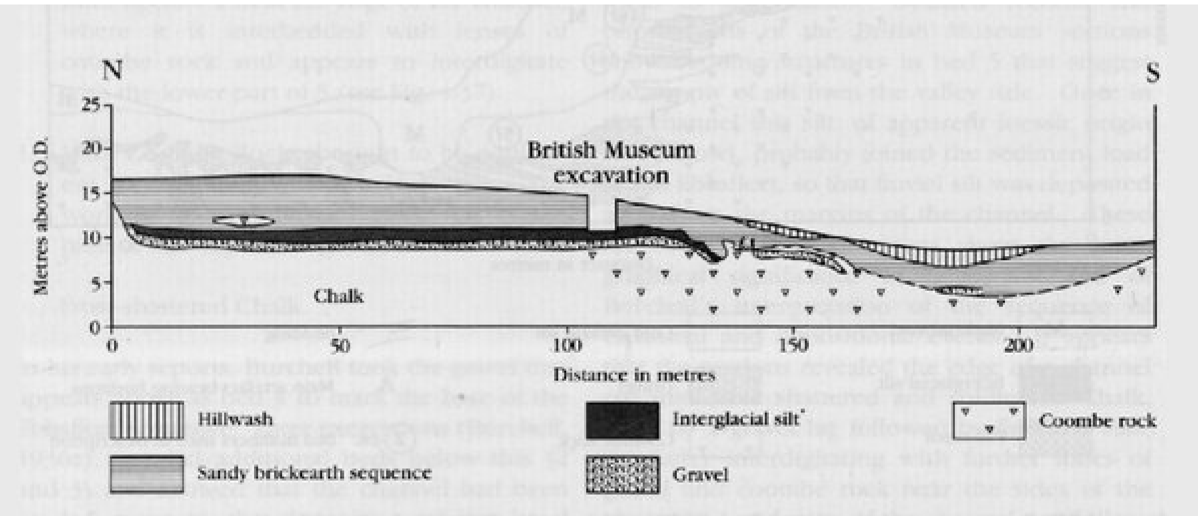
(Figure 4.35) Section at the original Baker's Hole site (after Dewey, 1932).



(Figure 4.36) Early records from Northfleet sketches of the original Baker's Hole site. (A) Map showing the location of the quarry known as 'Baker's Hole' and of the section there that yielded Palaeolithic artefacts, drawn by F.N. Haward in 1910. Reproduced by courtesy of the British Museum, London. (B) Measured drawing by F.N. Haward of the section on the west side of 'Newbarn Pit (Baker's Hole)' as seen in 1906, although the drawing is dated November 1920. The locations of artefact discoveries are indicated. (Reproduced by courtesy of the Natural History Museum, London). Thanks are due to F.F. Wenban-Smith, who drew the author's attention to the existence of these archival records, and S. Parfitt, who discovered the section drawing.



(Figure 4.37) Section excavated at Northfleet (B, (Figure 4.34)) by the British Museum (after Kerney and Sieveking, 1977). This is believed to coincide with Burchell's main 'Ebbsfleet Channel' section. Numbers refer to the description in the text.



(Figure 4.38) Section excavated at Northfleet (A, (Figure 4.34)) by the British Museum (after Kerney and Sieveking, 1977).

Age (in thousands of years)	Upper Thames	Middle Thames	Lower Thames	Essex	Stage	^{18}O
	---- Recent floodplain and channel deposits. Holocene alluvium of floodplain and coast ----				Holocene	1
10						
	Northmoor Gravel	Shepperton Gravel	Submerged	Submerged	late Devensian	2-4
	---- Rejuvenation event ----					
71						
		Temperate climate deposits at South Kensington (Ismaili centre), Isleworth and Kempton Park	Submerged	Submerged	early/mid Devensian? interstadial(s)	5a &/or 5c?
?						
	Cold climate gravels above Eynsham Gravel	**Reading area** U. levels of Taplow Gravel; **Slough area** Kempton Park Gravel	East Tilbury Marshes Gravel	Submerged	early-mid Devensian	5d-2
122						
	Eynsham Gravel	Within Taplow Formation; Trafalgar Square and Brentford deposits	Below floodplain	Submerged	Ipswichian (sensu Trafalgar Square)	5e
128						
	Stanton Harcourt Gravel	Taplow Gravel; Basal Kempton Pk Gravel - incl. Spring Gardens Gravel of Gibbard (1985)	Basal East Tilbury Marshes Gravel	Submerged	late Saalian	6
		---- Rejuvenation event ----				
		Taplow Gravel	Mucking Gravel			
186						
	Stanton Harcourt Channel Deposits, interglacial Magdalen Grove, Summertown etc.	Interglacial deposits at Redlands Pit, Reading	Interglacial deposits at Aveley, Ilford (Uphall Pit), West Thurrock, Crayford and Northfleet	Submerged	Intra-Saalian temperate episode	7
245						
	Basal Summertown-Radley Formation at some sites?	Basal Taplow Gravel?	Basal Mucking Gravel	Submerged		
	---- Rejuvenation event ----				mid-Saalian	8
	Wolvercote Gravel at some sites?	Lynch Hill Gravel	Corbets Tey Gravel	Barling Gravel		
303						
	Wolvercote Channel Deposits		Interglacial deposits at Ilford (Cauliflower Pit), Belhus Park, Purfleet and Grays	Shoeburyness Channel interglacial deposits	Intra-Saalian temperate episode	9
339						
	Basal Wolvercote Gravel	Basal Lynch Hill Gravel?	Basal Corbets Tey Gravel	Shoeburyness Channel - basal gravel		
	---- Rejuvenation event ----				early Saalian	10
	? Moreton Drift (Arkell, 1947a)					
	Hanborough Gravel	Boyn Hill Gravel	Orsett Heath Gravel	Southchurch/Asheldham/Mersea Island/Wigborough Gravel		
?						
	Reworked mammalian fauna in Hanborough Gravel		Swanscombe deposits	Southend/Asheldham/Cudmore Grove/Clacton Channel Deposits	Hoxnian (sensu Swanscombe)	11
423						
	Basal Hanborough Gravel?	Basal Boyn Hill Gravel?	Basal Orsett Heath Gravel (incl. Basal Gravel at Swanscombe)	Southend/Asheldham/Cudmore Grove/Clacton Channel - basal gravel		
	---- Rejuvenation event ----					
	Freeland Formation	Black Park gravel				
	Moreton Drift?	Anglian glacial deposits	Hornchurch Till	U St Osyth/U. Holland Gravel	Anglian	12
	Freeland Formation	Winter Hill/Westmill Gravel	Valley did not exist as a Thames course prior to this	St Osyth/Holland Formation		
478						
	Sugworth Channel Deposits	Rassler Gravel?		Wivenhoe/Cooks Green Fm Ardleigh/St Osyth Formation Waldringfield Gravel	Cromerian Complex	21-13
?						
	Combe Formation	Gerrards Cross Gravel		Bures Gravel*	Early Pleistocene	pre 21
	Higher divisions of the Northern Drift Group	Beaconsfield Gravel Satwell Gravel gravel at Chorleywood Westland Green Gravels Stoke Row Gravel Nettlebed Gravel Nettlebed interglacial deposits		Moreton Gravel* Stebbing Gravel*		

* Nomenclature for High-level Kesgrave Subgroup in Essex follows Whiteman (1990).

(Table 1.1) Correlation of Quaternary deposits within the Thames system. Rejuvenations that have occurred since the Anglian glaciation are indicated.