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A Middle Palaeolithic to Early Upper Palaeolithic succession from an open air site at Beedings, West Sussex[☆]



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ABSTRACT

The collection of flintwork from the site of Beedings, West Sussex (England) contains by far the largest number of stone tools from the earliest Upper Palaeolithic of Britain, and is one of the two largest assemblages of its type in Europe. Despite its obvious importance, its analysis has been hindered by several factors resulting from its early excavation. Chief amongst these is the almost total lack of stratigraphic or contextual information: its Early Upper Palaeolithic attribution has hitherto been made largely on its typological and technological similarity to stratified archaeology elsewhere.

New fieldwork in 2007 and 2008 in an area directly adjacent to the original site located further Upper Palaeolithic material, in addition to Middle Palaeolithic and Mesolithic material, situated within a series of fissures. Here we provide an overview of the excavation and details of the archaeological context within which further flint artefacts were found. By extension this work provides the first contextual information for the old, larger collection.

The results of OSL analysis accord with an Early Upper Palaeolithic age for the majority of the old lithic collection from the site. Stratigraphic data support this Early Upper Palaeolithic age, and also help to validate the separation of material within the old collection into Middle Palaeolithic, Early Upper Palaeolithic and Mesolithic. These stratigraphic data also suggest that Beedings is the only stratified Middle–Upper Palaeolithic open-air site in Britain. Taphonomic analysis indicates a mechanism for site formation, and accounts for the exceptional preservation of this Palaeolithic archaeology. In the light of this taphonomic analysis the “Sackung” hypothesis of site capture proposed previously for Beedings is upheld and further discussed. Wider implications for the preservation of open-air Palaeolithic sites in the region are also considered.

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1. Introduction: the significance of the Beedings lithic assemblage

1.1. Beedings and the LRJ

The open air site of Beedings (West Sussex, England: [Figs. 1 and 2](#)) has emerged in the last 25 years as central to discussions of the advent of the northern European Upper Palaeolithic, and, by extension, of the replacement of indigenous Neanderthals by anatomically modern humans ([Jacobi, 1990, 2007](#); [Allsworth-Jones, 1990](#); [Otte, 1990](#); [Flas, 2001, 2002, 2008, 2011](#); [Pettitt, 2008](#); [Dinnis,](#)

[2009](#)). Early collections from the site contain by far the largest British assemblage of stone tools from the Early Upper Palaeolithic Lincombian–Ranisian–Jerzmanowician (LRJ) techno-complex: an assemblage type with a geographical range that extends from Poland in the east to south-west England and Wales in the west ([Kozłowski, 1984, 1990](#); [Flas, 2002, 2008](#); [Jacobi, 2007](#)). In European terms, only the Polish cave site of Nietoperzowa has yielded a culturally comparable lithic assemblage of similar size.

The age of the LRJ continues to refined ([Aldhouse-Green and Pettitt, 1998](#); [Kozłowski, 2002](#); [Jacobi et al., 2006](#); [Jacobi, 2007](#); [Flas, 2008, 2011](#); [Cooper et al., 2012](#)). Only a few reliable chronometric data are currently available, but it is certainly the earliest Upper Palaeolithic in northern Europe, emerging by 38,000 ¹⁴C BP, and it is now thought unlikely to last beyond 36,000 ¹⁴C BP ([Jacobi, 2007](#); [Flas, 2011](#); [Cooper et al., 2012](#)). With the LRJ we see the appearance in northern Europe of an “Upper Palaeolithic” toolkit, with

[☆] This paper is dedicated to the memory of both Roger Jacobi and Con Ainsworth.

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Fig. 1. Location map.

characteristic production of thick blade blanks, most often from opposed platform cores, and the production of distinctive long, ventrally thinned blade-points (Fig. 3). The morphology of these blade-points is an indicator that they were used as spear tips: an assertion strengthened by the presence of fractures consistent with impact damage on several examples from Beedings (Jacobi, 2007). The Beedings collection is of particular importance as it also includes a variety of burin and scraper forms created on truncated blades and recycled portions of broken blade points, and also possible evidence for the deliberate production of a bladelet technology via core artefacts which have historically been referred to as “Kostenki knives” (see Jacobi, 2007: 262–266). Due to the paucity of stratified assemblages, artefact types beyond the readily

recognisable blade-points are uncommon in LRJ collections elsewhere (see Flas, 2008).

The LRJ represents a technological change from preceding Late Middle Palaeolithic technologies, but determining who created it remains difficult. Its precise chronology and longevity remain somewhat uncertain, and at no LRJ site is there a clear association with human fossils. Most have considered the LRJ to be authored by the last northern European Neanderthal populations (e.g. Otte, 1990: 248–249; Jacobi, 1999: 37; Flas, 2008, 2011; Jöris and Street, 2008; Semal et al., 2009; Cooper et al., 2012: but see Swainston, 1999: 41–42 for an alternative view). This is based upon the presence of leaf-shaped point types in the central/northern European Late Middle Palaeolithic, as well as some (limited)

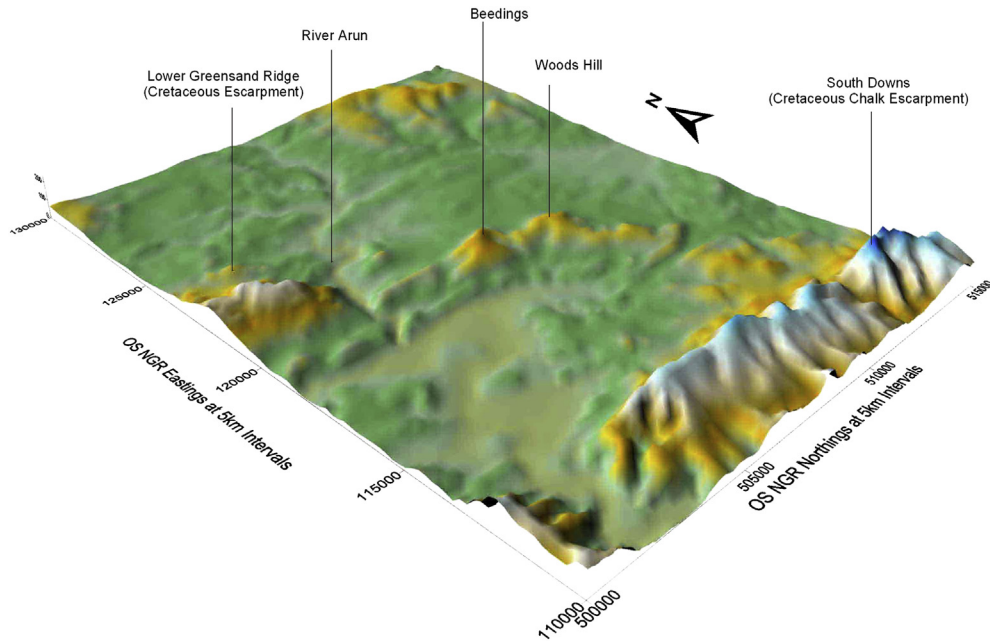


Fig. 2. Landscape setting of the Beedings site.

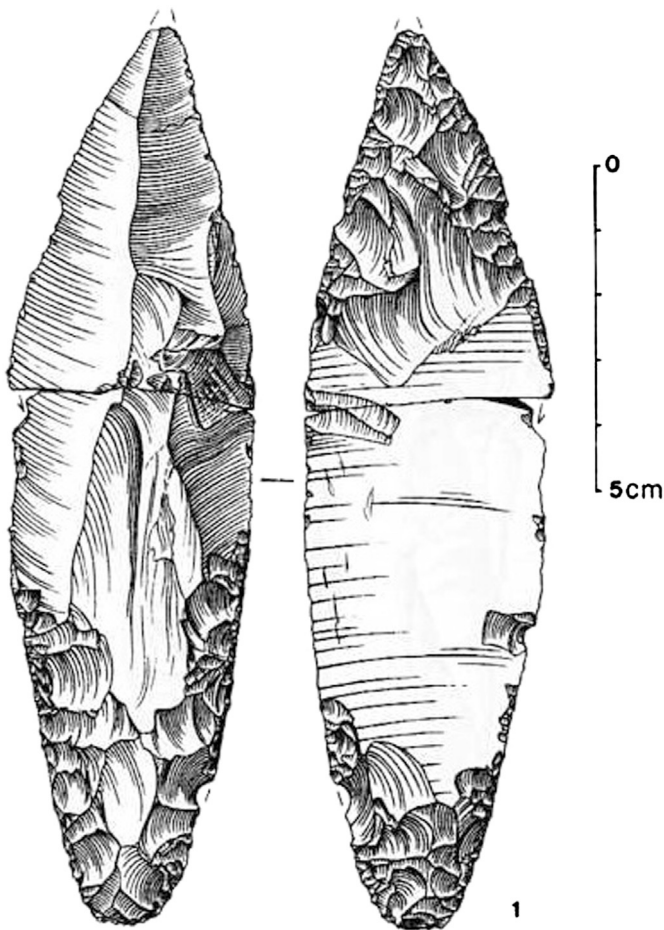


Fig. 3. Blade point from the 1900 collections from Beedings, illustrated by Hazel Martingale (Jacobi, 2007).

technological similarities between some of these assemblages and the later LRJ (see [Flas, 2011](#) and references therein). If this is correct, the technological change seen with the LRJ would therefore represent indigenous (Neanderthal) innovation, or else acculturation of Neanderthals via contact with colonising groups of anatomically modern humans (see [Flas, 2011](#) for the most recent consideration of this). Alternatively, the technological shift between the northern European Late Middle and Early Upper Palaeolithic may reflect a deeper, biological difference, with the LRJ authored by anatomically modern human populations. The recent claim for a very early modern human presence in Britain ([Higham et al., 2011](#)) once again raises this possibility, although the issue is likely to remain unresolved until discoveries of human fossils clearly associated with the LRJ are made.

1.2. The 1900 Beedings collection

Despite being key to the development of our current knowledge of the LRJ, the lithic assemblage from Beedings remains incompletely understood. This is the result of the conditions under which it was excavated and its subsequent curatorial history.

Collected in 1900 during construction of “Beedings” – a house built atop Beedings Hill – the assemblage apparently originally comprised 2300 flints ([Jacobi, 1986](#)). That it took almost a century to realise its significance is the result of the collection’s complex history ([Curwen, 1932, 1949, 1954](#); [Woodcock, 1978, 1981, 1986](#); [Jacobi, 1986, 2007](#)). Fewer than 200 lithics survive today, and the prevalence amongst these of retouched pieces shows that they have, at some point, been preferentially selected out of the assemblage and retained ([Jacobi, 1986, 2007](#)). Confounding this is a lack of contextual or stratigraphic information detailing the assemblage’s recovery, beyond that it was likely to have been found in “sand pockets (fissures in the Lower Greensand) in the excavations in which [the] house stands” ([Harley, n.d. cited in Jacobi, 2007: 231](#)).

Without recognition by Jacobi during the 1980s and subsequent analysis ([Jacobi, 1986, 1990, 2007](#)), the collection may well have languished in obscurity for many more decades. In addition to a smaller component of Late Middle Palaeolithic and Mesolithic, it was Jacobi who recognised that the Beedings collection contained

the largest assemblage of Early Upper Palaeolithic material from southeastern England. Jacobi, by necessity, initially argued an Upper Palaeolithic age for the majority of the collection on the basis of lithic techno-typology, and comparison with dated and/or stratified assemblages elsewhere in Europe (Jacobi, 1986). A thermoluminescence (TL) date of 31.1 ± 5.7 ka on a heated worked flint later helped to verify that the collection included Upper Palaeolithic age material (Debenham in Jacobi, 2007: 319), although with a range of 20.7–42.5 ka at two standard deviations this determination is unable to date the flint artefact precisely. It is therefore in spite of a lack of corroborating evidence from the site itself that the Early Upper Palaeolithic age of the majority of the Beedings collection is now generally accepted.

The importance of the LRJ, and of Beedings, is clear. The LRJ continues to be reassessed, and it is hoped that an improved understanding of the Northern European Middle–Upper Palaeolithic transition will follow in due course. Presented here is a contribution to this reassessment. This paper does not build on the excellent technological description undertaken by Jacobi (2007) but initiates, on the basis of recent excavations, a consideration of the context and dating of the site.

2. Beedings: background, situation and recent fieldwork

The topographic setting of Beedings Hill is shown in Fig. 2. The Lower Greensand escarpment of which Beedings Hill is a part forms a west–east trending ridge extending from the western limit of the Weald to the modern coastline some 65 km to the east. The ridge, being inclined as part of the Wealden uplift (Gallois, 1965), attains height in excess of 100 m in its western distribution, 90 m at Beedings Hill itself and progressively lower elevations to the east where the angle of incline does not appear so pronounced. The ridge is comprised of Hythe and Folkstone Beds of the Lower Greensand, which overlie Atherfield and Weald Clay; the junction between these porous sandstones and the clay form a clear spring line both at the base of the scarp slopes and within valleys incised through the Lower Greensand ridge. The Hythe beds are known to give rise to structural features known as gulls. These are progressively widened fissure in the solid geology which from close to slopes due to erosion of softer underlying geologies (Topley, 1875; Collcutt, 2001).

Recent fieldwork at Beedings was initiated in response to proposed landscaping across the site and surrounding fields, which were anticipated to impact into the surface of the Lower Greensand geology and the fills of gulls (vertical fissures) known to cross these plateaus (Gallois, 1965; Young and Morgan, 1981). During geophysical survey a series of prominent gulls, close to the original archaeological site, were isolated and defined. Seven trenches (Fig. 4a and b) were sited to sample a range of fissure features. Three of the fissure features, sited under trenches B, C, D and E, turned out to be superficial in nature, poorly developed and containing only Holocene archaeology. The gull targeted by trenches A, F and G, was contrastingly deep and well-developed (Table 1; Fig. 5).

3. The lithic assemblage: technological affinities and stratigraphic context

The controlled recovery in 2007 and 2008 of further lithic material, containing clearly Upper Palaeolithic material, from the Beedings hilltop allows for a proper consideration of the context of the original stone tool collection. The new excavated lithic assemblage comprised 578 flint artefacts >10 mm and further micro-debitage. This paper does not present a full technological and typological analysis of the material, which is currently underway; it

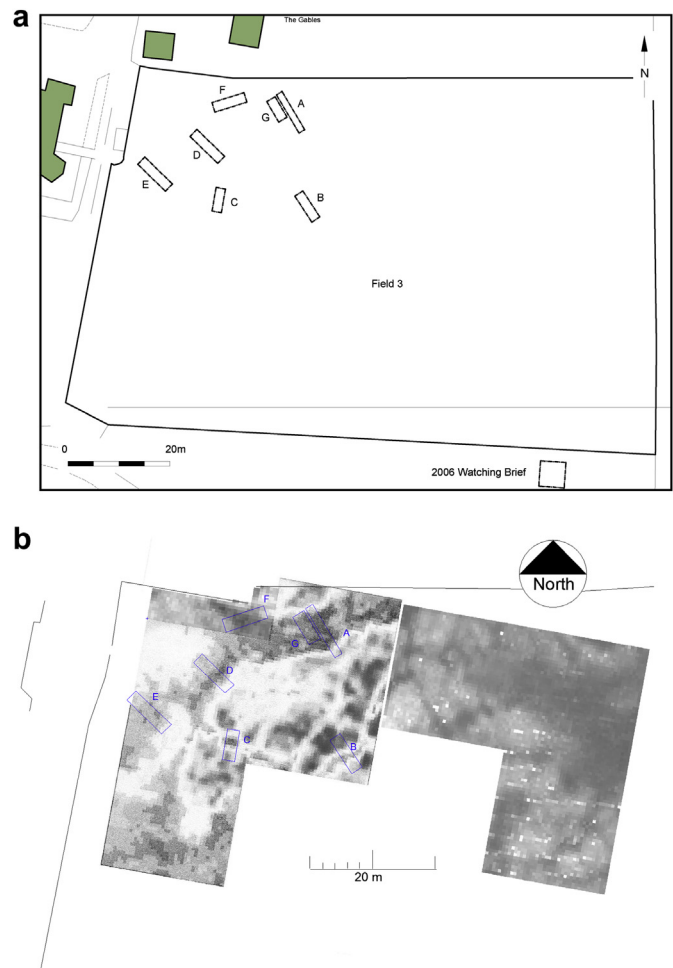


Fig. 4. a) Plan showing the layout of trenches sited to the east of Beedings House. b) Resistivity plot showing arrangement of identified gulls and the excavation trenches.

provides an initial and hitherto missing perspective on the likely context of preservation for the original collection. Furthermore, it elucidates the possible relationship of EUP material to Middle Palaeolithic and Mesolithic which formed part of the original collection and further constrains the time-scale in which this material became sealed within a sedimentary context. This paper therefore demonstrates, on the basis of identification of key technological and typological features of the lithic assemblage, that the Beedings site preserves at least three phases of hunter–gatherer archaeology (Late Middle Palaeolithic, Early Upper Palaeolithic, and Mesolithic) within sealed, datable contexts and preserving a degree of stratigraphic separation.

During the investigations, a consistent sedimentary sequence, summarized in Table 1, was encountered across all the excavated trenches (Figs. 4 and 5). Topsoil [unit 1] and subsoil [unit 2], where encountered broadly across entire plateau, except in localised areas where the solid rock geology came close to the surface and subsoil development was limited. Deeper subsoil development was observed across the gull features which crossed the hilltop. These gulls varied in form between curvilinear dissections of the ‘rag and hassock’ beds with apparently involuted remnants of the original solid geology, to larger more substantial gulls, up to four metres in width and with apparent ‘fills’ to depth in excess of 2 m, determined at the limits of our excavation. The gulls were not hard-sided fissures in the solid geology, rather they represented gaps in the surface capping of a stony bed in the Lower Greensand which

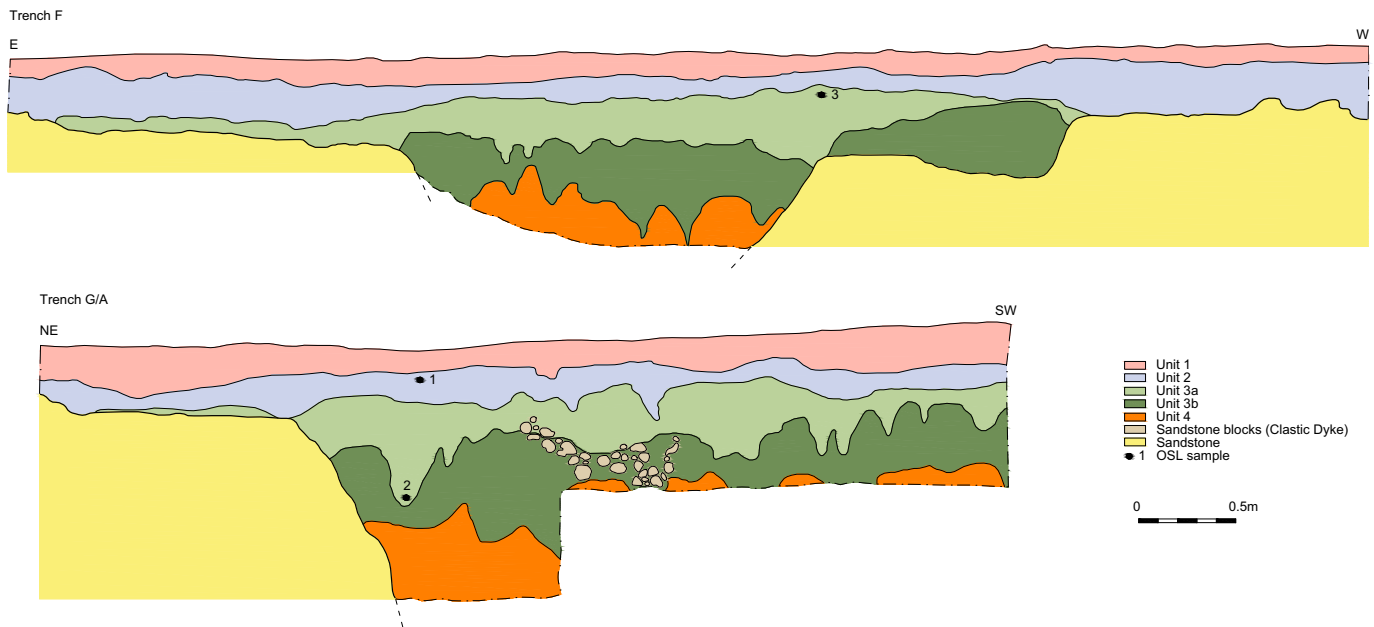


Fig. 5. Observed sections through the gulls for Trenches F, G and A.

appears to have been locally dissected through the pulling apart of structural joints and allowing the accretion of deeper, fine-grained deposits within the gaps. These fine-grained fills appeared to blend with finer-grained deposits of the Hythe Beds immediately under the hard stone capping on either side of each gull. More distinctive gulls with hard edges of solid ‘rag’ stone have been observed both at Beedings and elsewhere in the Lower Greensand, suggesting these features take on varying forms, each perhaps with distinctive formation histories.

Palaeolithic technologies was found to be present in the smaller assemblages from the Upper and Lower Gull Fills [units 3a, 3b and 4]. The presence of distinctive technologies within the collection has been identified on the following observations:

3.1. Late Prehistoric (both Mesolithic and possibly later material)

Mesolithic material, with a small suspected admixture of later prehistoric material was found across all trenches, and was

Table 1
Stratigraphy of the excavated gull features and artefact counts per unit including those clearly assigned to technological tradition on the basis of typology and technology.

Unit	Name	Description	Total finds (n)	Mesolithic/Late prehistoric	Early Upper Palaeolithic	Late Middle Palaeolithic
				(n)	(n)	(n)
[1]	Topsoil	Thin sandy humic layer	2	2	–	–
[2]	Subsoil	Fine sand with clasts of Hythe Beds geology. Extensive bioturbation.	348	346	2	–
[3a]	Upper Gull Fill (Upper Sandier Facies)	Fine sand with clay. Contains clast of Hythe Beds geology.	163	12	15	–
[3b]	Upper Gull Fill (Lower Clayier Facies)	Fine clay with sand. Rare clasts of Hythe Beds geology.	52	–	–	17
[4]	Lower Gull Fill	Stone free clayey sand	13	–	–	2

The gull deposits could be broadly divided between a lower and upper deposit. The Lower Gull Fill [unit 4] was a stone-free sandy clay, while the Upper Gull Fill [unit 3] contained less clay presenting as drier, more disturbed by earthworm activity and containing clasts from the parent Hythe Beds geology. Sometimes these clasts were arranged in linear ‘clastic dykes’ along the central axis of the gull. The Upper Gull Fill was more clayey with depth and during excavation was sub-divided into [unit 3a] and [unit 3b] on the basis of this textural difference.

Artefacts, all manufactured on flint, were found throughout the stratigraphic contexts but were concentrated within the subsoil [unit 2] and high in the Upper Gull Fill [unit 3a]. While at the current level of analysis most artefacts have not yet been assigned to any particular technological tradition, virtually all material from the subsoil is consistent with later prehistoric periods (Mesolithic to Bronze Age). However, distinctive, diagnostic material relating to

restricted to the topsoil unit [1] and, in greater concentrations, the subsoil unit [2] and with small numbers within the surface of the Upper Fill unit [3a] (Table 1). The assemblage includes 117 small blade/bladelet fragments and seven cores. The cores are typical of those from other Lower Greensand sites in the region, including Rock Common (Harding, 2000) and Iping Common (Keef et al., 1965). Three microliths were recovered, which are all consistent with an early to mid-Mesolithic date, including one hollow-based ‘Horsham’ point (Fig. 6). On the basis of blade size, it is likely later Mesolithic material is also present.

3.2. Early Upper Palaeolithic

17 pieces have been identified as having clear LRJ affinities, comprising blade and core elements which are metrically and technologically consistent with Jacobi’s 2007 observations. In terms

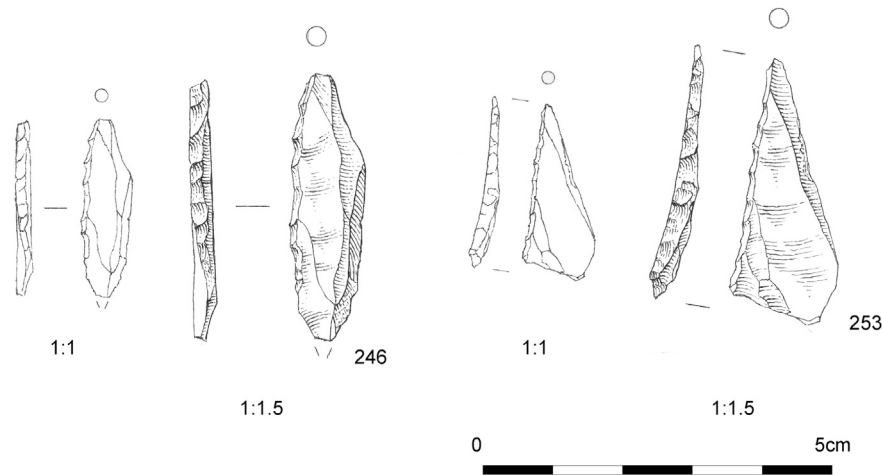


Fig. 6. Mesolithic artefacts.

of both technology and condition it is directly comparable to the original Beedings LRJ collection, being in a fresh, unpatinated to lightly-patinated condition; the flint is generally very dark grey to black. The newly recovered assemblage includes three blade fragments, two of which are dorsally retouched while a third has a burin-like removal from the distal end (Fig. 7). In addition, a distal fragment of a possible blade point was recovered, exhibiting dorsal retouch and a hinged fracture perhaps resulting from impact damage. The blade fragments are all triangular or trapezoidal in profile, with thicknesses exceeding 6 mm, falling firmly within ratios recorded by Jacobi (2007) for the original Beedings LRJ material. Where observable, the blade fragments have been struck from opposed platform cores, in accordance with preferences in other LRJ assemblages, including the original collection from Beedings.

With the exception of two pieces found within the overlying subsoil, all EUP material was recovered from the higher, sandier, facies of the Upper Gull Fill [unit 3a] (Fig. 5), often close to the contact with the overlying subsoil.

3.3. Middle Palaeolithic

Nineteen pieces have been identified as Late Middle Palaeolithic, including two retouched tools manufactured on broad flake-blanks probably struck through prepared core reduction (Fig. 8). Two fragments of discoidal cores (Fig. 8) and a collection of patinated hard hammer flake fragments all seem to derive from discoidal core working. The core fragments in particular are comparable to small, worked-out discoidal cores from the Wealden site of Oldbury, Kent (Harrison, 1892, 1928; Collins and Collins, 1970; Callow, 1986; Debeneath and Dibble, 1994; Cook and Jacobi, 1998). In addition are 12 soft hammer retouching spalls, recovered from a depth of 0.75 m within the fissure at Trench A. In terms of patination and technology these are consistent with the rest of the late Middle Palaeolithic collection. The stratigraphic position of this material was towards the more clay-rich base of the Upper Gull Fill [unit 3b].

Two further flakes found at depths >1.5 m in Trench G were recovered within the Lower Gull Fill [unit 4]. Both seem to be the result of soft hammer reduction of a bifacial tool. In terms of condition and stratigraphic position these artefacts are distinctive and were incorporated into the gull fill at an earlier stage. While the technology could be regarded as them as Lower Palaeolithic (soft hammer bifacial thinning) it could also be that these relate to Late Middle Palaeolithic (Mousterian) biface production.

Further detailed technological analysis currently being undertaken may help to characterise some of the remaining material to defined technologies. However, on the basis of this initial sample, it is apparent that there is a relationship between stratigraphic context and the technological composition of the lithic assemblages, with most of the apparent EUP material concentrated higher in the Upper Gull Fill [unit 3a] and apparently Late Middle Palaeolithic material within the lower part of the Upper Gull Fill [unit 3b]. No EUP material was identified in the Lower Gull Fill [unit 4], nor was any Late Middle Palaeolithic material identified in the subsoil [unit 2] or the upper part of the Upper Gull Fill [unit 3a]. It is therefore apparent that, while lithic technologies are not totally discrete within separate stratigraphic units, a remarkable and perhaps significant degree of separation exists at the site.

3.4. Summary: the stratigraphic succession of lithic industries at Beedings

Four major facies of gull fill were recorded and clearly diagnostic pieces relating to four distinct technologies were identified (Late Prehistoric, Mesolithic, Early Upper Palaeolithic and Late Middle Palaeolithic). Most significantly there was little stratigraphic overlap in the vertical distribution between material identified as Late Middle Palaeolithic and Early Upper Palaeolithic material (see Table 1, above). The concentration of patinated, scaler retouching spalls and tools of Middle Palaeolithic character at c.0.75 m within Trench A confirmed the stratigraphic separation and horizontal clustering of these elements. No Early Upper Palaeolithic material was recovered from below this depth anywhere across the site, suggesting both later burial and explaining the less patinated surface condition of the EUP material. To the knowledge of the authors, this is the only open air locality within the British Isles where possible separation and stratigraphic succession of LMP and EUP material has been demonstrated.

4. Considering the preservational context of the Beedings collection

Having established through modern excavation that at least three technological traditions are represented in the lithic scatters at Beedings we are now in a much stronger position to understand the nature of the original collection from the site and the processes which have led to the survival of material at relatively shallow depths in an open air situation.

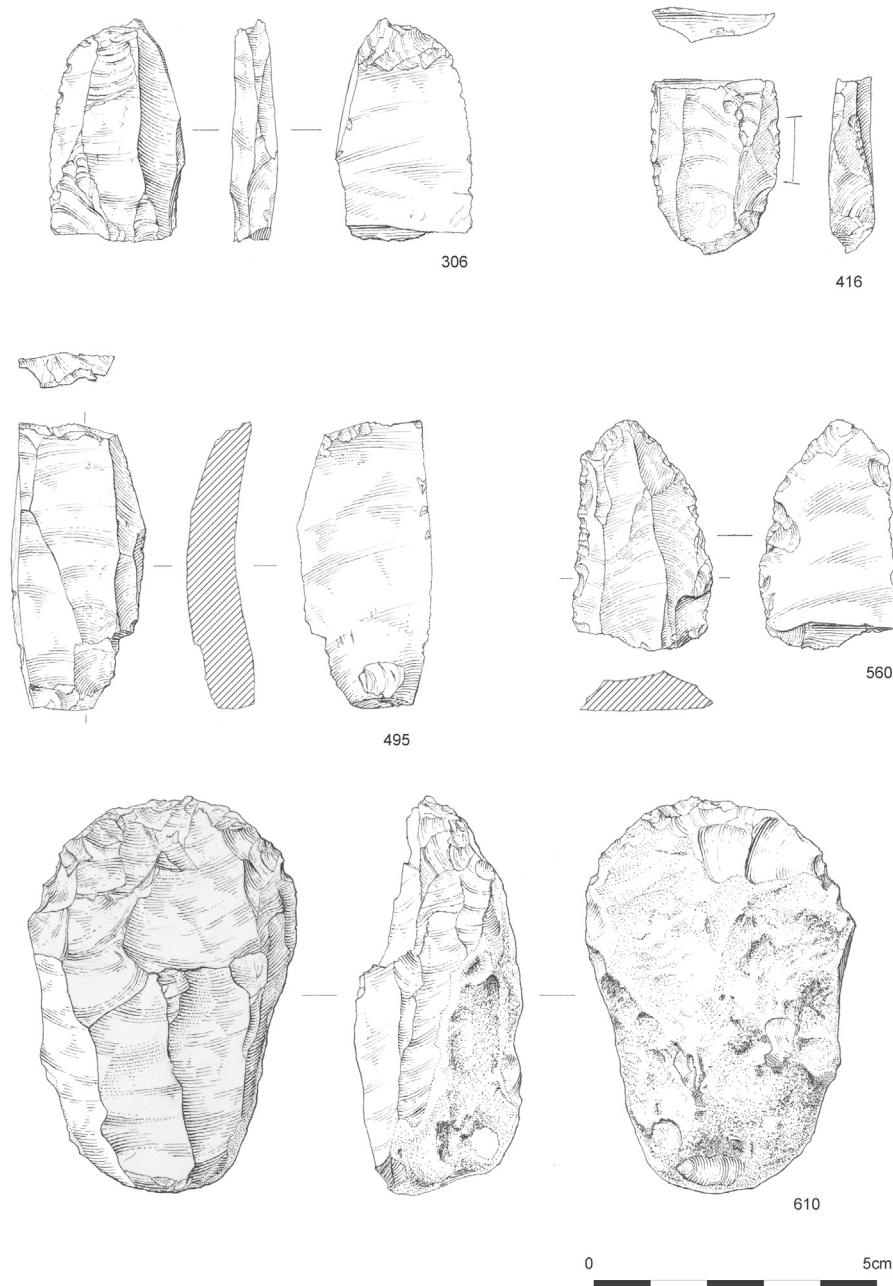


Fig. 7. Early Upper Palaeolithic artefacts.

The foundations of Beedings House (c.17 × 22 m in extent) were excavated in 1900 to a depth of some 2 m below the existing ground level across the entire ground plan of the building; it is therefore apparent that a large volume of the hill, around 748 m³, was quarried from the site ahead of its construction. Artefacts were described as coming from “sand pockets” within the solid Hythe Beds geology (Harley, 1900). If we accept that these sand pockets are a description of the same gull features we identified crossing the entire hill we must also accept that the construction of the house saw the wholesale removal of continuous gulls crossing the building’s footprint.

Thus the area exposed and volume of gull fill excavated away in 1900 was obviously a much larger excavation (748 m³), than that studied during our own excavations (60 m³). On the basis of these estimates there is no reason to consider that artefact densities

were necessarily higher under the house than they were at our adjacent site. However, there are apparent differences in the composition of the surviving parts of the old collection and our excavated assemblage: lithic material from our excavations was dominated by later prehistoric flintwork, contained a relative lack of LRJ material (blade-points and other retouched forms) and a much more visible presence of Middle Palaeolithic pieces. Although this may indicate a different spatial patterning of the two Palaeolithic techno-complexes, the selective discard of 90% of the original collection known to have taken place is likely to have been biased in favour of distinctive pieces. It is fair to assume that late prehistoric, Mesolithic and patinated Middle Palaeolithic material would have been more readily discarded while the striking and largely unpatinated Early Upper Palaeolithic artefacts were more likely to be retained.

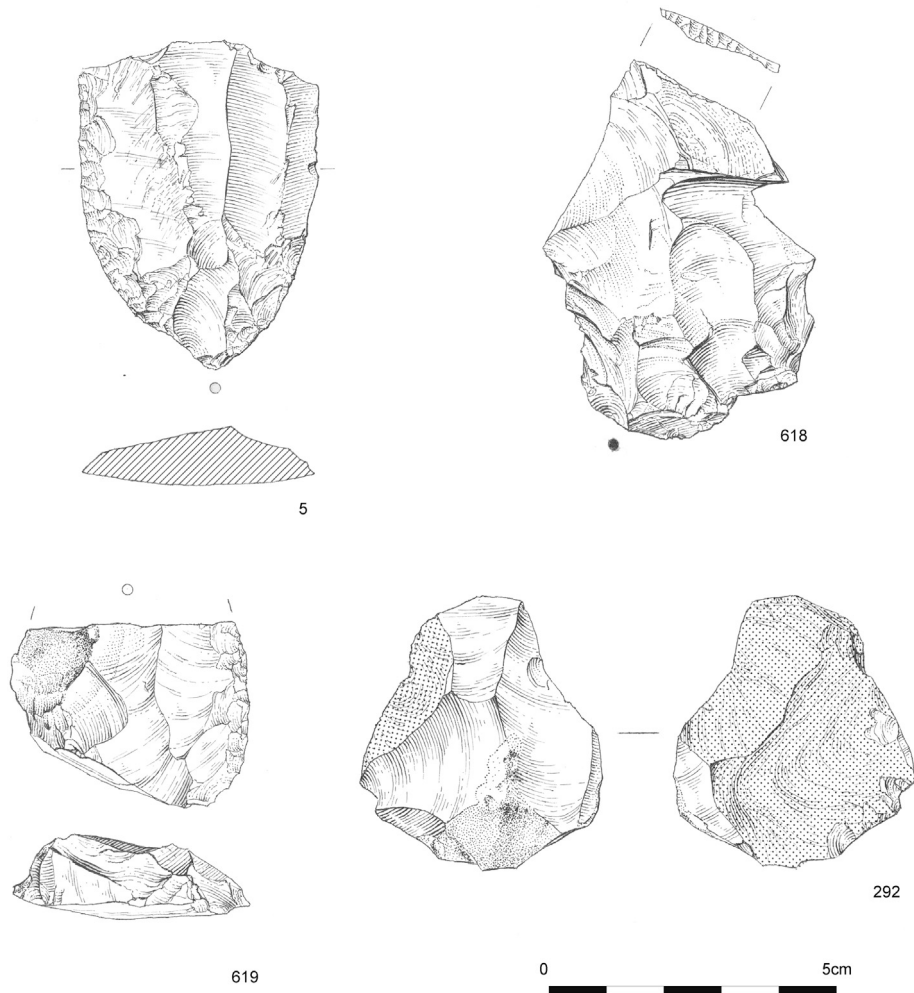


Fig. 8. Middle Palaeolithic artefacts.

These differences aside, the mechanisms by which material from both collections has become incorporated into the gulls are likely to be similar across the entire plateau. Our excavated area provides a proxy for understanding how material survived the LGM and later weathering events in such an exposed position. Specifically, two important questions can be addressed:

1. Did the original collection represent *in situ* or primary context scatters preserved within gull fills?
2. By which date were the Palaeolithic scatters sealed within the fissures?

Both these questions were addressed by taphonomic analysis and consideration of dating evidence from the site.

4.1. Surface condition of the lithic artefacts

Patination of the flint is extremely variable within the assemblage as a whole, but reasonably consistent within the groupings made on technological grounds. Material classified as Mesolithic is only lightly patinated, and reflects a wide range of high quality raw materials sourced directly from primary exposures of flint (eg. river cliffs or dug pits); cortex was relatively fresh and unweathered.

As is the case in the original Beedings collection, Early Upper Palaeolithic material is typically sharp, mint-condition and

manufactured on flint varying from deep lustrous black to speckled grey. A few of the Early Upper Palaeolithic pieces show a light patination of blue-white colour, often covering just one surface of the flint in a dendritic pattern reminiscent of rooting. This patination is also found on pieces in the original collection, on LRJ pieces (e.g. Jacobi, 2007, 253/254) as well as on the Middle Palaeolithic bifacial scraper (Jacobi, 2007, 240). The lack of frost pitting on struck surfaces of the Early Upper Palaeolithic material suggests no exposure to extreme cold before sealing within the fills.

Probable Late Middle Palaeolithic pieces, including the flake tools and discoidal core fragments, generally have a distinctive condition characterised by deep white patination, surfaces intensely polished by sediment abrasion and evidence for thermal fractures, sometimes exposing inner surfaces of dark lustrous flint. This distinctive condition is significant, and is consistent with it being exposed on the surface for a more prolonged period than the Early Upper Palaeolithic material prior to its incorporation within the fissure fills.

The condition of artefacts from these different techno-complexes suggests different taphonomic histories. Late Middle Palaeolithic material was seemingly discarded on the hill and left in the open to patinate prior to incorporation in the gull fill. The Early Upper Palaeolithic material was discarded and incorporated into sediment more rapidly, not having time to patinate, perhaps through direct burial. The differences in surface condition and the

degree of apparent stratigraphic separation suggests that these two assemblages became incorporated at different times. However, both are considered to be primary context assemblages, in the sense that their spatial position relates directly to occupation over the developing fissures during at least two separate episodes.

4.2. Artefact orientation

The only assemblage from the undisturbed fissure fills which was large enough to subject to artefact orientation analysis was from Trench A, unit 3a, which shows a broadly east–west trend of 105° from north (Fig. 9). This orientation lies very broadly along the direction of the fissure (75° from north) and the coincident orientation of the clastic dyke recorded running along its centre. The distinctive, non-random pattern suggests that post-depositional processes may have affected the spatial arrangement of lithic material in this part of the fissure.

In open air situations, a preferred axis of orientation is most often the product of fluvial processes, either aligning objects with the direction of flow or otherwise aligning them through a rolling action directly perpendicular to the flow. As there is no accompanying evidence for fluvial action (either through artefact rounding, particle sorting or bedding structures) another mechanism of reorganisation must be sought. The coincident alignment and proximity of the clastic dyke hints that a single mechanism is responsible for both phenomena. It is plausible that freeze–thaw processes operating on sediments within the fissure fill was enough to move material laterally. This process could have led to the migration of weathered sandstone fragments and possibly also artefacts over distances of up to 1 m, reorganising them as a discrete concentration of clasts arranged in a linear alignment along the centre of the exposed gull (Fig. 5). In future work at the site the possibility of periglacial rearrangement of material within the gulls need to be carefully considered as factor in the spatial arrangement of both human artefacts and natural clasts. These natural processes can have profound local effects on the distribution of material (Briggs, 1977; Potter and Pettijohn, 1977; Tucker, 1982; Ashton et al., 1992).

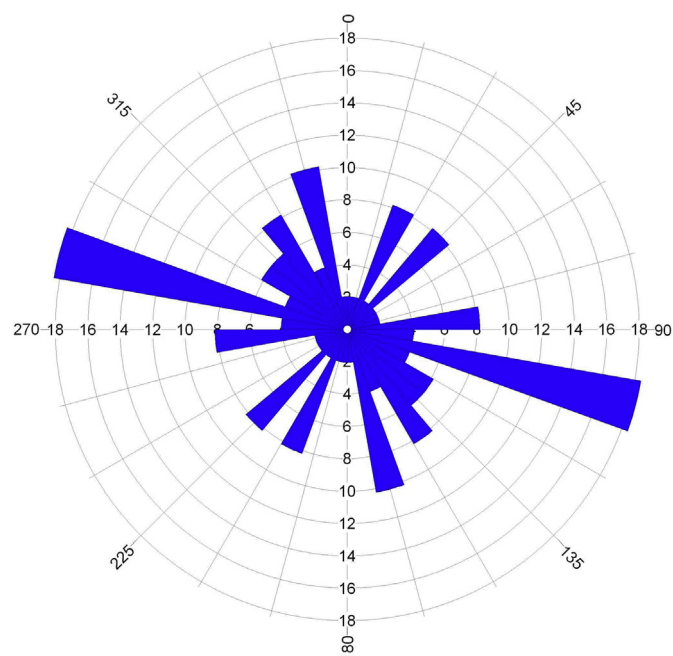


Fig. 9. Artefacts orientations for Unit 3 Trench A.

4.3. Size class distribution

The degree to which assemblages are compositionally intact can be determined through analysis of the distribution of particular size classes of artefact. Differences in the distribution, composition and mobility of particular elements occur as a result of a process or activity having a selective effect on assemblage composition. Examples of this might be the removal of small particles by water action or the selective removal or discard of particular artefact types by humans (Schick, 1986). Fig. 10 presents size class distribution curves for the major Beedings assemblages organised by trench and unit. The material included in Fig. 10 is both large debitage recorded three-dimensionally and small debitage (<10 mm) sieved from dedicated microdebitage samples taken from the entirely to metre square producing artefacts. They can therefore be taken to be complete samples.

Through experimental analysis it has been previously determined that intact artefact scatters should show a progressive increase in the quantity of debitage for smaller size classes (Pope, 2002). Assemblages that lack proportionally larger quantities of microdebitage are likely to have been subjected to winnowing by both fluvial and aeolian action or have been skewed as a result of the introduction of large material through size discriminant processes or human action.

The curves in Fig. 10 show broadly intact curves for all of the assemblages with the exception of Trench D, unit 3 and Trench G, unit 4, suggesting they are consistent with primary context assemblages formed directly through localised patterns of knapping activity.

The overrepresentation of artefacts >20 mm in the assemblage from Trench D, unit 3 may suggest the localised introduction of large artefact elements here, although the curve profile for the smaller material is otherwise entirely consistent with an intact, primary context knapping signature. It is interesting to note the modified signature for the assemblage from Trench G, unit 4. This is the only studied assemblage from the lower gull fill in Trench G and includes material that we have tentatively interpreted as Lower Palaeolithic. This may suggest that this material was introduced into the fissure fill via a different mechanism of weathering.

4.4. Site formation summary

The recently recovered stone tool assemblage from Beedings represents at least three distinct periods of accumulation. Artefacts entered the fissure systems through processes relating to the widening of joints in the underlying Lower Greensand geology under different regimes of climate, sediment accumulation, weathering and vegetation cover. Three taphonomically distinct assemblages can be identified through the analysis, which broadly conforms to divisions identified through technological analysis. These can be described as follows.

4.4.1. Late Middle Palaeolithic: [units 3b and 4]

The Upper Gull Fill of the main gull running through Trenches A, F and G contained a modest assemblage of patinated, sediment polished, and occasionally frost shattered flint. These were associated with intact microdebitage profiles and a single scatter of small retouching spalls of a similar condition indicative of *in situ* deposition. The debitage size composition profile for this unit suggests unmodified assemblages, this raises the likelihood that material was related to knapping activities directly over the footprint of the gull. The material was, however, left open to the elements for some time, and exposed to cold conditions prior to burial. The fresh, unpatinated condition of the frost shattered surfaces suggested rapid cessation of further patination after shattering, presumably through incorporation into the gull fill.

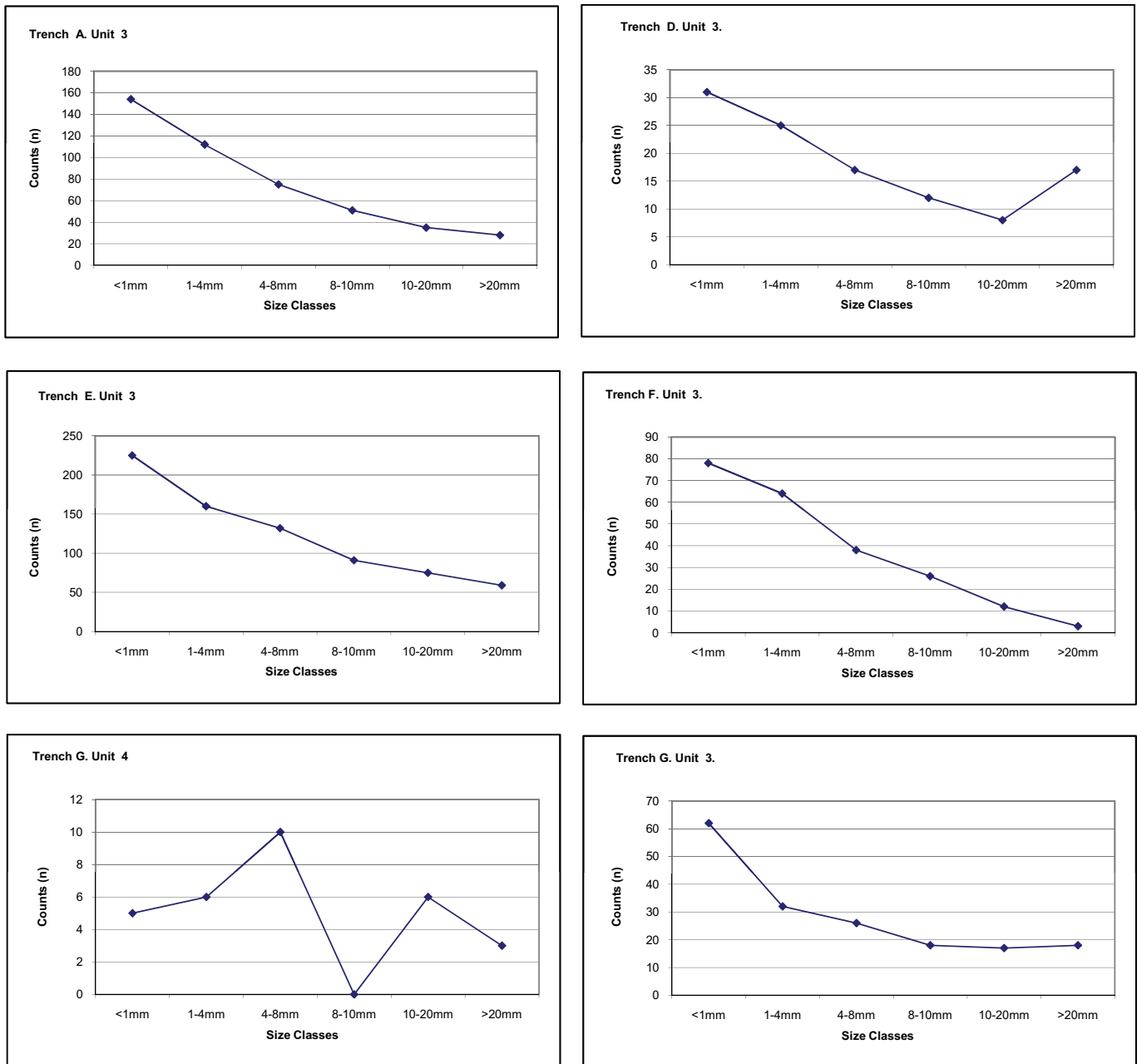


Fig. 10. Microdebitage size-class distribution curves.

4.4.2. Early Upper Palaeolithic: [units 3a and 2]

The Upper Gull Fill also contained debitage and tool elements with a technology and raw material character consistent with the original collection of Early Upper Palaeolithic material from the Beedings. This material shows only moderate and localised patination and is generally represented by pieces of black, unpatinated flint. In contrast to the Late Middle Palaeolithic material, the condition of the Early Upper Palaeolithic material suggests rapid burial shortly after deposition.

4.4.3. Mesolithic/Late Prehistoric: [units 1, 2 and 3a]

The bulk of lithic material recovered from the topsoil and subsoil across the site was of Mesolithic character, with a small component which may belong to any later prehistoric periods. This material was, with a couple of exceptions, unpatinated and did not present

any sediment polish. The bulk of material was confined to the topsoil and the bioturbated subsoil, although a small part of the assemblage was also recovered from the contact Upper Gull Fill at levels which slightly overlapped with the EUP finds. With the Mesolithic material, discarded within fully interglacial Holocene environments, we have the opportunity to understand, through examination of current processes, how material came to be incorporated into the fissures under relatively inactive, vegetated conditions. Bioturbation seems to be the most likely agent with Mesolithic material mapping closely the depths of intense earthworm activity. Other agents such as rooting and burrowing, both of which affected the subsoil and localised areas of the upper fissure fill, can be invoked to explain the vertical distribution of Mesolithic material.

The current conditions at the site, with greater depths of topsoil overlying the gulls effectively obscuring any surface topography

relating to their distribution, should not be taken as an indication of potential past conditions on the plateau. Under arid, highly seasonal, cold-climate conditions, vegetation and soil cover may have been minimal, exposing the blocky strata of the Lower Greensand rather like a Limestone pavement in upland karstic areas. The fine-grained fill of the fissures would under some conditions be prone to erosion by wind, perhaps exposing the gulls as low linear depressions between the rock outcrops, while at other times the relatively higher degree of retained moisture within the silty fills may have supported strips of grassland between the rock exposures. Progressive phases of fissure development during periods of climate change would have led to the periodic widening of the gulls. Alongside this, progressive cycles of sediment accumulation, including loess input, bioturbation during periods of active soil formation and possible deflation during arid cold periods would have led to active infilling of the opening gulls (Catt et al., 1971, 1974, 1986; Reynolds and Fisher, 1985). The overall effect would be the long-term incorporation of discarded artefacts into fissure fills, developing overprinted sequences of subsequent hunter–gatherer occupations. The assemblages themselves are consistent from period to period and do indeed appear to represent primary context preservation of activities directly relating to the Beedings hilltop. Our analysis suggests we can anticipate no loss of material due to fluvial or other high energy processes, and that lithic material relates directly to tool manufacture and modification at the site.

5. Optical Stimulated Luminescence (OSL) dating

Three sediment samples (Laboratory-coded GL08066 to GL08068) were taken from the main fissure investigated in Field 3 for OSL dating from (Table 2). Fine silt sized (5–15 μm) quartz was isolated under controlled laboratory illumination through acetone sedimentation and acid–alkaline–acid (10% HCl–15% H_2O_2 –35% H_2SiF_6) digestion. Absorbed dose was estimated through the Single-Aliquot Regenerative-dose protocol (Murray and Wintle, 2000, 2003) to produce Equivalent Dose (D_e) values. Thermal treatment was optimised for each sample by assessing D_e preheat dependence and conducting a Dose Recovery test. Repeat regenerative-dose ratios were overdispersed by 4% and 1% for samples GL08066 and GL08067, respectively. Feldspar contamination was absent and signal analysis did not evidence the occurrence of partial bleaching. Lithogenic dose rates (D_r) were assessed by a combination of *in situ* NaI and laboratory-based Ge gamma spectrometry. Cosmic dose rates were calculated based on overburden thickness and geographical position (Prescott and Hutton, 1994). Uranium disequilibrium was not present. Age, the quotient of D_e by D_r , is taken to reflect the interval since each sample's last exposure to sunlight accompanied by analytical uncertainty.

Table 2
 D_r , D_e and Age data of submitted samples. Uncertainties in age are quoted at 1σ confidence, are based on analytical errors and reflect combined systematic and experimental variability.

Sample	Location	Grain size (μm)	Moisture content	Total D_r (Gy ka^{-1})	Preheat ($^{\circ}\text{C}$ for 10 s)	D_e (Gy)	Age (ka)
OSL1	51°N, 0°W, 85 m	5–15	0.14 \pm 0.03	2.32 \pm 0.10	220	38.2 \pm 2.0	16 \pm 1 (1)
OSL2	51°N, 0°W, 85 m	5–15	0.16 \pm 0.04	2.40 \pm 0.10	280	73.8 \pm 4.2	31 \pm 2 (2)
OSL 3	51°N, 0°W, 85 m	5–15	0.13 \pm 0.03	2.44 \pm 0.10	260	72.7 \pm 6.7	30 \pm 3 (3)

OSL Sample 1 (GL08066) was taken from Trench G at 0.24 cm depth within Unit [2], the subsoil, providing a *terminus ante quem* for the main fissure fill of 16.1 \pm 1 ka. This indicates that the main gull was effectively filled by the Last Glacial Maximum (LGM).

OSL Sample 2 (GL08067) was taken from Trench G at 0.87 m within Unit [3a], the main artefact bearing horizon of Early Upper

Palaeolithic material at this location. It provides an age estimate of 31 \pm 2 ka. This can be interpreted as an indicated age for incorporation of these artefacts into the gull deposits, and thus a clear *terminus ante quem* for their discard at the site.

OSL Sample 3 (GL08068) was taken from Trench F at 0.3 m depth within the top of the upper fissure fill, Unit [3a] at the level which produced the bulk of Early Upper Palaeolithic artefacts and immediately above the level of Mousterian tools. Its age of 30 \pm 3 ka is broadly consistent with that for the same horizon at Trench G.

These chronometric data are consistent with the taphonomic interpretation of site formation processes and technological elements at the site as described above. They indicate that the entire process of fissure formation and final infilling by sediment now comprising the subsoil unit [2] was complete by the end of the Pleistocene. Dating of the top of the upper fissure fill unit [3] suggests an age which predates the LGM and broadly consistent with the burial of the Early Upper Palaeolithic material contained within it before this period. This OSL data is also in accordance with the TL determination previously obtained from a heated flint in the old collection. It is promising too that gull contexts within the Lower Greensand appear conducive to OSL dating and hold the potential for wider-ranging dating programmes within the region.

6. Concluding discussion: the context of the Beedings LRJ, and implications

New fieldwork and laboratory analyses have provided information about the context of newly excavated archaeological material from Beedings, and, via reasonable inference, the context of the finds made in the year 1900. The discovery of clearly defined gulls within the Lower Greensand bedrock making up the plateau of Beedings Hill, and the presence of Early Upper Palaeolithic LRJ and other archaeological material in these gulls, matches the description of “sand pockets” as the context of the original finds.

A small network of sinuous, sub-parallel fissures crosses the surface of the hill immediately adjacent to the house of Beedings and these contain stone tool assemblages. Overall, archaeological material recovered from recent fieldwork is consistent with Jacobi's (2007) interpretation of the old collection as containing Late Middle Palaeolithic, Early Upper Palaeolithic and Mesolithic artefacts. Archaeological material captured in these gulls is therefore testament to at least three phases of occupation of Beedings Hill by hunter–gatherer groups. It is now possible to say that the capture of both Late Middle Palaeolithic and Early Upper Palaeolithic LRJ material is the result of the widening of gulls relatively close to the scarp edge at the site. It is not possible to say that the gull running through Trenches A, G and F is the same one that produced the 1900 material, however it is highly probable that it was a gull feature of the same approximate age and nature.

Mesolithic material, found at relatively shallow depths within a smaller fissure further back from the scarp slope, offers an insight into the processes leading to site capture. Here, bioturbation, being more concentrated over the soft fills of the small gull running through Trenches D and E, appears to have worked down Mesolithic material into the top of the gull fill. The gull targeted by these

two trenches contained no clearly identifiable Palaeolithic material. It is suggested here that this gull is of more recent origin, perhaps initiating in the LGM and widening thereafter to allow incorporation of Holocene material.

The work at Beedings therefore supports developing interpretations at the apparently contemporary Early Upper Palaeolithic LRJ site at Glaston, in Rutland, UK (Cooper 2004). Contemplation of site formation processes at Glaston led Collcutt (2001) to consider models of landscape development, and to suggest that gulls offered productive site capture structure within lowland Britain: a model of site formation known as the 'sackung' hypothesis. Based upon an idea originally developed by Zischinsky (1969) to describe the process whereby upland plateau surfaces can 'sag' into fissures and basins formed parallel to steep slopes, the term was employed by Collcutt to model the development of depositional contexts on upland plateaus or hilltops. As these fissures widen with time, land surfaces on the hilltop will inevitably sag into the surface of the plateau, taking with them associated artefacts and faunal material. Collcutt (2001) predicted that artefact preservation at Beedings site would emerge as resulting from these processes and our observations uphold this hypothesis.

The further implications of Collcutt's (2001) work – that such contexts might be more widespread than previously thought and have the potential to routinely contain high-resolution Pleistocene signatures – now needs to be fully considered, and tested through systematic fieldwork. Such features were identified in the 19th century in other parts of southeast England (Anon, 1827; Abbott, 1899; Harrison, 1928; Pope, 2013), they have yet to be formally assessed for their wider potential for Palaeolithic archaeology.

Aside from the processes leading to artefact preservation, the Beedings locale undoubtedly exerted a pull for Late Pleistocene (Neanderthal and AMH) and Early Holocene hunter–gatherer groups possibly under a variety of climatic and environmental conditions. The natural affordances of the hill remained constant through all periods, providing commanding views, a high point on an escarpment edge suitable for long distance movement and constant proximity to a natural spring line which forms at the base of the Lower Greensand scarp slope. Such locales, with relatively rich LMP/EUP sites may have been widely prevalent in the landscape but without an active process of site capture, the survival of such sites through the LGM as anything more than widely scattered and weathered surface finds would have been impossible. Factors have fortunately combined at the Beedings site to preserve Northern Europe's richest LRJ assemblage and southeast England's first primary context Mousterian assemblage.

To conclude, one question remains. The LRJ is currently represented across Europe by poorly stratified cave assemblages and isolated finds, mostly from surface contexts. Beedings appears exceptional in that it comprises a technologically diverse and rich LRJ assemblage in an open air context. Should we now consider the possibility that cave contexts are only showing a restrictive part of the technology and may have occupied a marginal position in LRJ landscape use and ecology. Conversely should we start to conclude that a site such as Beedings does not represent a specialised hunting camp but something more central in EUP settlement patterns of the North European Plain? Further detailed consideration of technology, context and overlap with the distribution of Aurignacian technology in space and time might usefully address this issue.

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