Historic England

Curating the Palaeolithic

Summary

This guidance explains the importance of the English Palaeolithic record (about 1 million to 11,700 years ago) in its Pleistocene context and best practices for protecting it through the planning process, illustrated by case studies from across the country.

The guidance focuses on the curation of the Palaeolithic and Pleistocene records (Part A) and is particularly intended for curators. It also provides background information on the Palaeolithic and Pleistocene records for those less familiar with the period (Part B). The guidance document is accompanied by a number of concise online case studies that illustrate a range of approaches for curating the Palaeolithic record. The document is intended to be used alongside other key guidance produced by Historic England, and acknowledges the primacy of relevant legislation. It is not a statement of Government policy, nor does it seek to prescribe a single methodology.

This document has been prepared by Rob Hosfield (Department of Archaeology, University of Reading), Chris Green (QUEST (Quaternary Scientific), School of Archaeology, Geography and Environmental Science, University of Reading), Hannah Fluck (Historic England) and Rob Batchelor (QUEST (Quaternary Scientific), School of Archaeology, Geography and Environmental Science, University of Reading). This edition published by Historic England Janurary 2023. All images © Historic England unless otherwise stated.

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Front cover: Channel Sands and gravels, Podehole Quarry. [© Rob Hosfield]

Contents

Introduction

This guidance explains the importance of the English Palaeolithic record (about 1 million to 11,700 years ago) in its Pleistocene context and best practices for protecting it through the planning process, illustrated by case studies from across the country. The terms Palaeolithic and Pleistocene are used to distinguish between evidence of human activity (Palaeolithic) and of environments (Pleistocene).

The guidance is not designed to be read 'front-to-back'. Part A is concerned with the curation of the Palaeolithic and Pleistocene records and is divided into four sections:

- Section 1: Palaeolithic archaeology in the context of national planning policy
- Section 2: Sources of information about the Palaeolithic and Pleistocene
- Section 3: Requirements for pre-development investigations of Palaeolithic and Pleistocene remains
- Section 4: Assessing the importance of Palaeolithic and Pleistocene remains and managing their conservation and recording.

Part B contains background information on the Palaeolithic (Section 5), the Pleistocene record (Section 6) and Pleistocene deposits (Section 7). These sections are primarily intended for those less familiar with the Palaeolithic and the Pleistocene. For readers interested in further background detail we recommend the books by Stringer (2006), Pettitt and White (2012), Lowe and Walker (2014) and Ashton (2017).

The guidance document is accompanied by a number of online case studies, which are intended to be concise rather than exhaustive. Section 8 contains a short summary of each. The methodologies outlined in them illustrate the range of options that is available rather than providing a comprehensive list of all available approaches. It is essential therefore for contractors involved in preparing schemes for site investigation (WSIs) to consult Palaeolithic/Pleistocene specialists.

It will often be helpful to use this document alongside other key guidance produced by Historic England, in particular: *Sites of Early Human Activity: Scheduling Selection Guide*, *Managing Lithic Scatters and Sites* (currently in revision after consultation), *Geoarchaeology, Environmental Archaeology*, *Scientific Dating of Pleistocene Sites* (currently in revision after consultation), *Deposit Modelling and Archaeology* and *Mineral Extraction and Archaeology*.

This guidance acknowledges the primacy of relevant legislation, the National Planning Policy Framework (NPPF) and the related Planning Policy Guidance (PPG), and is intended to support their implementation. It is not a statement of Government policy, nor does it seek to prescribe a single methodology.

The guidance is particularly intended for curators (i.e. local authority archaeologists, those working as advisors to local planning authorities, and HER officers). Its focus is the issues they encounter in discharging their responsibilities for Palaeolithic archaeology. It will also be of interest to consultants, archaeological units, developers, historic environment advisors in government agencies and public bodies, and Palaeolithic and Pleistocene specialists.

Emphasised terms can be found in the Glossary.

Figure 1: Happisburgh footprints (Ashton et al 2014: fig. 5).

Why are Palaeolithic and Pleistocene remains important?

Our earliest prehistory

Palaeolithic and **Pleistocene** remains are the evidence that enables us to understand our earliest prehistory: how the landscape of Britain was shaped; patterns of past climate; changing animal and plant communities; what our ancestors looked like, how they lived, and where, when and how they fitted into those landscapes and ecosystems. Such remains provide us both with breathtaking glimpses into brief moments of our Palaeolithic past, such as the Happisburgh footprints (Figure 1) or perfectly preserved remains of 15 minutes of **handaxe**-making (Figure 2), and with an overarching, million-year perspective on our shared origins.

English Palaeolithic and Pleistocene remains are of both national and international significance. This reflects a long history of research, some exceptional sites and landscapes (e.g. Boxgrove and Creswell Crags) and a well-understood **Quaternary** framework. Successful curation of these remains therefore has wide-reaching implications and benefits.

Figure 2: Scatter of handaxe manufacturing flakes at Boxgrove (Roberts and Parfitt 1999: fig 239).

Finding and understanding the evidence

Pleistocene remains are the geological and biological deposits laid down by water, wind and ice between 2.6 million and 11,700 years ago. There is a wide range of Pleistocene geological deposits (Section 7), including river-lain gravels and sands, **glacial tills**, windblown sands and silts, and **slope deposits**. In some places, artefacts and/or plant and animal remains are contained in these deposits, including stone tools and the debris (**flakes**) produced when making them (Figure 2) and, much more rarely, artefacts of wood, bone and other organic materials, bones bearing marks of butchery, rudimentary structures and the remains of early humans (**hominins**). Palaeolithic remains therefore form part of the Pleistocene record and understanding our Palaeolithic past requires a wider appreciation of Pleistocene geological deposits and their associated palaeoenvironmental evidence.

Compared to later archaeology the nature of Palaeolithic evidence and its context can make it difficult to identify, hard to access and possible to overlook. In particular, much of the **Lower** and **Middle Palaeolithic** record is in the form of artefacts and environmental evidence associated with Pleistocene landscape fragments more deeply buried than the remains which characterise most later archaeological periods, including the **Upper Palaeolithic**. These deposits may also contain commercially valuable gravels and sands, **brickearths** and other deposits (e.g. **lacustrine** clays). The discovery and documentation of Palaeolithic and Pleistocene remains have therefore involved close cooperation among archaeologists, planners and developers, and also owe a particular debt to aggregate quarrying, both now and in the past.

However, many developments that potentially impinge on Palaeolithic and Pleistocene remains are on a much smaller scale. Investigating the deposit sequences and any artefacts or palaeoenvironmental remains from these smaller sites is no less important than larger-scale investigations in quarries and on infrastructure projects. The evidence from an individual site might not answer specific questions by itself, but it contributes to a gradually accumulating understanding of the Palaeolithic record.

Part A: Curating the Palaeolithic

1 Palaeolithic archaeology and planning

This section outlines the position of Palaeolithic and Pleistocene remains with reference to current national planning policy (NPPF), Scheduled Monuments (SMs), Sites of Special Scientific Interest (SSSIs) and other protected landscapes.

1.1 The Palaeolithic record

For post-Palaeolithic sites, methods of investigation are well established and widely understood by those involved in implementing planning policy (NPPF; MHCLG 2021). However, where Palaeolithic and associated Pleistocene remains are involved, conditions of preservation, the nature of landscape processes, and the chronological and spatial scale of the deposits are often different and present practical and interpretative challenges. For example, it is often more difficult to establish even the approximate age of the deposits; the relationships between artefacts, sediments and biological remains are often uncertain; the relative importance of reworked and in-situ remains is a matter of judgement; and from the developer's point of view there is the issue of balancing the recording and sampling of extensive and varied deposits, sometimes in the absence of artefactual remains, against the commercial demands of extraction and development (White et al 2016).

At the same time it is important to recognise that the Palaeolithic is not entirely a 'foreign country' where things are done differently. Palaeolithic and Pleistocene specialists ask the same questions as those who normally work with later archaeological periods: What is it? How old is it? Where is it from? Who made it? What was the landscape like? What were people doing here?

Approaches to curating Palaeolithic and Pleistocene remains have also evolved significantly over the past 30 years (for a historical perspective *see* Wenban-Smith 1994; 1995). Examples of best practice in methodologies and in relationships between curators and contractors are reflected in the case studies presented here (e.g. the Ebbsfleet Academy; *see also* Bates and Wenban-Smith 2005).

1.2 National Planning Policy Framework (NPPF)

Like all other archaeology, Pleistocene archaeology, regardless of designation, is a material consideration within the planning system in England (also referred to as 'development management'). This means that the impact of any proposed development should be considered as part of the decision a planning authority makes about an application. The current framework is set out in the National Planning Policy Framework (NPPF) but the principles outlined in this document regarding the importance of Palaeolithic remains and the criteria which merit their consideration within a development context are designed to also be applicable within any future planning frameworks.

The NPPF recognises that not all nationally important archaeological sites are designated and states that 'non-designated heritage assets of archaeological interest, which are demonstrably of equivalent significance to scheduled monuments, should be considered subject to the policies for designated heritage assets.' (NPPF, footnote 68, page 57). The Historic England Scheduling Selection Guide for *Sites of Early Human Activity* provides a framework for assessing the significance of Palaeolithic archaeology to determine whether the NPPF policies for designated heritage assets are applicable (*see also* Sections 1.3 and 4.4).

However, the majority of Palaeolithic remains and Pleistocene deposits are classified as non-designated heritage assets which are not of equivalent significance to Scheduled Monuments. With regards to these, the NPPF (paragraph 203) states: 'The effect of an application on the significance of a non-designated heritage asset should be taken into account in determining the application. In weighing applications that directly or indirectly affect non-designated heritage assets, a balanced judgement will be required having regard to the scale of any harm or loss and the significance of the heritage asset.'

Key criteria for judging the significance of Palaeolithic and/or Pleistocene remains are summarised in Section 4.

1.3 Scheduled Monuments and Sites of Special Scientific Interest (SSSI)

In England archaeological sites that are considered to be of national importance can be protected as Scheduled Monuments, for which additional consent is required from the government before any works can take place. However, designation of archaeological sites as Scheduled Monuments is discretionary (i.e. not all sites that are of sufficient significance to be scheduled have to be designated as such) and currently those without structures (most Palaeolithic sites) are not eligible for scheduling. Consequently, apart from those located in caves, most Palaeolithic sites recognised as being of national, or international, importance are not scheduled.

Some Palaeolithic sites may be within locations identified as geological Sites of Special Scientific Interest (SSSIs), e.g. Happisburgh, in which case assent will be required from Natural England for certain activities. However, it is important to note that designation as a SSSI is primarily for geological interest and archaeological interest may not always be recognised within that.

It is also possible that Palaeolithic sites may lie within sites or areas designated for other reasons, such as Scheduled Monuments of later periods, Registered Parks and Gardens, or Registered Battlefields.

2 Sources of information

The references and links below provide further sources of information on Palaeolithic and Pleistocene remains. They will not be essential in all curatorial situations but may be of value in specific circumstances. Where evidence is drawn from these sources it should be accompanied by an interpretation of its significance for the Palaeolithic potential of a development site.

Panel A: Key organisations

- British Caving Association
- British Geological Survey
- British Society for Geomorphology
- GeoConservationUK Groups (previously RIGS Groups)
- Geological Society (including Regional Groups)
- Geologists' Association
- Historic England
- Lithic Studies Society
- Natural England
- Portable Antiquities Scheme
- Prehistoric Society
- Quaternary Research Association.

There is also a wide range of other local and regional societies.

Table 1: Sources of selected guidance.

Source	Caveats
ADS (Archaeology Data Service)	
Ancient Human Occupation of Britain Projects (AHOB)	
BGS (British Geological Survey) mapping, including BGS Geology Viewer and BGS GeoIndex.	May not be precise at site-based scales. Shallow deposits may not be mapped at all (e.g. less than 1m not mapped). *See also* the Ebbsfleet Academy case study. Can be discrepancies in the mapping and/or naming of deposits between different map sheets, especially if produced at different times.
Historic Environment Records (HERs)	Inclusion of Pleistocene archaeology may be variable. Some HERs identify areas of archaeological potential that may include Pleistocene archaeology but many do not. *See also* the Worcestershire HER case study and Panel H.
Selected Historic England guidance: ■ Deposit Modelling and Archaeology ■ Environmental Archaeology ■ Geoarchaeology ■ Managing Lithic Scatters and Sites ■ Mineral Extraction and Archaeology ■ Scientific Dating of Pleistocene Sites ■ Sites of Early Human Activity: Scheduling Selection Guide	
Historical mapping (accessible on-line through EDINA Digimap and National Library of Scotland)	Can show old quarries but not necessarily indicative of extraction boundaries.
Journals: ■ Boreas ■ Journal of Quaternary Science ■ Lithics ■ Proceedings of the Geologists' Association ■ Proceedings of the Prehistoric Society ■ Quaternary International ■ Quaternary Newsletter ■ Quaternary Science Reviews Plus other national, international and local journals.	Limited accessibility in some cases.
Palaeolithic and Mesolithic Archaeology on the Sea-bed: Marine Aggregate Dredging and the Historic Environment (Wenban-Smith 2002) Marine Aggregate Dredging and the Historic Environment (BMAPA, English Heritage and Wessex Archaeology 2003)	

Source	Caveats
Overview monographs: ■ *Digging Up the Ice Age* (Buteux et al 2009) ■ *London Before London: Reconstructing a Palaeolithic Landscape* (Juby 2011) ■ *Lost Landscapes of Palaeolithic Britain* (White et al 2016) ■ *Quaternary of the Thames* (Bridgland 1994) ■ *Quaternary of the Trent* (Bridgland et al 2014b) ■ *The Pleistocene History of the Middle Thames Valley* (Gibbard 1985) ■ *The Pleistocene History of the Lower Thames Valley* (Gibbard 1994) ■ *Thames Through Time: The Archaeology of the Gravel Terraces of the Upper and Middle Thames: Early Prehistory to 1500 BC* (Morigi et al 2011)	Limited accessibility in some cases.
Ordnance Survey Mapping	
Palaeolithic and Mesolithic Lithic Artefact Database (PaMELA; Wessex Archaeology and Jacobi 2014)	
Portable Antiquities Scheme database	
QRA (Quaternary Research Association) Field Guides	Limited accessibility.
Regional Research Frameworks	
Derek Roe (1968; 1981)	
TERPS (The English Rivers Palaeolithic Survey; Mepham 2009)	
Upper Palaeolithic Site Database (Whyte 2011, based on Wymer and Bonsall 1977)	
John Wymer Archive (1968; 1985; 1999; Mepham 2008, 2009)	

3 Requirements and procedures for Desk-Based Assessments and field evaluations

This section summarises the main criteria for a Palaeolithic/ Pleistocene investigation, suggests key questions for consideration in a desk-based assessment (DBA), and outlines fieldwork approaches for field evaluation. The project case studies (Section 8) provide examples of a range of approaches, while types of palaeoenvironmental evidence and dating methodologies are summarised in Sections 6 and 7.

3.1 Overview

The NPPF states that local planning authorities should require applicants to 'describe the significance of any heritage assets affected [by proposed development]' (NPPF, paragraph 194). It also directs that 'Where a site on which development is proposed includes, or has the potential to include, heritage assets with archaeological interest, local planning authorities should require developers to submit an appropriate desk-based assessment and, where necessary, a field evaluation.' (NPPF, paragraph 194). The NPPF also states that in assessing heritage assets '... the relevant historic environment records should have been consulted and the heritage assets assessed using appropriate expertise' (NPPF, paragraph 194)."

3.1.1 Historic Environment Records (HERs)

The NPPF states that 'Local planning authorities should maintain or have access to a Historic Environment Record' (NPPF, paragraph 192). HERs are the most comprehensive records of archaeological sites within a local planning authority area, and in some cases their Palaeolithic entries have recently been enhanced (Panel H). However, they vary in their inclusion of Palaeolithic archaeology and mapping of Pleistocene deposits which might indicate the potential for Palaeolithic archaeology (*see* the Worcestershire HER case study). It is therefore important to consider other sources, such as those identified in Table 1, when considering the Palaeolithic archaeological potential of an area.

3.1.2 Palaeolithic/Pleistocene specialist expertise

The NPPF also recommends that 'appropriate expertise' is engaged to advise on the potential of a site. It is therefore important to involve a specialist with knowledge of Pleistocene deposits and of Palaeolithic remains. The earlier in the planning process that expertise is engaged the better, as it will help to deliver a positive outcome for all stakeholders by enabling a joined-up and cost-effective strategy. Approaches may evolve as work progresses (e.g. the Ebbsfleet Elephant case study) and the nature of specialist involvement may therefore expand (e.g. to undertake OSL sampling in the field, or laboratory analysis of palaeoenvironmental samples; Tables 4–7). We recommend the Historic England Regional Science Advisors as an appropriate first point of contact for identifying a Pleistocene specialist.

A key goal of this document is to give curators sufficient confidence to evaluate Pleistocene specialists' recommendations. The remaining paragraphs of Section 3 and Section 4 outline how expert advice can inform the development of a site investigation. This expert advice should include an interpretation of the available information. It is not recommended that curators make decisions if there is no evidence that a Palaeolithic/Pleistocene specialist has been consulted.".

Approaches to pre-development investigation will vary between local planning authorities but the stages identified below will be broadly applicable in all cases: DBA (Section 3.3) and field evaluation (Section 3.4). Depending on the results of the field evaluation, post-determination mitigation (Section 4) may also be necessary.

3.2 Requirement for a Palaeolithic/Pleistocene assessment

Two interlinked criteria trigger the requirement for a Palaeolithic/Pleistocene assessment:

- The presence or potential for Pleistocene deposits, as indicated by British Geological Survey (BGS) mapping and/or previous investigations (documented in the HER and other records; *see also* the Worcestershire HER case study). In evaluating BGS mapping, it is important to recognise that thin Pleistocene deposits are not always mapped, the boundaries and types of mapped deposits are not always precisely recorded, and only the uppermost superficial deposits are shown on BGS mapping.

- Prior discoveries of Palaeolithic and/or organic palaeo-environmental remains (documented in the HER and other records), either in the local vicinity or further afield, especially if occurring in a similar geomorphological context to the development location. Consideration of equivalent deposits and/or artefactual finds beyond the immediate vicinity of the development is important given the nature and distribution of Pleistocene deposits (e.g. river terrace units; *see* Figure 3 in the Worcestershire HER case study).

Panel B: Palaeolithic potential in the Midlands and the North

For curators working in the Midlands and the North, where Pleistocene deposits are often dominated by glacial material and the Palaeolithic record is relatively minor compared to the South-East (Figure 4), any discoveries of Palaeolithic artefacts or Pleistocene palaeoenvironmental remains will be significant. While deposits of **glacial till** are often discounted as potential sources of Palaeolithic or organic palaeoenvironmental remains, there is scope for discoveries on the margins of these deposits. Local prior discoveries would also indicate the potential of such deposits, which specialist advice will clarify. Recent discoveries (e.g. Launde and Glaston in the East Midlands [*see* the Glaston case study]) have also highlighted the potential for near-surface Upper Palaeolithic sites in these regions.

If either of these criteria is met, then a Pleistocene specialist with 'appropriate expertise' (NPPF, paragraph 194) should be brought in to: 'a) assess the significance of heritage assets and the contribution they make to their environment; and b) predict the likelihood that currently unidentified heritage assets, particularly sites of historic and archaeological interest, will be discovered in the future.' (NPPF, paragraph 192).

The initial approach of the specialist will normally be to undertake a detailed DBA (Section 3.3), which should assess two questions:

1. What Pleistocene deposits may be present within the site and what is their potential to preserve Palaeolithic archaeology and palaeoenvironmental evidence, i.e. the likelihood of material of interest being present (*see also* Section 4)? High potential may reflect previous discoveries from the same deposits, or deposits equivalent to those present on a site, while low potential may be due to factors such as low-impact developments or the presence of only thin and degraded Pleistocene deposits.

2. What is the significance of any potential remains? Significance will also be influenced by the setting, e.g. are the potential remains from a less well understood period (e.g. MIS 9) or region (e.g. the Palaeolithic of northern England; *see also* Panel B), or a period

with no current evidence for hominin presence (e.g. MIS 5e; *see also* Section 4.1.3). This significance is judged against regional and national research questions and frameworks (*see also* Historic England's Good Practice Advice note *Managing Significance in Decision-Taking in the Historic Environment* and *Sites of Early Human Activity: Scheduling Selection Guide*).

On the basis of this assessment, the DBA should recommend whether a site requires field evaluation (Section 3.4) to confirm the presence or absence of Palaeolithic remains and/or Pleistocene deposits, bearing in mind that Palaeolithic and other Pleistocene remains are not uniformly distributed through deposits of interest, and deposits that are barren in one location may contain rich assemblages in another.

Palaeoenvironmental evidence (deposits, plant and animal remains) is of equal importance to artefacts, and is critical to a holistic understanding of the Palaeolithic and Pleistocene (*see also* Section 4.1.1). Without it, the value of artefact assemblages is reduced. Moreover, the results of an evaluation that finds environmental evidence on one site can contribute to the interpretation of Palaeolithic artefacts in a contemporary deposit on a site elsewhere. Therefore if a pre-determination field investigation (evaluation) fails to identify Palaeolithic artefacts (which is not uncommon), further works at the post-determination stage (Field Mitigation; Section 4.2) can nonetheless be recommended by a Pleistocene specialist if:

- There are palaeoenvironmental indicators of the contemporary environment (*see also* Section 4.4).

- Identical and contemporary deposits elsewhere have been previously demonstrated to contain significant Palaeolithic remains (*see also* Section 4), i.e. the depositional context is an indicator of potential.

The nature and relative potential of the deposits will be reflected in the investigative strategies proposed by the specialist for both the evaluation and mitigation stages, which should be appropriate and proportionate (*see also* Managing Significance in Decision-Taking in the Historic Environment). This will usually take the form of a Written Scheme of Investigation (WSI; Section 3.4.1). In the case of field evaluation (Section 3.4), investigative strategies should be sufficient to evaluate the nature, extent, preservation and potential significance of any Palaeolithic deposits that are present. In the case of mitigation (Section 4), investigative strategies should be based on the potential of deposits to preserve significant Palaeolithic and/or Pleistocene remains, the nature of the proposed impacts on the resource, and the most appropriate techniques and methodologies for recovering particular kinds of evidence in particular sedimentological contexts. The Ebbsfleet

Elephant and Southall Gasworks case studies provide examples of appropriate evaluation and mitigation strategies for development sites with, respectively, clear and uncertain Palaeolithic potential.

The scope and purpose of each stage of investigation are set out below and provide further guidance on how to assess any specialist recommendations.

3.3 Desk-Based Assessment (DBA)

Guidance already exists for the preparation of DBAs: this section is intended to supplement that with prompts that are specific to the Palaeolithic.

All DBAs should address the potential for Palaeolithic archaeological remains as they would any other archaeological period. Where there is general Palaeolithic potential on a development site (e.g. the presence of a Pleistocene river gravel deposit) a Palaeolithic and Pleistocene specialist should contribute to the DBA (and, if required, an Environmental Impact Assessment [EIA]). If there is high potential for Palaeolithic remains, or very extensive and/or complex Pleistocene deposits are present, a specific Palaeolithic archaeological and geoarchaeological DBA may be considered necessary to help guide the requirements for evaluation. Where there are suitable data available (e.g. from ground investigations or previous archaeological works) the creation of a deposit model (Section 3.3.1) will allow field evaluation to be clearly targeted.

The close relationship between the potential for Palaeolithic archaeology and the presence of Pleistocene deposits does mean that other sources (e.g. BGS mapping; *see also* Table 1) will need to be considered beyond the archaeological references traditionally included in DBAs. Assessment of evidence from such sources should include interpretation of its significance for the Palaeolithic potential of the development site. A checklist of questions for consideration is presented in Table 2. This list is not exhaustive but gives an idea of the information that should be included in a DBA to ensure that it can support an informed judgement about the archaeological interest of a development site. The DBA may make recommendations for further work needed to clarify the understanding of Palaeolithic potential and/or mitigate the impact of the proposed development upon any remains that might be present.

Table 2 (page 16):
Checklist of key questions and associated approaches and issues relevant to a Desk-Based Assessment of Palaeolithic potential.

Key questions	Associated approaches and issues
Does the site contain or have the potential to contain Pleistocene geological deposits?	If yes or maybe then seek specialist advice. Be aware that BGS mapping of superficial Pleistocene geology is not always reliable with regards to the precise extent of superficial deposits (e.g. *see* the Ebbsfleet Academy case study). Sources in Table 1 will be helpful, especially geotechnical site investigation reports [boreholes and test pits].
Are there any known Palaeolithic finds in the vicinity of or within the geological deposit?	If yes or maybe then seek specialist advice. Be aware that the presence of Palaeolithic archaeology that is relevant to the potential of a particular development site may occur quite some distance (often several kms) away. Sources in Table 1 will be helpful here, especially TERPS.
What is known about the Pleistocene deposits? Their character? Their age? Depth? Thickness? Extent? Faunal/ environmental remains?	Refer to sources such as those identified in Table 1 including geotechnical site investigations [boreholes and test pits] and the BGS website. Consider the potential of different types of deposits such as those listed in Section 7. An initial deposit model (*see also* Section 3.3.1) is beneficial if suitable data are available.
Is there a history of investigation of these deposits? What was the nature of that investigation?	Refer to sources such as those identified in Table 1. Be aware that relevant investigations may have occurred some distance away, including in neighbouring planning authorities. Sometimes relevant investigations may have occurred decades or even centuries ago and the terminology used may be less familiar (this can be a particular issue with older BGS mapping). Also consider the purpose of those investigations – for instance was the focus artefact collection? Or understanding the sedimentary sequence? Or dating? If no investigation, what is known about the date of these deposits and their relationship to others that might be better understood? What might comparable/contemporary deposits elsewhere tell us about the potential for archaeological remains?
Refer to national and regional research frameworks	Be aware that for some regions research questions may be as simple as 'is there any Palaeolithic archaeology in this area?'
What is the potential for Palaeolithic remains and what is the likely significance of any Palaeolithic remains that might be present?	Consider the type and potential age of the deposits. While their likely significance is best considered post-assessment (DBA and field evaluation), it is possible to consider the probability of a primary or secondary context given the deposit type (*see also* Section 4 and Section 7). Refer to the Historic England *Sites of Early Human Activity: Scheduling Selection Guide* with regards to indicators of national importance, but sites likely to be of less than national importance should not be ignored. *See also Managing Significance in Decision-Taking in the Historic Environment*.
What is the nature of the impact of the proposed development?	Palaeolithic remains can occur at surface or near surface (Glaston case study), or within deeply stratified deposits (West Sussex Coastal Plain case study; Southall Gasworks case study; Nightingale Estate/Ponds Farm case study). However it should be noted that specific depths and locations of impacts are frequently not well established at the pre-determination stage.

3.3.1 Deposit Modelling

Deposit-led approaches should be at the heart of all investigations. Such approaches, which 'focus upon Pleistocene deposits as the core resource for Palaeolithic investigation' (Bates and Wenban-Smith 2005), are reflected in all of the case studies presented here, and in the majority of Palaeolithic and Pleistocene investigations in a development context over the last 30 years.

Deposit modelling is a key element of the deposit-led approach. As described in Historic England's guidance on *Deposit Modelling and Archaeology*: 'A deposit model provides a visual representation of the vertical and lateral distribution of sediment units beneath the modern ground surface. It interprets the past environments, landscape processes and human activities represented by these buried deposits and provides an enhanced understanding of the archaeological potential (both cultural and palaeoenvironmental) of the sub-surface stratigraphy.' It is important to emphasise that deposit modelling can vary from 2D transects (West Sussex Coastal Plain case study) to fully 3D models (Ebbsfleet Elephant case study), and that not all Palaeolithic archaeology is deeply buried (e.g. the Glaston case study): shallow remains can occur throughout the period (not only in the Upper Palaeolithic), as at the early Middle Palaeolithic site of Harnham (Bates et al 2014).

In cases where previous investigations of the deposits have occurred (including BGS borehole records from the site and/or the surrounding area), a preliminary deposit model may be produced as part of the DBA. In such cases the deposit model would then be updated in light of the results of field investigations. In all other cases deposit models will be generated through the field investigations.

Deposit modelling aims to delimit the nature of Pleistocene (and Holocene) deposits within different areas of a site. Through this approach, it may be possible to divide the site into landscape zones according to variations in the depositional sequence. Each of these zones reflects different site formation processes (and therefore landscape history), such as channel fill, channel margins, dryland etc. These are likely to contain varying evidence of Pleistocene and Palaeolithic potential, which can help guide field investigations; thus those zones with limited potential might warrant no or limited further investigation and those with good potential a more detailed investigative strategy. A deposit model may also help establish what deposits the development proposals will impact. Defining the relative potential of different areas of the site allows appropriate, clearly defined and targeted investigation (evaluation and, if required, mitigation).

3.4 Field evaluation

The purpose of the field evaluation stage is to evaluate the nature, extent, preservation and significance of any archaeological remains that may be present on a site. This is commonly undertaken prior to the determination of the planning application and the results will inform subsequent stages of investigation, either further evaluation or mitigation (Section 4.2). Given the staged nature of many Palaeolithic investigations it is particularly important that analysis of samples and finds recovered at the field evaluation stage is undertaken promptly and the results used to inform subsequent phases of fieldwork. Where the site is designated as an SSSI or Scheduled Monument (Section 1.3) additional permissions will be needed for invasive field investigations.

3.4.1 The Written Scheme of Investigation (WSI)

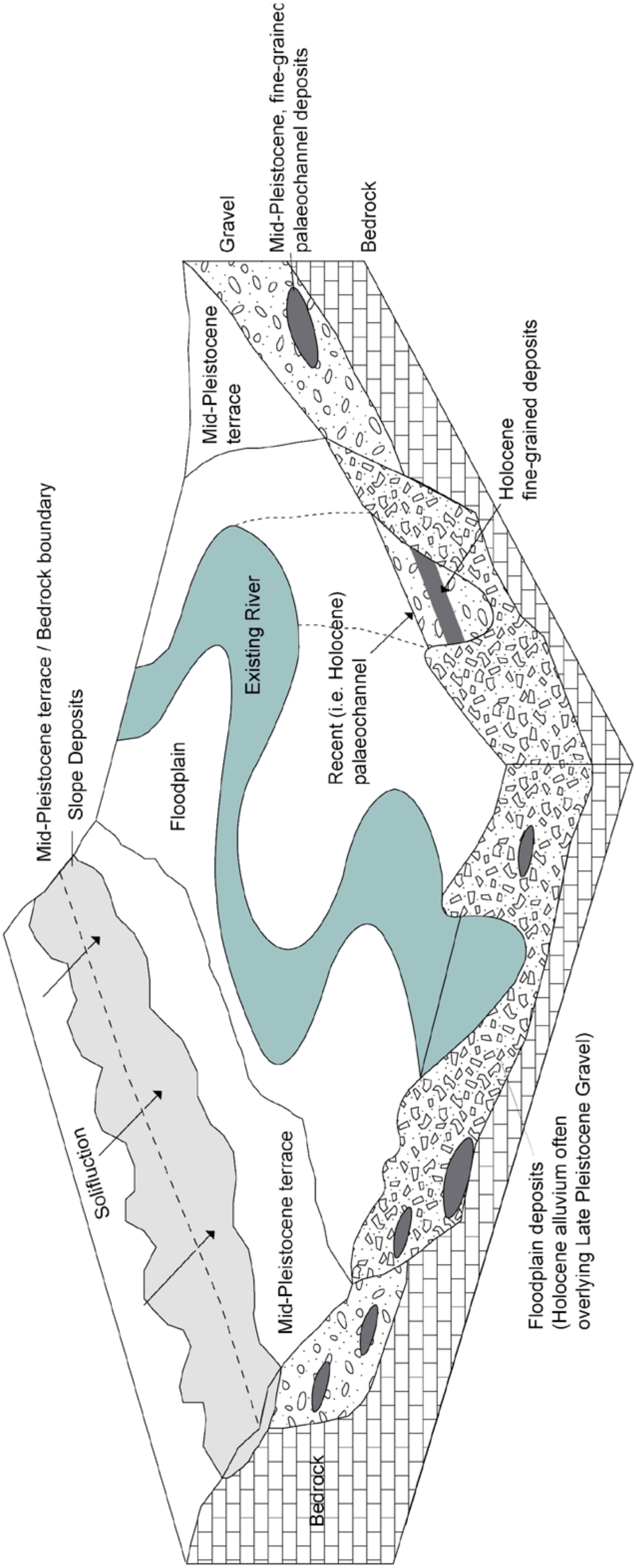
Formal recommendations for the field evaluation of a site are set out in a WSI which should be prepared by or with input from a Palaeolithic/Pleistocene specialist, identifying the scope and purpose of the investigation and the methods to be used. The WSI can allow for minor adjustments to the scope of the investigation (e.g. number and location of test pits/boreholes, number and size of samples) but if that investigation reveals unforeseen archaeological or palaeoenvironmental remains it will be necessary to prepare a new WSI setting out appropriate strategies and investigative techniques to deal with such discoveries.

Fieldwork occurs as part of a staged approach (DBA > evaluation > mitigation [if necessary]) that is clarified in the WSI, potentially with multiple phases of field investigation, both invasive and non-invasive, required to assess the archaeological potential and significance and to mitigate the impact of the development (*see* the Ebbsfleet Elephant case study). Given the close relationship between Palaeolithic remains and Pleistocene deposits a deposit-led approach is advised (*see* Section 3.3.1 and the Ebbsfleet Elephant, West Sussex Coastal Plain and Southall Gasworks case studies).

3.4.2 Field evaluation strategies: the scope and purpose of the investigation

Table 3 shows the range of techniques that is commonly applied in field evaluation, while Figure 3 highlights potential deposit variations (using a schematic valley landscape) and the importance of appropriate sampling strategies. Sampling at the evaluation stage should be sufficient to contextualise any archaeological remains and characterise the deposits, including their extent, and the presence or absence and nature of dateable deposits and palaeoenvironmental remains. The percentage of an area that is examined and the strategy used will depend upon the nature of the site, the sorts of deposits present, prior knowledge of the deposits and the research questions associated with them.

Figure 3: Schematic river floodplain and terrace landscape. Note the spatial variations in coarse-grained (gravel) and fine-grained (sand, silt) deposits, and the risk that lower resolution sampling will capture only some of that variability.



Typically the evaluation will seek to answer questions similar to those in Table 2 in order to inform the next stage of work: Are Pleistocene deposits present? Where? What is the nature of these deposits? Are Palaeolithic archaeological remains present? Where? What is the nature of those remains? The field evaluation strategy should be sufficient to address these questions while remaining proportionate to the importance of the heritage asset (NPPF, paragraph 205; *see also Managing Significance in Decision-Taking in the Historic Environment*) and recognising the commercial demands of extraction and development (White et al 2016).

In this context, Bates and Wenban-Smith (2005) have made the important observation that the accumulated knowledge arising from multiple investigations within the same region is critical to understanding the Palaeolithic record, as it is for all archaeological periods. They argue with reference to Pleistocene gravel deposits that:

> 'A single event [e.g. a field evaluation] may involve excavation of a couple of test pits, sieving of eight 100 litre gravel samples and recovery of no evidence. This in itself fails to provide sufficient information to make a more general summary of the Palaeolithic remains in a body of gravel that may cover several hundred hectares. However, once this exercise has been repeated a hundred times over a period of maybe 20 years, then we will actually begin to learn something that can make a major contribution to core national and regional research objectives.'

To achieve this outcome, standards of investigation need to be sufficient to produce meaningful comparative results. However, as the case studies illustrate, there is considerable variability between sites in the nature of their Pleistocene deposits and Palaeolithic archaeology. It is therefore important to note that the intensity of sampling (e.g. the total number of tests pits and samples) can and should be varied between investigations to reflect the potential of the deposits. Potential should be assessed by a Pleistocene specialist at the DBA stage (Section 3.3), based on the regional and chronological setting of the deposits (e.g. are they associated with a time period or locality with previous Palaeolithic finds?), the specific character of the deposits (e.g. are archaeological and/or palaeoenvironmental remains concentrated at particular depths or in association with particular sediment horizons?) and the potential significance of new information (e.g. does it relate to a chronological period which is currently poorly understood?). This should be documented in the DBA and reflected in the WSI, again highlighting the importance of involving a Pleistocene specialist in the preparation of these two documents.

It follows that prescribing precise sampling intervals is neither possible nor desirable here. At the same time it is important to meet agreed standards with regards to the sample sizes necessary to ensure meaningful analytical results (Panel C). Historic England guidance on *Environmental Archaeology*, *Geoarchaeology* and Scientific Dating of

Pleistocene Sites (forthcoming) should be consulted, and sampling strategies should also be designed with appropriate expertise. In many instances that will mean the introduction of further specialists in addition to the Pleistocene/Palaeolithic expertise already engaged (i.e. with expertise in topics such as lithics, mammalian fauna, dating, sediments, botanical remains, invertebrates etc; *see* the Nightingale Estate/Ponds Farm case study). The various case studies also provide context-specific examples of methodologies and sampling strategies which can be drawn upon.

3.4.3 Field evaluation techniques

Field evaluation for Palaeolithic archaeology will typically draw upon a range of techniques to investigate the nature of the sub-surface geology – both invasive (e.g. boreholes, test pitting, trenching) and non-invasive (e.g. geophysical survey [*see* the Happisburgh case study], walkover survey) – as well as techniques targeted at identifying archaeological remains (e.g. test pitting [*see* the Valdoe case study], sieving [*see* the Ebbsfleet Academy case study], trenching, fieldwalking). Which techniques are appropriate will depend upon the nature of the deposits, the requirements of the evaluation and the research questions being posed. It is possible that work undertaken at the evaluation stage in accordance with specialist advice might rule out the need for further investigation (e.g. the West Sussex Coastal Plain case study). Alternatively there may be more than one phase of evaluation fieldwork (e.g. the Southall Gasworks case study). Usually multiple strands of information are needed in order to understand the character of a deposit and its archaeological interest. Commonly used techniques and examples of their application are listed in Table 3. Specific techniques for lithic scatters, which are especially relevant for near-surface Palaeolithic sites, are discussed in Historic England's guidance on Managing Lithic Scatters and Sites (*see also* the Glaston case study). Assessing the findings of a field investigation is discussed in Section 4.

Table 3: Commonly used field investigation techniques. *See also* Historic England's guidance documents on *Geoarchaeology*, *Environmental Archaeology* and *Mineral Extraction and Archaeology* (paragraphs 45–49), and Section 6 with regards to palaeoenvironmental evidence and dating techniques.

Techniques	Case study examples	Typical stages
Coring	Happisburgh; Nightingale Estate, Hackney and Ponds Farm 2, Aveley; West Sussex Coastal Plain	Evaluation; Mitigation
Geophysics	Happisburgh	Evaluation
Palaeoenvironmental sampling: borehole samples and bulk samples (e.g. particle size analysis, organic matter determinations, pollen, plant macrofossils, vertebrates, mollusca, ostracods, chironomids, diatoms and worm granules)	Nightingale Estate, Hackney and Ponds Farm 2, Aveley	Evaluation; Mitigation
Test pits	Ebbsfleet Academy; Ebbsfleet Elephant; Glaston; Valdoe	Evaluation; Mitigation
Trenching	Ebbsfleet Elephant	Evaluation; Mitigation
Watching brief	Chard Junction Quarry; Ebbsfleet Academy; Kimbridge Farm Quarry	Mitigation

Panel C: Suggested sample sizes for artefacts, organic remains and sediments

Bates and Wenban-Smith (2005) recommend the following sample sizes for artefacts and organic remains for the purposes of field evaluation. These are minimum sample sizes for the evaluation stage (samples taken during mitigation for full assessment and analysis would be larger):

- Lithic artefacts and faunal remains: dry sieving (on-site) of 100 litre spit samples (1cm mesh)[1,2]
- Small vertebrates (in calcareous clays, silts, fine sands, clayey/silty gravels): 30 litre samples
- Molluscs (in calcareous clays, silts, fine sands, clayey/silty gravels): 1 litre samples
- Ostracods (in calcareous clays, silts, fine sands, clayey/silty gravels): 200g samples
- Pollen/diatoms (in humic acidic clays, silts, peaty deposits): 100g samples
- Insects (humic acidic clays, silts, peaty deposits): 10 litre samples.

Jones et al (1999) suggested the following sample sizes for sediment analyses:

- Grain size: >50 clasts per sample for assessing the mean grain size of gravel. Bulk samples should be taken for grain size analysis (*see also* below)
- Roundness and shape: >35 clasts per sample
- Fabric and sorting: >30 clasts per sample
- Clast lithology: >100 clasts per sample.

Samples of 300–500 clasts for clast lithological analysis was suggested (after Bridgland 1986), requiring the following bulk sample weights for a typical sandy gravel[3]:

- 10–15kg (where the grain size range is 8–16mm)
- 20–25kg (where the grain size range is 11.2–16mm)
- 30–50kg (where the grain size range is 16–32mm).

Finally, the following minimum sample weights were recommend to obtain c 100 clasts from sediments with different maximum particle diameters (after Gale and Hoare 1992):

- Till (maximum particle diameter: 2mm): c 1kg
- Glaciofluvial gravel (maximum particle diameter: 6mm): c 1kg
- Modern river gravel (maximum particle diameter: 9mm): c 1kg
- Till (maximum particle diameter: 50mm): c 18kg
- Glaciofluvial gravel (maximum particle diameter: 50mm): c 23kg
- Modern river gravel (maximum particle diameter: 50mm): c 31kg.

1 'If the sediment encountered is not suitable for dry-sieving (i.e. too clayey), excavation will proceed in shallower spits of 5 centimetres, looking carefully for the presence of any archaeological evidence, and the spit samples will also be carefully investigated by hand (using archaeological trowels) for any archaeological evidence' (Bates and Wenban-Smith 2005).

2 Mesh sieves for artefact sieving can potentially vary depending on sediment size characteristics: e.g. a 20mm mesh for coarse-grained gravel deposits, 10mm or less for fine-grained deposits.

3 To assess clast roundness, grain size and form, these bulk sample weights can be divided by 6.

4 Assessing the findings and further work

This section summarises key considerations when determining the significance of Palaeolithic and Pleistocene remains encountered during pre-development investigations, and identifies the grounds for recommending further work.

4.1 Assessing the significance of Palaeolithic and Pleistocene remains

There are various factors that affect the significance of Palaeolithic and Pleistocene remains:

- How much is already known about the region in which they are found and the time period that they represent.
- The depth and lateral extent of deposits.
- How they are preserved (Panel D) – whether in primary context or re-deposited by geological processes (secondary context).
- Their condition – whether fresh or affected by processes of weathering and transport.
- Their diversity – including the number of fossil groups (e.g. plants, animals, insects) represented; the range of artefact types; and the presence of dateable material.
- The volume of material – the number of artefacts (*see also* Figure 6), bones and other material.

4.1.1 Remains in primary context

Sites of the greatest significance are those where diverse remains are preserved undisturbed or with minimal disturbance, e.g. lake sediments and their contained flora and fauna; buried land surfaces and the flora and fauna that once occupied them; and surfaces on which the remains of hominin/human occupation are preserved where they were discarded (i.e. primary context sites). These sites are rare (Figure 7) but are of exceptional significance because they provide the ‘snapshots’ from which the prehistoric panorama has been built up and by which it can be revised and refined.

4.1.2 Remains in secondary context

At the other end of the spectrum are more or less damaged or degraded individual specimens that are found in isolation, no longer associated with the place and time in which they originated. Such specimens are less significant in regions rich in well-preserved and well-documented evidence, but they can be very significant in regions where little or no evidence has previously been recorded (*see also* Section 4.1.3).

Between these two extremes are disturbed, secondary context sites with multiple artefacts, occasionally in large numbers (Figure 6). Such sites have provided much of the national Palaeolithic context, indicating large-scale geographical and chronological trends in artefact types (e.g. fluctuations in the dominant shapes of handaxes between MIS 13, 11 and 9) and occupation histories (e.g. the apparent absence of hominins from Britain during MIS 6–4; Section 5.3).

4.1.3 Regional and stratigraphic contexts

All such remains, in both primary and secondary context, are of particular significance where they occur in regions and/or relate to time periods about which little has previously been recorded. For example, the recovery of a handful of artefacts in primary context from MIS 5e (Ipswichian) deposits would be very significant, given the current absence of any evidence for hominin occupation in Britain during this period (*see also* Section 5.3). By contrast, a handful of reworked artefacts (i.e. in secondary context) from the already well-understood MIS 11, which has a rich occupation record (*see also* Section 5.2), would be of less significance. However, from a geographical perspective, reworked artefacts from northern England would be more significant than similar artefacts from south-eastern England, given the archaeological records in the two regions (Figure 4; *see also* Panel B).

4.2 Field mitigation

If pre-determination evaluation (e.g. through test-pitting, trial trenching and/or boreholes; Section 3.4.3) identifies archaeological and/or palaeoenvironmental remains (e.g. through sieving: Panel C) or deposits with high Palaeolithic potential (e.g. fine-grained organic sediments), further works may be recommended to mitigate their loss. Appropriate mitigation options can be identified by reference to Historic England's guidance on *Preserving Archaeological Remains*).

Recommendations for further works in the form of a new WSI should be made by a Palaeolithic/Pleistocene specialist. Further works may consist of a watching brief or ongoing monitoring (e.g. the Dunbridge and Chard Junction case studies) or an excavation (e.g. Ebbsfleet Elephant and Valdoe Quarry case studies). In most instances some form of trenching or test pitting will be used but where deposits are located at depth this is usually informed by coring (e.g. Nightingale Estate/Ponds Farm and West Sussex Coastal Plain case studies; *see also* Table 3). It is not always the case that the most appropriate archaeological mitigation will be open-area excavation, as is typical for other archaeological periods. In some cases dating deposits or undertaking sampling for laboratory-based palaeoenvironmental analysis may be the most appropriate mitigation (e.g. Nightingale Estate/Ponds Farm case study).

4.3 Post-excavation analysis and reporting

It is important to note that, as with other archaeological investigations, much of the full analysis and investigation associated with Palaeolithic deposits recovered at the mitigation stage occurs off site. A list of commonly analysed remains can be found in Tables 4–6 (*see* e.g. Nightingale Estate/Ponds Farm case study).

As with all archaeological reporting current guidelines on good practice should be followed, including the requirement to make publicly accessible the evidence and archives relating to the understanding of heritage assets (NPPF, paragraph 205). Reporting of findings to HERs via OASIS is also important in light of the variability, and often paucity, of Palaeolithic archaeology within HERs, and the accumulated value of individual small-scale investigations, as emphasised by Bates and Wenban-Smith (2005).

Such reporting should not only cover the results of investigations undertaken as part of the planning process (i.e. the DBA, pre- and/or post-determination evaluations, and further mitigation works) but all findings and investigations. HERs are the first point of reference for those wanting to understand the archaeological potential of an area but can only represent the archaeology reported to them. While it is usual that HERs receive final investigation reports and publications it is not necessary to wait for those before alerting an HER to a site of Palaeolithic interest. It is also important that HERs recognise that local investigations can be relevant to understanding other deposits situated quite some distance away (often many kilometres). The Worcestershire case study is a good illustration of the benefits of enhancing an HER's Palaeolithic record (*see also* Panel H for other examples of HER enhancement projects which have focused on the Palaeolithic). Archives can also be made available digitally through the Archaeology Data Service (ADS), as with the Dunbridge case study.

4.4 National recognition

As discussed above (Section 1.3), a site may be designated as a Site of Special Scientific Interest (SSSI) or Scheduled Monument (SM) as a result of its Palaeolithic importance, though such sites tend to be rare (e.g. Happisburgh Cliffs; *see also* the Happisburgh case study).

The most important Palaeolithic assets (e.g. the Ebbsfleet Elephant case study) nevertheless have equivalent significance to Scheduled Monuments (*see also Sites of Early Human Activity: Scheduling Selection Guide*), and should therefore be considered of national importance and subject to the policies for designated heritage assets (NPPF, paragraph 200 and footnote 68; *see also* Section 1.3). The likely extent and importance of the Palaeolithic record for any given area can be identified from the national Research Framework and relevant Regional Research Frameworks. Criteria for defining nationally important Palaeolithic sites are set out in *Sites of Early Human Activity: Scheduling Selection Guide*, which suggests a Palaeolithic site may be considered nationally important if it contains any of the ten types of evidence listed below. Such evidence could consist of either primary context remains (e.g. the Ebbsfleet Elephant case study, which meets six of the ten criteria; *see also* Section 4.1.1 and Panel D) or secondary context remains (e.g. deposits in the Swanscombe landscape, many of which meet the 'artefacts are abundant' criteria; *see also* Section 4.1.2 and Panel D), depending on both the remains themselves and prior understanding of the local and regional Palaeolithic record.

1. Human remains
2. Remains that belong to a period or geographic area where evidence of a human presence is particularly rare
3. Organic (for instance, wooden) artefacts
4. Well-preserved indicators of the contemporary environment that can be directly related to the remains
5. Evidence of human lifestyles, for example interference with animal remains
6. One deposit containing Palaeolithic remains that has a clear stratigraphic relationship with another
7. Any artistic representation, no matter how simple
8. Features such as hearths, shelters, and floors
9. Exploitation of a resource, such as a raw material
10. Abundant artefacts.

Part B: Understanding the Palaeolithic

5 The Palaeolithic occupation of Britain

This section provides a short summary of the British Palaeolithic record, including site/findspot distributions, the main periods, key artefact types and hominin species, and major behavioural developments. It is primarily intended for curators who are relatively unfamiliar with the period, and complements the summaries of the Pleistocene record (Section 6) and key Pleistocene deposits (Section 7).

5.1 The British Palaeolithic Record

The majority of British Palaeolithic sites and artefact findspots are concentrated in the South-East and East Anglia (Figure 4), although they are also found in smaller numbers in the South-West, the Midlands and the North. Many Lower and Middle Palaeolithic sites and findspots are found in the deposits of extant river valleys (e.g. the Thames; Figure 5) or now-extinct rivers (e.g. the Bytham and the Solent; Figure 9). However sites and findspots are also found in other landscape settings (e.g. slope deposits including Head, upland and plateaux deposits such as Clay-with-Flints; *see also* Section 7). A greater proportion of Upper Palaeolithic sites are associated with caves and other karstic landscape features (e.g. fissures and rockshelters), but there are also key sites associated with river valleys and other settings in this period. Palaeolithic sites are often thought of as deeply buried, partly as a result of the association of 'headliner' sites with aggregates quarries (e.g. Boxgrove and Lynford). However shallowly buried Palaeolithic sites also occur, and date across the entire period (e.g. Glaston case study).

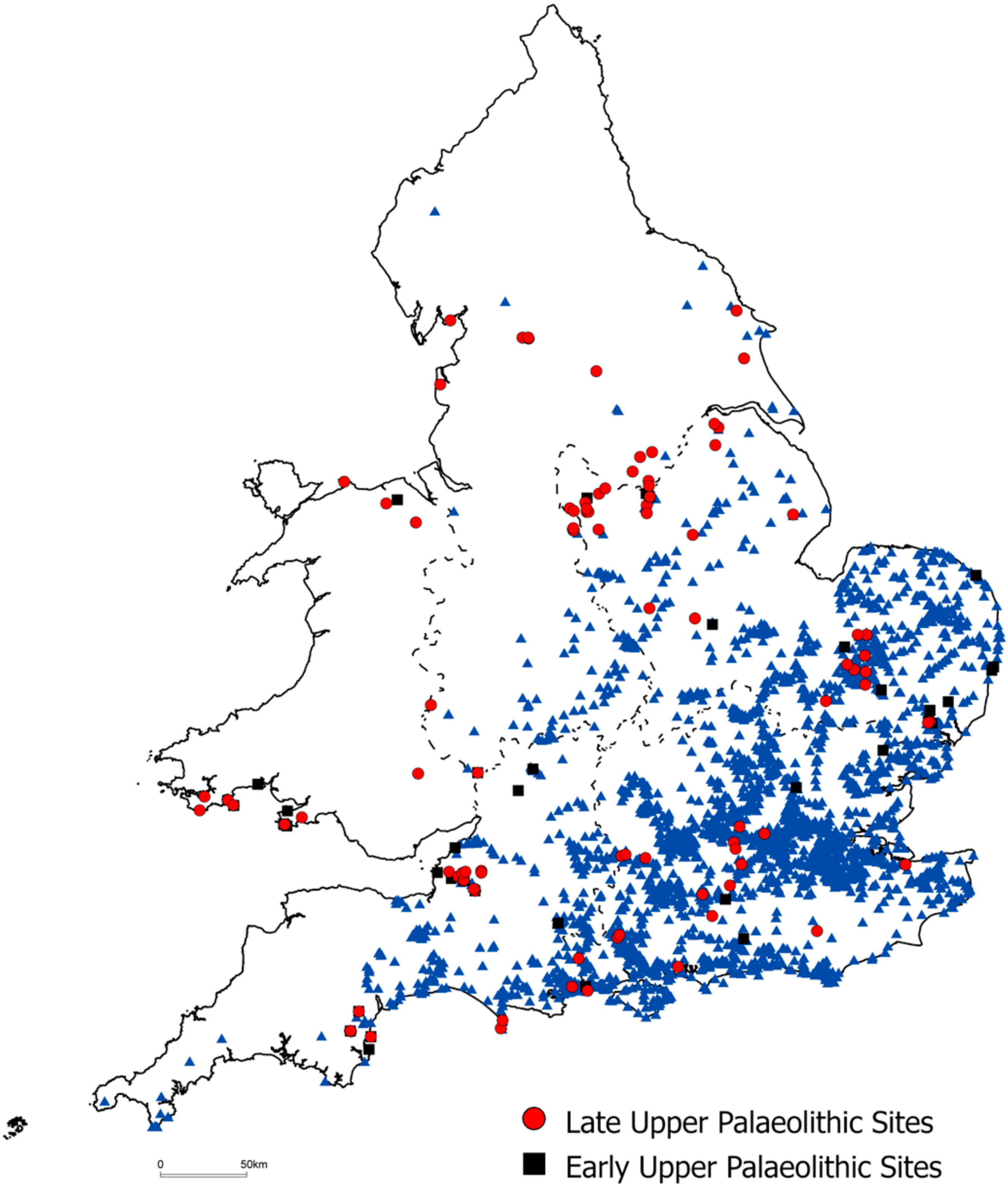


Figure 4: Distribution of Palaeolithic sites and findspots. Site data derived from the English Rivers Palaeolithic Survey (TERPS: Wymer 1999; Mepham 2009), the Gazetteer of Upper Palaeolithic Sites in England and Wales (Wymer and Bonsall 1977; Whyte 2011) and Campbell (1977), with later additions.

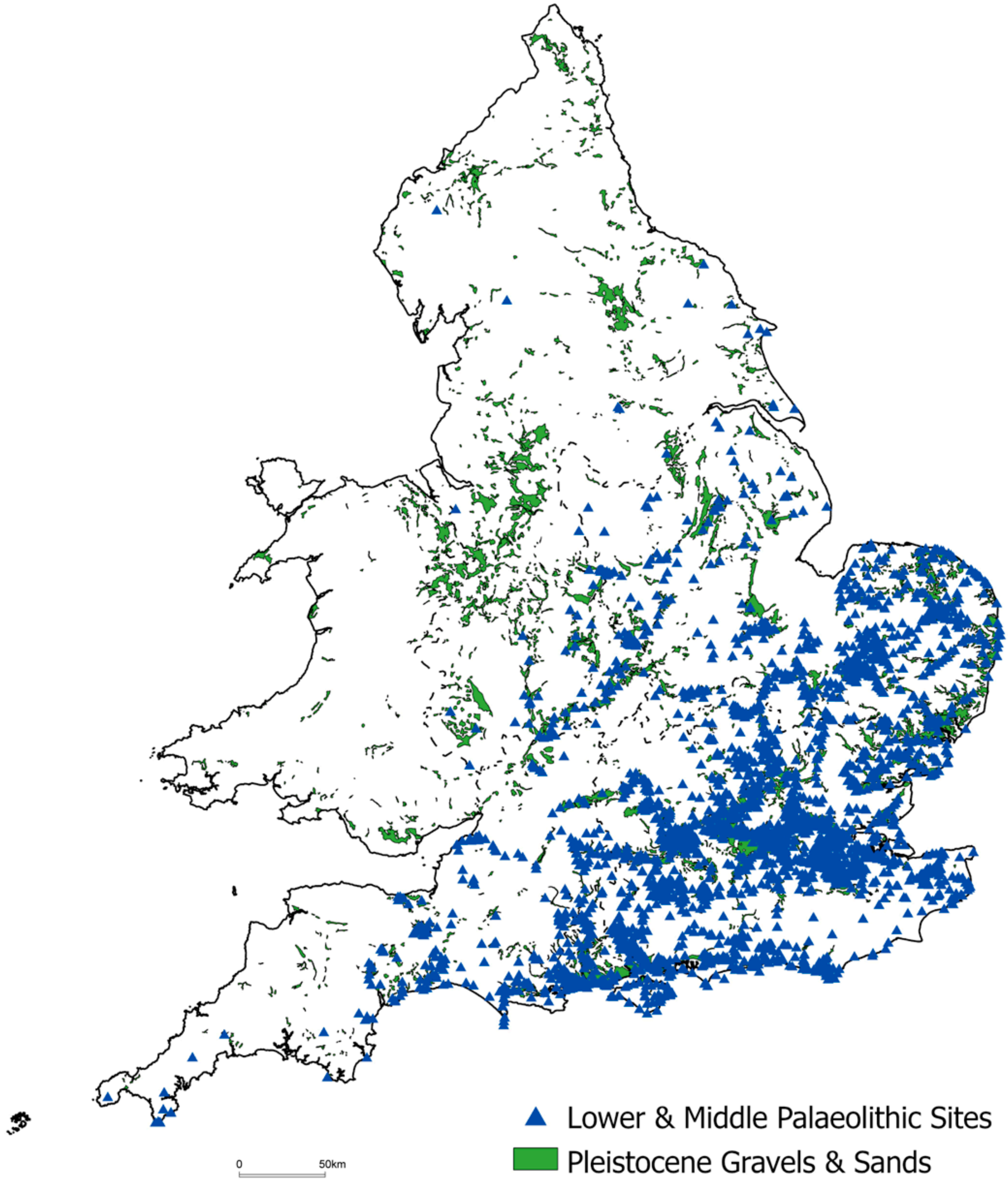
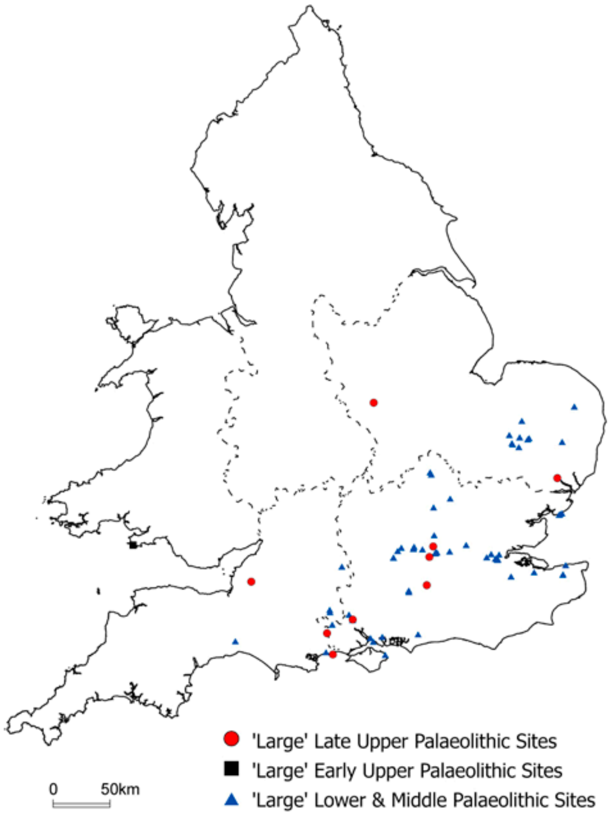


Figure 5: Distribution of Lower and Middle Palaeolithic sites and findspots, highlighting their spatial association with Pleistocene gravel and sand deposits. Site data derived from the English Rivers Palaeolithic Survey (TERPS: Wymer 1999; Mepham 2009), with later additions. Pleistocene sands and gravels data derived from the British Geological Survey (1:625,000 superficial geology mapping). Reproduced, with modifications, with the permission of the British Geological Survey ©UKRI. All Rights Reserved.



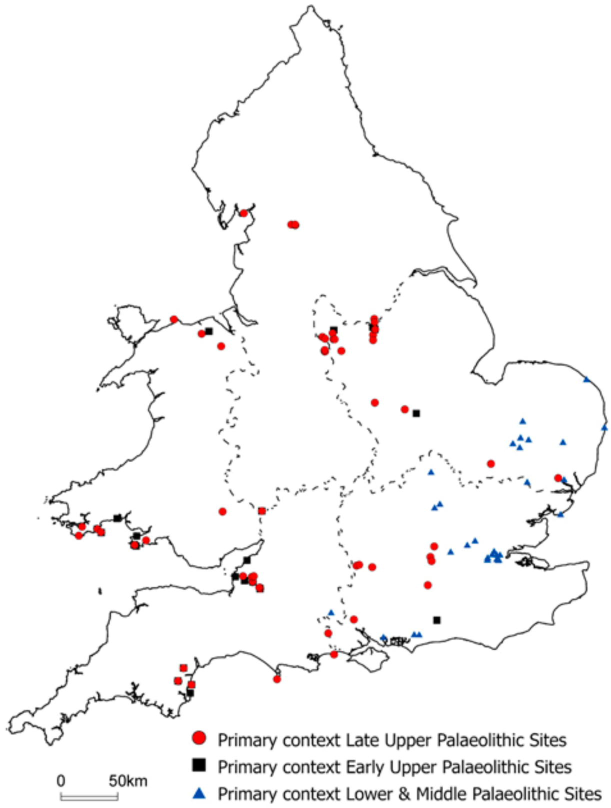


Figure 6: Distribution of 'large' Palaeolithic sites and findspots. Site data derived from the English Rivers Palaeolithic Survey (TERPS: Wymer 1999; Mepham 2009), the Gazetteer of Upper Palaeolithic Sites in England and Wales (Wymer and Bonsall 1977; Whyte 2011) and Campbell (1977), with later additions. 'Large' defined as 100+ cores, or 100+ Levallois artefacts (Middle Palaeolithic), or 250+ handaxes (Lower Palaeolithic), or 250+ retouched flakes/ blades (all Palaeolithic periods), or 500+ unretouched flakes/blades (all Palaeolithic periods), or some combination thereof.

Figure 7: Distribution of primary context Palaeolithic sites. Site data derived from the English Rivers Palaeolithic Survey (TERPS: Wymer 1999; Mepham 2009), the Gazetteer of Upper Palaeolithic Sites in England and Wales (Wymer and Bonsall 1977; Whyte 2011) and Campbell (1977), with later additions.

An important question concerns the extent to which the smaller site and artefact records in the Midlands and the North are a genuine reflection of the distribution of Palaeolithic hominins (i.e. a preference for the climates and landscapes of southern Britain), and if so, whether these patterns change from the earlier to the later Palaeolithic. Alternatively, it is possible that the smaller records in the Midlands and the North are a by-product of the destructive effects of glaciers (Figure 18) and/ or geographical bias in archaeological research (e.g. the potential for Palaeolithic evidence in midland and northern regions has sometimes been insufficiently considered because of the paucity of previous finds). For example, there is evidence for Upper Palaeolithic sites and artefacts in northern Britain (e.g. Ballin and Wickham-Jones 2017; Wymer and Bonsall 1977) and the broad contrast with the records for the Lower and Middle Palaeolithic periods may reflect the wider palaeoenvironmental tolerances of Upper Palaeolithic humans (*Homo sapiens*) or simply the greater preservation and visibility of material from this period. It is therefore important to note that because of the paucity of evidence from the Midlands and the North even relatively small occurrences of Palaeolithic remains may be of considerable significance and potentially meet criteria 2 for national importance ('Remains that belong to a period or geographic area where evidence of a human presence is particularly rare'; *see also* Section 4.4 and Panel B).

In the majority of Palaeolithic sites the number of artefacts is relatively small (Figure 6), or the artefacts have been re-worked from their primary context (Figure 7 and Panel D), although the latter is less typical in the case of the Upper Palaeolithic. Long-lasting interventions in a development context (e.g. as at Lynford Quarry or the Ebbsfleet Elephant site) are therefore rare occurrences. Moreover, it is important to recognise the value of both primary and secondary context Palaeolithic archaeology (Panel D).

Panel D: Palaeolithic archaeology – the contributions of primary and secondary context sites

Primary context Palaeolithic sites are those where sediments and artefacts have been minimally disturbed by geological agents (e.g. water or ice) and remain associated with the original landscape setting of the hominin activity (e.g. Boxgrove). Their value to Palaeolithic archaeology can be easily understood, as they can preserve artefact scatters, other activity residues (e.g. butchered animal bones), features (e.g. hearths), and direct associations between artefacts and their palaeoenvironmental context. However, such sites tend to represent small localities and short periods of Pleistocene time. By contrast, secondary context sites and findspots, where artefacts have been transported by geological agents, after being discarded by hominins (e.g. washed downstream by floodwaters, and then re-deposited in river gravel and sand deposits), can represent much larger areas and longer time-spans. While these sites and findspots typically lack the fine resolution of undisturbed primary context sites, their greater frequency and wider distribution mean that collectively they provide the overarching picture of the English Palaeolithic. Therefore secondary and primary context sites and findspots complement each other, and both are important for our understanding of the Palaeolithic.

The vast majority of artefactual evidence from the Palaeolithic is in the form of lithic (stone) tools and manufacturing debris. In the Chalk-rich landscapes of south-eastern England flint was predominantly used as a raw material, but away from this area other materials were utilised, such as chert in the South-West and quartzite in the Midlands (*see* the Trent case study). However, artefacts produced from organic raw materials can also be found, including wood (e.g. spears or digging sticks), antler (e.g. soft hammers, used in flint-knapping) and bone, although these are dependent on favourable preservation conditions.

5.2 The Lower Palaeolithic

The very earliest occupations of Britain (**Lower Palaeolithic**) are represented by the sites of Happisburgh 3 (MIS 25 or 21; 959–936 kya or 866–814 kya [for the MIS chronology *see* Section 6; all MIS ages are based on Lisiecki and Raymo 2005]) and Pakefield (MIS 19 or 17; 790–761 kya or 712–676 kya) on the coast of East Anglia (Figure 9). Both sites are represented by small numbers of **core and flake** technology artefacts (Figure 8) and appear to represent brief **hominin** visits to Britain. The hominin species associated with these sites is uncertain but may be ***Homo antecessor***, whose fossils are known only from the Atapuerca (Gran Dolina) site in northern Spain.

The Lower Palaeolithic record starts to increase in scale after about 600 kya, with a number of significant open-air sites appearing in East Anglia (e.g. Happisburgh 1, High Lodge, Warren Hill), where they are mainly associated with the deposits of the now-disappeared **Bytham River** (Figure 9) and with the warm stage climates of MIS 13 (533–478 kya). Boxgrove (West Sussex) also dates to late MIS 13, and is a key source of evidence for dietary strategies (probable hunting of medium-sized mammals such as horse), hominins (a tibia and teeth are thought to represent ***Homo heidelbergensis***), and handaxe technologies (Figure 10). Hominins appear to have been absent during the subsequent cold stage (MIS 12, 478–424 kya), which saw much of Britain covered by glaciers (Figures 16 and 18). As a general rule, cold stage occupations of Britain only appear to occur during the later Middle Palaeolithic (***Homo neanderthalensis***; Section 5.3) and Upper Palaeolithic (***Homo sapiens***; Section 5.4).

Figure 8: Lower Palaeolithic core (a), scraper (b) and flake (c) artefacts (Clactonian, from Clacton-on-Sea).

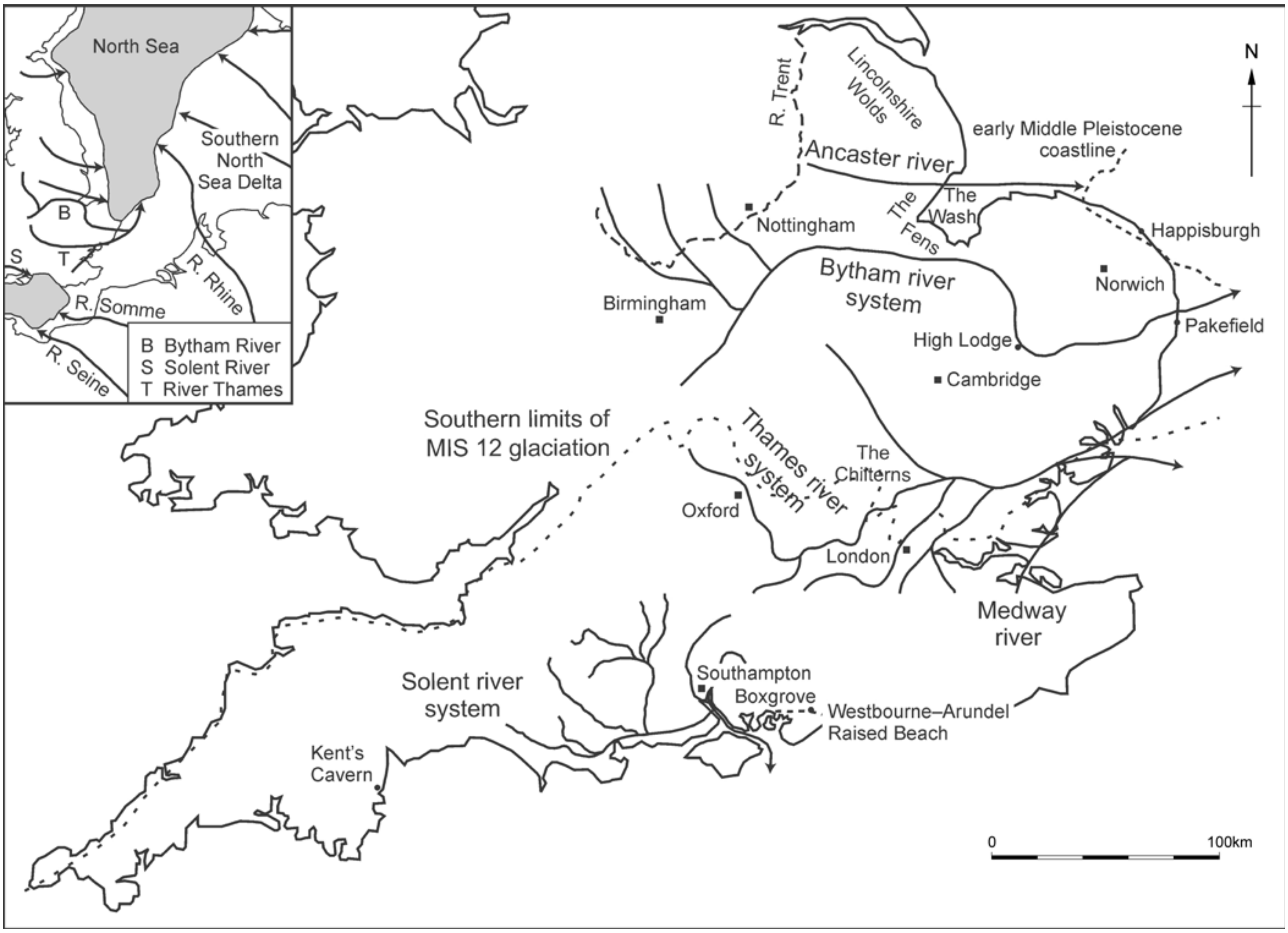


Figure 9: Pre-MIS 12 palaeogeography of Britain (modified after Hosfield 2011: fig. 1). The Bytham River was destroyed by the Anglian (MIS 12) glaciation and replaced by extant rivers (e.g. the Trent and the Ouse). The Anglian glaciation also shifted the Thames into its current position.

The Lower Palaeolithic archaeological record significantly expands after the **Anglian** glaciation (MIS 12), with increasing numbers of sites and artefacts. This is especially true in the East Anglian and Lower and Middle Thames landscapes, with several iconic Palaeolithic sites associated with MIS 11 deposits (424–374 kya), such as Hoxne and Barnham (Suffolk), Clacton (Essex) and Swanscombe (Kent). **Handaxes** (Figure 10) are abundant in many of these sites, but core and flake technologies (often referred to as **Clactonian**; Figure 8) are present on some sites (e.g. Clacton). The meaning of these different technologies remains an ongoing debate in Palaeolithic studies, with raw materials, site/task function and group traditions all highlighted as possible explanatory factors. The specific chronological relationships between these technologies is therefore of particular interest. Hominin fossil evidence is limited in this period, but the cranial fragments from Swanscombe have been described both as *Homo heidelbergensis* and as early *Homo neanderthalensis* – it is increasingly clear from evidence across Europe that the gradual emergence of Neanderthals began by at least 400 kya. Direct dietary evidence is limited, but there are key examples, most noticeably at the Ebbsfleet Elephant site in the Lower Thames. Britain's earliest evidence for controlled fire use may also date to this period (at Beeches Pit, Suffolk, dating to MIS 11).

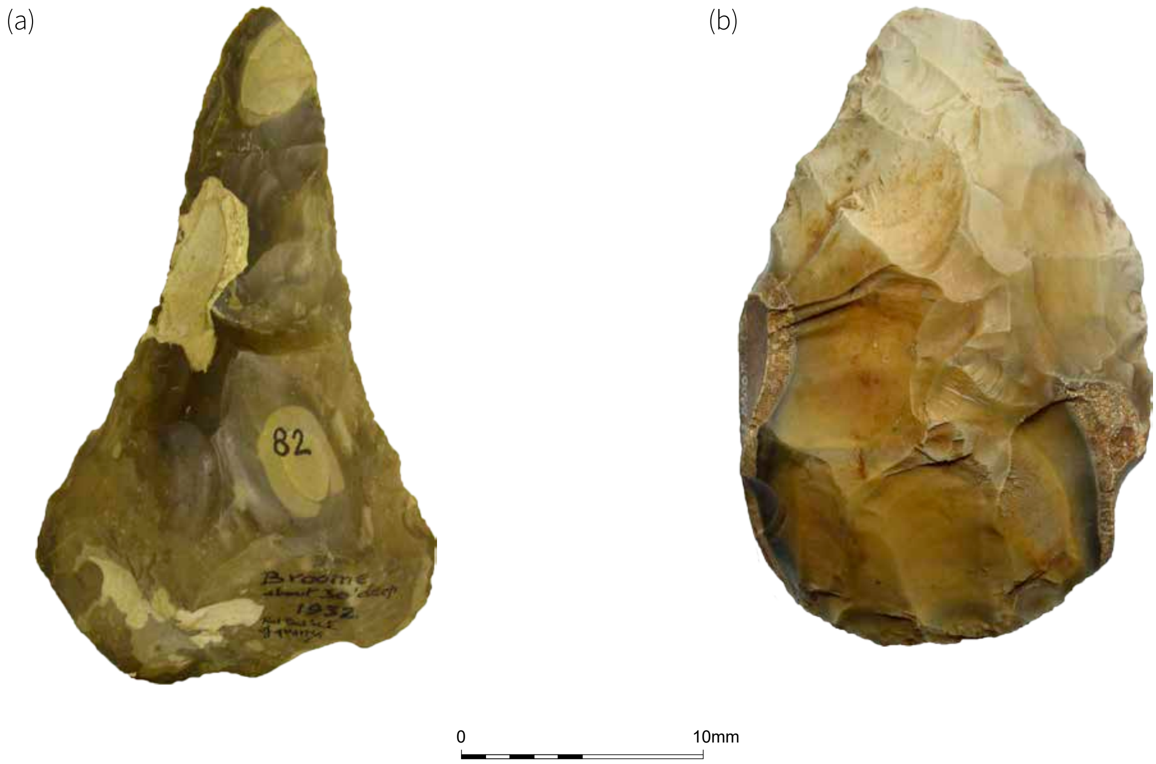


Figure 10: Lower Palaeolithic handaxes: ficron (a) and cordate (b).

Panel E: Britain is not an island…

Britain's connection with the continent fluctuated throughout the Pleistocene. Prior to the Anglian glaciation (MIS 12) there was a permanent connection, irrespective of global sea-levels. However glacial meltwaters at the end of MIS 12 breached the Dover–Calais landmass, and since then Britain has repeatedly cycled between island and peninsula status (Figure 11). These phases have broadly tracked climatic cycles, with island phases linked to warm interglacials and high sea-levels, and peninsula phases linked to cold glacials and low sea-levels, up to 100 metres below the present sea level. As a consequence of both climatic and sea-level fluctuations, Britain has been repeatedly occupied, abandoned and re-occupied throughout the Palaeolithic, by *Homo heidelbergensis* (e.g. abandonments during MIS 12 and 10), Neanderthals (e.g. abandonments during MIS 8, 6 and 4) and *Homo sapiens* (e.g. abandonments during the **Last Glacial Maximum** and the **Younger Dryas** in MIS 2; *see also* Figure 16). Increasingly, these occupation patterns are being related to artefact patterns, e.g. the changes in the dominant handaxe shapes between MIS 13, 11 and 9 during the Lower Palaeolithic period may reflect progressive replacements of one hominin group by another.

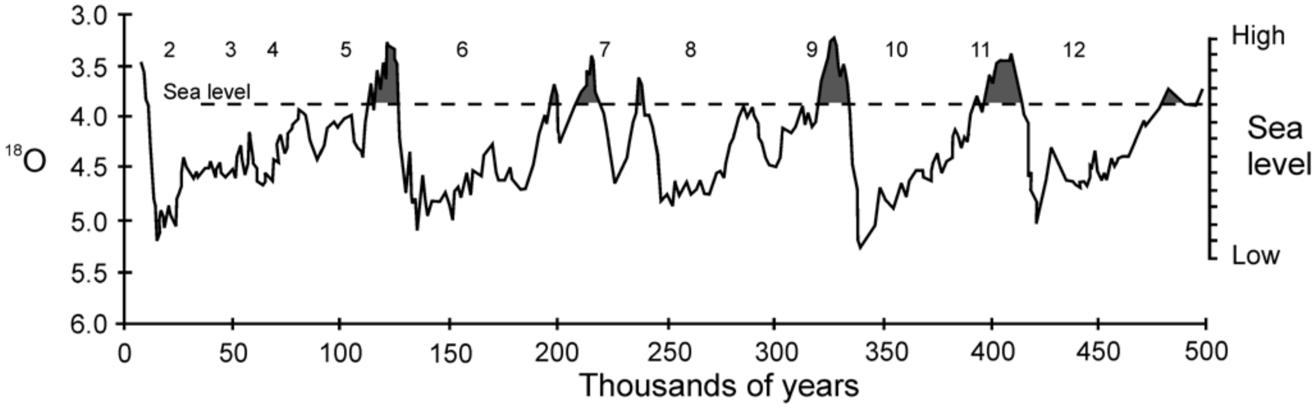


Figure 11: Britain's fluctuating geographical status (re-drawn after Ashton and Lewis 2002). Approximate island phases highlighted in grey.

The transition from the Lower to the **Middle Palaeolithic** starts to occur during MIS 9 (337–300 kya). This is reflected by the first appearance of Levallois technology (Figure 12) and the transition is best illustrated by the succession from core and flake and handaxe to **Levallois** technologies at Purfleet in the Lower Thames (Figure 19).

5.3 The Middle Palaeolithic

The British Middle Palaeolithic is commonly divided into early (MIS 8–7; 300–191 kya) and later (MIS 3; 57–29 kya) stages, separated by MIS 6–4. During both periods Britain was populated by Neanderthals, and the artefact record in the earlier Middle Palaeolithic is typified by Levallois technology. Key early Middle Palaeolithic sites are particularly concentrated in MIS 7 (243–191 kya) and are especially well known from the Lower Thames (e.g. Creffield Road, Crayford and Baker's Hole). Many of the largest sites (e.g. Baker's Hole) are focused around raw material sources. In some cases, primary context archaeology associated with buried landsurfaces (palaeosols) has been identified (e.g. at Crayford and Creffield Road). However early Middle Palaeolithic sites are also found elsewhere and in other contexts, most noticeably the cave-mouth occupations at Pontnewydd (North Wales) and the open-air occupation at Harnham (Wiltshire) associated with **interstadial** conditions towards the end of the MIS 8 cold stage (300–243 kya). Direct dietary evidence is again limited, but large mammal exploitation is suggested at Stanton Harcourt (Upper Thames) and other sites.

Figure 12: Early Middle Palaeolithic artefacts: Levallois core (a), flake scraper (b) and Levallois point (c).

Panel F: Palaeolithic climates – a world apart?

Palaeoclimatic research has increasingly revealed the dynamism and complexity of our Pleistocene past. While the earliest 19th century debates explored whether humans were strictly post-glacial, the 20th century saw an increasing acceptance of multiple 'ice ages'. Yet it has been the marine and ice core research of the last 50 years which has enabled us to appreciate more fully the scale and rapidity of past climate change. The isotope signals of oxygen suggest past temperature shifts of several degrees over just a few decades: older notions of long-lasting and relatively unchanging Pleistocene climates have melted away. The study of Pleistocene climates and environments, and human responses to them, is therefore of considerable value as we face our own, self-inflicted, climate crisis.

Current evidence then suggests a long period of abandonment of Britain, spanning two cold intervals (MIS 6 and MIS 4; 191–130 kya and 71–57 kya) but also the warmer conditions associated with parts of MIS 5 (130–71 kya). The reasons for this general absence, particularly in MIS 5, are the subject of ongoing debates. However two flakes have been identified in MIS 5 deposits in Dartford (Wenban-Smith et al 2010) – any new artefact discoveries from deposits of these ages will further transform these debates, and will meet criterion 2 for national importance ('Remains that belong to a period or geographic area where evidence of a human presence is particularly rare'; *see also* Section 4.4).

The later Middle Palaeolithic (associated with MIS 3, 57–29 kya, although the period ends around 40 kya) sees the return of Neanderthals to Britain. There are relatively few sites, in both open-air and cave settings (e.g. Pin Hole and Robin Hood Caves at Creswell Crags, Derbyshire/ Nottinghamshire), and numbers of artefacts are often small. This archaeological record probably reflects seasonal hunting parties rather than permanent occupations. Unlike the early Middle Palaeolithic, the characteristic technology of the later Middle Palaeolithic is small, flat-bottomed handaxes, known as ***bout coupés*** (Figure 13). The key open-air site at Lynford suggests exploitation of mammoths by Neanderthals, although the exact nature of this (e.g. hunting and/or scavenging) is uncertain. The final stages of the later Middle Palaeolithic, around 40 kya, see the appearance of **leaf-point** technologies (Figure 14), at sites such as Beedings (West Sussex). A key ongoing question is whether these are the tools of the last Neanderthals or the first modern humans (*Homo sapiens*).

Figure 13: Middle Palaeolithic *bout coupé* handaxe from Lynford.

5.4 The Upper Palaeolithic

The British **Upper Palaeolithic** (MIS 3–2; 43–11.7 kya) is divided by the **Last Glacial Maximum** (LGM; 31–16 kya), during which time humans are again apparently absent from Britain. During the Late Glacial (14.7–11.7 kya), short cold intervals such as the Younger Dryas (12.9–11.7 kya) led to further periods of human abandonment. Lithic artefacts throughout the Upper Palaeolithic are dominated by blade-based technologies (e.g. backed blades, endscrapers, burins and points; Figure 15), with specific types varying between sub-periods. There is also a wide range of organic artefacts, including bone harpoons and points. Evidence from elsewhere in Europe indicates complex clothing and shelter technologies during this period. Key British sites include: Gough's Cave (Somerset), with evidence for cannibalism; Three Ways Wharf (Uxbridge), with evidence of reindeer and horse butchery; Paviland (South Wales), with evidence for burial and personal decorative items; and Creswell Crags, to date Britain's only known Upper Palaeolithic cave art.

Figure 14: Middle Palaeolithic leaf point from Beedings.

Panel G: Diagnostic artefacts – a blend of technology and typology

Handaxes and **scrapers**: typological categories or functional (technological) descriptions? In truth, probably a bit of both. Many of our tool names date back to the earliest days of the archaeological discipline, and their adoption reflected assumptions about the tools' uses, often derived from ethnography. Over time, many of these names became formal typological labels, often crystallising perceptions of their functions. Certain tool types were also burdened with further archaeological baggage, often in the quest to establish robust chronologies. For example, the division of handaxes into sub-categories, based on perceived notions of their quality and the assumption that increasingly well-made artefacts progressively appeared over time, underpinned much of Lower Palaeolithic archaeology in the first half of the 20th century. However, absolute dating has challenged those simplistic notions of progression through time, although the key sub-divisions (Lower Palaeolithic: handaxes; Middle Palaeolithic: Levallois; Upper Palaeolithic: **blade technology**) have broadly survived. Moreover, use-wear studies are increasingly challenging single-use interpretations (Middle Palaeolithic scrapers, for example, appear to have been used to work all sorts of organic and inorganic materials).


(a)
(b)
(c)
(d)
(e)
(f)
(g)
0
10mm

Figure 15 (page 42): Upper Palaeolithic artefacts: blade core (a), blade (b), backed blade (c), end scraper (d), shouldered point (e), awl/piercer (f) and burin (g).

Panel H: Palaeolithic mapping projects

The Palaeolithic occupation of Britain has been documented in a range of projects. The Lower and Middle Palaeolithic record was synthesised in the English Rivers Palaeolithic Survey (TERPS) project during the 1990s – the site records can be accessed at: https://doi.org/10.5284/1000063 (Mepham 2009). The Upper Palaeolithic record was synthesised in Wymer and Bonsall (1977) – the site database can be accessed at https://doi.org/10.5284/1000181 (Whyte 2011). This should be used in combination with the Palaeolithic and Mesolithic Lithic Artefact (PaMELA) database, which can be found at: https://doi.org/10.5284/1028201 (Wessex Archaeology and Jacobi 2014).

The Aggregates Levy Sustainability Fund (ALSF) supported a wide range of projects exploring Palaeolithic artefacts, sites and landscapes – a full list of ALSF-funded Palaeolithic project resources can be found at: https://library.thehumanjourney.net/2795/55/Lost%20Landscapes-Appendix1-2.pdf.

Recent projects of note are:

- Mapping Palaeolithic Britain project (https://www.qmul.ac.uk/geog/research/research-projects/mappingpalaeolithicbritain);
- Medway Valley Palaeolithic Project (https://doi.org/10.5284/1000073);
- Stour Basin Palaeolithic Project (https://doi.org/10.5284/1046264);
- Trent Valley Palaeolithic Project (https://doi.org/10.5284/1000361);
- Palaeolithic Archaeological Potential of Pleistocene Deposits in England project (https://www.winchester.ac.uk/research/exploring-the-past-and-the-world-around-us/research-projects-exploring-the-past-and-the-world-around-us/the-palaeolithic-archaeological-potential-of-pleistocene-deposits-in-england-project/index.php).

The BGS Pleistocene deposit mapping can be accessed through the iGeology app (https://www.bgs.ac.uk/igeology/).

Finally, there has been a series of important HER-enhancement projects for Palaeolithic archaeology, based in West Berkshire, Essex, Kent (Stour Basin project: *see above*), Norfolk, Suffolk, South and West Yorkshire and Worcestershire (*see also* the Worcestershire case study and https://historicengland.org.uk/research/current/discover-and-understand/early-prehistory/raising-awareness-of-early-prehistory/):

- Tracing their Steps: Predictive Mapping of Upper Palaeolithic and Mesolithic archaeology – A Case Study of the Middle Kennet Valley (https://research.historicengland.org.uk/Report.aspx?i=16469);
- Managing the Essex Pleistocene (https://research.historicengland.org.uk/Report.aspx?i=15804);
- Enhancement of Early Prehistoric Information Within the Norfolk Historic Environment Record (https://research.historicengland.org.uk/Report.aspx?i=15808);
- Palaeolithic and Mesolithic Suffolk (https://heritage.suffolk.gov.uk/palaeolithic-mesolithic);
- Enhancing the Palaeolithic and Mesolithic Records of the South Yorkshire SMR (https://research.historicengland.org.uk/Report.aspx?i=15806);
- Revised Report on the Enhancement of the West Yorkshire Historic Environment Record for the Palaeolithic and Mesolithic Periods (https://research.historicengland.org.uk/Report.aspx?i=15807).

6 The Pleistocene record

This section provides a short summary of the Pleistocene framework for the British Palaeolithic record (Figure 16) and reviews the key evidence and methodologies used to reconstruct and date Pleistocene environments. It is primarily intended for curators who are relatively unfamiliar with the period, and complements the summaries of the Palaeolithic record (Section 5) and key Pleistocene deposits (Section 7).

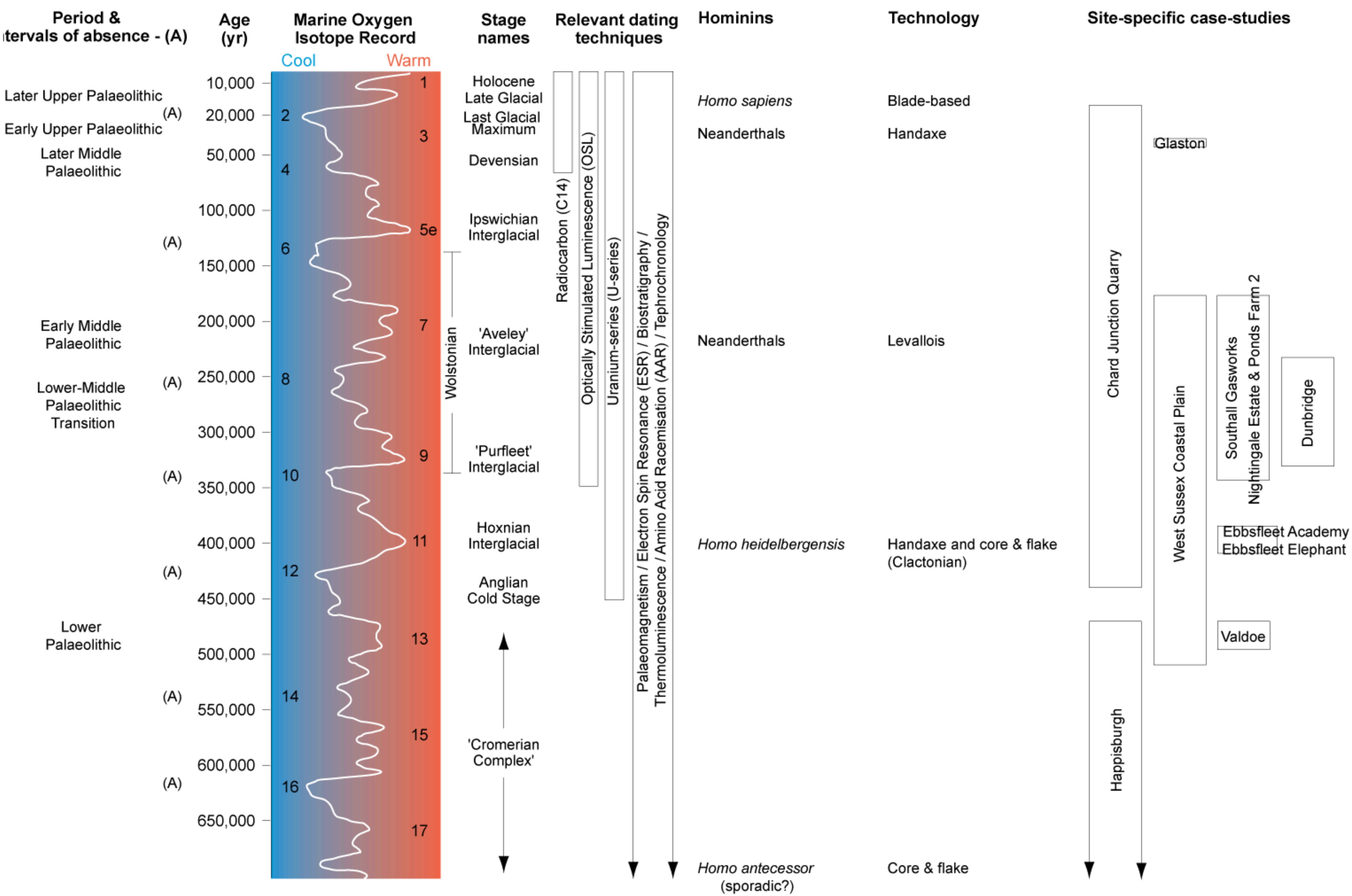
To establish the significance of Palaeolithic and palaeoenvironmental remains that come to light during site investigations we need to understand the history of environmental change during the Pleistocene. There are two separate but related strands that can be explored: (1) the evidence for environmental conditions (Section 6.1); and (2) the opportunities for dating that evidence (Section 6.2).

To provide some context, the Palaeolithic occurs in the geological epoch known as the Pleistocene which is split into Early (2.588 mya [millions of years ago] to 780 kya [thousands of years ago), Middle (780 to 128 kya) and Late (128 to 11.7 kya) sub-divisions. It has been further divided into a number of stages known as Oxygen Isotope Stages (OIS) or Marine Oxygen Isotope Stages (MIS), that are linked to broad global fluctuations in climate. Some of these stages have traditional names, which are summarised in Figure 16.

6.1 The environmental evidence

The Pleistocene deposits described in Section 7 provide an important indication of the landscape setting in which they were deposited – such as **meandering river**, **braided river**, lake, pond, glacier and marine beach. Where the remains of plants or animals are present, their known

Figure 16 (page 46): Key Palaeolithic periods and Pleistocene stages, with Marine Oxygen Isotope Stage (MIS) numbers and commonly used Stage names. Intervals of absence, hominins and technologies are based on current knowledge of the British Palaeolithic and may change as new finds come to light. Spans of relevant dating techniques are based on the forthcoming Historic England guidance on Scientific Dating of Pleistocene Sites. Specific case-study timeframes are approximate, *see* individual case studies for chronological details.



(Happisburgh site 3 is dated to MIS 21 or 25 (c. 850 or 950kya), and is currently the only British Palaeolithic site that pre-dates Pakefield at c. 700kya) habitat preferences provide an indication of environmental and climatic conditions when they were alive. The larger the number of different plants and animals represented in a deposit, the more reliable the interpretation of the environmental conditions.

Recording and interpreting the palaeoenvironmental evidence is important even when there are no associated archaeological remains. This is well demonstrated in the Nightingale Estate/Ponds Farm case study. The more we know about past environmental conditions, the easier it becomes to recognise those that favoured the Palaeolithic human occupation of Britain.

Plant remains are the key to past patterns of vegetation which in turn are largely a response to climate. Pollen can provide information about both local and regional vegetation. Plant macrofossils are a more reliable indication of local conditions.

The habitat preferences of terrestrial animals such as mammals, reptiles, insects and land snails can provide information about climatic conditions including temperature, rainfall and seasonality, which are closely related to the type of vegetation they would have occupied – such as broad-leaf woodland, coniferous woodland, grassland and marshland. Using the habitat preferences of insects in **Mutual Climatic Range** (MCR) calculations can determine the mean summer maximum and winter minimum temperatures experienced by the insect assemblage.

The habitat preferences of aquatic plants and animals such as fish, amphibians, snails, ostracods, diatoms and foraminifera (Tables 5 and 6) provide similar information about climatic conditions as well as the water body they occupied – such as standing or running water, intertidal or subtidal, water depth, bottom conditions and vegetation.

The type of plant and animal remains recorded from a deposit will vary according to the type of sediment (an indication of sediment/environment types with favourable preservation conditions is provided in Tables 5 and 6). For example, pollen is best preserved within fine-grained waterlogged deposits but tends not to preserve well in calcareous and/or coarse-grained deposits. By contrast, molluscs preserve well in calcareous sediments. In addition, post-depositional processes such as bioturbation, or the drying out of an organic-rich unit, can affect preservation of remains within any given sediment. It should also be noted that the concentration and preservation of plant and animal remains can vary both temporally and spatially within Pleistocene deposits.

Further information about the various techniques used for palaeoenvironmental reconstruction is detailed in Tables 4–6, and in the Historic England guidance on *Geoarchaeology* and *Environmental Archaeology*.

Table 4: Geoarchaeological techniques for sediment analysis.

Evidence	Information it gives us	Where can it be used?	Where can I find out more?
Geoarchaeology	(analysis of the sediments)		
Sediment descriptions	Description of the sedimentary sequences provides important, primary information on the nature of the depositional environment through time. For example, sands and gravels indicate deposition within a high-energy fluvial environment, such as a braided river system, during cold climatic conditions. Fine-grained mineral sediments, such as silt or clay, indicate deposition in a low-energy environment, such as a lake, pond or slowly moving river. Soil and peat formation indicate the formation of semi-terrestrial or fully terrestrial conditions resulting in the colonisation of vegetation adapted to the specific local conditions.	All environments	Historic England geoarchaeology guidance The Description and Analysis of Quaternary Field Sections (Jones et al 1999)
Deposit modelling	This technique uses existing information to map the distribution of deposits across a site or landscape through the creation of transects, contoured maps and/or 3D-models. These can be used to: (1) help understand the former landscapes and environmental changes that took place over space and time, and (2) identify areas of greater and lesser Palaeolithic and/or palaeoenvironmental potential. This in turn enables subsequent fieldwork to be focussed and the context of any remains to be better understood.	All environments	Historic England Deposit Modelling guidance, including Bytham case study (Howard et al) Relevant case study: Southall Gasworks

Evidence	Information it gives us	Where can it be used?	Where can I find out more?
Geoarchaeology	(analysis of the sediments)		
Micromorphology	This is an established technique that can provide information about sediment and soil formation on a microscopic level. The identification of sediment-forming processes, not visible to the naked eye, can provide important cultural and environmental information at a high resolution, such as the identification of depositional events/processes (e.g. palaeosols) and presence of micro-artefacts.	All environments	Historic England geoarchaeology guidance
Physical properties	Various tests can be undertaken to characterise the physical properties of individual sedimentary units. These can include organic matter and calcium carbonate content, particle size and shape analysis, clast lithology, magnetic susceptibility, peat humification and geochemical analysis. Such analyses can help to characterise the origin of the material (e.g. the bedrock material), the mode of deposition (e.g. fluvial, windblown) and any post-depositional processes (e.g. soil development, burning)	All environments	

NB: This table is not an exhaustive list of available techniques and the information they can provide, but documents those most frequently used within / associated with the Palaeolithic period.

Table 5: Archaeobotanical/palaeobotanical techniques for analysis of plant remains.

Evidence	Information it gives us	Where can it be used?	Where can I find out more?
Palaeobotany	(analysis of plant remains		
Pollen	The analysis of pollen grains and spores (palynology) is a widely used technique that can provide valuable information on vegetation composition, structure and succession, plant migration, climate change, potential human modification of the natural vegetation cover and diet.	Best preserved in fine-grained waterlogged deposits. Does not preserve well in calcareous and/or coarse-grained sediment.	Historic England Environmental Archaeology guidance
Phytoliths	Phytoliths are small (5-50µm) opaline silica bodies produced by plant cells from silica and water. Herbs, including grasses, and woody taxa can be differentiated. Unlike other techniques, specific parts of the plants can be identified, such as stems, leaves or husks. They are often preserved where other microfossils are commonly absent, including dry, alkaline and aerobic conditions.	All sediments	
Diatoms	Diatoms are unicellular algae, with different species occupying the bottom of, or floating within, water bodies (e.g. oceans, lakes, ponds, rivers, salt marshes), and living in soil and on trees. They are valuable because species are indicative of a wide variety of environmental conditions (e.g. marine, brackish or freshwater) and changes in temperature, salinity, pH, oxygen and mineral content.	Fine-grained deposits	

Evidence	Information it gives us	Where can it be used?	Where can I find out more?
Palaeobotany	(analysis of plant remains		
Plant remains	Seeds and other plant components (e.g. stems, leaves, buds) preserved in either a waterlogged, charred or mineralised state may provide valuable information on vegetation history, climate change and diet. Plant remains can also be suitable for radiocarbon dating.	Wet to waterlogged sediment (uncharred); all sediments (charred)	Historic England Environmental Archaeology guidance
Waterlogged wood and charcoal	Wood preserved by anaerobic, waterlogged conditions or burning (charcoal) can provide primary data on woodland composition, and hence vegetation history, fire, and material culture (wooden artefacts) and local environmental conditions.	Wet to waterlogged sediment (uncharred); all sediments (charcoal)	

NB: This table is not an exhaustive list of available techniques and the information they can provide, but documents those most frequently used within / associated with the Palaeolithic period.

Table 6: Zooarchaeological techniques for analysis of animal remains.

Evidence	Information it gives us	Where can it be used?	Where can I find out more?
Zooarchaeology	(analysis of animal remains)		
Insects	Insects can provide valuable information on regional and local environmental conditions, human and animal diet. Insects also have the potential to provide quantitative terrestrial palaeoclimatic records using the Mutual Climatic Range (MCR) method, based upon the modern climatic ranges of selected species in the fossil record.	All sediments	Historic England Environmental Archaeology guidance

Evidence	Information it gives us	Where can it be used?	Where can I find out more?
Zooarchaeology	(analysis of animal remains)		
Mollusca	Mollusca are preserved on land (e.g. soil, mires), and in freshwater (e.g. lakes, rivers), brackish water (e.g. high salt marsh) and marine (e.g. estuaries) sediments where there is an adequate amount of calcium carbonate. They have the potential to provide palaeoenvironmental reconstructions, which are dependent on recording species with particular climatic or habitat ranges.	Calcareous sediments	Historic England Environmental Archaeology guidance
Ostracoda	Ostracods (Ostracoda) are aquatic invertebrates, with species occupying the bottom of, or floating within, the water body. They are highly sensitive to changes in salinity, as well as rainfall, temperature and alkalinity.	Waterlain deposits	
Foraminifera	Foraminifera are organisms found in saline habitats from salt marsh to deep oceans. They are good indicators of changes in water depth, salinity and climate.	Brackish and marine sediments	
Vertebrates	Vertebrates, animals with backbones, are divided into five classes: mammals, birds, reptiles, amphibians, and fish. Bones and teeth are the most commonly preserved body parts, and on the majority of sites these tend to be dominated by mammalian skeletal elements. Studies of vertebrate remains allow a range of insights into human–animal relationships including palaeoenvironmental reconstruction and diet, and Pleistocene stratigraphy and relative dating.	Best preserved in calcareous sediment but found in a wide range of other sediment types	

NB: This table is not an exhaustive list of available techniques and the information they can provide, but documents those most frequently used within / associated with the Palaeolithic period.

6.2 Dating the Pleistocene

6.2.1 Geochronological methods

There are two main ways of dating events in the Pleistocene. Firstly, there are geochronological methods which analyse key physical or chemical characteristics of material remains with a view to obtaining absolute dates or results that can be used to construct relative chronologies. Further information about the various geochronological methods used for dating the Pleistocene reconstruction is detailed in Table 7, and in the Historic England guidance on *Scientific Dating of Pleistocene Sites* (forthcoming).

6.2.2 Stratigraphic methods

Stratigraphic methods rely on an understanding of how the physical landscape evolved in the Pleistocene or on knowledge of the stratigraphic range of individual species or combinations of species (Table 7). These methods can be used to construct relative chronologies.

Some of the most robust relative chronologies have been inferred from river terrace and raised beach sequences (Figures 19 and 20), based on the understanding that the British landmass has been subject to **tectonic** uplift throughout the Pleistocene and therefore higher elements in **river terrace** and raised beach sequences are generally older. There are complications in the more northerly parts of Britain associated with the effects of glaciation (isostatic depression and rebound).

The relative age and age range of deposits can also be inferred from the presence, or less reliably the absence, of animal and plant species with known age ranges (e.g. the presence of hippopotamus in MIS 5e / the Ipswichian Interglacial), or with a known stratigraphic level for their first or last appearance in the Pleistocene record.

Table 7 (page 54): Geochronological techniques (dating methods).

Palaeolithic technology, i.e. the characteristics of stone tools and the techniques used to prepare them, can also be used to identify major time periods in the Pleistocene (Section 5 and Figure 16).

Geochronology	(dating methods)	
Method	Summary	Materials
Radiocarbon dating	Radiocarbon (C14) dating can be carried out on a wide range of organic materials including: wood, charcoal, seeds, insects, bone/teeth, pollen, Ostracoda, Foraminifera, Mollusca, peat and organic sediment, and can be applied to materials up to 50,000 years old.	Organic remains / sediments
Luminescence dating	Optically Stimulated Luminescence (OSL) and Thermo-Stimulated Luminescence (TL) date the last time sediments were exposed to sunlight or heat, which resets the luminescence signal. It is a technique most often used on mineral-rich sediments and artefacts (e.g. struck flint) and can be applied over the last 500,000 years (depending on the source geology).	Mineral-rich sediments (OSL) and struck flints (TL)
Uranium series	Uranium (U) series dating can be used to provide ages for a range of different materials, and can be applied to materials over the last 450,000 years.	Carbonates, speleothems, molluscs, bone and peat
Amino Acid Racemisation	This technique measures the changes in amino acids in biological materials as an estimate of age over the last 400,000 years.	Biological material (especially molluscs)
Electron Spin Resonance	Electron Spin Resonance (ESR) detects the presence of electron charges trapped in biological and minerogenic material. The intensity of the ESR signal is a measure of the accumulated dose and can be used as an age estimate.	Carbonates and burnt flint
Biostratigraphy	A relative dating technique based around species' distributions and evolution, as expressed through the first and last appearance dates of specific taxa. A particularly good example of this technique is the 'Vole Clock', which tracks key changes in the dentition of Pleistocene water voles.	Biological remains (plant and animal)
Tephrochronology	The use of volcanic ash layers (tephras) to determine the age of associated sediments. Dating is either by comparison with previously recorded eruptions, or through direct dating of the tephra or associated material.	Tephra in stratified organic or inorganic sediments
Palaeomagnetism	The method exploits past changes in the earth's magnetic field. Magnetic signals can be recorded in igneous rocks, heated artefacts or sediments forming in marine or lake environments.	Igneous rocks, heated artefacts and/or marine/lake sediments
Age-depth modelling	Statistical calibration software can be used to combine multiple dates with stratigraphic information to create continuous chronologies for sequences, thus enabling age estimates for changes recorded in parts of the sedimentary or palaeoecological record that cannot be dated directly.	On all dating methods

7 Pleistocene deposits: origin, archaeological and palaeoenvironmental potential

This section provides a short summary of the key Pleistocene deposits with which Palaeolithic remains are associated and which, even in the absence of such remains, may contain palaeoenvironmental evidence critical for an understanding of the landscapes in which Palaeolithic artefacts were produced. It is primarily intended for curators who are relatively unfamiliar with the period, and complements the summaries of the Palaeolithic record (Section 5) and the evidence and methods used to reconstruct and date the Pleistocene (Section 6).

7.1 The Pleistocene geological record

Pleistocene deposits are geological deposits laid down during the Pleistocene epoch. Geologists tend to regard them as distinct from 'bedrock' and use the term '**superficial deposit**' when describing them. The terms 'drift deposit' or simply 'drift' were also widely used in the past and are still found occasionally in the modern literature.

Geological nomenclature can be confusing. Deposits of the same age, in different parts of the country, sometimes even in the same river basin, may have different names. In addition, as the understanding of **Quaternary** stratigraphy has evolved, new interpretations have led to the renaming of deposits. However, old names do not go away and may be encountered in key reference sources. This is another reason why expert advice is key when curating the Palaeolithic resource.

Pleistocene deposits contain much of the evidence for the Palaeolithic occupation of Britain, mostly in the form of stone tools. Of equal importance is the preservation of palaeoenvironmental remains, including pollen, seeds and other parts of plants, bones and teeth of animals, insects, snails and various microscopic plant and animal

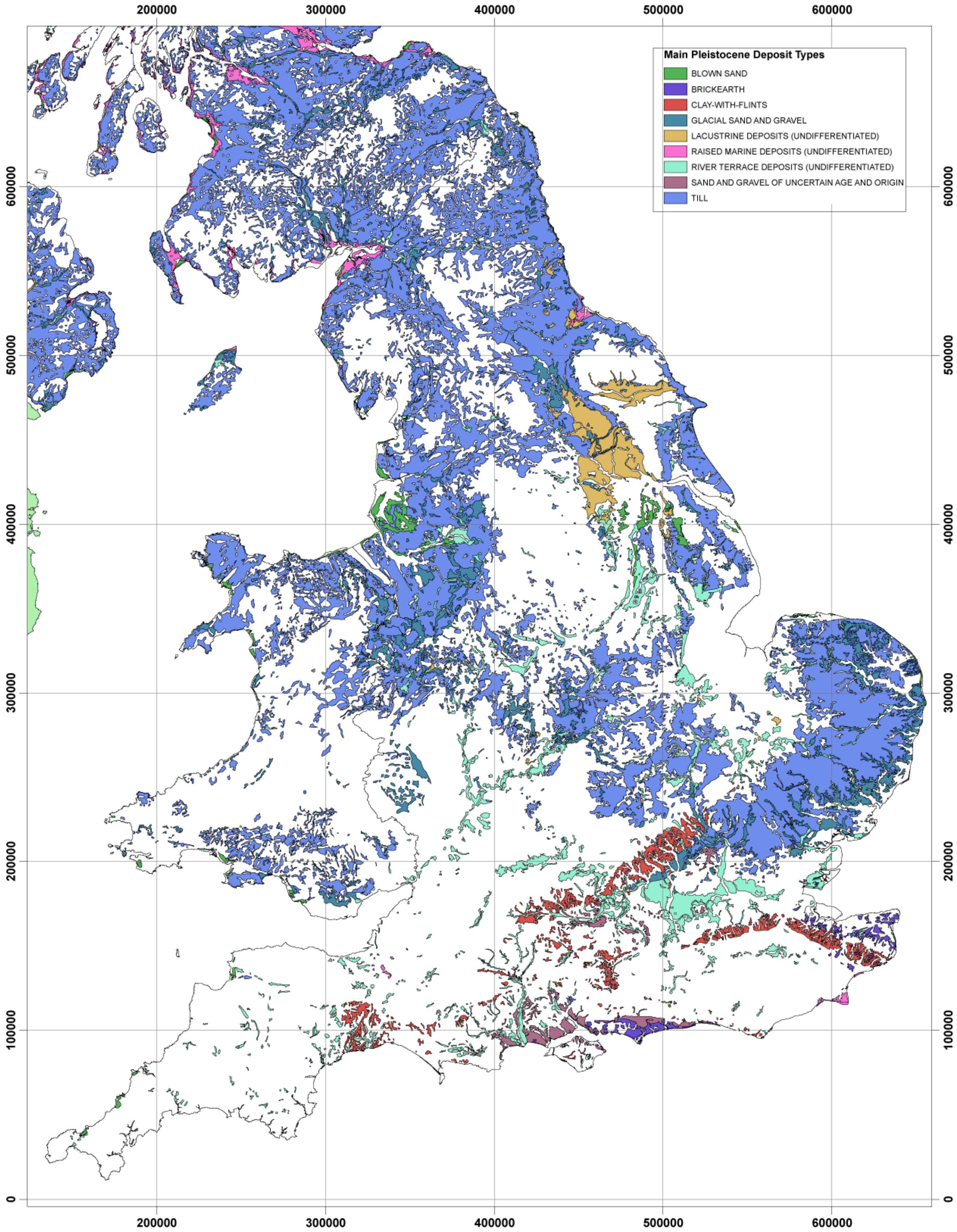
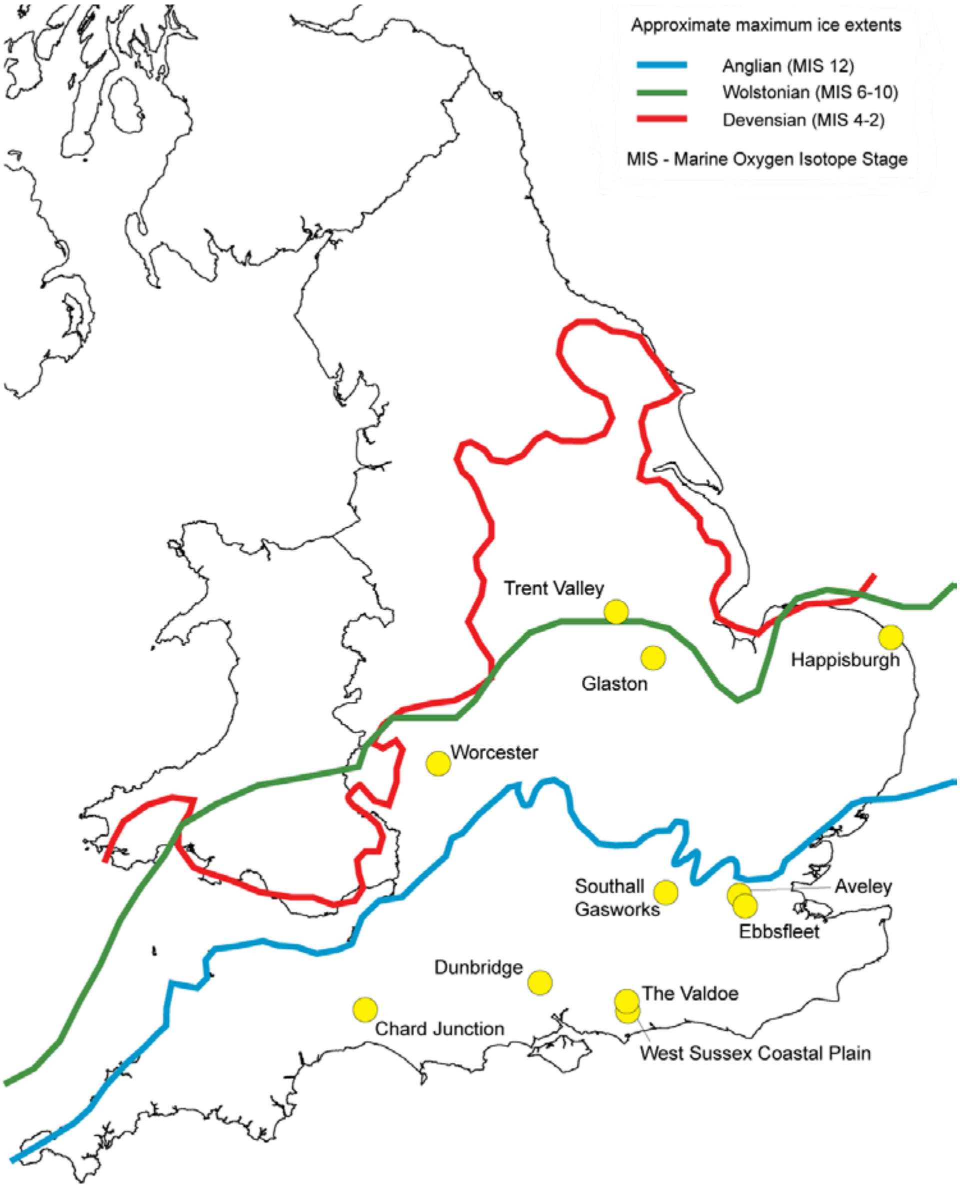


Figure 17: Distribution of main Pleistocene deposit types. Reproduced, with modifications (selected superficial Pleistocene deposits removed), with the permission of the British Geological Survey ©UKRI. All Rights Reserved. Thin superficial deposits (<1.0m) and those of limited extent may not be represented, thus unshaded areas do not necessarily imply an absence of Pleistocene deposits.

Figure 18: Limits of British glaciations and locations of case studies.



taxa. This biological material and the deposits themselves provide the evidence used to reconstruct the habitats in which the Palaeolithic occupation of Britain occurred.

In dynamic environments such as river floodplains, glaciated terrain, caves and marine beaches, individual deposits may represent deposition in spatially limited settings, such as floodplain ponds; and/or during short periods of time, sometimes as short as a single flood event or a single tidal cycle. As a result Pleistocene deposits may be locally variable with different types of deposit intimately juxtaposed in their stratigraphic relationships and in their spatial distribution. Where found, long and continuous records are therefore particularly valuable for their insights into palaeoenvironmental change, e.g. the lake deposits at Marks Tey (Essex). Deposit-led or deposit-centred approaches are critical to understanding the Pleistocene and Palaeolithic records (*see also* Section 3.3.1 and Historic England's *Deposit Modelling* Guidance). A Pleistocene specialist should be involved in the interpretation of such deposits.

The main types of Pleistocene deposit are described briefly in the following paragraphs with comments on their Palaeolithic and palaeoenvironmental potential. Their approximate distribution in England can be seen in Table 8 and Figure 17. When reading this section and Table 8 it is important to bear in mind the factors affecting the overall distribution of Palaeolithic and palaeoenvironmental remains in England. Of particular importance is the widespread destructive impact of glaciation on all remains, including pre-glacial Pleistocene deposits in Midland and northern England and the scarcity of evidence for Palaeolithic occupation north and west of a line approximately from the Humber to the Severn (Figure 18; *see also* Section 5 and Figure 4).

7.2 River deposits

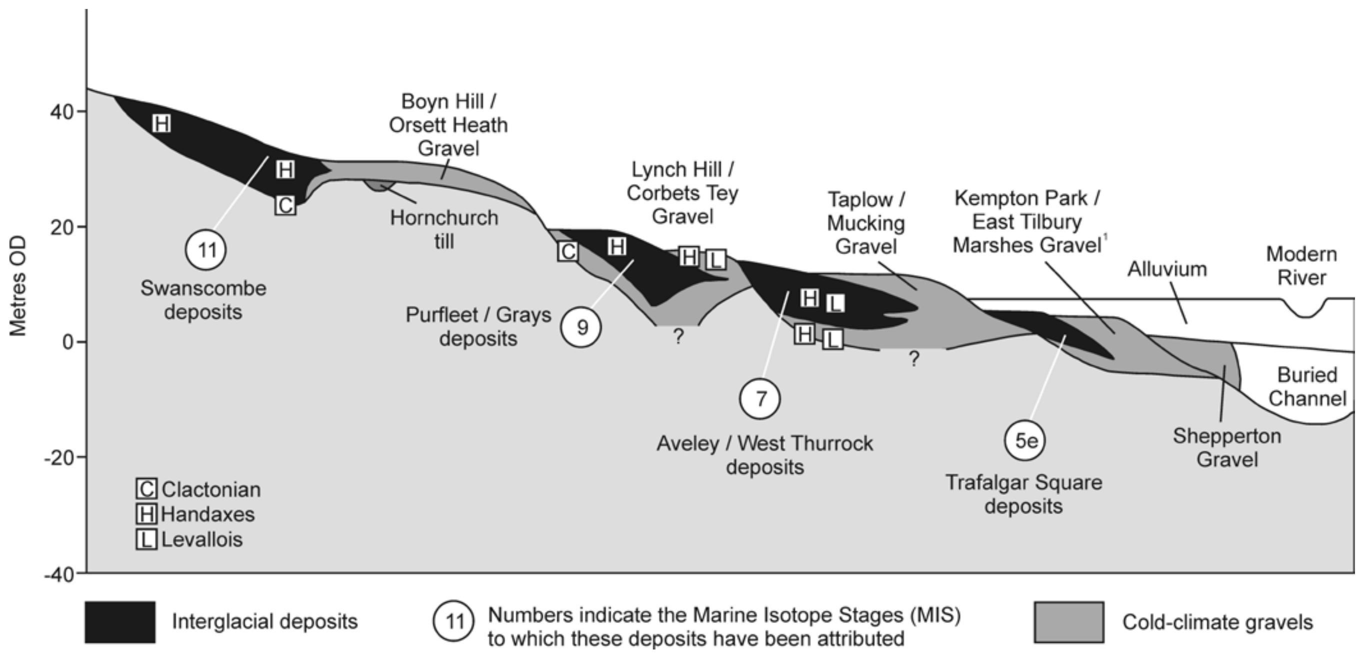
Relevant project case studies: Happisburgh; Ebbsfleet Academy; Ebbsfleet Elephant; Southall Gas Works; Nightingale Estate/Ponds Farm; The Trent; Dunbridge; Chard Junction.

Distribution: (Figures 17 and 21; Table 8) widely distributed in all regions.

7.2.1 River terrace formation

In Britain, as a result of **tectonic uplift** during the Pleistocene, rivers have cut down into the landscape to form the present river valleys. This **down-cutting** was episodic and remnants of former valley floors are preserved in some places on the valley sides. These are River Terraces. They are often underlain by deposits in which gravel and sand are major components (Figures 3 and 19). It is important to understand that in some places drainage patterns have changed in the past and river deposits can be found in areas where rivers no longer flow (e.g. the River Thames used to flow through St. Albans and discharge through Norfolk).

Figure 19: River terrace schematic for the Middle and Lower Thames (modified after Bridgland et al 2006: fig. 1b and Bridgland et al 2014a: front cover). **Levallois**, **Handaxes** and **Clactonian** refer to key types of artefacts and/or technologies: *see* Section 5 and Glossary for further information.
1 Upstream from Greenwich the Kempton Park Gravel is not buried beneath the Alluvium but forms a terrace above it.



7.2.2 River sand and gravel

Gravel is transported and deposited by energetic rivers. High energy conditions are associated with steep channel gradients and/or large discharge volumes. Today in Britain such rivers are active in upland and **piedmont** areas but in the colder parts of the Pleistocene climatic conditions in lowland Britain transformed lowland rivers so that the most common river terrace deposits from these periods in both lowland and upland areas are sand and gravel. Fine-grained deposits are much less common. In many gravel deposits, Palaeolithic and palaeoenvironmental remains are absent or rare, occurring only as isolated and worn or broken specimens. They are more likely to represent moved or **reworked** material (Section 4.3). In some localities, however, sand and gravel deposits have been a source of large numbers of artefacts and although such material is unlikely to be in primary context, overall, such deposits have been a key resource in the study of Palaeolithic archaeology.

7.2.3 Fine-grained river terrace deposits

Clay and silt are evidence of deposition in slow-moving or standing water. In river terrace deposits they are often preserved as the infill of floodplain ponds or ancient river channels (**palaeochannels**; *see also* Figure 3), sometimes recognisable as such in cross-section, occurring within, below or cut into the top of the more widely preserved gravel and sand. Favourable conditions for the preservation of fine-grained deposits are associated with locations remote from active channels, or with the warmer parts of the Pleistocene. Fine-grained deposits have the greatest potential for preserving Palaeolithic remains in **primary context**, former land surfaces, and palaeoenvironmental remains in general (Section 4.2). Organic deposits are most easily recognised where visible organic remains are present, such as plant macrofossils, snails and bones. Darker colours, greys and black, may also indicate the presence of finely divided organic material. However, regardless of appearances, it will normally be appropriate to examine fine-grained deposits for microscopic remains, e.g. pollen, diatoms, etc.

7.2.4 Peat

Peat accumulates on terrestrial surfaces where particular hydrological conditions exist. Peat may occur as a river terrace deposit, often in association with fine-grained deposits. It may consist exclusively of plant remains or may include some mineral sediment, usually an indication that the site of peat accumulation was subject to inundation by sediment-laden floodwater. Peat is a very important potential source of palaeoenvironmental remains. Whilst referred to here within the context of floodplain deposits, it is important to note that peat may also form in other settings (e.g. lakes; Section 7.8).

7.3 Slope deposits (Head)

Relevant project case studies: Valdoe

Distribution: (Figure 21; Table 8) occur in all regions

Near-surface geological material on valley-side slopes is always prone to downslope displacement by processes of creep and wash but in cold (periglacial) climates a thicker layer may be displaced by the process of solifluction. Displacement does not necessarily result in complete disruption of the displaced sediment and traces of primary structure and stratigraphy may be recognisable. The resulting slope deposits, often called 'head', are highly variable in character, depending on the nature of the upslope source area. Slope deposits can spread downslope onto the valley floor and may be found interfingering with fluvial sediments in river terrace deposits and in pre-Holocene sediments beneath the modern floodplain. Both palaeoenvironmental and Palaeolithic remains may be among the material displaced downslope, and slope deposits may bury landscapes that include palaeoenvironmental or Palaeolithic remains.

7.4 Windblown sands and silts

7.4.1 Coversands (described as Blown Sand in Figure 17)

Distribution: (Figures 17 and 21; Table 8): major deposits in the East Midlands and East Anglia (Region A) and also occur in the West Midlands and the North (Region D)

Coversands are windblown sand deposited in cold (**periglacial**) climatic conditions. In Britain they are localised in south-west Lancashire and in eastern England in an area between the **Breckland** in East Anglia and the Vale of York. Remnants of dune forms may sometimes be recognisable but the surface of the sand is usually featureless. Deposition has been dated to the last cold phase of the **Devensian Lateglacial** (Figure 16). There is potential for the preservation of **Upper Palaeolithic** remains within or beneath coversands.

7.4.2 Loess

Distribution: (Figure 21; Table 8) occur in all regions, with major deposits in the South-East (Region B)

Loess is windblown dust (mainly silt). In Britain substantial deposits of loess (over 1 metre thick) are recorded in only a few places in south-east and southern England (Essex, Kent, Sussex). There is however a windblown dust component in near-surface deposits and soils in many parts of England, notably but not exclusively on the Chalk and other limestone bedrocks. Most loess deposits are **Devensian** in age (Figure 16) but older deposits do exist. Loess deposits may incorporate or bury Palaeolithic and/or palaeoenvironmental remains.

7.5 'Brickearth'

Relevant project case studies: Southall Gasworks

Distribution: (Figures 17 and 21; Table 8) occur in all regions, with major deposits in the South-East (Region B)

The term 'brickearth' was originally applied in the 19th century to fine-grained, largely stoneless superficial geological deposits used for brickmaking. Deposits described as 'brickearth' usually incorporate a silt-rich component that is probably in most cases of windblown origin (loess; Section 7.4.2) but may also include lenses and seams of sand and occasionally gravel. Although the term 'brickearth' has often been used in the geological literature, deposits so named have probably not all been formed in the same way and there is no single explanation to account for their formation. However, the incorporation of coarser components in a predominantly silty deposit indicates derivation from more than one primary source and it seems likely that colluvial processes, such as creep, wash and solifluction, have been involved in the formation of 'brickearth'. 'Brickearth' has been recorded in various topographical and stratigraphic situations but most widely in the form of extensive outcrops on river terrace remnants overlying other river terrace deposits. Palaeolithic and palaeoenvironmental remains have been recorded in or beneath deposits described as 'brickearth'.

7.6 Glacial deposits

Distribution: (Figures 17 and 21; Table 8) common in the East Midlands and East Anglia (Region A) and the West Midlands and the North (Region D)

Palaeolithic or palaeoenvironmental remains are rare in glacial deposits and invariably more or less distant from their place of origin. However, glacial deposits typically mantle pre-existing landforms and deposits and may therefore bury landscapes and deposits that include such remains.

7.6.1 Glacial till

Often called '**boulder clay**' in the earlier literature, till is a geological deposit originating as material caught up in glacial ice and subsequently deposited as the glacier moves forward or when the ice melts. Tills are variable mixtures of fine-grained and stony material. Tills of more recent glacial episodes, especially the **Devensian**, may be locally shaped into topographically distinctive landforms, but tills of earlier glaciations generally survive as dissected and topographically featureless remnants.

7.6.2 Glacial sand and gravel

Sediment-laden meltwater from a glacier may deposit sand and gravel beneath or around the margins of the ice (**glaciofluvial deposits**). When the ice melts these deposits form distinctive topographic features marking the ice's former extent. Meltwater also feeds into river systems beyond the ice front and glacially-derived sediment may be a significant component in river terrace deposits downstream from the glaciated area.

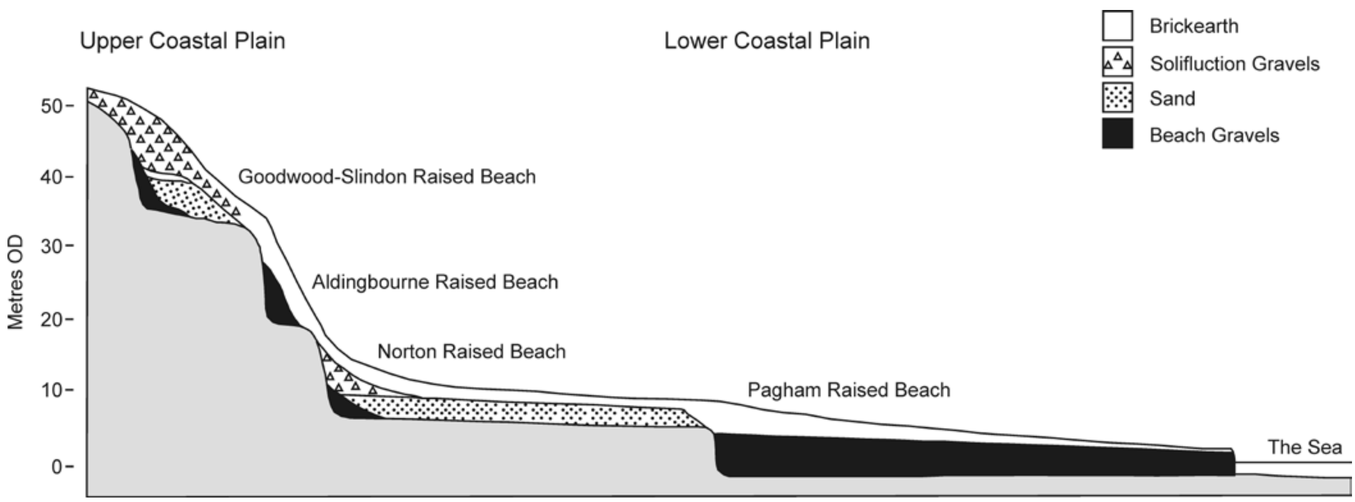
7.7 Raised beach deposits

Relevant project case studies: Valdoe; West Sussex Coastal Plain

Distribution: (Figures 17 and 21; Table 8) occur in all regions, with major deposits in the South-East (Region B) and the South-West (Region C)

As a result of tectonic uplift during the Pleistocene, raised shoreline features are present in many places around the coast of England, sometimes including beach and estuarine deposits (Figure 20). These deposits include shingle, sand and silt, any of which may incorporate palaeoenvironmental or Palaeolithic remains. Fine-grained deposits have the greatest potential for preserving Palaeolithic remains in primary context and palaeoenvironmental remains in general on former beach surfaces and on the surfaces of former coastal and estuarine sand and mud flats.

Figure 20: West Sussex Coastal Plain raised beach sequence (modified after Roberts et al 1997: fig. 13).



7.8 Lacustrine (lake) deposits

Relevant project case studies: Ebbsfleet Elephant

Distribution: (Figures 17 and 21; Table 8) occur in all regions, with large deposits in the West Midlands and the North (Region D)

Lakes vary greatly in size and in the length of time during which they exist, ranging from regional ice-dammed lakes to floodplain ponds. This affects significantly the extent and stratigraphic significance of lake deposits. These are typically fine-grained, reflecting deposition from suspension in still or slow-moving water. Lake deposits may display rhythmic bedding resulting from seasonal variations in sediment input. Annual layers produced in this way are termed **varves**. In long sequences, varves can provide very detailed information about the nature and rates of environmental change. Lake deposits may also incorporate Peat (Section 7.2.4). Coarser sediment may be present locally or periodically where or when faster-moving river water enters a lake. Lake deposits are an important potential source of palaeoenvironmental remains, and lake margins, due to their resource-rich nature, have significant potential for the preservation of Palaeolithic remains.

7.9 Clay-with-flints

Distribution: (Figures 17 and 21; Table 8) South-East (Region B)

Clay-with-flints consists of the insoluble residue of the Chalk, mainly represented by broken but unworn flint, mixed with reddish or yellowish clay representing the remains of formerly overlying sediments. Such material is sometimes referred to as Clay-with-flints sensu stricto. This deposit is widely present on the Chalk in the south of England and may locally be overlain by or pass laterally into similar deposits which include sand, water-worn pebbles and, less commonly, blocks of sarsen sandstone. This material is sometimes referred to as Clay-with-flints sensu lato. There are no records of palaeoenvironmental remains in the Clay-with-flints but its presence, particularly on level summit areas, identifies terrains with long, relatively undisturbed histories. As such, there is potential for evidence of Palaeolithic occupation to be preserved on or in the upper part of this deposit.

7.10 Tufa and Travertine

Tufa and **travertine** are names given to sedimentary deposits formed by precipitation of calcium carbonate. A distinction is sometimes made between tufa as a less dense, more porous and friable material and travertine as denser and less porous. These deposits form where lime-rich water evaporates in open-air locations such as spring heads, seeps, and river and lake margins. Where deposition continues for long periods it can form thick and extensive sheets, draping the local topography and enveloping organic material to become a rich source of palaeoenvironmental, and potentially Palaeolithic, evidence. Dates and palaeoclimatic data can also be obtained from tufa and travertine. Where tufa is subject to erosion, tufa sands may be present in associated sediment sequences.

7.11 Cave, solution pipe and fissure deposits

Relevant project case studies: Cave deposits

Distribution: (Figure 21; Table 8) occur in all regions, but major deposits in the South-East (Region B) and the South-West (Region C)

These are all deposits that result from the fall, collapse or inflow of material into voids in bedrock. They are mostly but not exclusively encountered on limestones. While cave deposits have not often been impacted by construction works, the mammal finds at Sherford, Devon (recovered from a cave system during housing development) demonstrate the potential for Palaeolithic and/or Pleistocene remains to be found.

7.11.1 Cave deposits

Cave deposits include coarse rubbles resulting from the collapse of bedrock within the cave, water-laid deposits representing both flowing and standing water, deposits accumulating as the result of material falling into the cave through openings in the roof and calcite deposits precipitated chemically to create a wide variety of forms collectively termed **speleothems**, of which stalagmites and stalactites are examples. These deposits often occur in complex stratigraphic arrangements reflecting episodic histories of deposition and erosion, and the irregular spaces that they occupy. Dates and palaeoclimatic data can be obtained from speleothems. Palaeoenvironmental remains are often preserved in cave deposits and evidence of Palaeolithic occupation may be present, including soot deposits.

7.11.2 Solution pipe deposits

Most solution pipes are initiated in limestone bedrock beneath a cover of other sedimentary rocks. Solution pipes are locally numerous, for example in the Chalk, particularly near and beneath the feather-edge of overlying Tertiary clays and sands. Such overlying rocks generally form much of the infill of the pipe and in large pipes the bedding of these rocks can be traced vertically downward into the pipe. Large pipes can be many metres across and can penetrate downwards for many tens of metres. The loss of sediment into the pipe may cause localised faulting around the pipe in the overlying sediments and pipes may contain rubbly deposits resulting from collapse into voids in the pipe infill. Closed ground depressions created by subsidence over pipes can become sites of localised deposition with the resulting deposits themselves becoming susceptible to subsidence and forming part of the pipe infill. These deposits may incorporate palaeoenvironmental material and preserve land surfaces with evidence of Palaeolithic occupation.

7.11.3 Fissure and graben deposits

Relevant project case-studies: Glaston

Fissures and grabens are depressions at the ground surface between masses of bedrock. Fissures are a common feature produced by solution on limestones. Less commonly such depressions are the result of lateral stresses, particularly on sloping ground, displacing coherent rock types to create widened joints (fissures) or allow downfaulting of masses of bedrock (grabens). As voids open at the ground surface they can receive and accumulate material blown, falling or washed in from above. This material may include palaeoenvironmental remains and possibly also Palaeolithic material.

7.12 Palaeosols

Palaeosols are old soils buried beneath later sediments. Their structure, fabric and fossil content (e.g. pollen, phytoliths) can provide evidence about the environments in which they formed. They mark the position of former land surfaces which can potentially retain evidence of Palaeolithic occupation.

Table 8: Approximate distribution of Pleistocene deposits in England (indicative presence/absence by region, intended as a guide only: y = present; yy = common).
1 Regions were principally defined as structuring devices for the project workshops. *See* Figure 21 for the borders of the four project regions.

Type of deposit	Project Regions[1]			
	East Midlands and East Anglia (A)	South-East (B)	South-West (C)	West Midlands and North (D)
River	yy	yy	yy	yy
Peat	y	y	y	y
Coversand	y			y
Loess	y	yy	y	y
Brickearth	y	yy	y	y
Glacial Till	yy	y		yy
Slope (Head)	y	y	y	y
Raised Beach	y	yy	yy	y
Lacustrine	y	y	y	y
Clay with flints		y		
Cave/rockshelter and/or fissures/solution features	y	yy	yy	y

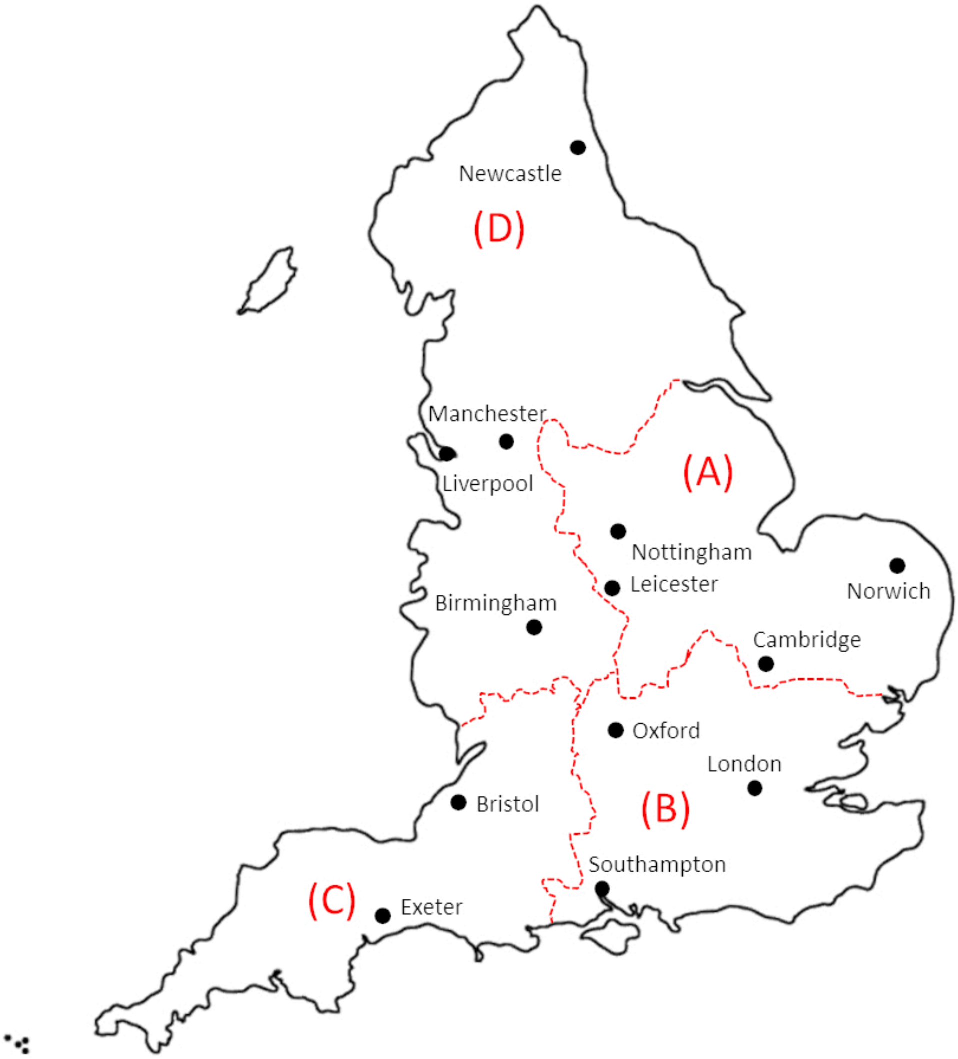


Figure 21: Project regions (*see also* Table 8, above): A: East Midlands and East Anglia; B: South-East; C: South-West; D: West Midlands and the North. Regions were principally defined as structuring devices for the project workshops.

8 Case Studies

This section provides a short summary of the 13 site-specific online case studies which accompany this guidance document and illustrate specific methodological approaches.

The case studies (Figure 18 and Table 9) have been selected to highlight differing approaches, both methodological and curatorial, to Palaeolithic and Pleistocene resources. They illustrate both high- and low-profile sites, deposits and regions. The focus of the individual case studies is briefly outlined below. Some of these cases involved public engagement to raise the profile and public understanding of Palaeolithic archaeology and this is highlighted in a number of case studies including Ebbsfleet Academy, Nightingale Estate, Chard Junction, and Happisburgh.

Several case studies (West Sussex Coastal Plain [Wilkinson], Southall Gasworks [Green and Batchelor], Nightingale Estate and Ponds Farm [Batchelor et al], and Ebbsfleet Academy [Wenban-Smith et al]) highlight 'workaday' examples, emphasising both methodological approaches and the accumulated understanding which is built up from such sites, where Palaeolithic artefactual remains both are, and are not, present. The challenge of working with deep deposits (in non-quarry contexts) is also addressed (Nightingale Estate and Ponds Farm) while the Glaston case study highlights the potential for Palaeolithic discoveries where development impact is relatively shallow.

Other case studies (Ebbsfleet Elephant [Wenban-Smith] and Happisburgh [Ashton]) are associated with internationally important discoveries, but the emphasis is nonetheless on methodological and curatorial approaches.

While some of the case studies (Happisburgh [Ashton], Chard Junction Quarry [Basell et al], Dunbridge [Bridgland and Harding] and Valdoe Quarry [Pope]) were not directly developer-funded as per current practices (e.g. the Valdoe Quarry work was ALSF-funded), they are included because of their valuable methodological contributions. They also highlight the importance of long-term watching briefs and successful working relationships with the aggregates industry (e.g. Chard Junction Quarry and Dunbridge).

The importance of good baseline data-sets, particularly in areas or regions with scarcer and/or lower profile Palaeolithic and Pleistocene resources is also highlighted (Worcester HER [Shaw]). The Trent Valley case study (Howard et al) provides an example of investigating the Palaeolithic potential of poorly understood regional Pleistocene landscapes.

While the majority of the case studies deal with open-air sites and fluvial deposits, Dinnis emphasises the potential of Cave deposits, while the Glaston case study emphasises the importance of sediment traps (i.e. fissures and grabens) as potential sources of Pleistocene and Palaeolithic remains.

All of the case studies include keywords to indicate location, Palaeolithic period(s), investigative method(s), type(s) of deposit, and any features of interest. These are summarised in Table 9. All of the case studies also have a "Project stages" section, based on a pro-forma graphic (Figure 22), to illustrate the various stages represented by the case study with reference to the planning process. Inevitably, the "Project stages" section is more suitable for some case studies (e.g. Ebbsfleet Academy) than others (e.g. Happisburgh), and is absent where not appropriate (e.g. Cave deposits).

Figure 22: Project stages pro-forma, as used in the majority of the case studies.

Pre-application		Pre-determination			Post-determination, Pre/during development				Post-excavation/research dissemination/HER enhancement				
Desk based assessment	Geotechnical/geoarchaeological survey	Literature/mapping review (DBA)	Test pitting/Borehole survey	Evaluation	Test pitting/boreholes	Evaluation	Excavation	Watching brief	Post-excavation assessment (and reporting)	Post-excavation analysis (and reporting)	Final Report	Deposit with HER and museum (and Oasis)	Publication (academic and/or public)

Table 9 (pages 69–70): Keyword summaries of project case studies.

Author	Where	Region	Palaeolithic periods	Type of investigation	Methods	Type(s) of deposit	Features of interest
Ashton	Happisburgh, Norfolk	East Midlands and East Anglia	Lower Palaeolithic (MIS 21–13)	Fieldwork	Boreholes; Geophysics; Offshore investigation	River channel deposits	Public involvement; Shoreline management; Earliest record of human activity in Britain
Basell et al	Chard Junction Quarry, Somerset	South-West	Later Middle and Late Pleistocene (MIS 12–2)	Fieldwork; Post-excavation analysis and publication	Terrestrial Laser Scanning; Gamma CPS; Cosmogenics; OSL; Geoarchaeology; Sedimentology; Deposit modelling	River terrace deposits (gravel)	Recording by Terrestrial Laser Scanning
Batchelor et al	Nightingale Estate, Hackney and Ponds Farm 2, Aveley, East London	South-East	Early Middle Palaeolithic (MIS 9–7)	Literature review; Fieldwork; Post-excavation analysis and publication	Boreholes (Ponds Farm 2); Deep trenching (Nightingale Estate); Dating (OSL, AAR, U-Series); Palaeoenvironmental assessment and analysis	Made ground; River terrace deposits (gravel, organic-rich sediment)	Media attention (Nightingale Estate)
Bridgland and Harding	Kimbridge Farm Quarry, Dunbridge, Hampshire	South-East	Lower Palaeolithic–early Middle Palaeolithic transition (MIS 9–8)	Watching brief (working quarry); OSL dating	Monitoring of quarry faces and 'reject heaps'; Digital Terrain Modelling; OSL dating	River terrace deposits	Geoarchaeological watching brief across lifetime of working quarry
Cooper	Glaston, Rutland	East Midlands and East Anglia	Early Upper Palaeolithic (MIS 3)	Chance finds; Excavation; Post-excavation analysis and publication	Sondage excavation; Grid-square excavation	Sands within geological fault (graben feature)	Co-association of lithic artefacts and hyena den remains
Dinnis	n/a	South-West; West Midlands and North	Later Middle Palaeolithic and Upper Palaeolithic	n/a	n/a	Cave deposits	Potential for surface fissures and outermost portions of larger caves to retain Pleistocene deposits and be threatened by development

Author	Where	Region	Palaeolithic periods	Type of investigation	Methods	Type(s) of deposit	Features of interest
Green and Batchelor	Southall Gasworks, West London	South-East	Early Middle Palaeolithic (MIS 9–7)	DBA; Evaluation	Deposit modelling; Test-pitting	Made ground, Brickearth; River terrace gravels	n/a
Howard	Trent Valley	East Midlands and East Anglia	All Palaeolithic (pre-Anglian to Holocene)	Regional evaluation	Boreholes; Desk-based; Field visits to quarries and other exposures	River terrace deposits; Glacial deposits	Regional study; Impact of glaciation on river drainage pattern
Pope	Valdoe Quarry, West Sussex	South-East	Lower Palaeolithic (MIS 13)	Fieldwork; Excavation	Topographic survey; Boreholes; Trenches	Raised beach, Head	Public involvement; High potential locality
Shaw	Worcestershire HER	West Midlands and North	All Palaeolithic	HER enhancement	Literature review; re-assessment of lithic and faunal collections; HER updating; GIS mapping and modelling	River terrace deposits; Colluvial and solifluction deposits	Enhancement of HER, enabling utilisation as tool to inform curators on areas of possible Palaeolithic potential
Wenban-Smith	Ebbsfleet Elephant, Southfleet Road, Swanscombe, Kent	South-East	Lower Palaeolithic (MIS 11)	Excavation	Section-cleaning; Palaeoenvironmental sampling; Ground-reflecting laser survey; Machine-trenching; Hand-dug test pits; Watching brief; 3D artefact recording; Sediment block lifting of faunal remains	Lacustrine; Fluvial gravel; Colluvial	Deep and complex sequence; Elephant remains; Undisturbed lithic scatter; Multiple horizons with lithic evidence
Wenban-Smith et al	Ebbsfleet Academy, Kent	South-East	Lower Palaeolithic (MIS 11–8)	Fieldwork	Trenches and test-pits; Sampling and sieving; Watching brief; Lithological analyses	River terrace deposits (fluvial sand and gravel)	Systematic and volume-controlled gravel sieving
Wilkinson	West Sussex Coastal Plain	South-East	Lower Palaeolithic (MIS 13–7)	Fieldwork	Boreholes; Trenches; Deposit modelling	Raised beach; Solifluction deposits	n/a

9 References

Ashton, N. 2017 *Early Humans*. HarperCollins: London.

Ashton, N., Lewis, S. G., De Groote, I., Duffy, S. M., Bates, M., Bates, R., Hoare, P., Lewis, M., Parfitt, S. A., Peglar, S. and Williams, C. 2014 'Hominin footprints from early Pleistocene deposits at Happisburgh, UK.' *PLoS One* 9(2): e88329.

Ballin, T. and Wickham-Jones, C. 2017 'Searching for the Scottish Late Upper Palaeolithic: a case study from Nethermills Farm, Aberdeenshire.' *Journal of Lithic Studies* 4(1): https://doi.org/10.2218/jls.v4i1.1907.

Bates, M. and Wenban-Smith, F. 2005 *Appendices to the Palaeolithic Research Framework for the Bristol Avon Basin*. Bristol City Council.

Bates, M. R., Wenban-Smith, F. F., Bello, S. M., Bridgland, D. R., Buck, L. T., Collins, M. J., Keen, D. H., Leary, J., Parfitt, S. A., Penkman, K. and Rhodes, E. 2014 'Late persistence of the Acheulian in southern Britain in an MIS 8 interstadial: evidence from Harnham, Wiltshire.' *Quaternary Science Reviews* 101: 159–176.

Bridgland, D. R. (ed.) 1986 *Clast Lithological Analysis*. Quaternary Research Association (Technical Guide No. 3): London.

Bridgland, D. R. 1994 *Quaternary of the Thames*. Chapman & Hall: London.

Bridgland, D. R., Allen, P. and White, T. S. 2014a *The Quaternary of the Lower Thames and Eastern Essex: Field Guide*. Quaternary Research Association: London.

Bridgland, D. R., Antoine, P., Limondin-Lozouet, N., Santisteban, J. I., Westaway, R. and White, M. J. 2006 'The Palaeolithic occupation of Europe as revealed by evidence from the rivers: data from IGCP 449.' *Journal of Quaternary Science* 21(5): 437–455.

Bridgland, D. R., Howard, A. J., White, M. J. and White, T. S. (eds.) 2014b *Quaternary of the Trent.* Oxbow Books: Oxford.

Buteux, S., Chambers, J. and Silva, B. 2009. *Digging Up the Ice Age: Recognising, Recording and Understanding Fossil and Archaeological Remains Found in British Quarries: a Guide and Practical Handbook*. Archaeopress: Oxford.

Campbell, J. B. 1977 *The Upper Palaeolithic of Britain*. Clarendon Press: Oxford.

English Heritage 2015 *Environmental Archaeology: A Guide to the Theory and Practice of Methods, from Sampling and Recovery to Post-excavation*. (2nd edition). English Heritage: Swindon. HistoricEngland.org.uk/images-books/publications/environmental-archaeology-2nd/environmental_archaeology/

Gale, S. J. and Hoare, P. G. 1992 Bulk sampling of coarse clastic sediments for particle-size analysis. *Earth Surface Processes and Landforms* 17(7): 729–733.

Gibbard, P. L. 1985 *The Pleistocene History of the Middle Thames Valley.* Cambridge University Press: Cambridge.

Gibbard, P. L. 1994 *The Pleistocene History of the Lower Thames Valley*. Cambridge University Press: Cambridge.

Historic England 2015 *Geoarchaeology: Using Earth Sciences to Understand the Archaeological Record.* Historic England: Swindon. HistoricEngland.org.uk/images-books/publications/geoarchaeology-earth-sciences-to-understand-archaeological-record/heag067-geoarchaeology/

Historic England 2018 *Sites of Early Human Activity: Scheduling Selection Guide.* Historic England: Swindon. HistoricEngland.org.uk/images-books/publications/dssg-sites-early-human-activity/heag242-sites-of-early-human-activity-ssg/

Hosfield, R. 2011 'The British Lower Palaeolithic of the early Middle Pleistocene.' *Quaternary Science Reviews* 30(11-12): 1486-1510.

Jones, A. P., Tucker, M. E. and Hart, J. K. 1999 'Guidelines and Recommendations.' In A. P. Jones, M. E. Tucker and J. K. Hart (eds.) *The Description and Analysis of Quaternary Stratigraphic Field Sections*: 27–76. Quaternary Research Association (Technical Guide No. 7): London.

Lisiecki, L. E. and Raymo, M. E. 2005 'A Pliocene-Pleistocene stack of 57 globally distributed benthic $\delta^{18}O$ records.' *Paleoceanography* 20(1). https://doi.org/10.1029/2004PA001071

Lowe, J.J. and Walker, M. 2014 *Reconstructing Quaternary Environments*. Routledge: Abingdon.

Mepham, L. 2008 *The J J Wymer Archive* [data-set]. York: Archaeology Data Service [distributor] https://doi.org/10.5284/1000062

Mepham, L. 2009 *TERPS – The English Rivers Project* [data-set]. York: Archaeology Data Service [distributor] https://doi.org/10.5284/1000063

MHCLG – Ministry of Housing, Communities and Local Government. 2021. *National Planning Policy Framework*. TSO: London.

Morigi, A. N., Schreve, D. C. and White, M. J. 2011 *Thames Through Time: The Archaeology of the Gravel Terraces of the Upper and Middle Thames: Early Prehistory to 1500 BC*. Oxford Archaeology: Oxford.

Pettitt, P. and White, M. 2012 *The British Palaeolithic: Human Societies at the Edge of the Pleistocene World*. Routledge: Abingdon.

Roberts, M. and Parfitt, S. (eds.) 1999 *Boxgrove: A Middle Pleistocene Hominid Site at Eartham Quarry, Boxgrove, West Sussex*. English Heritage: London.

Roberts, M. B., Parfitt, S. A., Pope, M. I., Wenban-Smith, F. F., Macphail, R. I., Locker, A. and Stewart, J. R. 1997 'Boxgrove, West Sussex: rescue excavations of a Lower Palaeolithic landsurface (Boxgrove Project B, 1989–91).' *Proceedings of the Prehistoric Society* 63: 303–358.

Roe, D.A. 1968 *A Gazetteer of British Lower and Middle Palaeolithic Sites*. Council for British Archaeology: York. https://doi.org/10.5284/1081690

Roe, D.A. 1981 *The Lower and Middle Palaeolithic Periods in Britain*. Routledge & Kegan Paul: London.

Stringer, C. 2006 *Homo Britannicus: The Incredible Story of Human Life in Britain*. Allen Lane: London.

Wenban-Smith, F. F. 1994 'Managing the Palaeolithic heritage: looking backwards, looking forwards.' In N.M. Ashton and A. David (eds.) *Stories in Stone*: 104–11. Lithic Studies Society (Occasional Paper No. 4): London.

Wenban-Smith, F. F. 1995 'Managing the Palaeolithic heritage IV: the end of the beginning.' In A. J. Schofield (ed.) *Lithics in Context*: 115–124. Lithic Studies Society (Occasional Paper No. 5): London.

Wenban-Smith, F. F. 2002 *Palaeolithic and Mesolithic Archaeology on the Sea-bed: Marine Aggregate Dredging and the Historic Environment.* Wessex Archaeology: Salisbury.

Wenban-Smith, F. F., Bates, M. R. and Schwenninger, J. L. 2010. Early Devensian (MIS 5d–5b) occupation at Dartford, southeast England. *Journal of Quaternary Science* 25(8): 1193–1199. https://doi.org/10.1002/jqs.1447

Wessex Archaeology and Jacobi, R. M. 2014 *Palaeolithic and Mesolithic Lithic Artefact (PaMELA) database* [data-set]. York: Archaeology Data Service [distributor] https://doi.org/10.5284/1028201

White, M. 2016 'Lost landscapes of the British Palaeolithic: where do we go from here?' In M. White, with M. Bates, M. Pope, D. Schreve, B. Scott, A. Shaw and E. Stafford (eds.) *Lost Landscapes of Palaeolithic Britain*: 131–136. Oxford Archaeology: Oxford.

White, M., Bates, M., Pope, M., Schreve, D., Scott, B., Shaw, A. and Stafford, E. 2016 *Lost Landscapes of Palaeolithic Britain*. Oxford Archaeology: Oxford. https://library.thehumanjourney.net/2795/

Whyte, C. 2011 *A Database of Upper Palaeolithic Sites Based on Wymer and Bonsall, 1977* [data-set]. York: Archaeology Data Service [distributor] https://doi.org/10.5284/1000181

Wymer, J. J. 1968 *Lower Palaeolithic Archaeology in Britain*. John Baker: London.

Wymer, J.J. 1985 *The Palaeolithic Sites of East Anglia*. Geo Books: Norwich.

Wymer, J.J 1999 *The Lower Palaeolithic Occupation of Britain*. Wessex Archaeology: Salisbury.

Wymer, J. and Bonsall, C.J. 1977 *Gazetteer of Mesolithic Sites in England and Wales*. CBA: York.

10 Glossary

Acheulean: A stone tool industry typified by handaxe technology. It mainly occurs in Britain between **MIS** 15 and **MIS** 9.

Anglian: A glacial stage (**MIS** 12; about 450 **kya**) associated with a major Middle Pleistocene glaciation, during which ice sheets extended as far south as Oxfordshire and north London.

Aveley Interglacial: The interglacial period associated with **MIS** 7 (about 243–191 **kya**).

Blade technology: Characteristic of the **Upper Palaeolithic** in Britain, this stone technology is defined by the careful preparation of cores (blade cores) that enables the production of large numbers of similar **blades**.

Blade: Elongated, parallel-sided flake.

Bout coupé: A distinctive type of **handaxe**, sub-rectangular in shape with a flat base. They are associated with **Neanderthals** and the **later Middle Palaeolithic**.

Boulder clay (*see* **Glacial till**)

Braided river: Typified by a network of river channels, usually relatively shallow, separated by small, often temporary, islands. Sediments tend to be coarse-grained (e.g. gravels).

Breckland: A landscape of sandy heathland in south Norfolk and north Suffolk. It contains significant **Pleistocene** deposits, relating to both glaciations and river activity (including the **Bytham River**).

Brickearth: A 19th century term used to describe fine-grained, largely stoneless geological deposits (which were used for brickmaking), that were often found capping river terrace deposits. The term has been used widely but it is likely that not all ‘brickearths’ formed in the same way (e.g. not all may have a windblown content).

Bytham River: One of Britain’s lost rivers, the Bytham drained the Midlands and East Anglia, and flowed into the southern North Sea. It was destroyed by the **Anglian** glaciation.

Clactonian: A stone tool industry typified by **core and flake technology**. Its main sites (e.g. Clacton) date to early MIS 11 and early MIS 9.

Clay-with-flints: A mixed deposit of clay and whole/broken flints that overlies the Chalk deposits in southern England (e.g. on the South Downs and the Chilterns).

Core and flake technology: Characteristic of the **Lower Palaeolithic** (although it occurs in all periods of prehistory), this stone technology is defined by an absence of core preparation and the production of irregular **flakes**.

Coversand: Windblown sands deposited during the last period of cold conditions in the **Devensian Lateglacial**.

Creffield Road: An important **Middle Palaeolithic** site in West London that contained a buried landsurface with refitting Levallois artefacts.

Devensian: The last glacial period, spanning **MIS** 5d–2 (about 115–11.7 **kya**). Climate was generally cold, with conditions at their harshest during the **Last Glacial Maximum** (26–19 **kya**).

Devensian Lateglacial: The period at the end of the **Devensian** from the peak of the Last Glacial Maximum (MIS 2) to the end of the **Pleistocene**. A period of fluctuating climatic conditions, both extremely cold (e.g. **Younger Dryas**) and relatively warm (e.g. the Windermere Interstadial).

Down-cutting: The process by which rivers have cut down into the landscape to form the present river valleys, in response to **tectonic uplift** during the **Pleistocene** and cyclical sea-level changes.

Early Middle Palaeolithic (eMP): Spanned late **MIS** 8–7 (about 250–180 **kya**) and was associated with **Neanderthals** and **Levallois technology**.

Flake: Stone piece removed from a block of stone (core) by percussion (with a hard or soft hammer) or pressure flaking.

Glacial till: A highly variable geological deposit of fine-grained and stony material, accumulated by glacial ice and then deposited when the ice melts.

Glaciofluvial deposits: Sediments consisting of boulders, gravel, sand, silt and clay, derived from glaciers and transported, sorted and deposited by streams of glacial meltwater.

Hackney Gravel: River terrace deposit in the Lower Thames.

Handaxe: A bifacially shaped stone tool, characteristic of the **Lower Palaeolithic**. They occur in a variety of shapes, including oval, pear or tear-drop, and pointed. They are commonly interpreted as large cutting tools, used in butchery. They first appeared in the British record about 600–500 **kya**.

Head (*see* **slope deposits**)

Hominins: All the fossil 'human' taxa that are more closely related to modern humans than they are to any other living taxon (e.g. chimpanzees).

Homo antecessor: An early European hominin species, whose fossils have only been identified at Atapuerca in Spain, where they date to about 900–800 **kya** (i.e. the earlier **Lower Palaeolithic**).

Homo heidelbergensis: An early European hominin species associated with the later **Lower Palaeolithic**, whose fossils have been identified from sites across Europe (including Boxgrove). They date from about 600–200 kya, and later fossils (e.g. the skull fragments from Swanscombe) have also been described as early or proto-**Neanderthals**. Occasional sites, e.g. Boxgrove, suggest an ability to hunt.

Homo neanderthalensis: Associated with the **Middle Palaeolithic**, Neanderthal fossils are rare in Britain. Their hunter-gatherer lifestyle is marked by complex hunting, cave/rockshelter sites, frequent fire use and burials, and there is increasing evidence for their use of personal decorative items (e.g. bird feathers).

Homo sapiens: Our own species. Present in Britain from the start of the **Upper Palaeolithic** onwards. Their hunter-gatherer lifestyle is marked by sophisticated hunting and fishing, complex sites (e.g. artificial shelters, controlled fires and storage pits), burials with grave goods, tailored clothing and personal decoration.

Hoxnian: British name applied to the **MIS** 11 interglacial (about 424–374 **kya**).

Ice age: Commonly used to refer to the **Pleistocene**, but an unhelpful term as the Pleistocene involved a sequence of cold and warm climatic phases.

Interglacial: Warm climate stage within the **Pleistocene**, although it is clear from the **MIS** record that such stages were not uniformly warm.

Interstadial: Short period of less cold climate during a glacial period.

Ipswichian Interglacial: The interglacial period associated with **MIS** 5e (124–119 **kya**).

Isostatic depression/rebound: Changes in the elevation of the earth's surface, largely in response to the advance and retreat of glacial ice.

kya: Thousand years ago.

Lacustrine deposits: Lake deposits, typically fine-grained as a result of forming in still water, with potential to document seasonal variations.

Langley Silt: Brickearth deposit that is found in West London, overlying **River Terrace** deposits and, less commonly, bedrock. It is associated with some important Middle Palaeolithic sites (e.g. **Creffield Road**).

Last Glacial Maximum (LGM): A period of extreme cold in **MIS** 2, with **Devensian** ice sheets at their maximum extent and very low global sea-levels.

Late Glacial (*see* **Devensian Lateglacial**)

Later Middle Palaeolithic (lMP): Spanned the early parts of **MIS** 3 (about 60–40 **kya**) and was associated with **Neanderthals** and **bout coupé** handaxes.

Leaf point: Bifacially shaped points, associated with the **late Middle Palaeolithic** and early **Upper Palaeolithic** in Britain, and typically interpreted as spear tips.

Levallois technology: Characteristic of the **early Middle Palaeolithic** in Britain, this stone technology is defined by the careful preparation of cores that enables the production of **flakes** with particular sizes and shapes.

Loess: Windblown dust deposit, with the main deposits in south-eastern and southern England, and mostly dating to the **Devensian**.

Lower Loam: Key river terrace deposit of the Lower Thames, identified in the Swanscombe area and dating to early **MIS** 11. It is associated with **Clactonian** technology at Swanscombe.

Lower Middle Gravel: Key river terrace deposit of the Lower Thames, identified in the Swanscombe area and dating to **MIS** 11. It is associated with **Acheulean** technology at Swanscombe.

Lower Palaeolithic: Associated with ***Homo heidelbergensis***, and possibly ***Homo antecessor*** (although no fossils of the latter species have been found to date in Britain), the Lower Palaeolithic in Britain spans **MIS** 25/21 (about 950–850 **kya**) to the end of **MIS** 9 (about 300 **kya**).

Lynch Hill Gravel: A River Terrace deposit in the Middle and Lower Thames, underlying the Lynch Hill terrace and dated to **MIS** 10–8.

Meandering river: Single-channel rivers characterised by regular, sinuous curves.

Middle Palaeolithic: Associated with **Neanderthals**, the Middle Palaeolithic in Britain spans **MIS** 8–3 (about 250–40 **kya**). It is typically divided into an **early Middle Palaeolithic** (early **MIS** 8–7) and a **later Middle Palaeolithic** (**MIS** 3), separated by a long period of hominin (**Neanderthal**) absence.

Marine Isotope Stage (MIS): Alternating warm and cool periods in the Earth's palaeoclimate, indicated by changing oxygen isotope values in deep sea core samples that reflect variations in global temperatures.

Mucking Formation: River terrace deposits in the Lower Thames, mapped by BGS as **Taplow Gravel** underlying the Taplow Terrace. It can be split into the Mucking Upper Gravel (**MIS** 6), **Aveley interglacial** deposits (**MIS** 7), and the Mucking Lower Gravel (**MIS** 8).

Mutual Climatic Range: A method of determining the past climate at an archaeological site by examining the climatic tolerances of a range of species found at the site. The method utilises animal groups with specific requirements and tolerances (e.g. beetles).

mya: Million years ago

Neanderthal (*see* ***Homo neanderthalensis***)

Palaeochannel: A remnant of a river or stream channel that has been filled or buried by younger sediment.

Palaeolithic: The Old Stone Age, spanning about 950–11.7 **kya** in Britain.

Palaeolithic record: The archaeological record associated with the **Palaeolithic** occupation of Britain. It is dominated by lithic artefacts, but also includes modified animal remains, organic artefacts (e.g. in wood, bone and antler), **hominin** remains, traces of fire, and cave art.

Palaeolithic technology: Palaeolithic technology is dominated by lithic (stone) artefacts, reflecting preservation bias. Specific technologies vary broadly between the sub-divisions of the **Palaeolithic**: **Lower** (unprepared core and **flake**; **handaxes**); **Middle** (prepared core and flake [**Levallois**]; flake tools); **Upper** (prepared blade core; **blade** tools).

Periglacial: Landscapes on the margins of fully-glaciated areas.

Piedmont: An area at the base of a mountain or mountain range.

Pleistocene: A geological epoch that lasted from about 2,588,000 to 11,700 years ago, and was characterised by repeated glaciations.

Primary context: Sites where sediments and artefacts have been minimally disturbed by geological agents (e.g. water or ice) and remain associated with their original landscape setting.

Quaternary: The current and most recent of the three geological periods of the Cenozoic Era. It spans the period from roughly 2,588,000 years ago to the present day, and therefore contains both the **Pleistocene** and the Holocene epochs.

Raised beach deposits: Associated with raised shoreline features, raised beach deposits include shingle, sand and silt.

Reworked: An artefact or other material which has been eroded out of its original location (e.g. where an artefact was discarded by a hominin), transported and then redeposited in a new location by natural agents (e.g. water or ice).

River terraces: The remnants of former valley floors, which are preserved in some places on the valley sides as a by-product of **downcutting**. They are often underlain by river terrace deposits in which gravel and sand are major components.

Scrapers: A characteristic Palaeolithic stone tool, made on flakes and blades, with a steeply blunted (retouched) working edge. Use-wear increasingly shows a wide range of functional uses, not just as, e.g. hide scraping tools.

Secondary context: Sites where artefacts and sediments have been transported by geological agents (e.g. washed downstream by floodwaters, and then re-deposited in river gravel and sand deposits).

Slope deposits (Head): Variable geological deposits, originating from valley sides and transported downslope through the processes of soil creep, slope wash, **solifluction** and freeze-thaw activity.

Solifluction: Slow, downslope movement of fine-grained surface material, saturated with water, on typically gentle slopes.

Speleothems: Chemically-precipitated deposits in cave environments, most commonly consisting of calcite (the crystalline form of calcium carbonate).

Superficial deposits: Materials of Pleistocene or Holocene age, that formed independently of the underlying bedrock, and were typically moved into their current positions by natural agencies (e.g. water or ice). Also referred to as Drift Deposits or Drift.

Syncline: A trough or fold of stratified sediments in which the strata slope upwards from the axis.

Taplow Gravel: A **river terrace** deposit in the Middle and Lower Thames, underlying the Taplow Terrace and dated to MIS 8–6.

Taxon (*pl* **Taxa**): A unit of organisms (e.g. a geographic population or a genus) which are related and whose characteristics can be differentiated from other such units.

Tectonic uplift: Vertical elevation of the earth's surface in response to natural geological causes.

Tufa/Travertine: Sedimentary deposits formed by precipitation of calcium carbonate, where lime-rich water evaporates (e.g. spring heads, seeps, and river and lake margins).

Upper Palaeolithic: Associated with ***Homo sapiens***, the **Upper Palaeolithic** in Britain spans later **MIS** 3–2 (about 40–11.7 **kya**).There is a significant period of human absence around the time of the **Last Glacial Maximum**.

Varves: Annual sedimentary layers, often associated with lake deposits.

Younger Dryas: A brief period of extremely cold conditions during the **Devensian** Late Glacial, lasting from about 12,900 to 11,700 years ago, which both started and stopped very rapidly.

11 Where to get advice

We recommend the Historic England Regional Science Advisors as an appropriate first point of contact for identifying a Pleistocene specialist. Further sources of information are listed in Section 2.

11.1 Acknowledgements

11.1.1 Images

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Figure 8: Dr John McNabb (University of Southampton)

Figure 10: Dr Rob Hosfield

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11.2 Contact Historic England

East of England
Brooklands
24 Brooklands Avenue
Cambridge CB2 8BU
Tel: 01223 582749
Email: eastofengland@HistoricEngland.org.uk

Fort Cumberland
Fort Cumberland Road
Eastney
Portsmouth PO4 9LD
Tel: 023 9285 6704
Email: fort.cumberland@HistoricEngland.org.uk

London and South East
4th Floor
Cannon Bridge House
25 Dowgate Hill
London EC4R 2YA
Tel: 020 7973 3700
Email: londonseast@HistoricEngland.org.uk

Midlands
The Foundry
82 Granville Street
Birmingham B1 2LH
Tel: 0121 625 6888
Email: midlands@HistoricEngland.org.uk

North East and Yorkshire
Bessie Surtees House
41-44 Sandhill
Newcastle Upon Tyne NE1 3JF
Tel: 0191 269 1255
Email: northeast@HistoricEngland.org.uk

37 Tanner Row
York YO1 6WP
Tel: 01904 601948
Email: yorkshire@HistoricEngland.org.uk

North West
3rd Floor, Canada House
3 Chepstow Street
Manchester M1 5FW
Tel: 0161 242 1416
Email: northwest@HistoricEngland.org.uk

South West
Fermentation North (1st Floor)
Finzels Reach
Hawkins Lane
Bristol BS1 6JQ
Tel: 0117 975 1308
Email: southwest@HistoricEngland.org.uk

Swindon
The Engine House
Fire Fly Avenue
Swindon SN2 2EH
Tel: 01793 445050
Email: swindon@HistoricEngland.org.uk

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