Appendix 1:
ALSF Palaeolithic Project Resources

The following appendix includes a summary of ALSF Palaeolithic projects referred to in this volume whose digital archives have been deposited with the Archaeological Data Service (ADS). The projects are arranged by ALSF project number as they appear on the ADS website. **http://archaeology-dataservice.ac.uk/archives/view/alsf/** In addition the results of several projects have been published in academic monographs and papers and references are included where relevant.

3253/5881: LYNFORD QUARRY
Norfolk Archaeological Unit, Northamptonshire Archaeology, Royal Holloway, UoL
A pdf of the full academic monograph published in 2011 can be downloaded from the English Heritage website:
http://www.english-heritage.org.uk/publications/neanderthals-among-mammoths/
Boismier, W, Gamble, C, and Coward, F, 2011 *Neanderthals Among Mammoths: Excavations at Lynford Quarry, Norfolk*, English Heritage

3263/3913: THAMES THROUGH TIME, VOLUME 1
Oxford Archaeology
An academic monograph was published in 2011:
Morigi, T, Schreve, D, White, M, Hey, G, Garwood, P, Robinson, M, Barclay, A, and Bradley P, 2011 *Thames Through Time: The Archaeology of the Gravel Terraces of the Upper and Middle Thames – Early Prehistory to 1500BC*, Thames Valley Landscapes Monograph, Volume 1

3277/3543: SUBMERGED PALAEO-ARUN AND SOLENT RIVERS: RECONSTRUCTION OF PREHISTORIC LANDSCAPES
Sanjeev Gupta, Jenny Collier, Andy Palmer-Felgate, Julie Dickinson, Kerry Bushe, Stuart Humber
The final integrated project report can be downloaded from the ADS website:
http://archaeologydataservice.ac.uk/archives/view/palaeoarun_eh_2007/
Gupta, S, Collier, J, Palmer-Felgate, A, Dickinson, J, Bushe, K, and Humber, S, 2004 *Submerged Palaeo-Arun River: Reconstruction of Prehistoric Landscapes and Evaluation of Archaeological Resource Potential, Integrated Projects 1 and 2*

3282: THE LEA VALLEY MAPPING PROJECT (LVMP)
Museum of London Archaeology
An academic monograph was published in 2011:
Corcoran, J, Halsey, C, Spurr, G, Burton, E, and Jamieson, D, 2011 *Mapping Past Landscapes in the Lower Lea Valley: A Geoarchaeological Study of the Quaternary Sequence*, Museum of London Archaeology, MOLA Monograph 55

3279: THE PALAEOLITHIC ARCHAEOLOGY OF THE SUSSEX/HAMPSHIRE COASTAL CORRIDOR (PASHCC)
Martin Bates, Francis Wenban-Smith, Rebecca Briant, Richard Bates
The GIS datasets and final report can be downloaded from the ADS website:
http://archaeologydataservice.ac.uk/archives/view/pashcc_eh_2007/overview.cfm
Bates,M R, Wenban-Smith,F, Braint, R, and Bates, C R, 2007 *Curation of the Sussex / Hampshire Coastal Corridor Lower/Middle Palaeolithic Record*

3310: MIDDLE THAMES NORTHERN TRIBUTARIES (MTNT)
Essex County Council, University of Wales Trinity St David, Hertfordshire County Council
The GIS datasets and final report can be downloaded from the ADS website:
http://archaeologydataservice.ac.uk/archives/view/mtnt_eh_2007/
Bates, M, Heppell, E, and Gascoyne, A, 2006 *Assessment Report: Middle Thames Northern Tributaries*. Final Report as submitted to English Heritage.

3322: ARTEFACTS FROM THE SEA
Wessex Archaeology
The following reports can be downloaded from the ADS website:
http://archaeologydataservice.ac.uk/archives/view/artefactssea_eh_2007/
Wessex Archaeology, 2003 *Artefacts from the Sea*. Source Appraisal, ref: 51541.01
Wessex Archaeology, 2003 *Artefacts from the Sea*. Year 1 Report, ref: 51541.02
Wessex Archaeology, 2003 *Artefacts from the Sea*. Year 2 Report, ref: 51541.03

Wessex Archaeology, 2003 *Artefacts from the Sea. Catalogue of the Michael White Collection*, ref: 51541a and b

3338: STOPES PALAEOLITHIC ARCHIVE
Francis Wenban-Smith
The final report and project maps can be downloaded from the ADS website:
http://archaeologydataservice.ac.uk/archives/view/stopes_eh_2007/
Wenban-Smith, F, 2004, *Stopes Palaeolithic Project.* Final Report as submitted to English Heritage

3361: THE ARCHAEOLOGICAL POTENTIAL OF SECONDARY CONTEXTS
Robert Hosfield, Jenni Chambers, Phil Toms
The following reports can be downloaded from the ADS website:
http://archaeologydataservice.ac.uk/archives/view/apscontexts_eh_2007/
Hosfield, R T and Chambers, J C, 2004: *The Archaeological Potential of Secondary Contexts*. English Heritage Project Report (Project No. 3361), English Heritage Archive Report: London
Toms, P S, Hosfield, R T, Chambers, J C, Green, P C, and Marshall, P, 2005 *Optical Dating of the Broom Palaeolithic Sites, Devon and Dorset*, Centre for Archaeology Report 16/2005, English Heritage, London

3362: RE-ASSESSMENT OF THE ARCHAEOLOGICAL POTENTIAL OF CONTINENTAL SHELVES
Justin Dix, Rory Quinn, Kieran Westley
The following report can be downloaded from the ADS website:
http://archaeologydataservice.ac.uk/archives/view/continentshelves_eh_2008/
Westley, K, Dix, J, and Quinn, R, 2004 *Re-assessment of the Archaeological Potential of Continental Shelves*. English Heritage ALSF project no. 3362. School of Ocean and Earth Science, University of Southampton

3388: THE SHOTTON PROJECT: A MIDLANDS PALAEOLITHIC NETWORK (SEE ALSO NIAN)
Lang, A, 2004 The Shotton Project: A Midlands Palaeolithic Network, *PAST* 46
http://www.le.ac.uk/has/ps/past/past46.html

3426: CRESWELL CRAGS LIMESTONE HERITAGE AREA MANAGEMENT ACTION PLAN
Creswell Heritage Trust, Archaeological Research and Consultancy at the University of Sheffield
The Management Plan is available to download from the ADS website:
http://archaeologydataservice.ac.uk/archives/view/creswellcrags_eh_2011/
Davies, G, Badcock, A, Mills, N, and Smith, B, 2004 *Creswell Crags Limestone Heritage Area Management Action Plan*

3447: WELTON-LE-WOLD, LINCOLNSHIRE: AN UNDERSTANDING OF THE ICE AGE HERITAGE LINCOLNSHIRE
The project report is available to download from the ADS website:
http://archaeologydataservice.ac.uk/archives/view/weltonlewold_eh_2011/
Aram, J, Hambly, and Rackham, J, 2004 *Towards and Understanding of the Ice Age at Welton-le-Wold, Lincolnshire*, Heritage Lincolnshire report for English Heritage

3495: TRENT VALLEY PALAEOLITHIC PROJECT (TVPP)
Mark White, Andy J. Howard, David Bridgland
The educational booklet for local outreach is available to download from the ADS website:
http://archaeologydataservice.ac.uk/archives/view/tvpp_eh_2008/
The Trent Valley: Landscape and Archaeology of the Ice Age
Published monographs and papers include:
Bridgland, D R, Howard, A J, White, M J, White, T S, 2014 *Quaternary of the Trent*, Oxbow Books
Howard, A J, Bridgland, D R, Knight, D, McNabb, J, Rose, J, Schreve, D, Westaway, R, White, M J, and White, T S, 2007 The British Pleistocene fluvial archive: East Midlands drainage evolution and human occupation in the context of the British and NW European record, *Quaternary Science Reviews* 26, 2724-2737
White, T S, White, M J, Bridgland, D R, and Howard, A J, 2008 Lower Palaeolithic quartzite artefacts from the River Trent at East Leake, Nottinghamshire: New light on a hidden resource, *Quaternary Newsletter*

3502: CRESWELL CRAGS: MANAGEMENT OF PLEISTOCENE ARCHIVES AND COLLECTIONS
Creswell Heritage Trust
The following report accompanied by a series of tables is available for download at the ADS website:
http://archaeologydataservice.ac.uk/archives/view/creswellcrags_eh_2006/
Wall, I J, and Jacobi, R E M, 2000 *An Assessment of the Pleistocene Collections from the Cave and Rockshelter Sites in the Creswell Area*, Creswell Heritage Trust

3790/3952: NATIONAL ICE AGE NETWORK (NIAN)
Royal Holloway, University of London, University of Leicester, University of Birmingham
The leaflets, recognition sheets and a number of other promotional materials are available for download from the ADS website. The digital archive also contains the Palaeolithic GIS created for the West Midlands by staff at Birmingham Archaeology (University of Birmingham) http://archaeologydataservice.ac.uk/archives/view/nian_eh_2010/

3836: THE MEDWAY VALLEY PALAEOLITHIC PROJECT (MVPP)

Francis Wenban-Smith

The two reports for Essex and Kent can be downloaded from the ADS website:
http://archaeologydataservice.ac.uk/archives/view/medway_eh_2009/

Wenban-Smith, F F, Bates, M R, and Marshall, G, 2007 *Medway Valley Palaeolithic Project Final Report: The Palaeolithic Resource in the Medway Gravels (Essex)*

Wenban-Smith, F F, Bates, M R, and Marshall, G, 2007 *Medway Valley Palaeolithic Project Final Report: The Palaeolithic Resource in the Medway Gravels (Kent)*

Published papers include:

Wenban-Smith, F F, 2004 Handaxe typology and Lower Palaeolithic cultural development: ficrons, cleavers and two giant handaxes from Cuxton, *Lithics* 25, 11-21
http://eprints.soton.ac.uk/41481/

3847: THE PALAEOLITHIC RIVERS OF SOUTHWEST BRITAIN (PRoSWeB)

Tony Brown, Robert Hosfield, Laura Basell, Phil Toms, S. Hounsell, R. Young

The ADS digital archive consists of the project report along with various outreach resources and selected artefact images. Individual images can be cross-referenced to the Artefacts Database:
http://archaeologydataservice.ac.uk/archives/view/proswb_eh_2007/

Hosfield R T, Brown, A G, Basell, L S, Hounsell, S and Young, R, 2007 *The Palaeolithic Rivers of Southwest Britain: Final Report (Phases I & II),* English Heritage Project Report (Project No. 3847)

Project Booklet: The Palaeolithic Rivers of South-West Britain

Project Flyer: The Palaeolithic Rivers of South-West Britain Project

Project Poster: The Palaeolithic of the South-West

School Teaching Resources: Palaeolithic Stone Tools; Hominin Species; Palaeolithic Chronology; Pleistocene Climate, Flora & Fauna; Pleistocene Landscapes; Palaeolithic Lifestyles & Behaviour

Published monographs and papers include:

Hosfield, R, and Green, CP (eds) *2013 Quaternary History and Palaeolithic Archaeology in the Axe Valley at Broom, South West England*, Oxbow, Oxford

Brown, A G, Basell, L S, and Toms, P, 2015 A stacked Late Quaternary fluvio-periglacial sequence from the Axe valley, southern England with implications for landscape evolution and Palaeolithic archaeology, *Quaternary Science Reviews* 116, 106-121

3854: CHRONOLOGY OF BRITISH AGGREGATES USING AMINO ACID RACEMIZATION AND DEGRADATION

Kirsty Penkman, Matthew Collins, David Keen, Richard Preece

The ADS digital archive currently consists of the project report accompanied by data tables:

Penkman, K, Collins, M, Keen, D, and Preece, R, 2008 *British Aggregates: an Improved Chronology using Amino Acid Racemization and Degradation of Intracrystalline Amino Acids (IcPD)*, English Heritage Research Department Report Series 6-2008, ISSN 1749-8775

Published Papers include:

Ashton, N, Lewis, S, Parfitt, S, Candy, I, Keen, D, Kemp, R, Penkman, K, Thomas, G, and Whittaker, J, 2005 Excavations at the Lower Palaeolithic site at Elveden, Suffolk, UK, *Proceedings of the Prehistoric Society* 71, 1-61

Collins, M J, Cappellini, E, Buckley, M, Penkman, K E H, Griffin, R C, and Koon, H E C, 2005 Analytical methods to detect ancient proteins, in Gunneweg, K, Greenblatt, C, and Adriaens, A, (eds) *Bio- and Material Cultures at Qumran*, 33-40

Langford, H E, Bateman, M D, Penkman, K E H, Boreham, S, Briant, R M, Coope, G R, and Keen, D H, 2007 Age-estimate evidence for Middle-Late Pleistocene aggradation of River Nene 1st Terrace deposits at Whittlesey, eastern England, *Proceedings of the Geologists' Association* 118 (2)

Parfitt, S A, Barendregt, R W, Breda, M, Candy, I, Collins, M J, Coope, G R, Durbidge, P, Field, M H, Lee, J R, Lister, A M, Mutch, R, Penkman, K E H, Preece, R C, Rose, J, Stringer, C B, Symons, R, Whittaker, J E, Wymer, J J, and Stuart, A J, 2005 The earliest humans in Northern Europe: artefacts from the Cromer Forest-bed Formation at Pakefield, Suffolk, UK, *Nature* 438, 1008-1012

Preece, R C, Parfitt, S A, Bridgland, D R, Lewis, S G, Rowe, P J, Atkinson, T C, Candy, I, Debenham, N C, Penkman, K E H, Griffiths, H I, Whittaker, J E, and Gleed-Owen, C, 2007 Terrestrial environments in MIS 11: Evidence from the Palaeolithic site at West Stow, Suffolk, UK, *Quaternary Science Reviews* 26, 1236-1300

Preece, R C, and Penkman, K E H, 2005 New faunal analyses and amino acid dating of the Lower Palaeolithic site at East Farm, Barnham, Suffolk, *Proceedings of the Geologists' Association* 116, 363-377

Schreve, D C, Harding, P, White, M J, Bridgland, D R, Allen, P, Clayton, F, Keen, D H, and Penkman, K E H, 2006 A Levallois knapping site at West Thurrock, Lower Thames, UK: its Quaternary context, environment and age, *Proceedings of the Prehistoric Society* 72, 21-52

3876/4600/5684 SEABED PREHISTORY

Wessex Archaeology

The Seabed Prehistory ADS archive comprises eight reports of which Volume I presents an introduction to the project, Volumes II to VII focus on the individual study areas and Volume VIII presents the results and conclusions of the project overall:
http://archaeologydataservice.ac.uk/archives/view/seaprehist_eh_2009/

Wessex Archaeology, 2008 *Seabed Prehistory: Gauging the Effects of Marine Aggregate Dredging* Volumes I–VIII, ref. no. 57422.31-38
An academic monograph was published in 2015: Tizzard, L, Bickert, A, and De Loecker, D, 2015 *Seabed Prehistory. Investigating the Palaeogeography and Early Middle Palaeolithic Archaeology in the Southern North Sea*, Wessex Archaeology Report 35, Wessex Archaeology Ltd, Salisbury

4620: VALDOE ASSESSMENT SURVEY
Matthew Pope
The ADS digital archive consists of a combined volume of specialist reports:
http://archaeologydataservice.ac.uk/archives/view/valdoe_eh_2010/
Micropalaeontological Report *John Whittaker*
Assessment of vertebrate remains from Valdoe Pit, West Sussex *Simon Parfitt*
Pollen Analysis *Phil Gibbard & Sylvia Peglar*
Molluscan Analysis *Richard Preece*
Amino Acid Racemization *Kirsty Penkman*
Site photographs
Sediment logs
Lithics spreadsheets
Published papers include:
Pope, M, Roberts, M, Maxted, A and Jones, P, 2009 The Valdoe: Archaeology of a locality within the Boxgrove Palaeolandscape, West Sussex, *Proceedings of the Prehistoric Society* 75, 239-263

4996: ARCHAEOLOGICAL POTENTIAL OF CAVE AND FISSURE DEPOSITS IN LIMESTONE
Archaeological Research and Consultancy at the University of Sheffield
The project report can be downloaded from the ADS website:
http://archaeologydataservice.ac.uk/archives/view/caves_eh_2011/
Oliver, J, and Davies, G, 2008 *Caves as Cultural Heritage: Research into the Impact of Limestone Quarries on Archaeological Caves and Fissures and their Protection through Planning*. ARCUS Report No. 1081.b (1)

5088: THE J J WYMER ARCHIVE
Lorraine Mepham
John Wymer's Field Note Books have been digitised in eight volumes and can be viewed on the ADS website:
http://archaeologydataservice.ac.uk/archives/view/wymer_eh_2008/

5266: LOWER AND MIDDLE PALAEOLITHIC OF THE FENLAND RIVERS OF CAMBRIDGESHIRE (FRCPP)
Durham University
The ADS digital archive contains several key outputs available for download, including a gazetteer of Lower and Middle Palaeolithic sites in Cambridgshire; a project bibliography; and a project report/booklet:
http://archaeologydataservice.ac.uk/archives/view/palaeofen_eh_2010/
White, T S, Boreham, S, Bridgland, D R, Gdaniec, K, and White, M J ,2008 *The Lower and Middle Palaeolithic of Cambridgeshire*

5285: SOMERSET AGGREGATES LITHICS ASSESSMENT (SALSA)
Somerset County Council
The following report can be downloaded from the ADS website:
http://archaeologydataservice.ac.uk/archives/view/salsa_eh_2008/
Firth, H, and Faxon, K, 2008 *Somerset Aggregates Lithics Assessment (SALSA), Aggregates Levy Sustainability Fund Project Number 5285,* Somerset County Council Heritage Service

5703: KIMBRIDGE FARM QUARRY, DUNBRIDGE
Wessex Archaeology
The deposit modelling report, artefact database and photographs can be downloaded from the ADS website:
http://archaeologydataservice.ac.uk/archives/view/dunbridge_eh_2012/
Wessex Archaeology, 2011 *Palaeolithic material from Dunbridge, Hampshire: Deposit modelling report*, ref: 69592.01

THE LOST LANDSCAPES ARTEFACT DATABASE (LLAD)
A number of ALSF projects included Palaeolithic artefact databases and gazetteers in various formats. Where sufficient data was available these have been collated into a single database to be hosted on the ADS in due course on a dedicated project page. The Lost Landscapes Artefact Database (LLAD) is primarily an update of The English Rivers Project (TERPS) database. It includes data from the ALSF projects, but also all of the original TERPS datasets.

The TERPS dataset comprises some 3600 records of sites and findspots originally listed by John Wymer on index cards, and subsequently issued as the six unpublished volumes (regionally based) of the Southern Rivers Palaeolithic Project, then the English Rivers Palaeolithic Project, between 1993 and 1997. This dataset essentially summarises information for each Lower and Middle Palaeolithic findspots in England, detailing location, geology, circumstances of discovery, numbers and types of artefacts and their current location, current nature of site, and bibliographic sources (including references to TERPS mapping). This data formed the basis of The Lower Palaeolithic Occupation of Britain, published in 1999.

Some new and updated data were subsequently added by John Wymer, and the database, created in 2008, was also augmented by a few new entries from two ALSF Palaeolithic projects the Medway Valley Palaeolithic Project (MVPP) and the Palaeolithic Archaeology of the Sussex/Hampshire Coastal Corridor (PASHCC)

Following a review of the data as part of the Lost Landscapes project it became apparent that many of the ALSF project datasets included historical and HER data already in the TERPS database, and in these instances records have been identified and updated with ALSF project numbers and additional references. As each site entry in the TERPS database had a unique identifier number it was considered most efficient to update TERPS at the outset rather than create a separate database in order to avoid duplication of records. In some instances ALSF projects identified additional findspots from HER records and other historical sources and these, along with recently investigated sites, form new entries in the database. Additional fields within the site table of the database allows ALSF entries to be filtered by project.

OTHER WEB-BASED PALAEOLITHIC RESOURCES

The English Rivers Project (TERPS)
http://archaeologydataservice.ac.uk/archives/view/terps_eh_2009/

Ancient Human Occupation of Britain (AHOB) project
http://www.ahobproject.org/

The Boxgrove Project
https://boxgroveproject.wordpress.com/

Research and Conservation Framework for the British Palaeolithic (2008)
http://www.english-heritage.org.uk/publications/research-and-conservation-framework-for-british-palaeolithic/palaeolithic-framework.pdf/

National Heritage Protection Plan
http://www.english-heritage.org.uk/professional/protection/national-heritage-protection-plan/all-about-NHPP/

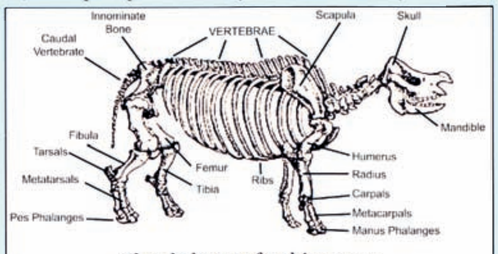
Appendix 2:
National Ice Age Network 'Recognition sheets'

Introduction

Welcome to the Vertebrate Fossil Recognition Sheet, one of a series of factsheets produced by the National Ice Age Network, covering Pleistocene (Ice Age) sediments, vertebrate fossils, plants, shells and stone tools.

Complete fossil skeletons are rare and only individual bones and teeth, or fragments of them, are usually found. Only in exceptional circumstances, such as the permafrost zones of Alaska and Siberia or the arid caves of Chile and Australia, will the soft tissues of animals be preserved – these can give direct insight into the appearance, diet and health of Ice Age vertebrates (animals with a backbone), as well as preserving ancient DNA. The first stage in analysis is to identify the part of the body represented, then the species, before establishing age, sex and numbers of individuals present.

The following panels provide a guide to the identification of some of the most common vertebrate forms found in Britain. As well as the physical remains of animals, their past presence may also be indirectly inferred from preserved trackways, carnivore or rodent gnaw marks, fossilised droppings as well as depiction in Palaeolithic (Old Stone Age) art.

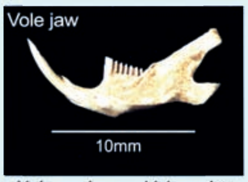


The skeleton of a rhinoceros

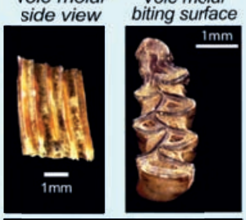
Small Vertebrates

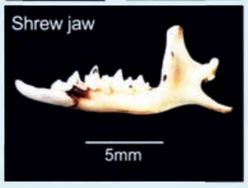
Fish remains commonly include vertebrae (the backbone), fin spines, teeth and, occasionally, the fragile scales. Amphibians such as frogs and toads are characterised by their vertebrae and 'fluted', hollow long bones, and reptiles by their vertebrae, although tortoise shell fragments may also be found. Bird remains are rare, particularly on open sites, and are light and hollow; the beak and limb bones being most recognisable.

Most small mammals are readily distinguished to species level by their teeth, particularly the rodents (e.g. mice, voles, lemmings, squirrels and beavers), which possess two pairs of long, curving enamel incisors and 3-4 cheek teeth in each jaw. Vole and lemming molars resemble small radiators from the side and consist of a complex series of interlocking enamel triangles when viewed from the biting surface, whereas mice have low-crowned, rounded molars. Insectivores such as hedgehogs, shrews and moles have a long row of sharply pointed teeth.



Vole molar side view | *Vole molar biting surface*





Carnivores

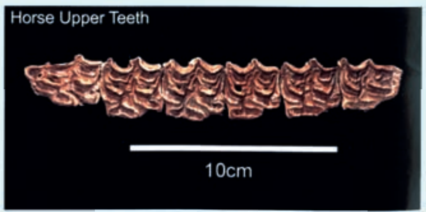
A range of large carnivores occurs in British Ice Age terrestrial deposits, particularly in caves, including cave and brown bears, lions, sabre-toothed cats, leopards, wolves and spotted hyaenas. Smaller predators include foxes, wild cats and mustelids (otters, weasels and their relatives).

The carnivores are readily identified by their prominent canine teeth (in sabre-toothed cats, these evolved into dagger-like points with serrated edges) and by the presence of carnassial teeth (except in bears). The carnassial teeth comprise the first lower molar and the fourth upper premolar and have a blade-like structure for shearing meat. Depending on the dietary adaptation of the carnivore in question, a range of slicing, crushing or grinding teeth will also be present. Bears differ from the general carnivore plan by having only low-crowned cheek teeth, thereby reflecting their omnivorous diet.

Rhinos and Horses

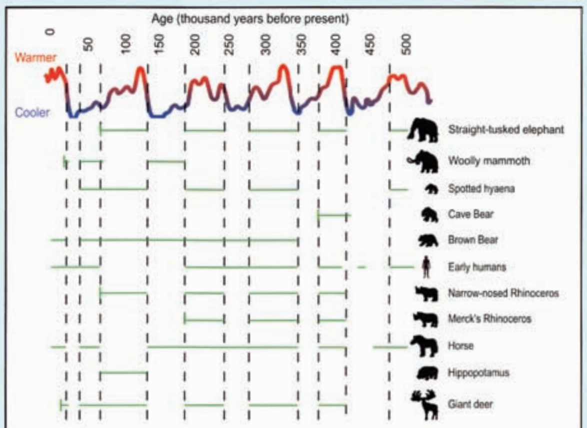
Rhinos and horses are members of the mammalian Order Perissodactyla, meaning that they have an odd number of toes (3 in rhino and 1 in horse). The limb bones and toes are therefore very diagnostic, in particular the cannon bone (3rd metacarpal or metatarsal - see the skeleton in introduction) of horse and the digits. Several species of rhino are known from Ice Age interglacials, adapted to either woodland or grassland habitats, whereas the woolly rhino is a characteristic component of cold stage faunas. Horses are common to both.

Rhinos have large, robust teeth with a complex pattern of ridges and thick enamel. The upper molars are square-ish, whereas the lower are 'w' shaped. The woolly rhino has an additional isolated enamel ring in the upper molars that distinguishes it from interglacial species. Horses possess tall, column-like teeth with complex enamel folds in both upper and lower sets.



Interpretation

Many Ice Age vertebrates or their close relatives are still alive today. Studying these fossil remains can shed light on past environments (by examining anatomical adaptations and modern habitat preferences), as well as revealing how many species (particularly mammals and birds) changed their size and shape in response to Ice Age climate change. Many mammal lineages show clear patterns of evolution and extinction, in addition to local patterns of presence and absence, that may be used to construct faunal histories. As with all palaeontological studies, an understanding of the taphonomy (i.e. how the bone assemblage formed) is critical.

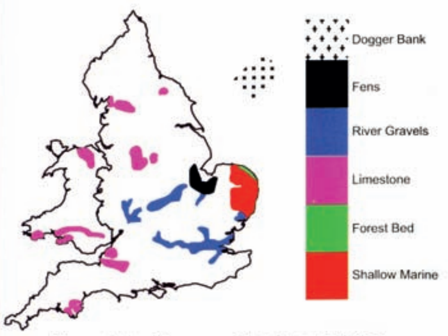


Presence and absence of selected Ice Age species in Britain

Ice Age Mammal Localities

Fossilised vertebrate remains have been found in an enormously wide range of environments in Britain, including limestone caves and fissures, former lakeshores and beaches, shallow marine sediments, the Fenland peats and even on the floor of the North Sea!

One of the most common places to find vertebrate fossils is in fluvial and estuarine deposits laid down by former rivers. Many such finds have been made on the north Norfolk coast in the Cromer Forest-bed Formation, as well as in sand and gravel pits in ancient river deposits in the Thames, Trent, Warwickshire / Worcestershire Avon and other river valleys. These finds represent both animals that would have lived in the water and other species that may have died on the floodplain and been washed in, or which may have become mired at the water's edge, been hunted there or even drowned in the water.



The main Ice Age mammal localities in Britain

Excavation & Sampling

Most fossils in soft sediments can be excavated by hand using a standard pointing trowel, switching to a wooden or plastic implement when near the bone surface so as not to damage it. The specimen should preferably be recorded in three dimensions, tied into a site plan. As a minimum, however, recording should include descriptions of the bed where the specimen was found, a photograph or sketch of its position in the ground or section, and an OS grid reference for the site.

Specimens can be cleaned with warm water and a soft brush prior to being allowed to dry slowly (never in direct sunlight) but more fragile remains may require consolidation *in situ* (e.g. using a plaster jacket) and lifting as a block for later excavation. Full records of conservation measures taken should be kept and specialist advice sought, as required, especially prior to the application of any glues or consolidants as these can affect on later analyses.

Bulk sediment samples (a minimum of 10 litres/10-20kg) should be taken for wet-sieving for microvertebrate remains, which cannot easily be seen in the field with the naked eye. These normally consist of column samples from the base to the top of a section, so that any change through the sequence can be identified. All sediment should be wet-sieved using a 0.5mm mesh. Once the residue is clean and dry, it can then be sorted under a low-power (10x) binocular microscope for specimens. Identification of remains is carried out using keys, drawings and reference material.

Excavating a fossil aurochs

Deer and Bovids

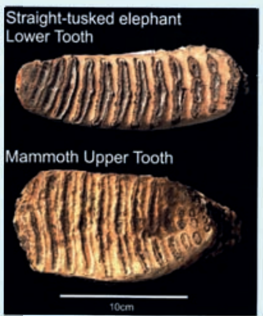
The deer and large bovids (aurochs and bison - wild cattle) are some of the most abundant Ice Age fossils. The species encountered range from reindeer and musk ox, which were restricted to cold climate episodes, to fallow deer and aurochs in interglacials. Bison, red deer, giant deer are common to both, although the latter occupied only open habitats on account of their enormous antler span (up to 3m, see cover).

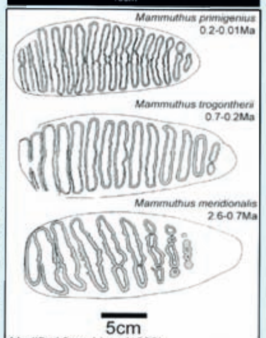
Both deer and bovids have typical herbivore teeth, consisting of linked crescent-shaped molars with enamel infoldings. In deer, the antlers are most diagnostic, in particular the surface texture, the arrangement of tines (projections off the main beam) and the degree of palmation or flattening of the end. The shape of the horn core in bovids is also characteristic – the single upward tilt in bison, the upward and forward projection in aurochs and the 'helmeted' form of the musk ox. The limb bones are similar in both, although those of the deer are relatively longer and more slender.

Elephants

Elephants (including mammoths) were the largest of the Ice Age megafauna (all animals weighing more than one ton) in Europe. The straight-tusked elephant (*Palaeoloxodon antiquus*) was found exclusively under temperate (warm) conditions whereas the mammoth (*Mammuthus*) lineage was present in both warm and cold episodes. The ivory tusks of these animals are immediately recognizable – long and straight in *Palaeoloxodon* and downward-spiralling in *Mammuthus*.

Elephants have only four teeth in their jaws at any one time and go through a succession of six sets in their lifetime. The teeth are comprised of large enamel lamellae or 'plates' stacked one behind the other; where the enamel is worn away at the surface, it creates a characteristic pattern of diamond shapes in *Palaeoloxodon* and parallel strips in *Mammuthus*. Over the last 2.6 million (Ma) years, as mammoths moved from temperate habitats, where they ate soft vegetation, into cold steppes, their molars doubled in height and in the number of enamel plates present, in order to cope with a diet of abrasive grasses.



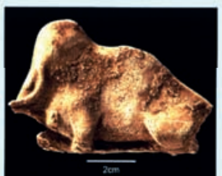


Modified from Lister(1993)
Quaternary International, Vol.19, p.77-84.

Vertebrates and Interactions with Stone Age Peoples

Vertebrate remains, particularly mammals, sometimes bear evidence of modification by early humans, such as cutmarks left by stone tools. These can be distinguished from scratches and other natural marks by their position, usually arranged as parallel incisions near joints or major muscle blocks, and by their sharp, v-shaped cross section under the microscope. Other bones may have a characteristic 'spiral fracture' where the fresh bone was broken and twisted apart for marrow extraction. As well as supplying meat, fat and marrow that were important in the diet, animals also provided a source of furs, fuel (burning fat or dung) and raw materials for making tools or art objects.

Cutmarked brown bear paw bones (arrows indicate cuts)



Carved Mammoth Figure

Reindeer bone broken for marrow (arrow indicates impact)

Leaflet Text & Design: Dr B Silva & Dr D Schreve. With thanks to the Natural History Museum Photographic Unit for many of the pictures used in this publication.

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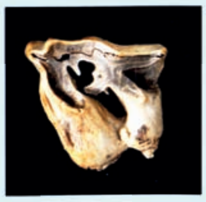

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Sediments Recognition Sheet

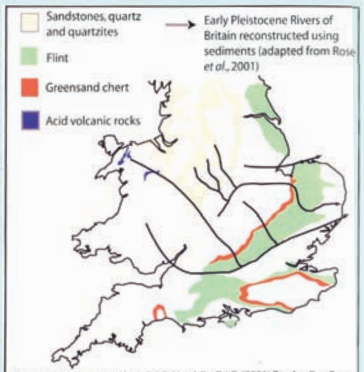

Introduction

Welcome to the Sediments Recognition Sheet, one of a series of factsheets produced by the National Ice Age Network, covering Pleistocene (Ice Age) stone tools and vertebrate, molluscan, insect and plant fossils.

Sediments are fragments of rocks or minerals that are transported and deposited by water, wind or ice. Soils are a horizon of organic and inorganic weathered materials that accumulate and develop on stable surfaces. The identification of certain types of sediments and soils can thus provide important information on the depositional environment and help build a picture of the past landscapes in Britain that our ancestors may have faced.

The deposition of sediments in layer-cake sequences (i.e. younger sediments overlying older sediments) is very useful for understanding past environmental and climatic changes. However, layer-cake sequences are rarely preserved in Britain due to erosion by successive glaciations, thus we must piece the information together from different locations.

The following panels provide a guide to the description, identification, and formation of the main sediment types to be found in Britain.



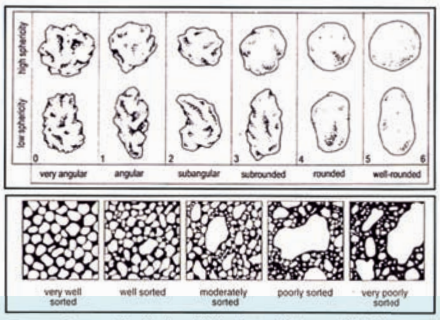
Reference: Rose, J., Moorlock, B.S.P., Hamblin, R.J.O. (2001) Pre-Anglian fluvial and coastal deposits in Eastern England: lithostratigraphy and palaeoenvironments. *Quaternary International*, 79, 5-22.

How are sediments described?

Sedimentary investigations are best carried out on open section faces so that vertical and horizontal variations can be carefully recorded. Before commencing fieldwork, the section should be cleaned of slumped material, and a 'fresh' face revealed by cutting back into the exposure.

Sediments are typically described in terms of their grain sizes, sorting (to what degree are the grains of a similar size: well-sorted = grains are all of a similar size; poorly sorted = grains are of widely different sizes), roundedness of pebbles, colour (using comparative colour charts e.g. Munsell), texture (e.g. gritty or smooth?), and the nature of the contacts between different sediment types (e.g. sharp contacts indicate erosion of the underlying layer).

Categories of:
a) roundedness,
and b) sorting.



Roundedness and sorting images source: Jones, A.P., Tucker, M.E., Hart, J.K. (1999) The Description and Analysis of Quaternary Stratigraphic Field Sections. QRA technical guide 7, QRA, London.

Glacial Till

'Till' or 'boulder clay' is typically a deposit of clay that is full of boulders (poorly sorted), which is formed in and beneath ice sheets and glaciers. As the till is the result of the abrasion of the older rocks over which the ice has travelled, it takes its colour from them, e.g. where the ice has passed over chalk the clay may be quite pale and chalky. Boulders may be angular, sub-angular, or well-rounded, and frequently bear grooves and scratches caused by contact with other rocks while held firmly in the moving ice. Like the clay in which they are borne, the boulders belong to districts over which the ice has travelled. By the nature of the contained boulders it is often possible to trace the path along which a vanished ice-sheet moved; thus in the till of the east coast of England many rocks from north Britain can be recognized.

A modern glacier ploughing through the landscape and mixing up sediments in its path.

Typical poorly sorted glacial till with pebbles in a clay matrix.

Buried Soils

Soils form on stable ground surfaces by the action of chemical, biological and physical weathering processes over time. Relict buried soils may thus be good indicators of past warm interglacial conditions and their features may be compared to modern soils for information on past climatic conditions. Weak soils also form, however, in cold climates and are dominated by the physical action of freeze-thaw cycles.

The most important property for identifying a soil is that it has vertically differentiated layers (or 'horizons') due to the movement of weathering products up and down the soil profile. Typically, however, in buried soils the topmost 'A' horizon has been eroded and only the underlying 'B' horizon is preserved. Important diagnostic features of the 'B' horizon include colour, texture (e.g. high clay content), and enrichment (e.g. soils of semi-arid climates) or depletion (acid soils) of the carbonate content (a white mineral).

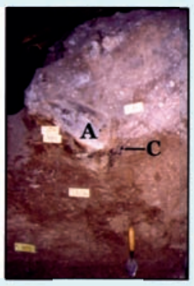
Left: Brown-red palaeosol of a former warm (interglacial) climate in England.

Right: Ice wedge cast of a soil formed under Arctic conditions and permafrost.

Cave and Lake Deposits

Caves and lakes form natural sediment traps where sediments can accumulate and provide detailed information on past climatic and environmental changes. Sediments have accumulated in caves in Britain through stream deposition, wind action and deposition associated with prehistoric man (e.g. ash/charcoal from hearths, bones, teeth and shells) and animals (e.g. bones in hyena dens). Sediments also form within the caves themselves through the deposition of roof fall and the formation of stalactites and stalagmites (or 'speleothems').

Lakes that have formed in front of glaciers ('proglacial lakes') may produce annually rhythmic layers of fine sand/silt and clay (termed 'varves'). The coarser sand and silt are deposited first leaving the clay in suspension. During winter the lake freezes over and the suspended clay particles gradually settle forming a layer of clay.



Left: Grey ash (A) and black charcoal (C) in cave sediments.

Right: Ice Age lake clays from England.

Identifying different sediment types

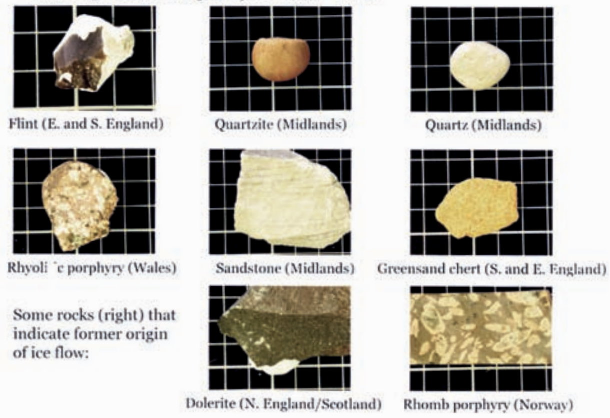
Sediments can be classified in terms of their size, ranging from fine sediments such as clay (0.001-0.004 mm) and silt (0.004-0.063 mm) to boulders (>256 mm) which as a rough rule of thumb is 'bigger than your head'!. The size of sediments indicates the energy and power of their depositional environment. For example, layers of clay are deposited in quiet water lakes; silt is blown by wind; silt, sand, gravels (or 'pebbles') and cobbles are transported by rivers; large boulders are transported by glaciers.

In soils, clays often become concentrated down-profile due to weathering and being washed downwards in Britain's moist climate.

How are different pebble types identified?

As sediments are fragments of rock or minerals, it is possible to identify the parent rock or mineral type. From geological mapping we know where certain rock types and minerals occur in Europe and so we can therefore determine from where and in what direction the sediment originally came from. This has been particularly important for working out the flow paths of major ancient rivers and where the ice sheets in Britain came from (e.g. North Britain or Scandinavia?).

Some of the main rock/mineral types found in British river gravels, and their origin (scale: one grid square width = 1 cm):



Marine Sediments

The sea level in Britain has varied dramatically in response to climate change. The growth of ice sheets in northern Europe locked up much of the ocean water and so sea levels fell and Britain became a peninsula of Europe. As the ice sheets melted, sea levels rose again. Marine deposits in Britain are typically found in coastal areas and may be testament to higher sea levels in the past. Beach deposits can be recognised by very well-sorted and well-rounded pebbles. Beach pebbles are typically covered in "chatter-marks" due to agitation caused by tidal action. Marine fossil shells preserved in sands are also good indicators of past marine conditions.

Raised beach sediments at Brighton, south England.

A "chatter-marked" pebble.

River Sediments

Britain is currently enjoying a warm interglacial period, and our rivers are mainly meandering, cutting sinuous valleys with single channels. During cold glacial periods, however, Britain was dominated by large braided rivers that carried vast quantities of sediment fed by the meltwaters from giant ice sheets. Braided rivers were large with numerous shifting channels and bars of sand and gravel. River deposits are typically well to moderately sorted and have rounded to sub-rounded gravels.

Evidence for past warm interglacial rivers and streams may come from dark, organic-rich silts and sands. These are very important for preserving shells, microfossils (e.g. pollen), vertebrate fossil remains and even evidence for early humans (e.g. stone tools and bones).

Top left: Modern braided river in Iceland with shifting bars of sand and gravel.

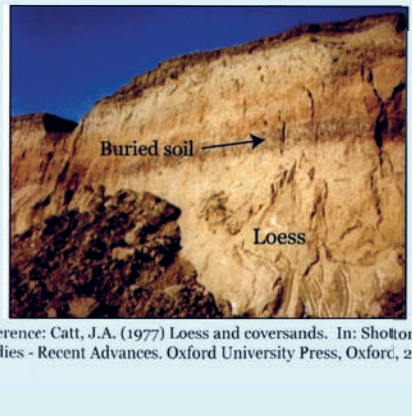
Top right: Ice Age braided river sediments in England.

Bottom left: Modern meandering river in England.

Bottom right: Past interglacial organic river channel in England.

Wind-Blown Sediments

Silt is mainly produced by the grinding action of glaciers. The silt is transported in large volumes by glacial rivers and may be subsequently picked up by the wind and deposited elsewhere. Particles of silt are preferentially picked up and blown by wind and large deposits (termed 'loess') accumulated during cold periods in Europe. Loess is typically a pale yellow colour and small patches can be found in Britain. Analysis of wind-blown deposits at sites from Kent to south Devon has revealed a westward decrease in particle size – indicating that the loess had been transported by easterly winds from river plains in the North Sea basin that were exposed as much of the sea water was tied up in ice sheets (Catt, 1977).



A 5 m-thick cliff section of loess with interbedded buried soils.

Reference: Catt, J.A. (1977) Loess and coversands. In: Shotton, F.M. (ed.) British Quaternary Studies - Recent Advances. Oxford University Press, Oxford, 22-229.

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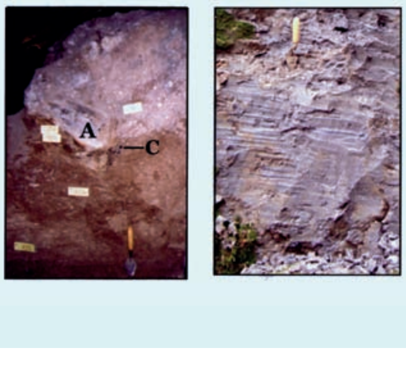


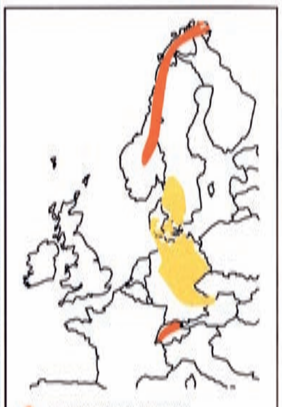
Left: Grey ash (A) and black charcoal (C) in cave sediments.

Right: Ice Age lake clays from England.

Introduction

Welcome to the Mollusc, Insect and Plant Fossils Recognition Sheet, one of a series of factsheets produced by the National Ice Age Network, covering Pleistocene (Ice Age) sediments, vertebrate fossils and stone tools. This sheet provides information on fossil molluscs (snails), insects and plants, and how these are used to reconstruct Ice Age environments.

Land and freshwater molluscs (a term that includes snails, mussels and slugs) are probably the most common fossils in Ice Age deposits. The mollusc fauna of Britain today consists of about 220 species, although not all of these have been found as fossils. Most Ice Age snails have no English name and are identified by their Linnean (Latin) names only.



Columella columella

Clausilia pumila

Modern distributions of two snail species which lived in Ice Age Britain

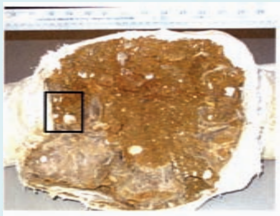
Molluscs are known from all Ice Age sediments dating back 2.5 million years. During this time few new species have evolved and very few have become extinct. Thus, Ice Age species can be used to reconstruct past environments as they still have living descendants whose habitats are well known.

The chemical composition of shells can also be analysed to estimate ancient water temperatures (from isotopes of oxygen in the shells) and furthermore, the shells can be dated by measuring their fossil protein (amino acid) or radiocarbon content.

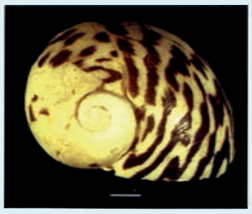
Finding Ice Age Molluscs

Molluscs are usually found in sand or mud rather than in gravel or clays. Silted-up river channels exposed by gravel quarrying are often the most productive, containing an abundance of freshwater shells, but also land shells washed into the river by floods. Occasional sandy deposits in large rivers like the Thames may also be very rich in shells, including the largest bivalves. Shells are often noticed because they have been bleached white over time although the original shell colours may also sometimes be preserved.

Warm interglacial period deposits usually contain a wide variety of species (70 or 80), whereas those from cold conditions have fewer species (10 or so), but with many individuals. Because many shells are small (usually under 5 mm) only the largest species are visible in deposits, although sediment faces wetted by rain may show shells that have been washed clean. Shells can also be found in more unusual settings, including hollows in fossil animal bones and skulls that they have colonised after the death and decomposition of the host animal.



Corbicula shells within an aurochs' (wild cattle) skull



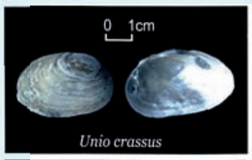
A 500,000 year old *Theodoxus danubialis* shell excavated from Swanscombe in Kent

Mollusc Types

Bivalves

Bivalves (mussels and clams) consist of two 'valves' (shell halves) joined by a hinge that is held together by an elastic ligament. The animal can open the two valves of the shell to feed, breathe and reproduce but can also hold the shell closed as a defence against predators or fast moving water.

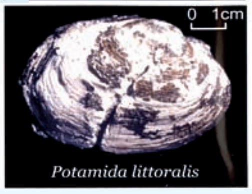
Bivalves live only in water where they either burrow into the bottom sediments or attach themselves to stones or other hard parts of river beds. Some species, however, are only found in freshwater (e.g. *Potamida littoralis* and *Unio crassus*, both freshwater mussels), whilst others are more tolerant of saline conditions (e.g. *Corbicula fluminalis*, which can live in estuarine environments). The presence or absence of species in the fossil assemblage can also have a climatic significance, with both *Corbicula fluminalis* and *Pisidium clessini* being associated exclusively with warm, interglacial conditions.



Unio crassus

Corbicula fluminalis

Pisidium clessini



Potamida littoralis

Plant Macrofossils

Plant macrofossils are defined as fragments of plant material which are visible to the naked eye. The fragments can represent any part of a plant, most often seeds, leaves, stems and roots, but sometimes larger fragments such as tree trunks, are found. These tend to be best preserved in organic deposits such as peat horizons or silt and fine sand river channel infills.

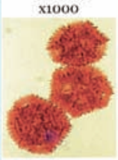
The particular advantage of plant macrofossils over pollen (see next panel) is that they are frequently recognisable to species level so precise information can be obtained about past environments. Also, as they are relatively large and tend to only travel short distances, the presence of plant macrofossils generally provides good evidence that a specific plant once grew at, or close to, the fossil deposit. They are therefore reliable indicators of how local environmental conditions have changed over time.

Plant fossils are also sometimes found in association with animal remains giving us important insights into their diets. For example, plant remains embedded in woolly rhino teeth from the Whitemoor Haye Quarry, Staffordshire, indicate a diet of grasses and herbs.

From top to bottom:
Fossil Pine tree stumps buried in peat in Scotland; A sedge seed magnified 40x; Plant fragments embedded in the teeth of the Whitemoor Haye woolly rhino.

Microscopic Fossil Remains

Pine pollen grain x1000



Dandelion pollen grains x1000

Pollen Grains

Despite not being visible to the naked eye, many Ice Age sediments preserve pollen grains, millions of which are produced and dispersed by the flowers of trees and plants. All pollen grains are microscopic, with few exceeding 1/10th of a millimeter in size, and are identified and counted under high-powered microscopes. Unlike plant macrofossils, they can usually only be identified to family level (e.g. *Betula* = birch family). However, due to their high preservation in many sediments and wide dispersal rates, pollen grains can provide valuable insights into regional vegetation cover and, indirectly, into climatic conditions.

Chironomids

Chironomideae are a family of midges (flies); the adults look similar to mosquitoes but do not suck blood. Chironomids are extremely sensitive to changes in environmental conditions, particularly temperature. Juvenile chironomids hatch from eggs into aquatic larvae before becoming winged adults. The larval outer 'casing' preserve well in sediments and are easily identifiable. Statistical techniques can then be used, comparing fossil and modern communities, to produce estimates of past temperatures. This procedure has been most successful in reconstructing conditions from the last glacial period onwards.

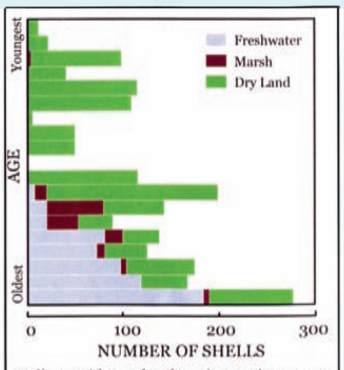
Chironomid head capsule x 1600

Mollusc Habitats

Different species of molluscs occupy a range of habitats including water bodies (from the largest rivers to small ponds), grasslands, scrub and woodlands. Calcium carbonate-rich limestone bedrock and a relatively humid climate provide favourable conditions for land species, whilst flowing, well-oxygenated water with a good lime content is best for freshwater species.

Molluscs are also adapted to more specific niches. Thus the arctic/alpine species *Columella columella* only lives in unshaded places in tundra or mountains whilst *Clausilia pumila* is solely found in mature woodlands in central Europe. Although neither of these species lives in Britain today, both have been found here as Ice Age fossils. These 'specialisations' allow researchers to use fossil 'assemblages' (groups of individual fossils) to produce detailed reconstructions of Ice Age environments in the past.

At Marsworth in Buckinghamshire, analysis of the fossil mollusc assemblages based on modern ecologies illustrates the drying out of the site, from freshwater pond to dry land 200,000 years ago.



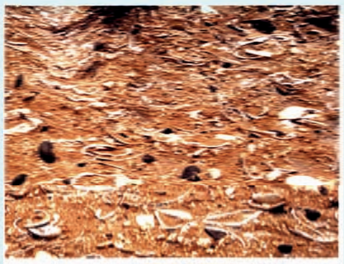
Mollusc evidence for changing environments 200,000 years ago in Buckinghamshire

Sampling for Molluscs

As not all mollusc shells are obvious to the naked eye, bulk samples (a minimum of 10 litres/10-20kg) should be taken from the sediments of interest. These are normally taken as column samples from the base to the top of a section, in order to identify any changes through the sequence.

Due to the generally small size of the shells, their separation from the sediment is a job for experts, involving washing sediment samples through fine sieves down to a mesh size of 0.5 mm, drying the residues and then extracting the shells.

This method may sometimes produce thousands of shells from only a few grams of sediment, although such occurrences are usually restricted to lake marls (calcium carbonate-rich clays) of limestone areas, where preservation is exceptionally good.

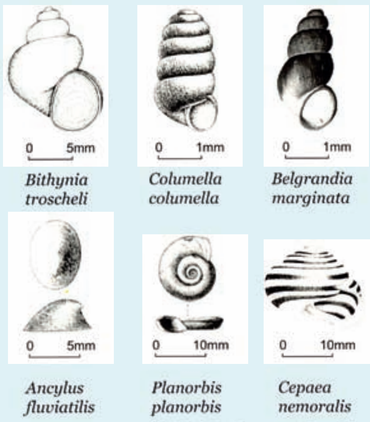


Top: Shells exposed in the sands of the Thames
Bottom: The shells after sieving

Mollusc Types

Gastropods

Gastropods (snails) have coiled or cone-shaped shells and include both terrestrial and aquatic species. They move by contractions along a muscular "foot" on the underside of the animal and can retract their soft parts into the shell to avoid danger or drought.



Some examples of common gastropod species (adapted from: Kerney, M.P. and Cameron, R.A.D, 1979, 'A field guide to the land snails of Britain and North-West Europe' Collins.)

The figure on the left shows a few examples of common land and freshwater gastropods found in Britain.

Bithynia troscheli (here pictured on the far left) was one of the fossil molluscs found at Pakefield in Suffolk. Dating the shells by measuring the fossil protein (amino acid) content helped to establish the age of the Pakefield archaeological site as being 700,000 years old, thereby pushing back the date of the earliest human colonisation of Britain by 200,000 years.

Plant and Insect Fossils

Plant and insect fossil remains can provide valuable insights into former vegetation cover (whether a landscape was covered by forest or grassland for example) and past climates (understanding the modern preferences of the species found can be used to reconstruct past landscapes as well as local and regional climatic conditions).

Plant fossil remains are also sometimes found in association with animal remains and can provide interesting insights into animal diet. Fossil insects, interpreted with reference to modern ecologies, can also indirectly indicate the presence of other animals or vegetation, e.g. some beetle species are solely dependent on particular plants or trees. Plant and insect fossils found in archaeological sites can provide information about which plants ancient peoples would have utilised in the past, not only as food but also as a fuel source (e.g. charcoal), and to make tools (e.g. twine or hunting implements).

To analyse sediments for plant and insect fossils, bulk samples (a minimum of 10 litres/10-20kg) should be taken normally as column samples from the base to the top of a section, to identify any changes through the sequence. To isolate the plant and insect macro fossils (those visible with the naked eye), the sediment should be wet-sieved using a fine (200µm) mesh. Once the residue is clean and dry, it can then be sorted under a low-power (10x) binocular microscope for specimens. To analyse microscopic fossils (e.g. pollen and chironomids), small sub samples are taken from the column (1cm³), and the fossils concentrated using various chemical treatments. Both plant and insect fossils are then identified using keys, drawings and reference material.

A 400,000 year old spear point made from Yew

Beetles

Twenty five per cent of all known animal species are beetles. Different beetle species occupy almost all habitats from freshwater bodies to scrubland and woods. Many beetle species are specialists adapted to particular environments and/or narrow temperature ranges. For example, *Stephanocleonus eruditus* is a weevil that is only found near snowfields in the alpine tundra of Siberia. Other beetle species have specific dietary needs, for example dung beetles require the presence of large herbivores locally to provide their food source.

The beetle fauna of Britain today consists of more than 3800 species. They are best preserved in fine grained sediments such as silts and sands and organic deposits within gravel bodies. However, beetles do not tend to survive intact and generally what remains will be the wing cases and thorax (the 'shell' between neck and abdomen). As beetles have not evolved or 'changed' over the last 2 million years, the distinctive species features are the same for fossil beetles as for modern beetles living today. This means that fossils can be directly interpreted with reference to the diet and habitat of modern beetle specimens. Fossil beetle assemblages, once subjected to statistical analysis, are invaluable in providing very detailed climatic reconstructions of the Ice Age.

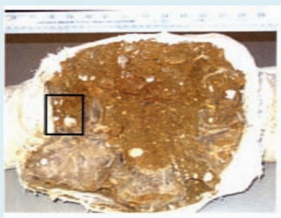
Stephanocleonus eruditus head capsule

Beetle wing cases

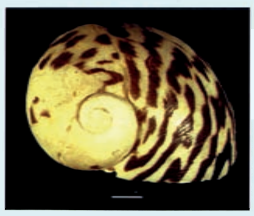
Finding Ice Age Molluscs

Molluscs are usually found in sand or mud rather than in gravel or clays. Silted-up river channels exposed by gravel quarrying are often the most productive, containing an abundance of freshwater shells, but also land shells washed into the river by floods. Occasional sandy deposits in large rivers like the Thames may also be very rich in shells, including the largest bivalves. Shells are often noticed because they have been bleached white over time although the original shell colours may also sometimes be preserved.

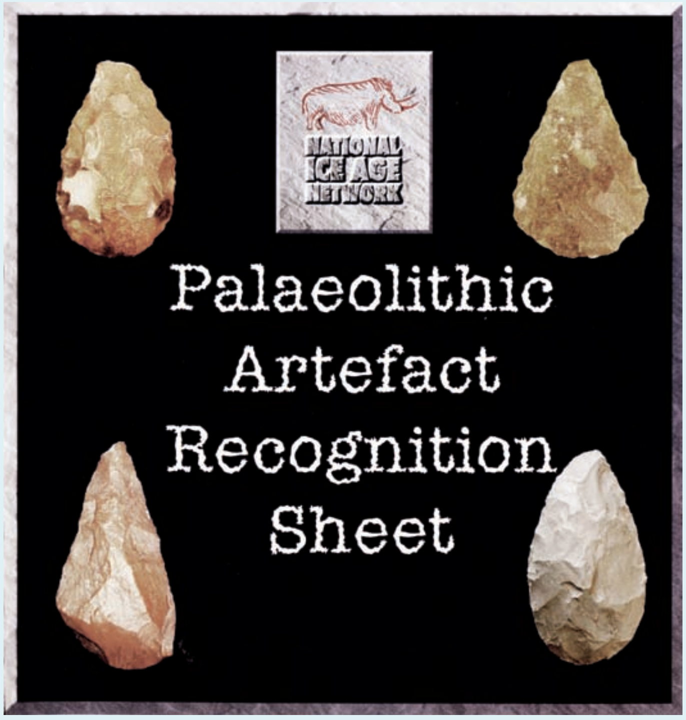
Warm interglacial period deposits usually contain a wide variety of species (70 or 80), whereas those from cold conditions have fewer species (10 or so), but with many individuals. Because many shells are small (usually under 5 mm) only the largest species are visible in deposits, although sediment faces wetted by rain may show shells that have been washed clean. Shells can also be found in more unusual settings, including hollows in fossil animal bones and skulls that they have colonised after the death and decomposition of the host animal.



Corbicula shells within an aurochs' (wild cattle) skull



A 500,000 year old *Theodoxus danubialis* shell excavated from Swanscombe in Kent



INTRODUCTION

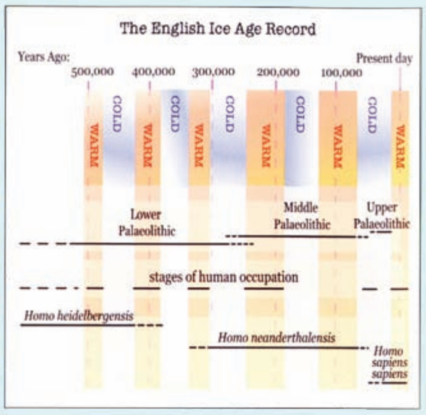
Welcome to the Palaeolithic Artefact Recognition Sheet, one of a series of introductory factsheets produced by the National Ice Age Network, which will include Pleistocene (Ice Age) sediments, fossil animals, plants and shells and lithic artefacts (stone tools).

Palaeolithic literally means 'Old Stone Age', and in Britain the oldest manufactured artefacts are over half a million years old. Due to this great age only very durable types of artefact - such as stone tools - have survived for study by the archaeologists of today. This makes stone tools a unique line of evidence for reconstructing the technologies, habits and behaviours of the earliest human inhabitants of our country. The timeline shows when different species of human (*hominins*) arrived in Britain and an overview of their technologies.

This sheet will introduce you to the main types of Lower and Middle Palaeolithic artefact, from simple *flakes* and the *cores* they come from to *handaxes* and *Levallois* techniques.

All the artefacts described in this sheet were produced by *knapping* - *knapping* is the process of removing *flakes* from blocks of stone and the shaping of suitable materials into a desired end product.

The *knapping* techniques focused on here are *direct percussion* (hitting) techniques. *Direct percussion* may be done using a *hard hammer* made of stone, or a *soft hammer* usually made of antler. Both *hammer* types can be used to detach and shape *flakes* and *cores* and to *retouch flakes* into other tools.



SIMPLE CORES

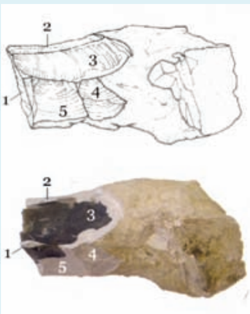
Cores are the pieces of lithic raw material from which *flakes* are detached. Just like *flakes*, *cores* have a series of diagnostic features known as *negative flake scars* that help us distinguish humanly-made artefacts from naturally fractured stones.

Negative Flake Scar(s): when *flakes* are detached from the *core* they leave a hollowed out depression of their shape in the *core*. This *negative flake scar* shows a marked hollow corresponding to the 'positive' *bulb of percussion* present on the detached *flake*, and *ripples* indicating the direction from which the *flake* was detached from the *core*.

Each *flake* removed creates a *negative flake scar* on the *core* and as *knapping* of the *core* continues these *negative scars* may overlap and overprint one another - the most complete *negative flake scars* belong to the *flakes* that were removed last.

Sample Core

Flake 1 was removed first. The *core* was then rotated 90° and the *scar* of the first *flake* used as a *platform* for *flake* removals 2 and 3. The *core* was then re-rotated 90° and *flakes* 4 and 5 removed from the *core*. Further *flake* removals from the same location as 4 and 5 would have been possible.



Negative Flake Scars can also tell us about the way in which the *core* was *knapped*.

Single Removal

A single *flake* is detached from the *core* - perhaps to test the quality of the raw material

Parallel Flaking

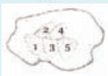
2 or more *flakes* are detached from the *striking platform*

Simple Alternate Flaking

1 or more *parallel flakes* are removed, then the *core* is rotated through 90° and the *scars* of these removals used are as the *striking platform* for further *flakes*

Classic Alternate Flaking

A single *flake* is removed, then the *core* is rotated 90°, and the *scar* used as the *striking platform* for detaching the second *flake*. More flakes may be removed, rotating the core 90° before each removal

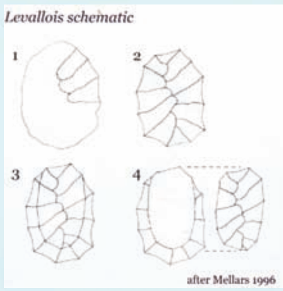


after Ashton *et al.* 1998

LEVALLOIS

Levallois technique is the name of a specific type of *prepared core technology*, usually associated with the Middle Palaeolithic and the Neanderthals. As the name implies, the *core* is first prepared so that a *flake* of predetermined size and shape can be removed.

Levallois schematic

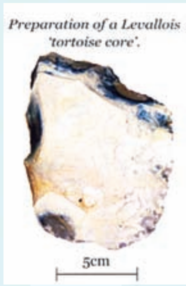


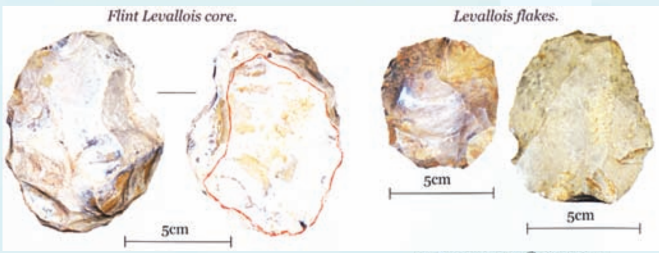
after Mellars 1996

Levallois techniques create a conical *core* with a convex upper surface, which controls the shape of the final removal, the *Levallois flake*. The shape of this *'tortoise core'* allows several *Levallois flakes* to be removed with little further modification of the *core*.

Levallois flakes have a distinctive *dorsal scar pattern*, testifying to the earlier *core* preparation.

Preparation of a Levallois 'tortoise core'.





Location of *Levallois flake* removal marked in red.

Levallois photographs © Birmingham Museums & Art Gallery

WHAT IS A HANDAXE?

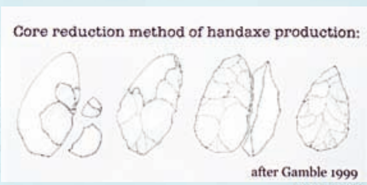
The most commonly recognised type of Palaeolithic tool recovered in this country is the *handaxe*. The *handaxe* is the diagnostic tool type of the Lower Palaeolithic Acheulean technology. The oldest *handaxes* known from this country are over half a million years old.

HOW WERE THEY MADE?

Handaxes are also known as *bifaces*, and this alternative name alludes to how they were made - the *handaxe/biface* is a tool that has been extensively shaped and flaked on both faces. These tools dominate the Palaeolithic record because they are large (larger than most *flakes*), durable and easily recognisable as humanly-made artefacts.

Handaxes can be made in 2 different ways. Firstly a nodule may be reduced by *hard hammer flaking* to create a *roughout* - an approximation of the shape of the finished *handaxe* - then finally shaped using a *soft hammer*. Alternatively if you have access to large *nodules* of raw material then very *large flakes* known as *blanks* can be produced; these are then flaked further to produce the handaxe.

Core reduction method of handaxe production:



after Gamble 1999

WHAT WERE THEY MADE FROM?

Handaxes have been recovered in this country in a range of raw materials including *andesitic tuff, quartz, quartzite, chert* and *flint*. The Raw Material Map should give you an idea of the most dominant raw material in your local area. Remember though that 'exotic' raw materials may also have been present and could have been used to make stone tools.

WHAT WERE THEY USED FOR?

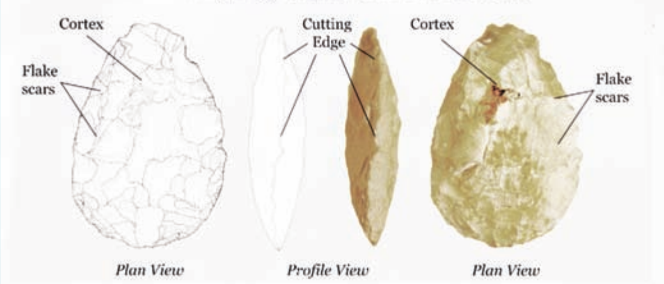
Handaxes are considered to be multipurpose tools - sometimes referred to as the Palaeolithic 'Swiss Army Knife'. Many experiments have shown *handaxes* to be highly efficient butchery tools. They are also easily resharpened which both extends the useful life of the *handaxe* and can also provide a source of sharp *flakes* if required.

HANDAXE SHAPES & SIZES

There is no standard size for a *handaxe*. Occasionally very large examples (over 30cm long), and smaller specimens (approx. 5cm long) are found, though these artefacts are more typically sized to fit comfortably in the hand (as the name implies).

Handaxes are found in a wide range of shapes and with varying degrees of 'refinement'. It was once thought that *handaxe* forms evolved through time and that crude stone-struck examples were older than more finely flaked forms. Sites such as Boxgrove in West Sussex with 'finely' made *handaxes* of an early date, finally disproved this theory. It is now recognised that 'refinement' is not a useful indicator of the age of a *handaxe*. Similarly, whilst *handaxe* shapes were once considered to represent different 'cultural' groups, variations are now thought to relate to more 'practical' reasons, such as raw material size or tool function. Some of the common *handaxe* shapes are shown below (after Wymer 1968).

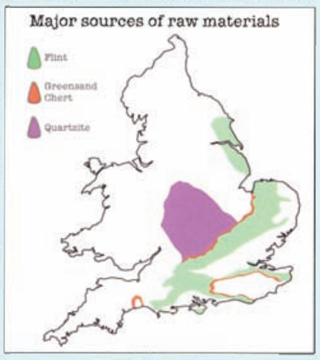
A lightly stained Flint Handaxe



RAW MATERIALS

In Europe, *flint* was the most widely used lithic raw material in Palaeolithic times. *Flint* is a fine-grained, very homogenous stone, similar to glass in its mechanical properties. This means that not only does it create very sharp edges as it fractures, it does so in a predictable and consistent manner. *Flint* fractures conchoidally (literally 'shell-like') so as it is *knapped* a series of recognisable *percussion features* are produced.

Flint forms in Chalk, and both large and small nodules can be found where Chalk outcrops. *Flint* collected from eroding Chalk outcrops would have provided early humans (*hominins*) with high quality raw materials for tools. *Flint* would also have been available in secondary sources such as river gravels – though the size and quality of these flint pebbles and cobbles would have been very variable.



Most, but by no means all, of the Palaeolithic artefacts from England are made of *flint*. However, flint was not always available and then Palaeolithic people used other suitable rocks such as *quartzite* and *Greensand chert* and less common materials such as *andesitic tuff* (a very ancient volcanic deposit) to make tools.

The raw material map should give you an idea of what materials Palaeolithic artefacts in your area are likely to be made from – though remember that non-local 'exotic' materials may also have been utilised!

Many of the examples in this sheet are *flint* artefacts, because not only are they the most commonly found material, but *flint* is also the easiest stone in which to "read" the distinctive *percussion features;* however we have also included other raw materials. We hope that you can use this recognition sheet to help identify more Lower and Middle Palaeolithic stone tools, in different locations across England, and in a variety of raw materials. If you would like further advice about stone tool identification please contact the National Ice Age Network or your local museum.

IDENTIFYING ARTEFACTS

Bulb of Percussion: this occurs just below the place where the core was struck to remove a flake - on flakes this bulb is a pronounced swelling and on cores a corresponding hollow.

Flake Scars: the evidence on an artefact for earlier *flake* removals. They are made up of *ripples* and a 'hollowed out' *negative bulb of percussion*. Multiple *negative flake scars*, help us to identify *deliberate knapping* as natural processes do not usually create a series of complete *negative flake scars*.

Retouched Flakes: the removal of small flakes that alter the shape and/or the angle of the edge can be a good indicator of artefact status. However, when dealing with Ice Age river gravels it is always worth remembering that such small flakes may have been removed by natural processes, damaging the edges of the artefact.

Handaxes: handaxes or *bifaces* are among the easiest types of artefact to identify, due to the intensive degree of shaping and flaking evidence they preserve. Use the pictures on this sheet as a guide to identifying any potential artefacts you find.

Artefact Size & Shape: Palaeolithic artefacts come in a wide range of sizes and shapes. As a very rough guide, *handaxes* are generally approximately hand-sized, and *flakes* somewhat smaller. *Cores* can be any size. Due to the ferocity of Ice Age rivers it can be difficult to prove that very small pieces are genuine artefacts as the features they display may well result from impacts with cobbles in fast flowing water.

Artefact Colour & Physical Condition: many Palaeolithic artefacts will show iron staining of an orangey colour. Artefacts may also have been damaged by processes such as river transportation; most typically this shows as abrasion to the ridges between the negative flake scars and/or chipping to the edges of the piece.

References:

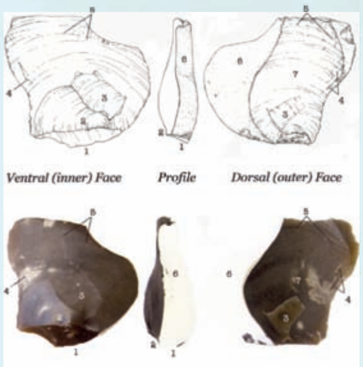
Ashton, N., Lewis, S.G. & Parfitt, S. 1998. *Excavations at the Lower Palaeolithic site at East Farm, Barnham, Suffolk 1989-94.* British Museum Occasional Paper 125, British Museum Press, London.
Gamble, C. 1999. *The Palaeolithic Societies of Europe.* Cambridge University Press, Cambridge.
Mellars, P. 1996. *The Neanderthal Legacy.* Princeton University Press, Princeton.
Wymer, J. 1968. *Lower Palaeolithic Archaeology in Britain as represented by the Thames Valley.* John Baker, London.

Credits:

Text and design by Dr. Jenni Chambers & Bryony Ryder

FLAKES

Flakes are the simplest type of lithic artefact; quick to produce, very sharp and easily *retouched* into other tool types. *Knapping* creates a series of recognisable attributes on both the *flake* and the *core* it is detached from. It is these *percussion features* that allow us to recognise Palaeolithic artefacts.



1 = **Striking Platform:** this is the flat area where the *hammer* strikes the *core* to remove the *flake*
2 = **Bulb of Percussion:** adjacent to where the *hammer* strikes, the force of the impact produces a conical swelling
3 = **Eraillure Scar:** a small secondary *flake* that may be removed as the *bulb of percussion* forms
4 = **Radial Fissures:** small cracks known as *'Hackles'* may be present and point towards the *bulb of percussion*
5 = **Ripples:** *ripples* radiate from the *bulb of percussion*, travelling the length of the *flake*. *Ripples* indicate the direction of the blow that removed the *flake* from the *core*
6 = **Cortex:** the 'outer skin' of a *nodule*
7 = **Dorsal Flake Scar(s):** evidence of previous flaking may be present on the *dorsal* (outer) surface of the *flake* as *ripples*, or complete *negative scars* which have a hollow where the *bulb of percussion* of the previous *flake* formed

The example above is a modern replica of an ancient *flake*. Archaeological examples you might find are more likely to be stained, patinated or coated in minerals from their long exposure to chemicals in the soil. Orange, brown, yellow and cream are the most common stains for *flint* to develop. On other raw materials such as *chert* and *quartzite* this staining is harder to see due to the natural colouration of these materials.

A *flint flake* stained orangey brown

A *chert flake*, naturally dark brown, showing some orange staining

RETOUCHED FLAKES

Freshly *knapped flakes* are extremely sharp, and would have been used for a variety of cutting tasks. However, this very sharp, thin edge quickly becomes worn down and blunted with use. *Retouching* the edge of a flake makes it much more durable and suitable for tasks such as wood working and hide processing which would quickly blunt a *non-retouched flake*.

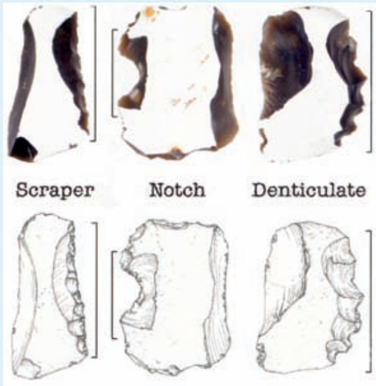
Retouch is the removal of a series of small *flakes* to modify the shape or edge of an artefact, when done to one face of an edge this is called *unifacial retouch* and when both faces of an edge are *retouched* this is called bifacial retouch. Retouch removals may be made with a small *hard hammer* (stone) or a *soft hammer* (antler) - both *direct percussion* methods.

Illustrated are some common *unifacial retouched* tool types:

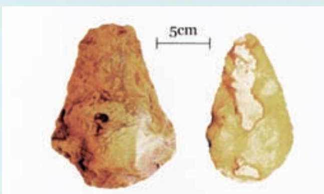
Scraper:
Small *retouch flakes* are removed from one side of the *flake*, creating a durable working edge that could be used for hide or wood working.

Notch:
Larger *retouch removals* concentrated in one location produce this distinctive *notch*. It has been suggested *notches* were used for wood working.

Denticulate:
Small *retouch removals* create a 'saw' like edge, that could have been used for meat or wood processing tasks.



EXAMPLES OF HANDAXES FOUND IN GRAVEL DEPOSITS AROUND ENGLAND



Flint handaxes occur in many parts of England, and have been found in a wide range of shapes and sizes. Commonly they are iron-stained, as shown above. *Handaxes* from gravels may also show abrasion and/or damage similar to the *handaxe* on the left.

Quartzite cobbles suitable for *handaxe* manufacture are scattered throughout central England. *Handaxes* are commonly made on split *quartzite* cobbles like those above.

Greensand Chert is mechanically similar to *flint*, though it often looks much coarser. The largest numbers of *Greensand Chert* artefacts occur in the Southwest of England.

Andesitic tuff is an ancient volcanic deposit, suitable for stone tool manufacture. Palaeolithic *handaxes* of *andesitic tuff* have been found mainly in the Midlands.

Contact your local 'National Ice Age Network' centre by email at info@iceage.org.uk or write to:

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