

LOWER AND MIDDLE PALAEOLITHIC ARTEFACTS AND OTHER RESULTS FROM RIVER GRAVELS AT DUNBRIDGE: IMPORTANT NEW DISCOVERIES

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ABSTRACT

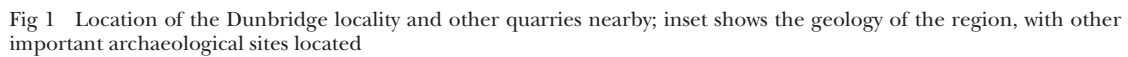
This report describes important new findings relating to the sequence and dating of Palaeolithic activity, using the typology of artefacts and their context in Quaternary deposits laid down by the River Test, from a geoarchaeological watching brief at Kimbridge Farm Quarry, Dunbridge. This work involved detailed recording and sampling of pit sections at intervals during the life of the quarry. An additional 198 artefacts, principally hand axes, have supplemented what was already the richest Lower and Middle Palaeolithic (800,000–35,000) assemblage from Hampshire and helped place it into its geological context. Post-excavation analysis of this material and its context has been funded through English Heritage under the Aggregates Levy Sustainability Fund (ALSF), and included digital terrain modelling and optically stimulated luminescence (OSL) dating of the terrace deposits. Digital terrain modelling, compiled from borehole logs and recorded sections, has confirmed the three-dimensional form of two gravel terraces: an upper deposit defined as the Belbin Formation, which contained most of the artefacts, and a lower Mottisfont Formation. Most importantly artefacts demonstrating elements of Levallois technology, a sophisticated controlled-core technique, were recovered from the deposits. These discoveries provide the most detailed record of Levallois technology to be identified in the River Test valley. They suggest correlation with the deposits at Warsash, in the lower reaches of the river, from which Levallois material was found in the 1930s. Previously published OSL dating, supplemented by the first results from Dunbridge, has been combined with uplift modelling to suggest dates of Marine Isotope Stage (MIS) 9 (340–280 ka) and MIS 8 (280–250 ka), respectively, for the two gravels at Dunbridge, which is contemporary with the onset of the Middle Palaeolithic in Britain, as demonstrated in the

Thames, particularly at Purfleet. These results have demonstrated that a watching brief, supplemented by scientific dating techniques, can provide a relatively cost-effective method by which important scientific data can be salvaged from commercial quarrying.

INTRODUCTION

The Pleistocene river terrace gravels in the Hampshire Basin have produced some of the most important collections of Lower and Middle Palaeolithic artefacts in Southern Britain (Bury 1923; Calkin & Green 1949; Wymer 1999). The most prolific site in Hampshire was at Dunbridge, where almost 1000 hand axes were found in gravel pits that were dug between the end of the 19th century and 1945 (Roe 1968; 1981; Wessex Archaeology 1993). In addition three flakes produced using Levallois technology (Middle Palaeolithic) were amongst the artefacts recorded from unspecified deposits at Dunbridge (Roe 1968). This technique marks a fundamental shift in stone tool technology, moving it from a core tool (hand axe) technology to a flake technology. It requires a sophisticated approach to flaking, with attributes that predetermine the shape of the flake blank that can be transformed into a retouched flake tool. The appearance of this advanced technique provides a crucial chronological and technological bench-mark, signifying the appearance of the Middle Palaeolithic and also of Neanderthal populations. The documentation of Levallois technology at Dunbridge therefore highlighted it as a potentially significant location in the chronology of the Palaeolithic in Britain and NW Europe.

The Dunbridge gravel pits were located on



the western side of the Test valley, approximately 900m from the present river channel and 500m south of its confluence with the tributary River Dun (Fig. 1). The importance of the site, both geologically and archaeologically, was recognised when it was designated as a Site of Special Scientific Interest (SSSI) in the mid-1980s (cf. Bridgland & Harding 1987). At much the same time (1987), Halls Aggregates (South Coast Limited; now Cemex), sought consent for renewed gravel extraction from farmland, centred on NGR SU321255, to the south of the SSSI. This proposal met with considerable local environmental and archaeological opposition and was subject to a lengthy planning enquiry before consent was granted. A number of archaeological evaluation trenches (Collcutt *et al.* 1988) demonstrated that it was unlikely that undisturbed Palaeolithic deposits would be present on the site. A Section 52 agreement was drawn up, as a condition of consent, to implement an archaeological watching brief to be undertaken throughout the working life of the pit and funded by the gravel company. This aimed to recover additional artefacts and where they came from, record the geological stratigraphy and understand the chronology of the site. Work commenced in April 1991 and concluded in May 2007, when the reserves were deemed uneconomical.

Optically Stimulated Luminescence (OSL) dating and digital terrain modelling were both applied subsequently to samples and data collected from the deposits at Dunbridge. These scientific techniques, funded with support by the Aggregates Levy Sustainability Fund (ALSF), provided additional approaches by which the site could be studied and the stone tools placed in their correct chronological and geological context.

Much of this background history of the site and interim results of work from 1991–8 have been published elsewhere (Bridgland & Harding 1993; Harding 1998). The results of nearly two decades of research at the site have been published recently (Harding *et al.* 2012) and should be consulted for further detail. The description presented here provides a synthesis of the work and assessment of the methodology.

GEOLOGY

Early descriptions of the deposits, provided by Dale (1912; 1918) and White (1912), identified two terrace gravels in this area that both yielded Palaeolithic implements: an upper deposit, termed the 'Belbin Stage', was present in the original Dunbridge Pit, which lay immediately south of Dunbridge Station in an area that is now heavily wooded, and a lower 'Mottisfont Stage', which was quarried at Kimbridge, to the south either side of Kimbridge Lane. Dale subdivided the gravels into those towards the base, which were stained orange/orange-red by iron minerals in the gravel, and a separate upper white gravel, in which the material was patinated, a surface alteration of the flint. Implements from the lower parts of the gravel were frequently heavily rounded by prolonged movement in the fast flowing river, whereas those from the upper beds were sharper in condition, thought to be more recent and only slightly moved from their place of manufacture.

Subsequent work (Bridgland & Harding 1987; Collcutt *et al.* 1988) confirmed the presence, within the quarry area, of bedded, water-lain gravels containing artefacts in varying states of condition and representing two separate River Test terrace formations. These equated to the upper (Belbin) and lower (Mottisfont) terraces as established by the earlier workers.

Additional study during the watching brief demonstrated that the Belbin Gravel (Bridgland & Harding 1993; see also Harding *et al.* 2012, figs 2, 5–6), which accounted for most of the quarry area, was deposited on an undulating bedrock surface and had a maximum thickness of 4–5m. It was characterised by well-bedded water-lain material towards the base, with bedding becoming increasingly poorly preserved towards the top. This less structured gravel probably resulted from disruption of the original bedding by frost heaving (cryoturbation) during one or more subsequent glacial periods. Dale's (1912) division of bleached upper and heavily stained basal gravel was dismissed as a sedimentary distinction. The obvious separation, which was defined by an iron-manganese pan, was instead attributed to

the downward translocation of mineral salts as part of the (pedogenic) bleaching process.

The Mottisfont Gravel, which was present along the eastern edge of the quarry, also showed water-lain bedded gravel of similar depth to the Belbin Gravel. Characterised by a loamy or clayey matrix, it contained large pieces of poorly consolidated clay from the underlying bedrock that had been ripped from the side of the valley as frozen lumps during down-cutting by the river. Palaeolithic implements may also have been eroded from the Belbin Gravel at this time and become incorporated into the Mottisfont Gravel. Iron/manganese staining and panning was present, with a notable pan typically found at the base of the Pleistocene deposits.

DIGITAL TERRAIN MODELLING OF THE GEOLOGICAL DEPOSITS

The digital terrain model was compiled from 260 geotechnical borehole logs taken before extraction began and from section drawings compiled during the watching brief. The results defined the extent and form of the two gravel terraces across 42ha, beyond the limits of the quarry, and showed that the overall topography of the bedrock surface fell, on average, from 44 to 32m OD west to east across the study area. The overlying Belbin and Mottisfont river terrace deposits were confirmed as

two separate gravels demarcated by the 37 and 40m OD bedrock-surface contours. The Belbin Gravels extended south from the former pits studied by Dale (1912; 1918) and White (1912) to occupy the north-west corner and western edge of the recent quarry. The thickest deposits were present in the central parts of this terrace remnant, coinciding in part with the location of old channels ('deeps') of the River Test (Harding 1998). The Belbin terrace deposits were separated from the Mottisfont Gravels, which covered the south-east corner of the quarry, by an inclined 'bluff' running north-south through the centre of the study area. The Mottisfont Gravels could be traced (Fig. 1) south-east beyond the limits of the pit, beneath Dunbridge Lane, towards the former workings at Kimbridge, which were described by White (1912).

PALAEOLITHIC ARCHAEOLOGY

One hundred and ninety eight artefacts were recovered during the watching brief (Table 1). A consistent, if imprecise, technique was adopted by which artefacts could be located to general areas within the quarry. Objects from the pit, which constituted 30% (60) of the total, could be provenanced spatially with some certainty, having dropped vertically from the quarry face or dragged up during the construction of protective bunds around

Table 1 Artefact assemblages from Dunbridge showing recovery by the watching brief from the quarry and washing plant with comparable figures from the extant collections (Roe 1968)

Artefact	Quarry	Watching Brief		Roe (1968)		
		%	Washing plant	%	No	%
Hand axe	9	15	45	33	953	93.3
Rough out	1	2	6	4	14	1.3
Flake	44	73	70	51	27	2.6
Core	5	8	11	8	3	0.3
Retouched/scrapper	1	2	3	2	16	1.5
Debitage	0	0	3	2	8	0.7
Total	60		138		1,021	

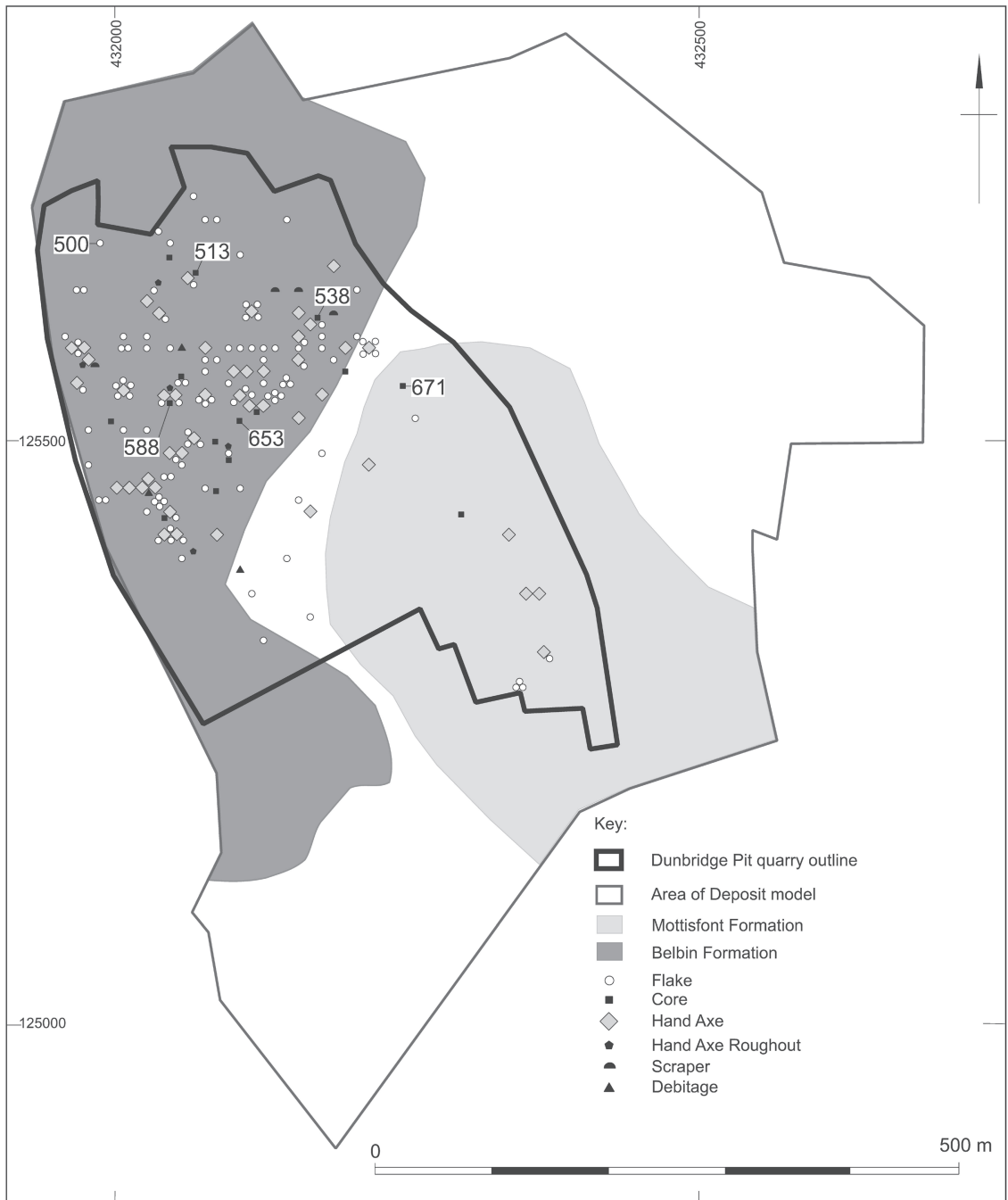


Fig 2 Artefact distribution plotted over the approximate terrace footprints as derived from the digital terrain modelling

the quarry edge. The remainder, from the >40mm 'reject' heap at the washing plant, were recorded by date of discovery, relative to the known plotted extensions and additions to the pit face since the previous visit. This quota was less precisely located, especially in the case of material that might have been stockpiled for some length of time before it was processed.

The artefact distribution, when superimposed onto the terrain model (Fig. 2) relative to the terrace geology, confirmed that most material was recovered from the high-level Belbin Gravel, with very few artefacts from the Mottisfont Gravel, a pattern that is consistent with implement density from the old workings (Roe 1968).

Although none were found *in situ*, it is most likely that the heavily stained artefacts corresponded with beds of heavily stained gravel in the lower parts of the Belbin Gravel, below the bleached horizon, or, increasingly as quarrying moved south in the later parts of project, from the Mottisfont Gravel, which was also heavily stained. The most heavily stained pieces were also frequently more heavily rolled. The upper 'bleached' gravels, in contrast, were more commonly patinated and less heavily stained. These features could be used to identify artefacts that were more likely to have come from those levels.

Cores

These artefacts represented the most important discoveries from the watching brief; three single-platform 'proto-Levallois' flake cores (Fig. 3. 513, 588, 653 and Fig. 4) and three fully developed Levallois flake cores (Boëda 1995) with opposed striking platforms (Fig. 3. 538, 671, 685 (the last was too imprecisely located to be included on Fig. 3) and Fig. 4) The 'proto-Levallois' technology, as first described (Wymer 1968), was taken to represent an embryonic form of the technique, which evolved into a fully developed form as the technology was perfected. By the nature of development the 'proto-Levallois' technique is less well defined and cores with these attributes have been recorded from deposits that pre-date the Middle Palaeolithic; however the developed

Levallois technique is unambiguous and easily recognised.

At Dunbridge the 'proto-Levallois' cores were all rolled, stained and undoubtedly from the main body of the Belbin Gravel. The developed Levallois cores were all remarkably similar in terms of technology, morphology, size and weight, indicating that they were from a single industry. All were in a sharp/slightly rolled condition, especially core 685, which showed undoubted signs of having been transported in a river. All were covered by a light yellow surface stain overlying a patina, indicating that they were likely to have come from the upper, bleached part of the gravel sequence. Most importantly the positions of two of the developed Levallois cores (538, 671) could be plotted with some degree of certainty. This indicated that they were found in gravel that could be sourced to both the Belbin and Mottisfont terraces and therefore dated to the end of, or later than, the deposition of the Mottisfont Gravel, making them later than the 'proto-Levallois' cores.

The remaining cores included elements of migrating platform or alternate flaking, which are common to many periods of prehistory. Most demonstrated similar variations in condition and staining to those present on the hand axes.

Flakes

The 114 flakes and broken flakes, 57% of the watching brief assemblage, were biased in favour of easily recognizable, large (60–80mm) pieces. By-products of both core-tool (hand axe) manufacture and deliberate flake production from cores were represented. Most importantly, one flake (Fig. 3 500 and Fig. 4), found in the north-west part of the site, was identical in condition, surface staining and technology to the opposed-platform Levallois cores from the site and was undoubtedly related to that industry.

Hand axes

These artefacts formed 31% of the collection. Pointed implements, often with flattened, cortical butts, were prevalent, but ovates, three

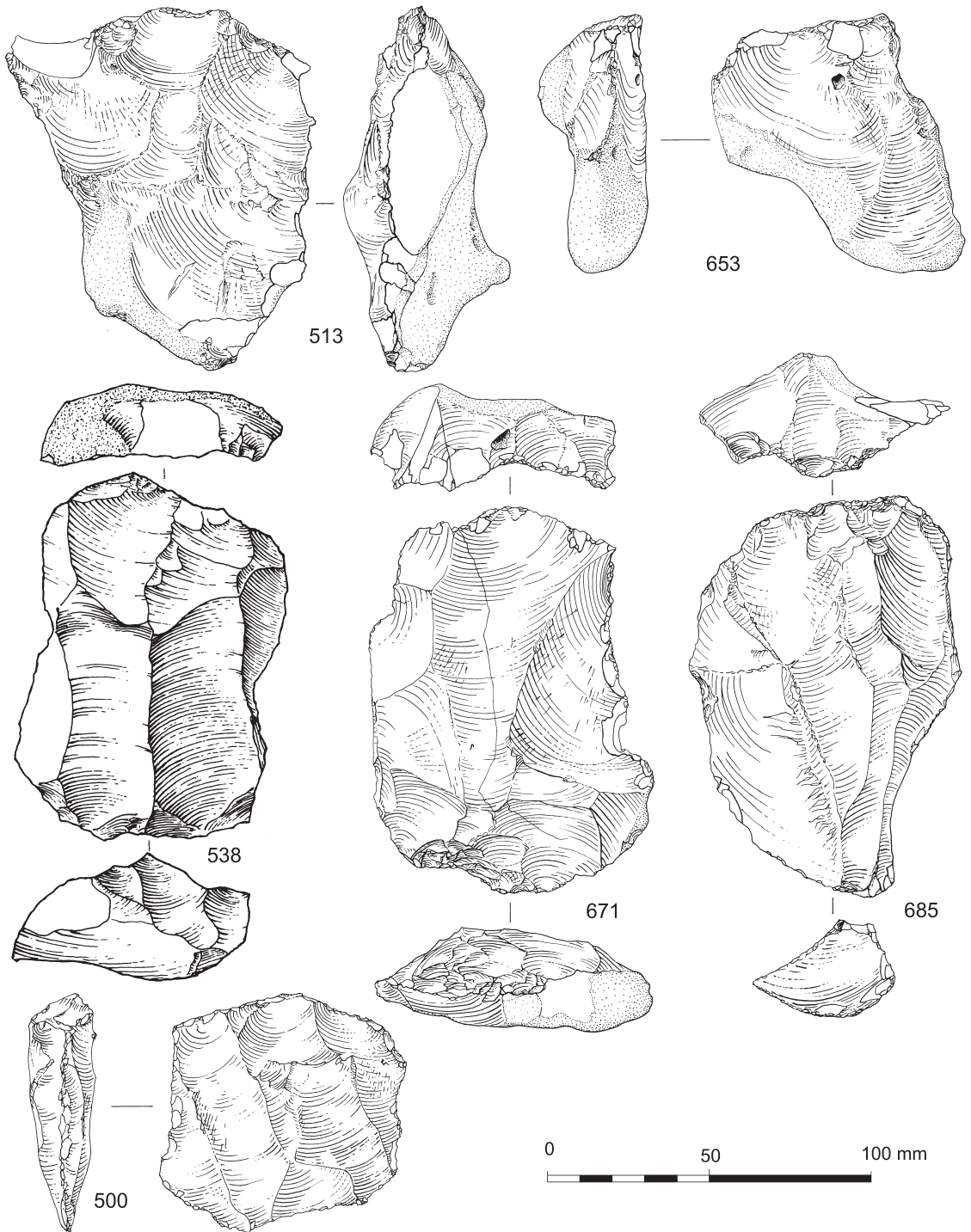


Fig 3 Proto-Levallois cores 513 and 653 and developed Levallois cores 538, 671 and 685 and Levallois flake 500 from Dunbridge. Core 538 reproduced from Harding 1998, fig. 11.1.1

cleavers and two ficrons were also included. Sixty per cent of the hand axes were in a rolled and stained condition, with the observed correlation between heavily rolled and heavily stained pieces maintained.

Individual implements of note included the butt of a probable bout coupé hand axe (Harding 1998, fig. 11.1.2) that was found by the plant manager when the Belbin Gravel was being exploited. The implement seems most likely to have come from Dunbridge. Its pale yellow stain and rolled condition are similar to other material that probably came from the upper part of the gravel.

Flake tools

The watching brief produced two end scrapers and a side scraper, all made on flakes, and a retouched flake. Flake tools of a comparable type, although chronologically undiagnostic within the Palaeolithic, confirm the importance of flake production and of flake tools in general in the area. Dale (1912) noted that large flakes, slightly rolled and trimmed along one edge, were found near the base of the Mottisfont Gravel, along with heavily rolled hand axes.

OPTICALLY STIMULATED LUMINESCENCE (OSL) DATING

The Pleistocene terrace gravels of the River Test form a complex set of features of which Dunbridge forms a very important part. Unfortunately in the upper part of the valley, around Dunbridge, they await detailed geological survey, unlike in the lower Test, where the terraces have been mapped and separated in detail. This has made it extremely difficult to correlate the deposits and artefact collections at Dunbridge with those at locations further downstream, notably at the important Palaeolithic site of Warsash (Burkitt *et al.* 1939), where more detailed mapping exists. In addition, neither site has been dated accurately using modern scientific techniques, although from a number of other localities in the Solent there are valuable results obtained using OSL dating techniques (Schwenninger *et al.* 2006; 2007;

Bates *et al.* 2010). The successful application of this technique elsewhere in the Solent since the start of the watching brief gave rise to optimism that it might be appropriate at Dunbridge.

Twelve samples were collected from the quarry sections through the Mottisfont Gravel (Harding *et al.* 2012, figs 2 and 7) after extraction had been completed. The results were in general inconsistent, however, the most coherent and reliable set of dates being obtained from three samples that were collected from a sand lens, only 0.15m apart. These samples indicated deposition around 277 ± 18 ka years ago, within the anticipated date range of Marine Isotope Stage (MIS) 8, (280–240 ka). The results of the other samples indicated a mean age of 305 ± 10 ka, somewhat older than might have been anticipated. This was attributed to the influence of two factors: a lack of understanding of the water content of the sediments and incomplete bleaching of the mineral grains at the time that they were reworked from the bedrock sand into the river gravels (Schwenninger *et al.* 2011).

The use of OSL dating at Dunbridge proved to be a valid methodology by which to study the site, providing determinations within the anticipated date range that can now be added to the current database from the Solent catchment, albeit with some reservations about their consistency. However the results have demonstrated that the nature of the parent geology at Dunbridge is a challenging factor for future use of the technique at the site.

CONCLUSIONS

Much of our past knowledge of the Palaeolithic period has been derived from implements collected from secondary contexts, principally gravel deposits, when hand digging was the norm. Significant artefact-based studies have been undertaken using assemblages, now held by museums, from these sources (Roe 1968; Wymer 1999; Hosfield & Chambers 2004; Hosfield *et al.* 2007; Ashton & Hosfield 2010).

Advances in gravel extraction, not least in methods of quarrying it, have changed the face of the industry and the ways in which archaeology responds to this. At the time of its inception

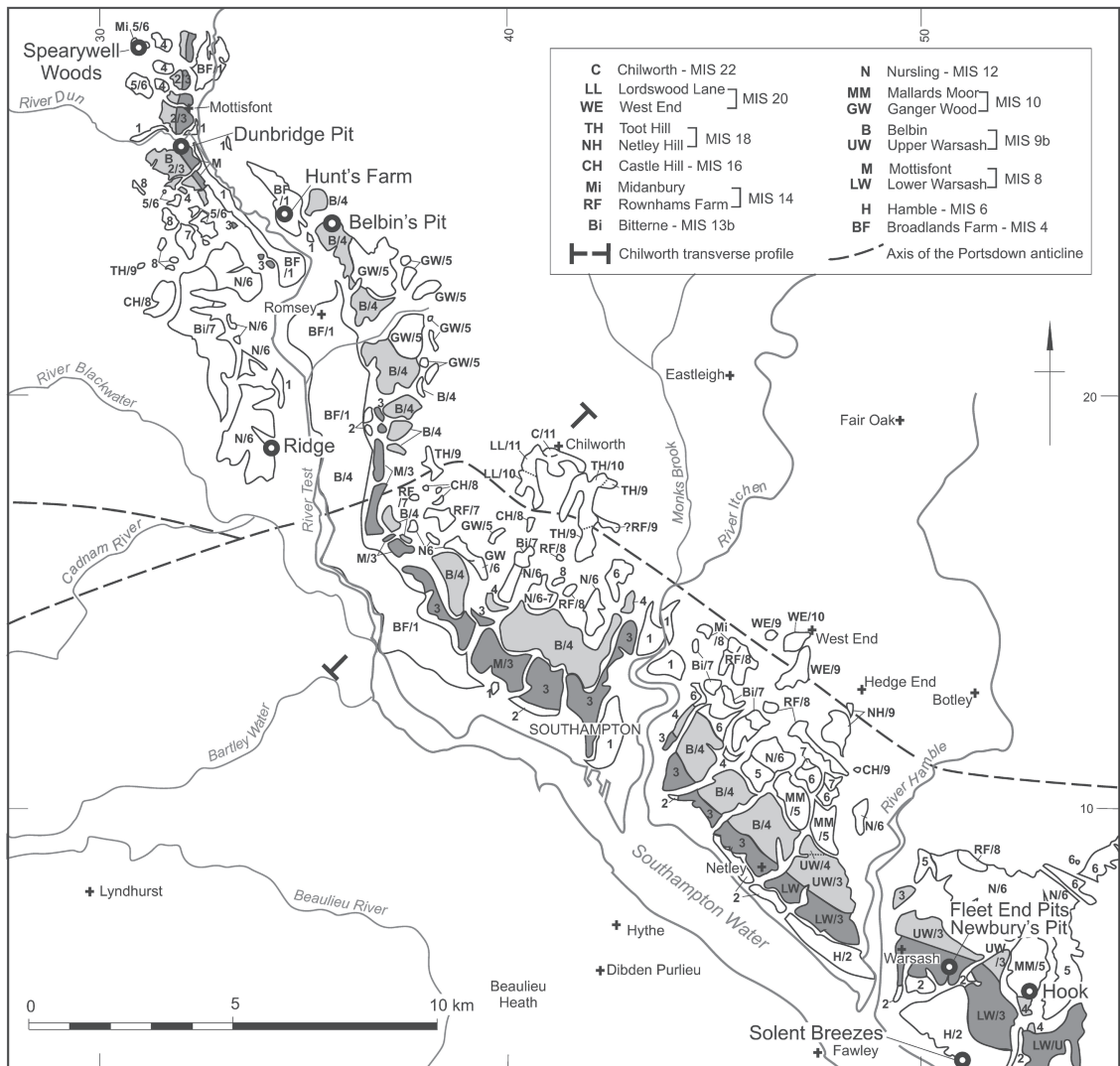


Fig 4 Terraces of the River Test. Ornaments follow the named terrace scheme of Westaway *et al.* (2006), although BGS terrace numbering is also indicated

very few watching briefs of the type undertaken at Dunbridge had been commissioned. The project therefore sought the recovery of new, accurately recorded data capable of advancing the study of the human colonisation of the River Test valley and its relationships across Britain in the Palaeolithic period.

The pace of Palaeolithic research has itself advanced and quickened in the lifetime of the

Dunbridge project. The discipline now incorporates more multi-disciplinary approaches, including new techniques that were unheard of or in their infancy when the project began, but which have now become routine. The current approach to Palaeolithic fieldwork in gravel pits allows for at least three approaches, employing (1) assessment of borehole data with preliminary test-pit excavation, accompa-

nied by detailed recording, exactly as preceded aggregates extraction at Dunbridge (Collcutt *et al.* 1988); (2) regular watching brief(s), as at Brooksby, Leicestershire (Stephens *et al.* 2008) and reported here; or (3) detailed excavation, as at Lynford, Norfolk (Schreve 2006; Boismier *et al.* 2012). Of these, all but the watching brief may be relatively short-term projects, although, as the work at Dunbridge has demonstrated, a watching brief may continue for many years, until a quarry is worked out.

An important feature of the Dunbridge project in post-excitation was the opportunity to compile a three-dimensional terrain model extending across the quarried site and adjacent areas to depict the surface of the underlying Tertiary bedrock and the disposition of the Pleistocene gravels. This form of analysis is now regarded as a standard form of approach; the technology required to undertake it improved immeasurably over the 20 years of the Dunbridge watching brief. The precision of the reconstruction and of interpretation was greatly enhanced by not only using 260 borehole logs obtained before quarrying began but also supplementing this data with detailed sections observed during the watching brief. This supplementary source became available as the watching brief progressed. It provided an accurate record of the deposits that could be used to interpret the Pleistocene geology of the borehole logs rather than their commercial potential. The terrain model therefore now provides the most reliable terrace mapping yet compiled of Pleistocene deposits in the Dunbridge area, an area that currently lies outside the zone of modern mapping in the River Test valley.

In many respects the issues facing the modern field archaeologist when undertaking work at a gravel pit in search for Palaeolithic material are not so different from those faced by the early collectors. In those days the recovery of artefacts was seen as the primary aim. This was, in some respects, easier for those collectors than it is today. Labourers, working in close proximity to the material, became more adept at spotting artefacts than gravel workers today, of whom only a few are able or inclined to look for artefacts: inevitably more difficult from the cab of a machine or in a mechanical washing

plant. The issue of context remains a problem. As Dale (1912) admitted, most of the artefacts from Dunbridge were collected from the sieve, although, in an attempt to redress these issues, he gave specific instructions to the diggers to note the position of white patinated material, a policy that was rewarded by the observation that most of this material was recovered from the upper 6 feet (1.8m) of the gravel. In this respect the conditions available to the antiquary were more favourable than those available to the modern prehistorian, where machinery prevails.

The Dunbridge watching brief attempted to redress the problem by adopting a policy of locating artefacts by date of discovery and correlating this to the location of the quarry face. This imprecise technique allowed a distribution of artefacts to be reconstructed as the face receded and demonstrated that meaningful horizontal artefact distributions can be reconstructed, as confirmed by superimposition on the results of digital terrain modelling.

Despite many things remaining unchanged, others have advanced greatly, even within the life of the most recent workings at Dunbridge. The compilation of a detailed site archive is also seen as being of primary importance. Detailed drawn and annotated records of precisely located sections using GPS are now a routine by-product of the watching brief. These are supplemented by photographs. Photography often represented the only methods by which sections were recorded by Dale, and these as unlocated views (Dale 1912, figs 1 and 3). Survey techniques have also advanced. Initial face locations in the watching brief were plotted by tape and levelled between 1992–7, with surveys from 1997–2000 employing a total-station theodolite and thereafter using differential GPS data supplied by the gravel company.

Most significantly advanced scientific techniques have been developed, principally associated with palaeo-environmental and dating methods. These techniques now make it essential to place greater emphasis on seeking and sampling sand, silt and clay deposits that were laid down under slack-water conditions. The results have the potential to transform understanding of human activity and place it

in its correct environmental and chronological context. Deposits of this type may exist in only relatively confined locations in small pockets within the pit but are worth looking for. Sandy deposits were sampled and analysed using the still developing technique of OSL dating methods for the first time at Dunbridge with mixed success.

The watching brief at Dunbridge has contributed significantly to clarifying the context of the largest assemblage of Lower and Middle Palaeolithic artefacts from Hampshire. The deposit model has defined the extent of the two distinct Pleistocene river terrace deposits that were exploited by the quarry, effectively a confirmation of White's (1912) Belbin and Mottisfont Stages, and placed the artefacts in their correct Quaternary context. Analysis of artefact distribution from the watching brief has confirmed that the upper Belbin Terrace was the principal source of Dale's (1912; 1918) Palaeolithic finds from Dunbridge. Hand axes remain the predominant implement type from the site, with 54 from the watching brief complementing the 967 finished and rough out forms catalogued by Roe (1968) that constitute 95% of the extant collections. Roe (1981) concluded that the assemblage was mixed, contained a large number of pointed forms with a range of other forms and included no diagnostic manufacturing techniques, such as twisted profiles. The sample from the watching brief broadly confirms these conclusions but was of insufficient size to contribute more.

The confirmation of Levallois technology at the site, especially developed Levallois, is undoubtedly the most significant addition to knowledge of the Palaeolithic in the Test valley and the wider region. The presence of embryonic 'proto-Levallois' technology has been noted; this appears to be confined to the Belbin Gravel and to precede the fully developed Levallois technology that is also represented at the quarry. This development is reminiscent of, but not necessarily comparable with, the sequence at Purfleet, Essex (Schreve *et al.* 2002; Bridgland *et al.* 2012), where 'proto-Levallois' technology was seen within the stratigraphy to develop into a fully fledged Levallois technology. However, cores demonstrating similar 'proto-Levallois' charac-

teristics are known from much earlier deposits that pre-date MIS 9 (Scott 2011); they are reminiscent of the techniques used to prepare hand axes, from which it is argued that the Levallois technique may have developed from the hand-axe making industry. The 'proto-Levallois' cannot therefore be used unequivocally as a diagnostic chronological indicator.

The technology and condition of the developed Levallois material is consistent and undoubtedly represents a single industry. The issue of context remains crucial. This material was recorded from the areas of both the Belbin and Mottisfont Gravels and cannot therefore be linked specifically with one terrace or the other. At least one of the cores shows clear traces of having been transported by fluvial action and must have originated from within the gravel; the clear lack of deep staining suggests the upper, cryoturbated bleached gravel that occurs across both terraces. The possibility that the cores were from the overburden exists but, given the clear evidence for water transport, this is unlikely. The overburden was, in any case, stripped away before gravel extraction commenced; indeed overburden is an unwanted component at the washing plant. Nevertheless the objects are not rolled and therefore are unlikely to have moved far from their place of manufacture. This is in stark contrast to many of the hand axes, which have been derived from a much broader catchment.

The dating of the deposits has been contentious, especially in relation to the occurrence of Levallois technology (Westaway *et al.* 2006; Ashton & Hosfield 2010), principally due to the low numbers of finds displaying this technique from the Test valley, the lack of scrutiny of the published identifications or actual contexts and the paucity of dating constraints. Ashton & Hosfield (2010) could locate only 36 pieces, of which 24 were from the gravel pits at Warsash (Burkitt *et al.* 1939). The relationship of Warsash to Dunbridge is therefore of crucial importance to the chronology and terrace sequence of the River Test valley. Ashton & Hosfield (2010) concluded that the Levallois material from Warsash probably came from deposits overlying the terrace gravel and therefore could not be

used to establish the introduction and distribution of Levallois technology in the Solent region or provide a reliable indicator of terrace age, as advocated by Westaway *et al.* (2006), following Bridgland (1994) in the Thames. However Burkitt *et al.* (1939) could not establish the precise bed from which the Levallois material at Warsash originated, only confirming that it came from 'below a 'blue clay' (Burkitt *et al.* 1939, 41), which was no longer visible, and that it was not from the heavily stained basal gravels. They speculated, but could not guarantee, that the Levallois material was from an overlying stony loam, equivalent to the Dunbridge overburden. Given the slightly rolled condition of the material from Dunbridge, the evidence for river impact and the removal of overburden prior to gravel extraction it seems most likely that the Dunbridge Levallois, and possibly that from Warsash, originated from the upper parts of the gravel deposits.

Existing schemes of terrace definition in the Test valley (Edwards & Freshney 1987; Westaway *et al.* 2006; Wilkinson 2007; Bates & Briant 2009) have attributed the Belbin Formation to Marine Oxygen Isotope Stage (MIS) 10 (360,000–340,000 years ago). The identification of 'proto-Levallois' technology from this terrace during the watching brief is a significant addition to the data available. In isolation this cannot be regarded as an unequivocal indicator of date; however, the apparent presence of fully fledged Levallois technology in the upper part of the Belbin Gravel, otherwise unrecorded at such an early date, and its relationship to the Mottisfont Gravel has provided an additional element to the discussion. As a result the Belbin Gravel is now considered to be late in MIS 9 (340,000–280,000). The Mottisfont terrace at Dunbridge is thought (Edwards & Freshney 1987; Westaway *et al.* 2006; Wilkinson 2007; Bates & Briant 2009) to correlate with MIS 8 (280,000–250,000), an interpretation supported by the most coherent and reliable OSL dating results from the new quarry at Dunbridge. This terrace has also been correlated (Harding *et al.* 2012) with a Lower Warsash terrace from which developed Levallois technology was found at the Fleet End and Newbury's Pits at Warsash (Burkitt *et*

al. 1939) and which has also been dated to MIS 8.

If correct, this interpretation implies an important link with similar sites in the Lower Thames valley, principally at Purfleet, Essex (Bridgland *et al.* 2012) where the proto-Levallois was first recognised and where it is considered to mark the initial steps of development of this technique in Britain. This site has also been dated to MIS 9b. There is thus a potential chronological framework for the archaeological material and associated geological deposits that links the Rivers Thames and Test. It is highly likely that the Middle Palaeolithic knappers at Dunbridge were attracted by the availability of fresh, good-quality flint in the valley side, in much the same way that they were drawn to locations in the Lower Thames valley at Purfleet (Wymer 1968; Bridgland 1994; Bridgland *et al.* 2012) and Crayford (Spurrell 1880; Chandler, 1916).

The watching brief also produced the butt of an implement (Harding 1998, fig. 11.1.2) that displays features included by Tyldesley (1987) as typical of bout coupé hand axes. This enigmatic artefact type, of which only 75 'true' examples (Tyldesley 1987) are known, is considered to be a diagnostic chronological indicator (White & Jacobi 2002) of the re-colonisation of Britain by Neanderthal groups approximately 60,000 years ago (MIS 3), significantly later than both the Belbin and Mottisfont Gravels. Another bout coupé hand axe from Dunbridge, now in the British Museum (Roe 1981), is unrolled and unstained and may have come from deposits overlying the gravels. The implement from the watching brief, in contrast, is rolled and clearly from a fluvial deposit. Such hand axes are rarely associated with Levallois technology. Other anomalous examples are known and it was acknowledged by White & Jacobi (2002, 123) that they might necessitate 'special pleading' to refute their presence from pre-last Interglacial contexts.

The results of the watching brief at Dunbridge have been derived from one of the first and certainly longest commercial Palaeolithic fieldwork projects undertaken in the UK. The project was in itself a response to a situation and was seen as undertaken with short term objectives. The results of

the watching brief have demonstrated that a project of this type can make a major contribution to the Palaeolithic archaeology. At the time of its inception very few, if any, comparable projects had been undertaken. Indeed one of the first benefits of its existence (Gamble & Wymer 1994) was the funding by English Heritage of the Southern Rivers, later English Rivers Palaeolithic Project (Wymer 1999). This project aimed to map and record all known records of Palaeolithic artefacts on their geology to provide a database for future use by county archaeologists to identify future threats by commercial exploitation to gravel deposits that might contain stone tool assemblages. Since then the need to identify research priorities within the Palaeolithic and Mesolithic periods has been reviewed (Pettitt *et al.* 2008; Gardiner 1999), although the use of developer-funded watching briefs as an appropriate response to sites where Palaeolithic material may be threatened by gravel extraction remains relatively underused. The experience of Dunbridge and a similar exercise undertaken to monitor gravel extraction at Switchback Road, Maidenhead (Harding & Bridgland 1999) has demonstrated that the methodology can offer relatively low-cost but effective opportunities to observe and record deposits, collect artefacts and define their extent and context within the gravel. In addition it makes it possible to monitor progress through the geology to identify sensitive deposits that might warrant detailed excavation or preservation *in situ*. Most importantly the experience at Dunbridge has shown that it can make a significant contribution to Palaeolithic studies. Advanced techniques of data recording are now available to the gravel industry, which can be of mutual value to Palaeolithic archaeology; collaboration between the two interests therefore remains essential.

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The archive is currently stored at the offices of Wessex Archaeology under project codes W436, 34351, 69590–92. The archive, comprising the paper record and artefact assemblage, will be deposited with the Hampshire Museums Service in due course.

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