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its lithic artefacts and natural environment

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Cover: A herd of reindeer crossing the Cairngorms (photo: Cairngorm Reindeer Centre)



HISTORIC  
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# In memory of Alan Saville

31 December 1946 – 19 June 2016



*(Photo: Tam Ward)*



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## Summary

In 2006 and 2009, excavations were carried out at Howburn Farm near Biggar, South Lanarkshire. A total of 5,070 lithic artefacts were recovered, including 2,091 pieces of flint, 2,906 pieces of chert, 33 pieces of pitchstone, as well as small numbers of other lithic raw materials. As in this part of Scotland chert usually relates to Mesolithic, Early Neolithic and Early Bronze Age industries (Paterson and Ward 2013), and as it is well known that much flint was imported into southern Scotland from north-east England during the later Neolithic (Ballin 2011b), the various elements of the assemblage were first thought to date to these periods. However, close inspection of the finds, and the identification of diagnostic types and technological attributes of pre-Mesolithic character, showed that probably almost all the flints date to the Late Upper Palaeolithic period (Ballin *et al.* 2010). It is estimated that approximately half of the lithic artefacts date to the Palaeolithic, and most of the remainder to the Late Mesolithic – Early Neolithic period, supplemented by a small number of later Neolithic and Early Bronze Age pieces.

Diagnostic elements suggest that the Late Upper Palaeolithic finds date predominantly to the Late Hamburgian (the centuries just prior to 12,000 cal BC; Grimm and Weber 2008), with some probably representing visits to the site by slightly later *Federmesser-Gruppen* hunter-gatherers (cf. Saville and Ballin 2009). It was decided in this volume to focus on the site's Hamburgian sub-assemblage, as this industry almost exclusively used exotic flint and to a lesser extent exotic chert. This made it easy to distinguish the Hamburgian material from the site's post-Palaeolithic artefacts, and it was possible to define a full Hamburgian typo-technological 'package' including the industry's operational schema, whereas the blanks and typologically undiagnostic tools of the chert-dominated *Federmesser-Gruppen* settlers are difficult to distinguish from the site's post-Palaeolithic objects.

As the Hamburgian represents a techno-complex centred on northern Germany and southern Denmark (Weber 2012), it is more likely that the industry's flint was procured from sources on Doggerland (Ballin 2016c), when the Howburn settlers passed those in connection with their stalking of reindeer herds through the landscape, than that the flint was procured from sources in the greater Yorkshire area, from which area similar flint was imported into Scotland in the later Neolithic.

Late Upper Palaeolithic finds were recovered throughout the site, but particularly from a number of more or less discrete concentrations. Some of these concentrations appear almost devoid of later elements, such as the southern concentration in Trench I (2009) – possibly the footprint of a tent-like structure – and, slightly less so, the main concentration in Trench II (Block 2). The site's Late Hamburgian (Havelte) type spectrum and technological approaches are characterized primarily on the basis of these two concentrations. Finds probably dating to the *Federmesser-Gruppen* period are found throughout the location, but they seem to be most prolific in Trench II (Blocks 3-4), which formed the basis of the type spectrum and technological profile suggested for this sub-assemblage.

The raw material preference of the Havelte settlers is best characterized by the finds from Trench I (2009) which included 70% flint, with the exclusively Hamburgian finds from the lowest levels ('the subsoil') including 98% flint. The flint was reduced following a well-defined operational schema which embraced careful decortication and cresting, and large blades were detached mainly from opposed-platform cores by the application of soft percussion *en éperon* technique.

The tools include some common types, such as plain end-scrapers, but they are first and foremost characterized by numerous diagnostic pieces. The latter include 29 tanged points of Havelte Type; many elegant blade-scrapers and double-scrapers, as well as large flake scrapers, mostly with acute edge-angles; numerous burins, many of which are based on truncated blanks; and small numbers of *Zinken* and *becs*.

The raw material preference of the *Federmesser-Gruppen* settlers is best defined by the sub-assemblage from Trench II (Blocks 3-4), which has a flint ratio of only 14%, with most of the remaining 86% being chert. Although most of this chert is local, a considerable number of artefacts are in exotic orange chert. Although it is difficult to distinguish the concentration's Palaeolithic local chert from later finds based on this raw material, *Federmesser-Gruppen* broadblade tool blanks appear to have been produced by the application of soft percussion opposed-platform technique, but possibly without the use of platform-faceting.

The general assemblage includes 71 backed points, including fragments, and although it can not be ruled out that some of those date to other Late Upper Palaeolithic periods, it is most likely that the majority are of *Federmesser-Gruppen* affinity (cf. Saville and Ballin 2009). The backed points include angle-backed and curve-backed pieces, but

most are straight-backed specimens. It is uncertain exactly which of the chert implements from Trench II (Blocks 3-4) are contemporary with the backed pieces, but the exotic orange chert includes, *inter alia*, a blade-scraper, two short end-scrapers, and one plain burin.

Unfortunately, it was not possible to obtain any absolute dates for the Late Upper Palaeolithic material.

The Palaeo-environmental work at Howburn focused on one specific question, namely whether there was a small lake ('Loch Howburn') in front of the terrace on which the camp was situated, thus mirroring the settlement locations of contemporary hunter-gatherer camps in north-west Europe (e.g. Slotseng and Jels in southern Denmark; Holm 1991; Holm and Rieck 1992). Following coring and additional analyses, it was concluded that there was indeed a lake in front of the site during the Late Glacial period, but it was neither contemporary with the Hamburgian, nor the *Federmesser-Gruppen* settlement. Most likely, 'Loch Howburn' dates to the Loch Lomond stadial.

Following the discovery of the Howburn site, other Late Upper Palaeolithic lithic discoveries have been made in Scotland, either in connection with excavations or as stray finds, or in connection with the re-examination of old 'backlog assemblages' or museum collections. Together, these lithic artefacts state 'beyond reasonable doubt' that Scotland had indeed a Late Upper Palaeolithic period, and that it includes a number of material cultures known from the European Continent or Scandinavia. They include the Late Hamburgian; the *Federmesser-Gruppen* complex; the Ahrensburgian; and the Fosna-Hensbacka complex (Ballin 2017a).

The Late Upper Palaeolithic finds from Howburn, as well as from Scotland at large, shed light on several important general trends, such as the 'acclimatization' of pioneer settlers, as well as the development of regional differences following the initial Late Glacial recolonization.

In Scotland, the Late Glacial settlers initially favoured flint, which they brought with them on their journeys through the landscape. It is thought that at this time flint was mainly procured from sources on Doggerland, where outcrops of Cretaceous flint would have been plentiful (Harker 2002). Later groups, such as *Federmesser-Gruppen* hunter-gatherers, seem to have become accustomed to their new setting and its locally available raw materials, and at Howburn chert was now favoured, and at Kilmelfort Cave on the west-coast (Saville and Ballin 2009) quartz was widely used. This scenario mirrors the recolonization of Late Glacial western Norway, where assemblages were initially totally dominated by flint, and where local raw materials with time became more and more heavily exploited (Bruen Olsen 1992, 84).

As shown in Ballin (2016a), the flooding of Doggerland caused geographically extensive material cultures to fragment, leading to the development of smaller, local material cultures. However, even before the disappearance of this landmass, a techno-complex as physically extensive as the Hamburgian, stretching from Poland to Scotland, is likely to have included local groups which, although sharing the same basic tool-kit and technological approaches, would also have been characterized by subtle differences in terms of implement style, specific technological approaches, and assemblage composition, with the differences probably representing what Madden (1983) referred to as 'differentiation due to distance'.

The most significant difference between Howburn's Havelte sub-assemblage and the assemblages of contemporary sites in Continental north-west Europe is the general composition of the tools. Where the Continental assemblages (Grimm and Weber 2008) are characterized by many Havelte points, scrapers, burins and *Zinken*, with the latter being a key diagnostic element, Howburn only includes a handful of these implements (1-3% against the 24-46% of Continental sites) (this volume's Tables 18-19). It is uncertain whether this reflects different subsistence strategies, or whether the discovery of new Hamburgian sites in Scotland may show that Howburn is an exception, with new Scottish assemblages from this period including the tool forms commonly found on Continental sites.

Another significant difference is the common occurrence at Howburn of *en éperon* blades, where these blades are less common, and frequently absent, in Continental Hamburgian assemblages (Weber *et al.* 2010, 18). It is possible that the use of the *en éperon* technique at Howburn reflects the fact that the Scottish Hamburgian territory bordered the Creswellian techno-complex towards the south, where the *en éperon* technique (as amongst Magdalenian groups in general) was an integral part of the operational schema associated with Creswellian blade production (Jacobi 2004). The absence of small tanged Wehlen scrapers (Holm 1991, 14) at Howburn – a scraper form associated with Late Havelte and early *Federmesser-Gruppen* assemblages on the Continent – may either indicate that the Palaeolithic sub-assemblages from Howburn do not date to this transitional phase, or the absence of these scrapers may represent yet another regional difference.

However, many of the conclusions made need corroboration, and at this moment in time we must bear in mind that Howburn is presently Scotland's (and Britain's) only Hamburgian settlement site. The main sub-assembly from Howburn is of indisputable Havelte character, and the combination of its blank, core and tool types, its technological approaches, and its raw material preferences, is a clear pre Mesolithic trait. Key questions Scottish Upper Palaeolithic research needs to focus on now include: 1) What went before Howburn (is there a Scottish Classic Hamburgian or Creswellian stage); 2) are assemblages from other (as yet undiscovered) Scottish Havelte sites composed in the same manner and reflecting the same economical strategy, or does Howburn represent a 'niche' in a broader economical approach; 3) how does Howburn's raw material preferences, type spectrum and technological approaches compare with other Late Upper Palaeolithic industries represented in Scotland; 4) are there within Late Upper Palaeolithic Scotland internal regional differences, for example representing differences in terms of raw material availability and adaptation to these differing resources (e.g., differences between the Scottish east and west, as seen during the Scottish Mesolithic); 5) what happened in Scotland at the Upper Palaeolithic/Mesolithic transition, and how is this transition defined in terms of material culture changes; 6) which role did the constantly changing natural environment (climate, vegetation, fauna, etc.) play in the transformation of one Palaeolithic material culture into another, including their economical strategies, mobility and settlement patterns, and lifeways in general; and 7) how did Doggerland change over time, affecting cross-Doggerland cultural networks and, not least, where exactly was the northern shoreline of this landmass at any one time?

Although the discovery of Howburn was hugely important in terms of research into Scotland's earliest prehistory, we need more Late Upper Palaeolithic sites in general, and more Hamburgian sites specifically, to deal with these new questions, and absolute dates are essential.



## Acknowledgements

The Howburn Project has been a complex undertaking, and it took 15 years to bring this project on Scotland's Late Upper Palaeolithic (LUP) beginnings from initial fieldwalking to final publication. Briefly summarized, the project involved a fieldwalking phase (2003–2005); excavation of Trench I (2006); processing of the finds from 2006, and production of several papers on our findings (2007–2010); excavation of Trench I extension and Trench II (2009); processing of the finds from 2006, and production of a first draft manuscript on the full assemblage from the two excavations (2010); production of a publishable manuscript (this volume; 2010–2018); other tasks, such as illustration of artefacts, production of maps and plans, etc.; and palaeo-environmental work relating to the question of the nature and date of 'Loch Howburn' was carried out parallel to the archaeological investigations.

Like all complex and temporally extensive archaeological projects, the Howburn Project involved contributions from a large number of people and institutions. The work could not have been undertaken without the funding offered by Historic Scotland/HS (now Historic Environment Scotland/HES), the Society of Antiquaries of Scotland, and the Robert Kiln Trust, and we are truly grateful. We would like to specifically thank Noel Fojut, Rod McCullagh, and Kirsty Owen from HS/HES for their advice and support along the way.

Tam Ward thanks the farmers at Howburn, Ann and Graham Barrie, for permission to undertake fieldwork, and all members of the Biggar Archaeology Group (BAG) and other volunteers for assistance during and after the fieldwalking and excavations – over one hundred and fifty people of all ages took part. The BAG are grateful to the late Alan Saville for his visits to the site and for explaining the site and its meaning to the group's members.

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The Howburn Project would also like to thank David Davison and his staff at Archaeopress for their practical help and advice in connection with the publication of this monograph.

In 2014, Alan Saville unexpectedly became seriously ill, and in 2016 he sadly passed away. The entire project team would like to thank Alan for his contributions over the years, and not least for our many engaged discussions of the Scottish Late Upper Palaeolithic period in all its aspects. We dedicate this monograph to the memory of Alan Saville. Finally, the team would like to thank Alan's wife, Annette Carruthers, for access to Alan's files on Howburn, including the original artefact drawings



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## Preface

The Howburn Project has had a long and complex 'life', involving dedicated work by many volunteers, archaeologists and scientists. In a sense, the project reflects general developments in Scottish early prehistoric archaeology during this period, not least in terms of how we perceive the earliest part of Scottish prehistory, and the site and its assemblage has had to be reinterpreted along the way.

Biggar Archaeology Group (BAG), led by Tam Ward (TW), began surveying the fields around Howburn Farm in 2003, and due to the presence of several notable concentrations of lithic finds, they carried out an excavation at the location in 2006. The group subsequently produced a report on their work (Dudds *et al.* 2006), and in this report it was suggested that the assemblage included Mesolithic, Neolithic and Early Bronze Age objects, due to the presence of well-known diagnostic implement forms in flint and chert, as well as some diagnostic pottery.

The flint, however, presented an interesting problem, as it was considerably more abundant, and the individual pieces larger, than one would have expected from this chert-dominated part of Scotland. As later Neolithic lithics, such as chisel-shaped arrowheads, and pottery had been recovered from neighbouring fields (Dudds *et al.* 2006), and as it is consensus that large nodules and implements of flint were imported into Scotland from north-east England during the Middle and Late Neolithic periods (Ballin 2011b), it was assumed that the collection's flint component dated mainly to the later Neolithic.

As at the time one of the authors (Torben Ballin; University of Bradford) was carrying out work on Scotland's later Neolithic industries, he borrowed the finds from Howburn for this work, kindly made available by the BAG. It was thought that the Howburn assemblage would provide comparative material for the discussion of Scottish later Neolithic flintwork, but unexpected diagnostic pieces soon made it clear that the finds represented something considerably more interesting, namely a Late Upper Palaeolithic assemblage, pre-dating other lithic finds from Scotland by several millennia. At this time, only a small number of stray Upper Palaeolithic lithics had been recovered from locations in western and northern Scotland (Ballin and Saville 2003; Ballin and Bjerck 2016), and only one other Late Upper Palaeolithic settlement assemblage was known, also from western Scotland (Kilmelfort Cave; Saville and Ballin 2009).

The finds from the 2006 excavation, as well as those from the fieldwalking campaign, were examined and discussed by TB and Alan Saville (National Museums Scotland), and it was agreed to jointly carry out a project, the purpose of which was to investigate and publish the lithic objects. As part of this work, a first paper was produced (Saville *et al.* 2008) in which the finds were characterized as 'very old', but without the authors being overly specific about the objects' true date. The date of the lithic objects only became obvious in connection with the subsequent detailed characterization and cataloguing of the assemblage, where two fragments were conjoined to form one intact tanged point (Pitts 2009), and several typical *en éperon* blades were identified. *En éperon* blades are generally only found in connection with Hamburgian, Creswellian and late Magdalenian assemblages, and broadly dating to the period 13,000-12,000 BC.

As the distribution maps of the finds from the 2006 investigation suggested that the prehistoric site had only been partially excavated (Ballin *et al.* 2010), it was agreed to carry out further work at the site to secure more datable material. Tam Ward and the BAG therefore began their second excavation at Howburn in 2009, increasing the total number of lithic artefacts from 1099 to 5070 pieces, and the number of tanged arrowheads from four to 29. On the basis of the tanged points and their diagnostic attributes, it was now possible to say with confidence that most of the Late Upper Palaeolithic finds dated to the Hamburgian Havelte phase (the centuries just prior to 12,000 cal BC; Grimm and Weber 2008), with some probably representing visits to the site by slightly later *Federmesser-Gruppen* hunter-gatherers.

In popular terms, Hamburgian hunter-gatherers are referred to as reindeer hunters, and it was assumed that the Late Upper Palaeolithic groups visiting the site were following reindeer on their trek across the landscape (e.g., Vang Petersen and Johansen 1996). The well-known camps of north-west European reindeer hunters, such as those in the tunnel-valleys of northern Germany, as well as the Danish sites of Jels and Slotseng, are all situated in similar locations in the landscape, such as terraces facing a lake, providing drinking water for game. It was therefore suggested that the same could have been the case at Howburn, and that a small lake – 'Loch Howburn' – could have existed in the valley immediately north of the site. To investigate this question, environmental scientist Richard

Tipping (University of Stirling) was invited to join the team, hoping that he could shed light on this question. Following coring in the valley floor by Tipping, analysis of the sediments by Clare Wilson (University of Stirling), and dating of the sediments by tephra-analysis by Rupert Housley (Royal Holloway, University of London) and his team (Lucy Verrill and Matthew Bradley [University of Stirling]; Paul Lincoln [University of Portsmouth]; and Alison MacLeod [University of Reading]), it was determined that a loch might indeed have existed at some stage below the settled terrace, but not during the Hamburgian or *Federmesser-Gruppen* periods.

Investigation of the finds continued after the second excavation (2009), but during the following years our colleague Alan Saville became seriously ill, and he sadly passed away in 2016 (Ballin 2016a). We have chosen to dedicate this volume to Alan.

In 2017, a grant was offered by Historic Environment Scotland for the final publication of the finds from this interesting and – in a Scottish context – unique assemblage, presenting the finds from both excavations, as well as a discussion of their importance to Scottish and north-west European early prehistory. Howburn does, after all, represent the north-western frontier of a techno-complex or material culture, which stretched from Poland in the east to the Atlantic seaboard in the west.

At the beginning of the project, only a few stray Late Upper Palaeolithic finds (Livens 1956) and one settlement site (Saville and Ballin 2009) were known from Scotland, and although these finds clearly suggested that the country had been visited during the Late Glacial period, it was still uncertain whether the finds represented ‘scouting parties’ or pioneering settlement. This explains the caution shown by the authors in the project’s first publication (Saville *et al.* 2008) in terms of what the assemblage from Howburn might represent.

As the general understanding of Scottish Late Upper Palaeolithic types, technological approaches, and raw material preferences expanded – partially as a ‘spin-off’ from the work of the Howburn Project – more finds were being made, partly in connection with the processing of old ‘back-log’ assemblages, but also in connection with new research and rescue excavations. The old mainly Mesolithic assemblage from Shieldaig, Highland (Ballin 2014c), yielded an Ahrensburgian arrowhead, formally related to the well-known piece from Tiree (Livens 1956; Ballin and Saville 2003), and the processing of the finds from Nethermills Farm, Aberdeenshire, led to the identification of a number of almost certain Upper Palaeolithic flint implements, although it has not been possible to date these within this general period (Ballin and Wickham-Jones 2017). Re-examination of the assemblage from Lunanhead, Angus, has prompted reinterpretation of this flint collection (initially thought to be later Neolithic), with its large broad blades, a blade-scraper, and several burins indicating an Upper Palaeolithic date (Ballin 2017a).

A string of rescue excavations in Aberdeenshire has brought about several likely Upper Palaeolithic pieces, mostly representing residuality in assemblages dominated by later finds. This group includes objects from for example Blackdog and Wester Clerkhill (Ballin *et al.* 2017; Cameron and Ballin forthcoming). However, a relatively numerous scatter at Milltimber, west of Aberdeen, included a sub-assemblage of impressively large blades, preparation flakes and cores (Ballin forthcoming), which have allowed a Late Upper Palaeolithic operational schema to be defined (Ballin 2017a), which may allow Scottish assemblages from this period without diagnostic tools to be recognized. Finally, research projects on Orkney and Islay have resulted in the recovery of flints of Scandinavian Fosna-Hensbacka (Lee and Woodward forthcoming) and Continental Ahrensburgian (Mithen *et al.* 2015) affinities. At present, these projects are either ongoing or being prepared for final publication.

In all these cases, the finds or assemblages represent well-known Scandinavian (Fosna-Hensbacka) or Continental European (Hamburgian, *Federmesser-Gruppen*, or Ahrensburgian) industries or techno-complexes, with Scotland being a form of *Ultima Thule* on the north-western edge of the European continent of the day. The existence of Doggerland is therefore essential to our understanding of this period, and of how Scotland was settled after the retreat of the glaciers by c. 13,600 BC.

During the years of the Howburn Project, the understanding of Doggerland – its extent, development and finally flooding – increased manifold, as did our understanding of how the presence of Doggerland allowed Scotland to become settled, and how the flooding of this land-mass severed existing cultural networks, and caused old material cultures to fragment (Ballin 2016c). There is still a degree of uncertainty regarding the shape and precise position of Doggerland’s northernmost shores at any given point of time during the Upper Palaeolithic, but in this unusual case, archaeology may inform science – where the roles are usually reversed – as the presence in Scotland of diagnostic pieces and technological practices of north-west European affinity clearly proves that contact, even if indirect, was possible across Doggerland.

Summing up the progress made in recent years – in terms of research into Scotland’s earliest prehistory and into the environment the first Scottish settlers inhabited – the discovery and investigation of the Howburn site and its lithic assemblage has clearly played an important role. However, the work has only just started, and many questions relating to the Scottish Late Upper Palaeolithic period remain, such as – might there be sites ‘out there’ in the Scottish landscape dating to times before Howburn? It may be possible, in time, to find camps relating to the first pioneering ‘scouting parties’, defined by artefacts of for example Classic Hamburgian or Creswellian affinity.

Good hunting!



# Introduction

## Background

As part of its 'Prehistory North of Biggar Project', Biggar Archaeology Group (BAG) investigated an arable field at Howburn Farm, Elsrickle, South Lanarkshire, in southern Scotland (Figure 1). The field was walked by BAG on four occasions between 2003–2005, producing a range of prehistoric lithic artefacts and potsherds, mainly from the upper eastern part of the field, close to a small watercourse. Thousands of lithic artefacts were recovered, mostly of flint and chert, with occasional flakes and blades of Arran pitchstone and Cumbrian tuff. Diagnostic types and attributes suggested that the fieldwalked chert artefacts were mainly Later Mesolithic in date, the pitchstone and polished axeheads Early Neolithic, and most of the flint was thought to date to the Neolithic or Early Bronze Age periods. These typochronological estimates seemed supported in part by the recovery of Neolithic and Early Bronze Age pottery (sherds of plain vessels of the Carinated Bowl Tradition, as well as Impressed Ware, Grooved Ware, and Beaker sherds) in and near the field.

In 2005, fieldwalking located a previously unnoticed concentration of flint and chert artefacts in an area approximately 40 m in diameter on the eastern side of the field. This concentration, marked especially by a higher presence and larger size of artefacts of flint than elsewhere in the field, was assumed to have been brought to the surface by recent ploughing. Accordingly, an exploratory excavation was undertaken by BAG in December 2005 and January 2006 (in this volume generally referred to as the 2006 excavation) to test for the presence of any remaining archaeological deposits. Six small pit-like features were observed in the subsoil. The fills of these features were sampled for sieving and flotation, producing charcoal but no diagnostic artefacts. A piece of *Betula* (birch) charcoal from Pit 3 provided a radiocarbon date (SUERC-17872/GU-16472: 1855±35 BP or cal AD 70–240), indicating a brief visit to the site in the Roman Iron Age, and it was assumed that the other small pits dated to the same period.

The fieldwork by BAG was recorded in an interim note and report (Dudds *et al.* 2006) and the lithic finds



Figure 1. The winter before the beginning of the second field season in 2009. View from the site towards the Pentland Hills north of Biggar, with the valley floor and the How Burn stream in the centre (photo: Tam Ward).

were stored at Biggar's Moat Park Heritage Centre as primarily representing the residues of Mesolithic and later Neolithic activity. In the course of research by one of us (TB) into later Neolithic flintwork in southern Scotland, attention was drawn (by TW) to the Howburn assemblage, and its contrast with other assemblages from the area was noted. Subsequent loan of part of this assemblage (to TB) allowed it to be examined more closely (by TB and AS) and it was at this stage that the unusual and potentially very important character of some of the artefacts began to be recognized. Whilst the majority of the chert artefacts fitted what was known of later Mesolithic lithic traditions in this region, most of the flint artefacts represented a different kind of industry, focused on the production of very large and broad blades, and with a tool-kit including end-of blade scrapers and burins. This led to an initial note in which this part of the Howburn assemblage was tentatively assigned to the early Holocene and analogies drawn with artefacts of Star Carr type, although the presence of *en éperon* blades (Plates 1-2) suggested the presence of even earlier material (Saville *et al.* 2008).

In view of the rarity of such early lithic assemblages in Scotland, Historic Scotland (now Historic Environment Scotland) agreed to fund a more detailed study (by TB with AS) of the Howburn finds, involving all of the material recovered by BAG to date. It was at this stage, that TB and AS became aware of the range of implements in the collection, and the technological details of manufacture, and it was realized that a Late Upper Palaeolithic date of the majority of the finds would be more appropriate. This was confirmed when refitting by TB revealed that a piece previously classified as an obliquely blunted microlith fragment (Saville *et al.* 2008: Figure 2.5) was actually the tip of a tanged point (Plate 5.765/1084).

This was the background to the media announcements in 2009 of the discovery of evidence for Scotland's first settlers and the realization that during the Late Upper Palaeolithic, Scotland was not isolated from the Upper Palaeolithic world at large (e.g., Pitts 2009). A first publication of the Late Upper Palaeolithic finds from Howburn was presented by the authors in 2010 (Ballin *et al.* 2010), in which the lithic artefacts from the 2006 excavation were presented and discussed.

Although the results of this analysis were exciting, diagnostic tools, such as tanged points, *Zinken*, and burins were relatively rare, and datable features and charcoal absent. For these reasons, it was agreed that further investigations at the location would be desirable. BAG therefore carried out additional excavations on the site during the summer of 2009. Two trenches were opened, both in areas in which fieldwalking suggested excavation might prove fruitful. Trench I (2009) formed an extension to the excavation of 2006 (below referred to as Trench

I [2006]), and it was situated immediately south of, and joining, the initial trench. Trench II was opened east of Trench I, along and west of the A702, the road linking Biggar with Edinburgh towards the north-east.

Historic Scotland (now Historic Environment Scotland or HES) and the Society of Antiquaries of Scotland jointly offered to fund an investigation of the new finds and other information gained during the new excavation, as well as of the production of the present monograph on the findings from both excavations (2006 and 2009). Additional funding was kindly offered by the Robert Kiln Trust. As shown below, the 2009 excavation resulted in the recovery of substantial additions to the Late Upper Palaeolithic assemblage from 2006, with the number of tanged points rising from four (including a fragment recognized in 2010) to 29; *Zinken* from one to three; and burins from three to 34! An additional premium was the recognition of a likely concentration (Trench II [Block 3-4]) dating to the *Federmesser-Gruppen* period, in many respects similar to the assemblage from Kilmelfort Cave near Oban (Saville and Ballin 2009). A selection of Late Upper Palaeolithic finds from Howburn are illustrated as Plates 1-16.

The evaluation of the lithic material is based upon a detailed catalogue of all the lithic finds from the Howburn site, and in the present report the artefacts are referred to by their number (CAT no.) in this catalogue.

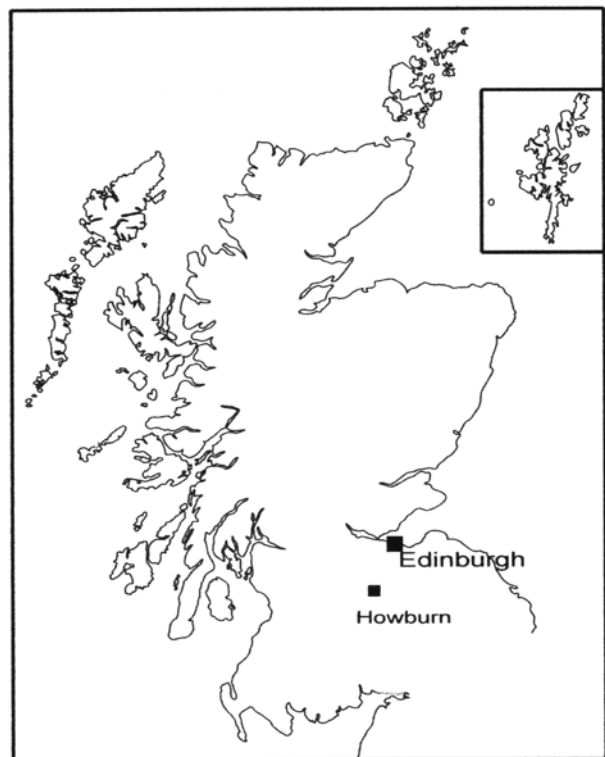


Figure 2. The location of the Howburn site in Scotland.

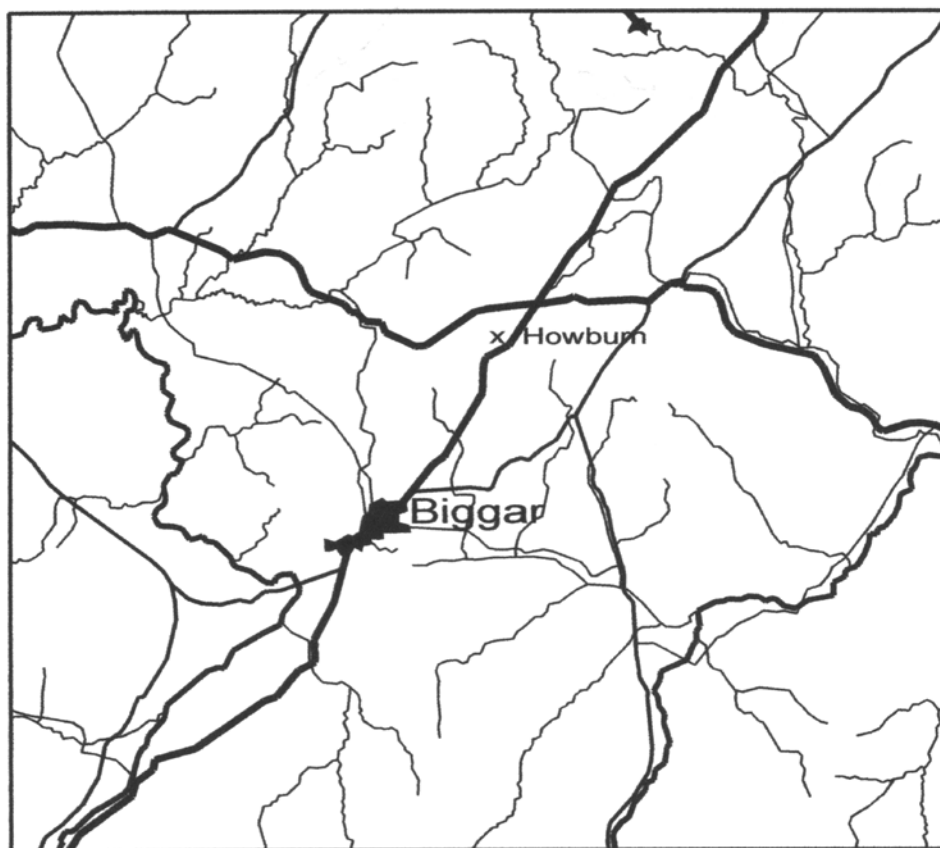


Figure 3. The location of the Howburn site in the general Biggar area. The main roads (thick black lines) and rivers are shown.

### The location

The Howburn site is in South Lanarkshire, southern Scotland, some 7 km north-east of the town of Biggar, approximately 50 m west of the A702 road from Biggar to Edinburgh (NGR: NT 08209 43629; Figures 2-3). This is an inland location, c. 35 km from the nearest modern shore at the Firth of Forth to the north and c. 75 km from the nearest point on the modern east-coast. Biggar lies on the axis of a broad south-west to north-east trending pre-glacial, fault-guided valley between a ridge of Devonian sandstones, the Pentland Hills to the north, rising to c. 560 m above OD and 516 m above OD directly opposite the archaeological site, and the Silurian mudstones of the Southern Uplands to the south, rising locally to c. 750 m above OD on Culter Hill (Figure 4). The Rivers Clyde and Tweed run parallel for some distance before diverting north and east respectively. Between and connecting them, the Biggar 'gap', east of Biggar, is a valley floor occupied today by a small stream.

The archaeological site is situated on the lower, west-facing flank of Broomy Law, at 265-268 m above OD (Figure 5). The bedrock geology is of Lower Devonian andesite, but this crops out only on higher and steeper valley sides. Lower slopes are mantled by a thin sandy

diamict (see pedological section, this volume). A stream drains the slope, with a small catchment, its headwaters originating in part in a meltwater channel, one of a series, c. 450 m to the south-east and c. 75 m higher than the archaeological site. The stream is incised through a series of glaciofluvial gravel terraces. It flows to the south of the archaeological site (Figure 6) and is currently incised below it. Excavation Trench 2 is in a slight depression on a generally fairly level terrace of diamict (Figure 7). Other horizontal terrace surfaces, fragments of probable former lake shorelines, are cut into this in places at slightly lower altitudes. Viewshed analyses, made assuming no vegetation taller than herbs, show that the view to the Pentland Hills to the north-east is patchy but extends c. 15 km. That to the south west is more circumscribed, blocked by the hills at Greenwood (Figure 5).

The stream then falls onto a broad, flat valley floor lying at around 245 m OD. The head of this valley, to the north-east at Melbourne (Figure 4), is a small plug of mounded glacial deposits rising to 265 m OD, separating the north-east flowing Back Burn from the south-west flowing How Burn. The How Burn is at present a straight canalized ditch, draining a spread of lacustrine alluvium c. 1.2 km long and c. 0.2 km wide, extending over some 30 ha. The alluvium represents a

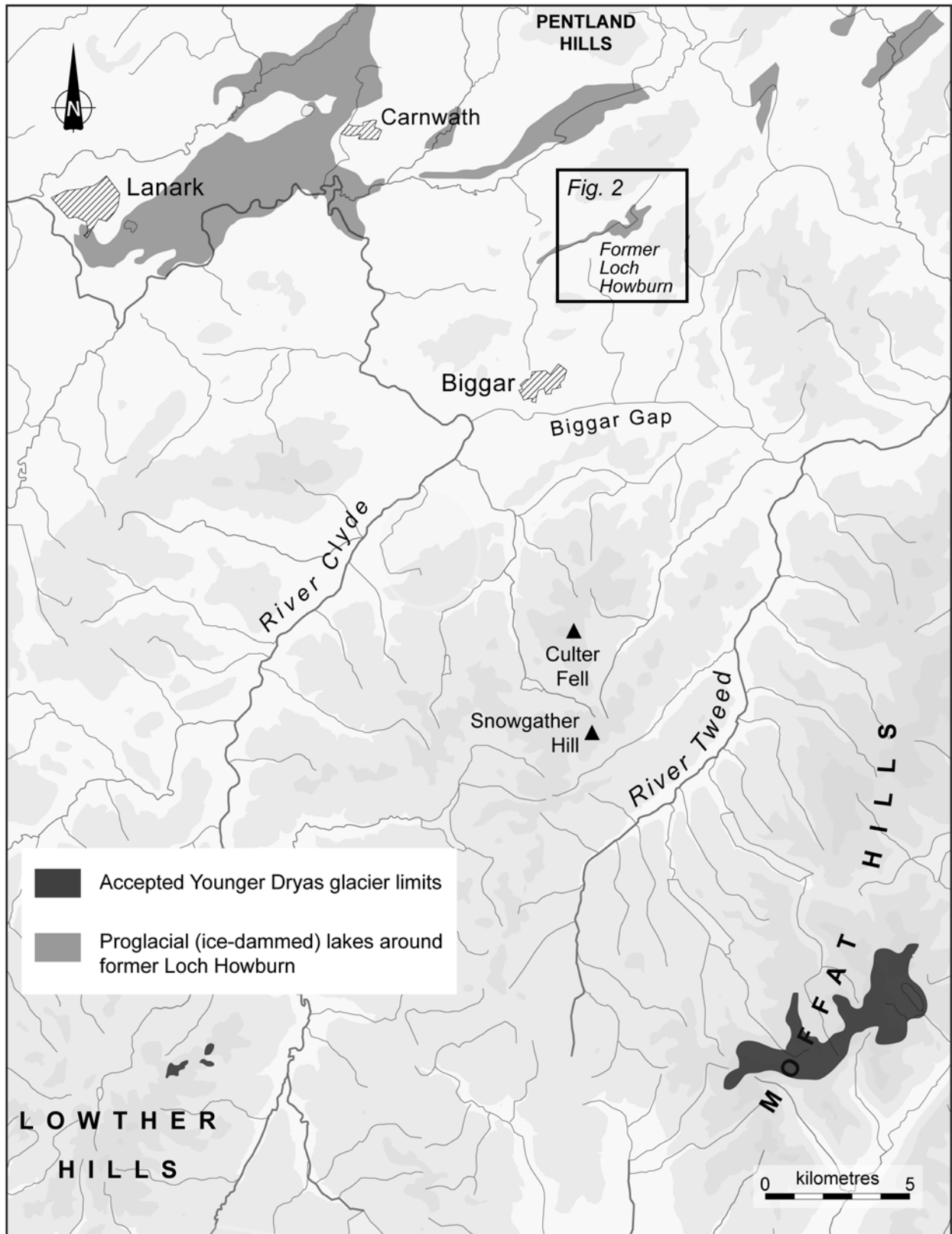


Figure 4. The location of the former 'Loch Howburn' in southern Scotland near the Biggar Gap, between the Pentland Hills and the Southern Uplands, showing the courses of the Rivers Clyde and Tweed and Clyde, the outlines of similar glacio-lacustrine lake basins (Bennett, Huddart & Thomas 2007; Price 1961; Thomas and Montague 1997) and the currently accepted extents of Younger Dryas (Loch Lomond Stadial) glaciers (Golledge 2010).

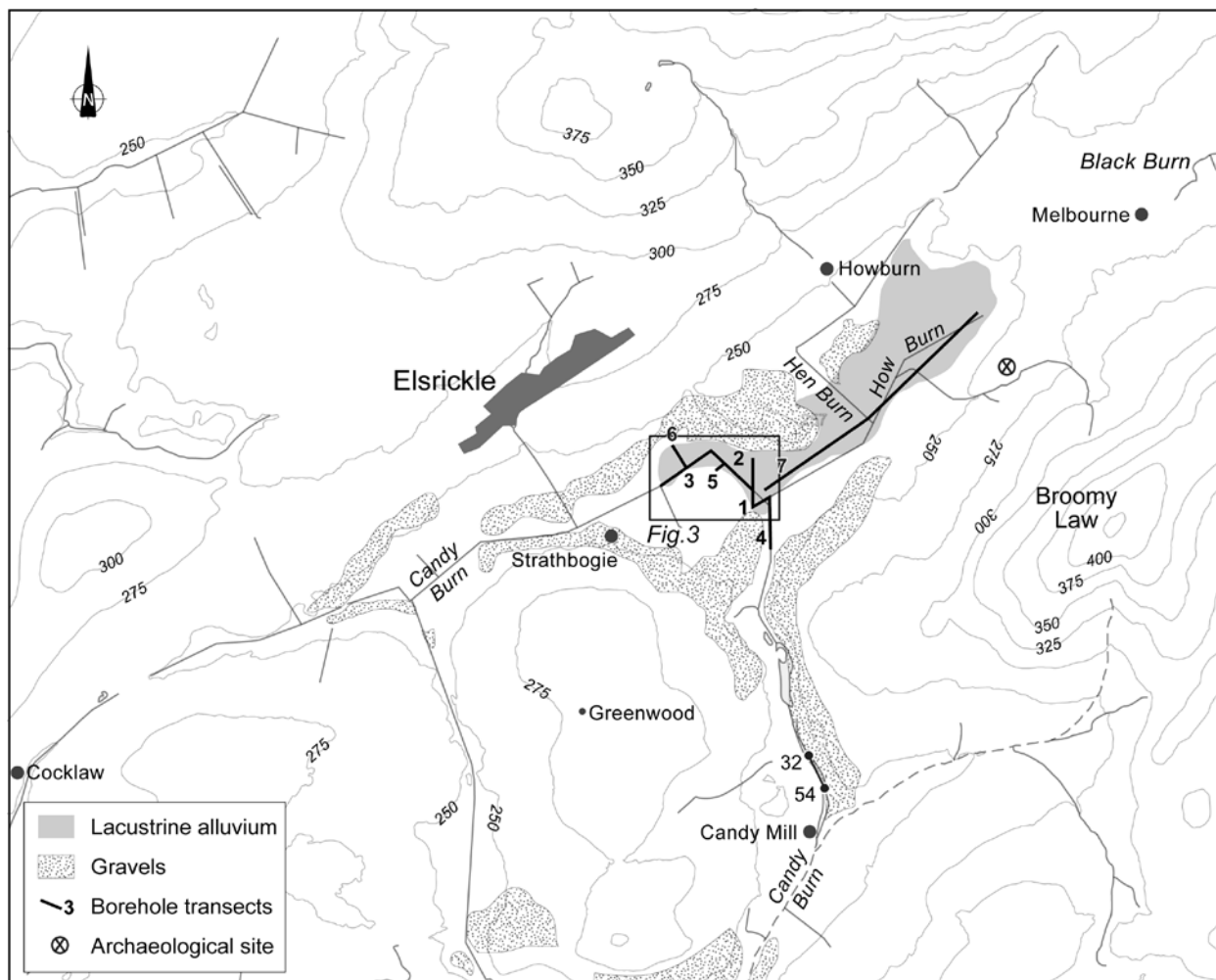
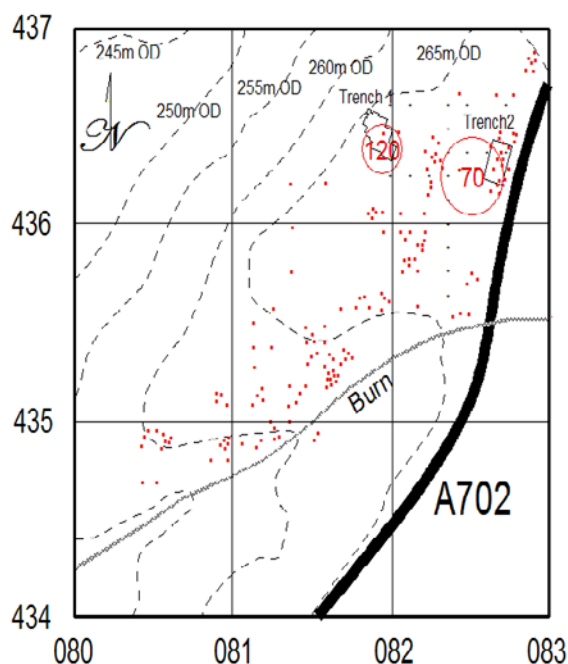


Figure 5. The area around the Howburn archaeological site showing settlements, surrounding hills and valleys, streams and rivers as they are today, the extent of lacustrine alluvium of the former ‘Loch Howburn’ and glaciofluvial gravels on valley sides (McMillan et al. 1981). The distance from Cocklaw to Candy Mill is 3.5 km.



former lake on the valley floor, in this volume referred to as ‘Loch Howburn’. The How Burn barely falls in altitude over more than a kilometre to its confluence with the Candy Burn east of Strathbogie, which flows north-east from another low col in the west at c. 250 m OD. Gravel mounds and poorly defined terraces line both these valley sides below c. 260 m OD. From their confluence, the Candy and How Burns turn south and down a narrow, steep-sided bedrock-lined gorge from c. 240 m OD to below 230 m OD at Candy Mill.

Figure 6. The Howburn terrace, the two excavation trenches, and the lithic surface finds (dots) (based on map by Ian Paterson, BAG). The grid lines relate to the 100 m intervals of the national grid.

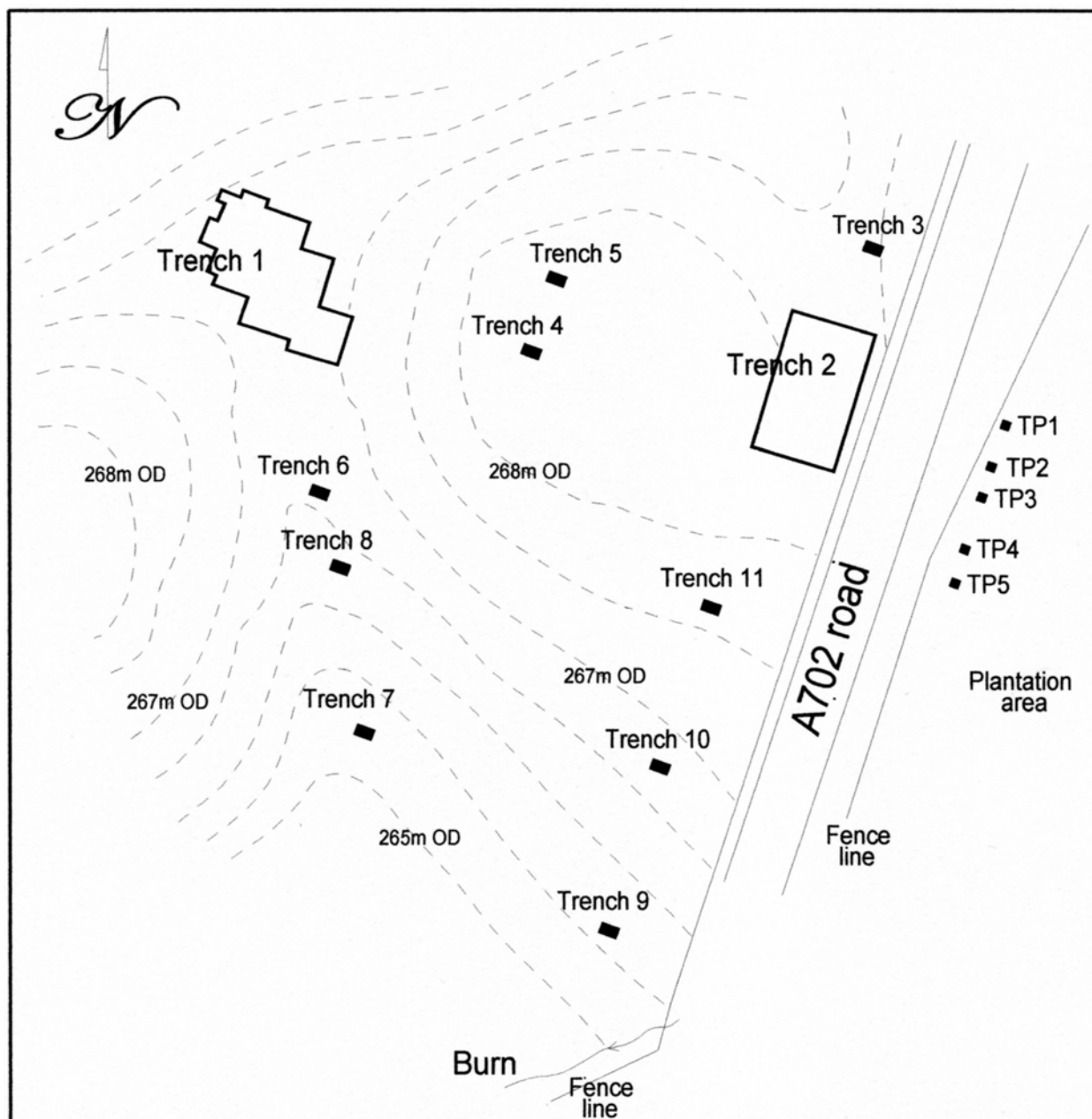


Figure 7. The Howburn terrace and all excavation trenches and trial pits (based on map by Ian Paterson, BAG).

### The investigation of the site

The fieldwalking at Howburn in 2003–2005 by members of the BAG followed their standard practice of walking in parallel rows, 2–3 m apart. It was noticed that the area outside the terrace, which measures c.150 x 100 m NE–SW, yielded few finds, and the later stages of fieldwalking therefore focused on this part of the field. Renewed ploughing of the field in 2005 revealed one particularly dense concentration, unusually of flint rather than chert (the main raw material exploited during the Mesolithic and Early Neolithic of South Lanarkshire; e.g., Ballin and Johnson 2005; Ballin and

Ward 2013; Paterson and Ward 2013). This concentration was therefore selected for excavation.

The excavation was carried out over the winter of 2005–2006, when a grid of 79 metre squares was positioned over the concentration (Figure 8). The ploughsoil was excavated entirely by hand and, in the absence of any obvious archaeological stratigraphy, finds were bulk recorded within each metre square. All the fieldwalked finds (Figure 6) were retrieved before the excavation grid was established, and although the position of most finds recovered during the fieldwalking was fixed by GPS, some significant artefacts are only recorded as

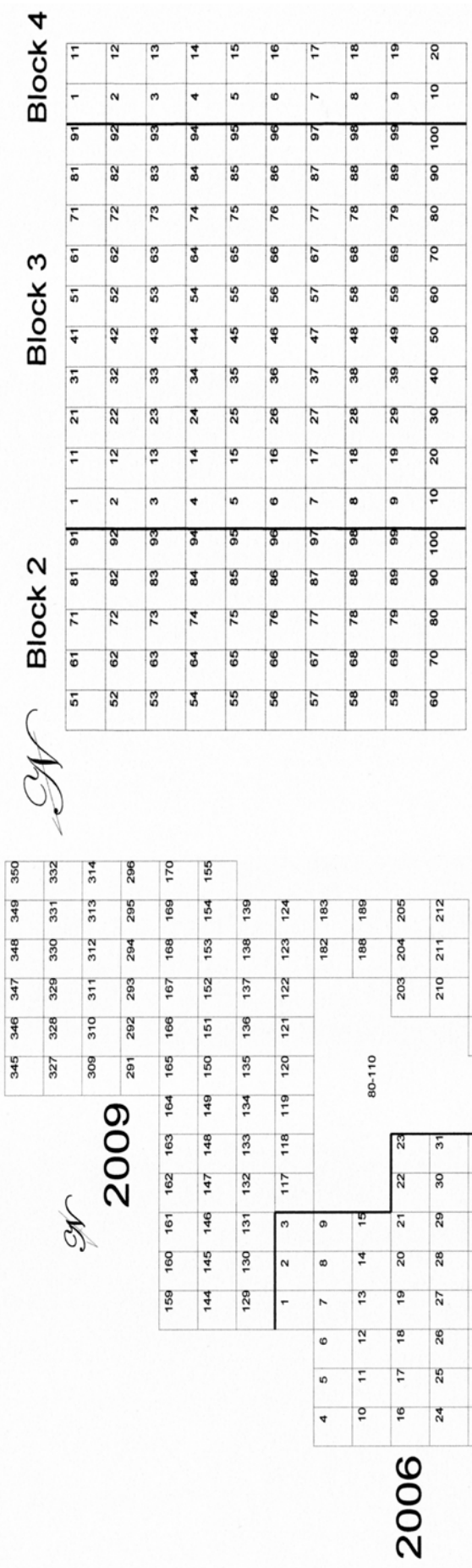


Figure 8. Trench I (left) and Trench II (right) with the original grid numbers. Trench I has been subdivided into the parts excavated in 2006 and 2009, respectively. Trench II has been subdivided into the original 'blocks' referred to during the excavation. The location of these two trenches is shown in Figures 6 and 7.

coming from the surface of the ploughsoil above the excavated area, rather than from particular metre squares. The excavation confirmed the observations from fieldwalking, that the ploughing was regularly cutting into the subsoil and subjecting lithic artefacts to both vertical and horizontal displacement, and inevitably to damage. This is probably reflected in the high blade-fragmentation ratio, which is 88% – that is, only 12% of the blade material is intact.

From the 2006 excavation at Howburn, 1099 lithic artefacts were recovered (Table 4). These constitute the key outcome of this excavation and provided the focus for the first report on the Upper Palaeolithic finds from Howburn (Ballin *et al.* 2010). The lithic assemblage is clearly mixed chronologically, but in the course of the excavation there was no clear stratigraphic or preservational evidence to guide subdivision of the 2006 finds.

As mentioned above, the excavation of 2009 saw the extension of the initial trench (Trench I [2006]) towards the south (Trench I [2009]), as well as the opening of a new trench immediately west of A702 (Trench II). The two new trenches measured 113 m<sup>2</sup> and 170 m<sup>2</sup>, respectively (Figure 8). The positioning of the two new trenches was partly directed by results from

fieldwalking but, in the case of Trench I (2009), it was also directed by the hope that an extension of the initial trench towards the south would allow distribution analysis by contour-mapping to more precisely define the outline of the main concentration in the southern corner of Trench I (2006). Distribution analysis would show whether this scatter might be the footprint of a tent-like structure like that suggested by Holm (1991: Figure 8) in connection with his interpretation of the Hamburgian and *Federmesser-Gruppen* settlement at Slotseng, southern Denmark. Although typotechnological scrutiny of the finds from the grid units (80-110) west of the original trench suggests that this area may indeed have formed part of this potential dwelling, these finds unfortunately became mixed during the excavation and now form an uncontexted sub-assemblage within the general collection from Trench I (2009).

During the 2009 excavation, Trench II was subdivided into four blocks (1-4), each of 100 grid units (Figure 9). Only three m<sup>2</sup> of Block 1 were excavated, nine metres north of the excavated parts of Block 2; 50 m<sup>2</sup> of Block 2 were excavated (grid units 51-100); 100 m<sup>2</sup> of Block 3; and 20 m<sup>2</sup> of Block 4 (grid units 1-20). As these ‘mechanically defined’ excavation trenches, blocks



Figure 9. Excavation of Trench II by BAG (2009) (photo: Tam Ward).

and units have proven to match individual Upper Palaeolithic concentrations and distribution patterns in a useful manner (see distribution section), they have been retained through this report.

During the fieldwork, it was noticed that, in places, soil initially perceived to be sterile moraine differed slightly from the glacial deposits by its colour (a slightly darker yellow), and it also contained some artefacts (Figure 10). It is thought that this context incorporates the cryoturbated Late Glacial ground surface, which has not been affected by ploughing (below referred to as 'subsoil', with the term 'topsoil' referring to the site's ploughed upper levels). This hypothesis was confirmed by the lithic finds from the excavation of the context, which are almost entirely in flint, and which only included artefacts datable to the Upper Palaeolithic period (Figure 11). This undisturbed (by man) layer was only recognized consistently in Trench I (2009), southern corner, as well as in Trench II (Block 2).

The new trenches were generally excavated in the same way as the 2006 trench, that is, entirely by hand and without the consistent application of sieving. In the absence of any obvious archaeological stratigraphy, most finds were bulk recorded within each metre square, although in the two areas with surviving Late Glacial soil, also by level. As noted during the excavation of Trench I (2006), ploughing is regularly cutting into the subsoil and subjecting lithic artefacts to vertical and horizontal displacement, thus causing some mixing of finds of different dates in the topsoil.

No structural remains or stone-set hearths were found (by Erwin Czesla referred to as 'evident structures'; Czesla 1990: 257), but as shown in the distribution section below, it is possible to define some 'latent

structures' (Czesla 1990: 257) on the basis of distribution patterns (reduction waste, cores, tools, burnt flint, etc.).

Finds from the smaller trenches, as well as from the initial fieldwalking (Figures 6-7), suggests a wider distribution of Late Upper Palaeolithic finds around the two main trenches, and it is almost certain that the terrace and the fields around it include remains from other visits to the area during the Hamburgian and *Federmesser-Gruppen* periods.

### Pedological analyses at Trench II

A c. 8 m long section at Trench II, close to the field edge, was excavated down to the underlying till and examined in order to fully describe the deposits and to get a better understanding of their origins and formation processes.

Table 1 is the profile description, after Hodgson (1976). Two undisturbed 8 x 6 x 4 cm 'Kubiena' tin samples were taken from the deposits at depths of 40-48 cm and 55-63 cm, covering Units C1, C2 and C3 (see Table 1). They were prepared according to methods outlined at <http://www.thin.stir.ac.uk/> and examined on a light box and then using an Olympus BX51 petrological microscope at magnifications of between x20 and x200 in plane polarised light (PPL), cross polarised light (XPL), and oblique incident light (OIL). Descriptions (Table 2) were made using the standard terminology of Stoops (2003).

*Thin section 1 (40-48 cm):* Light box examination showed C1 to be a mid brown, dense and seemingly structureless sandy loam containing few sand-sized iron nodules. The boundary with C2 is straight, clear and sharp, although it is traversed by fine plant roots. C2 is a mid



Figures 10-11. The subsoil.

Figure 10. Excavation of the flint-bearing subsoil.

Figure 11. Vertical blade-scraper in the subsoil, indicating solifluction or cryoturbation (photos: Tam Ward).

Table 1. Soil profile field description.

Depth cm	Description
0-15	(Ap1) Dark brown 7.5YR 3/2, organo-mineral silty clay loam with a well developed crumb and fine/medium blocky structure and moderately porous. Contains many fine roots, few small and medium sub-rounded stones, few abraded tile and pottery inclusions, and rare charcoal, all randomly distributed and orientated throughout the soil. Lower horizon boundary clear, straight and abrupt: <i>upper plough soil</i>
15-29	(Ap2) 10YR 4/2, organo-mineral, silty clay loam with a well developed medium blocky structure. This horizon contains common fine roots, few small and medium sub-rounded stones, and few abraded tile and pottery inclusions all with a random distribution and orientation. There are a few distinct mottles towards the base of the horizon that are concentrated around root channels. Lower horizon boundary is clear and wavy (vertical variation of 5 cm over 0.8 m) and is broken by vertical channel voids infilled with humic topsoil material: <i>plough soil associated with intermittent deep ploughing</i>
29-42	(C1) 10YR 4/3, structureless sandy silt loam which although compact was weak and brittle. It contained few fine roots, few sub-rounded, small and medium stones and rare charcoal that was predominantly found in the upper few cm of the deposit. The stones were randomly distributed and had no preferred orientation, but increased in frequency towards the base of the deposit. Lower boundary was clear, straight and abrupt.
42-48	(C2) 7.5YR 4/6, structureless, weak and brittle, sandy silt loam, containing slightly less clay than C1. This deposit contains few fine roots and few sub-rounded and sub-angular, fine and medium stones. Lower boundary clear, abrupt and straight.
48-78	(C3) 10YR 4/5, structureless and very compact sandy silt. This deposit contains very few fine roots and few fine and medium sub-rounded stones. The stones appear to have a weakly banded distribution with an inclined orientation that broadly reflects the underlying slope angle. Towards the base of this deposit are rounded clods of up to 10 cm diameter of C4 material. There are common, distinct bands of mottles, strong brown and reddish brown in colour, which follow the inclined orientation of the stone bands: <i>C1-C3 Sedimentary deposits (fluvial?)</i>
78+	(C4) 5YR 5/4 Compact, structureless, silty clay loam with common medium sub-rounded and sub-angular stone inclusions, root free: <i>diamict (glacial till)</i>

Table 2. Micromorphological summary descriptions for Howburn C1, 2 and 3.

Slide	Zone	Coarse mineral matt					Fine groundmass (<10 microns)	Voids		Pedofeatures						Micro-structure	Coarse material arrangement	Total porosity	Related distribution	C:F ratio	
		Quartz	Feldspar	Muscovite	Biotite	Igneous	Sandstone	Vughs	Packing voids	Channels	Amorphous & crypto-crystalline Fe nodules	Clay coatings	Silt coatings	Silt cappings	Excremental (mamillate)						Excremental (spheroidal)
1	C1	***	*	*	t	*	Mid brown in PPL, orange brown in OIL, organo-mineral, with a stipple speckled b-fabric and occasional black punctuations.	*		*	***				t	t	Vughy	single space porphyric	10%	random	2:3
1	C2	***	*	*	*	**	Orange brown in PPL, and orange in OIL, mineral, with a stipple speckled b-fabric.	*	**	**	*	*	*	t	*	Vughy and channel	close porphyric	20%	random	1:1	
2	C3	****	**	*	*	**	Greyish brown in PPL and grey or orange in OIL, mineral, with a weakly stipple speckled b-fabric.	*	**	*	*	**	*	**		Single grain	gefuric, chitonic and close porphyric	25%	banded	5:1	

Frequency classes      Textural pedofeatures  
t trace <1%      \* rare <2%  
\* very few 1-5%      \*\* occasi 2-5%  
\*\* few 5-15%  
\*\*\* frequent 15-30%  
\*\*\*\* common 30-50%

pinkish brown, dense sandy loam. The deposit shows little evidence of structural development of peds (aggregates), and the porosity is dominated by channel voids, which appear to be largely root derived. The matrix is well sorted, but contains frequent weathered

basalt clasts between 5 mm and 30 mm long. These gravel sized clasts are generally arranged randomly through the deposit. However, towards the base of the slide the gravel clasts appear to have a steeply inclined (c. 35°) banded distribution.

Examined under the microscope, C1 has a mid-brown, organo-mineral fine groundmass with a stipple-speckled b-fabric. The microstructure is vughy (total porosity c. 10% context area) with no evidence of aggregate development. Vugh voids are typically around 100 microns long, whilst the channels that traverse this material are up to 500 microns wide. The coarse mineral component is dominated by fine-to-medium quartz sand with few feldspar grains, few coarse sand-sized grains of basaltic material, and few silt-sized, acicular biotite and muscovite grains. No coarse organic component is present; the organic component is confined to the fine groundmass in the form of amorphous organic matter and fungal biomass. Trace spheroidal and mammilate excrements typical of earthworms and *enchytraeids* are present in the channels, but these are heavily coalesced, indicating ageing. The material also contains few amorphous and crystalline iron nodules which are mostly orthic (*in situ*) although rare disorthic nodules are also present, indicating some turbation of the material.

The fine groundmass of C2 is orange brown in PPL and orange in OIL, indicating that this is a mineral deposit with a stipple-speckled b-fabric. The deposit shows no evidence of aggregate development and the microstructure is instead dominated by channel and vugh voids. Total porosity is around 20% of the context area with vughs in the order of 200-500 microns long and channels up to 2000 microns wide and sub-vertical in orientation. The mineral component is dominated by fine and medium sand-sized quartz grains, randomly distributed and with a tight single-space porphyric distribution relative to the fine groundmass. Also present are few sand-sized feldspar grains, few silt-sized acicular muscovite grains, and few acicular and tabular biotite. The deposit also contains few gravel-sized clasts, predominantly of weathered basalt, but also with traces of sandstone. These are randomly distributed with the exception of a band of gravel-sized clasts towards the base of the slide. This band is inclined by ca. 35°. The coarse: fine ratio (10 microns) is ca. 1:1.

Very few spheroidal and trace mammilate excrements (typical of *enchytraeid* and earthworms respectively) are present within channel voids and are moderately to strongly coalesced. Low numbers of amorphous and crystalline iron nodules are present throughout this material. Some of these are *in situ* orthic features whilst others are disorthic and possibly even anorthic. Limpid orange clay coatings and infillings are present within some voids. The coatings exhibit diffuse extinction lines indicating only partial orientation of the clay particles, but the coatings are intact. At the base of the slide on the upper surfaces of the band of basaltic gravel clasts, a poorly sorted silt link-capping is also present.

*Thin-section 2 (55-63 cm):* Underlying C1, the bulk of the slide consists of C2, which on the light box is seen to be a dense, pale greyish-brown sandy loam, containing frequent weathered basalt clasts. The deposit is structureless and has a low porosity, dominated by closed, irregular vugh-type voids. Both the sandy loam matrix and the basalt clasts are well sorted. The basalt clasts are rounded and sub-sounded, 5-10 mm long (rarely 15 mm) and are arranged in distinct parallel bands c. 15-20 mm apart, with a slight inclination of c. 2°.

Examined under the microscope, C2 has a fine groundmass composed of two materials. Amorphous yellow material distributed as chitonic coating on sand grains with an undifferentiated b-fabric, and a mid-brown silty clay material distributed as gefuric bridges between sand grains, with a weakly stipple-speckled b-fabric. The microstructure of this deposit is single-grain with the porosity (total c. 25% of the slide area) dominated by simple open and closed packing voids and very few vughs (up to 1000 microns long) and channels (up to 1500 microns wide). The coarse mineral component is dominated by fine quartz sand with lesser amounts of coarse silt-sized and medium sand-sized grains. Also present are few fine sand-sized feldspar grains, as well as few silt-sized acicular muscovite and acicular tabular biotite sand and silt grains. The rare igneous gravel clasts (principally basaltic) are sub-angular, sub-rounded and rounded, and predominantly equant in shape. They have a clearly banded arrangement. These gravel bands are not associated with any distinctive characteristics in either the sand- and silt-sized fractions or the fine groundmass. The coarse: fine distribution is chitonic and gefuric, and the ratio is in the order of 5:1.

This context contains significant evidence of clay and silt translocation in the form of a range of textural pedofeatures. The most extensive features are silt link-cappings covering the upper surface of the bands of gravel clasts and occasionally sand grains in discontinuous layers between these bands. Textural void coatings are also present; they include both limpid and dusty clay coatings, and impure and silt coatings. Where the coatings are layered, silt coatings are always overlain by limpid clay. The distribution of the two types of coatings also differs, with the silt coatings largely limited to the silt cappings on gravel clasts, whilst clay coatings are predominantly found lining channel voids and occasionally within the silt cappings. Low numbers of opaque amorphous iron nodules of coarse silt and fine sand size are present; they are randomly distributed, and appear to be anorthic in nature, suggesting that they are inherited rather than *in situ*.

### Discussion

The field and micromorphological evidence suggests a truncated sequence of glacial diamict (till: C4), overlain in depressed areas with sandy silt sediment (C1-3), which on the basis of its texture, sorting and preserved sediment stratigraphy appears to be fluvially or glaciofluvially derived. No evidence of soil formation was identified affecting the glacial till surface below the sandy silts, which suggests that the deposits are Devensian Late Glacial in origin.

Evidence of soil formation (pedogenesis) was present in the upper sandy silt layers (C1 and C2) in the form of iron and excremental pedofeatures, root traces and channel voids. These features suggest processes of wetting and drying as well as bioturbation, possibly resulting in the loss of a micro-stratigraphy similar to that preserved in C3. Units C1 and C2 were identified by the excavation team as those bearing the Palaeolithic flints. If so, their presence in fluvial/glaciofluvial deposits may mean that the flint is not *in situ*. However, it is also possible that the flints were deposited later than C1 and C2, perhaps incorporated through later bio- or cryo-turbation processes.

Micromorphology highlights freeze-thaw activity at the microscopic scale in these deposits, in the form of silt cappings and coatings in unit C3. However, at the field scale, the limited section exposures examined contained little evidence of cryoturbation, with glacial stratigraphic layers largely preserved intact. The trench sections did not penetrate deeply enough into the adjacent and underlying C4 glacial deposits to unambiguously identify freeze-thaw features.

These deposits are sealed beneath a plough soil that shows signs of intermittent deep ploughing to a depth of 29 cm. The absence of a B horizon between the Ap and C1, C4 contexts hints at truncation of earlier land surfaces, hence the mixing of Mesolithic and Neolithic lithics in the plough soil. This interpretation is supported by the field-scale evidence of the plucking of stones from the surface of C4.

### Conclusion

Contexts C1-3 appear to have been deposited in water, either fluvially or fluvio-glacially. The deposits have been affected by freeze-thaw processes, but within the limited exposure examined, there was no evidence of more extensive cryoturbation affecting the deposits. There is evidence of pedogenesis in contexts C1 and C2 consistent with a sub-soil, but plough activity, and particularly intermittent deep ploughing to 29 cm, appears to have led to truncation of the C1 and C4 contexts and the loss of any earlier top soils.

### Post-excavation aims and history

Once the affinities of the dominating mainly flint segment of the assemblage had been established to be Late Hamburgian or Havelte (see dating and discussion sections below), a number of key aims were more or less given, and it was decided during the final combined write-up of the two excavations to focus on the following points:

- To allow the comparison of the Howburn lithic assemblage with contemporary assemblages (primarily Continental Hamburgian and British Creswellian assemblages) it was necessary to first characterize the finds in detail and store the information in a computer-based catalogue (an Access database).
- Although the assemblage is thought to also include other Late Upper Palaeolithic finds, such as artefacts of *Federmesser-Gruppen* affinity, this material is difficult to quantify, due to the shift of raw material preferences, from almost (but not entirely) Doggerland flint during the Hamburgian to local and exotic forms of chert. It was therefore decided to focus on the collection's Hamburgian element, but characterize and discuss the *Federmesser-Gruppen* element to the degree this was possible.
- The typo-technological data stored in this database was then to be summarised and discussed in a detailed report, with the main points of focus being: raw material preference, typo-technological composition, vertical and horizontal distribution, dating, comparison with contemporary assemblages, and discussion of these points as well as cultural affinities and economy/activity patterns to the degree the finds would allow this.
- As part of the discussion of distribution patterns, the possible presence of remains of one or more dwellings (possibly tent-like structures), activities, and the dating of the finds, distribution maps should be produced by the application of suitable computer software.
- Finally, it was also necessary to integrate the results of the palaeo-environmental analysis of the Howburn settlement into the report, not least regarding the possibility of a small lake having been present below the Howburn terrace during stages of the Late Upper Palaeolithic ('Loch Howburn').

During the project, and as a consequence of most of the finds from Howburn being characterized by typo-technological attributes usually associated with the Late Hamburgian of north-west Continental Europe, relevant expertise was consulted, first and foremost investigators at Centre for Baltic and Scandinavian Archaeology (ZBSA)

at Schloss Gottorf, Schleswig-Holstein, whose chief research focus is the Hamburgian period. Throughout the project, contacts were maintained mainly with Drs Sonja Grimm and Mara Julia Weber of ZBSA, but matters were also discussed with Dr Jørgen Holm (then the Danish National Museum), the excavator of the Hamburgian sites Jels and Slotseng in southern Jutland, but also British Late Upper Palaeolithic expertise was consulted, such as *inter alia* Professor Nick Barton, School of Archaeology, University of Oxford.

Following the production in 2010 of the report on the combined finds from the 2006 and 2009 excavations (by TB), the finds and draft manuscript was passed on to AS for commenting, and it was hoped that publication of Howburn (eagerly awaited by researchers of the Late Upper Palaeolithic throughout north-west Europe) was imminent. However, Saville unexpectedly became seriously ill, and in 2016 he sadly passed away (Ballin 2016a). TB therefore completed the Howburn manuscript, and final comments on this document were obtained from Dr Weber at ZBSA, for which we are grateful.

### Chronological framework

In the present volume, the Late Upper Palaeolithic period is defined as in Pettitt (2008) and Pettitt and White (2012: 423) as the period from the beginning of the Late Glacial amelioration to the beginning of the Holocene (the Mesolithic), and in Scotland embracing the Hamburgian (Pettitt's LUP I; Rust 1937; 1943; Grimm and Weber 2008), *Federmesser-Gruppen* (LUP II; Schwabedissen 1954; Terberger 2006; Conneler 2007) and Ahrensburgian industries (LUP III; Rust 1958; Vermeersch 2015), as well as possibly elements linked to the Scandinavian Fosna Hensbacka Culture, which may date to the Late Upper Palaeolithic-Mesolithic transition (Ballin and Bjerck 2016) (Table 3; for an overview, see Ballin 2017a).

At the present time, the only potential Creswellian object recovered in Scotland is the angle-backed point

from Fairnington in southern Scotland (Saville 2004: Figure 10.23), which the authors find of 'dubious' value in terms of stating a Creswellian presence north of the Anglo-Scottish border, and certainly in need of corroborating evidence. In a sense, this piece corresponds to the Early Hamburgian shouldered point from Bjerlev in central Jutland (Becker 1970) which, half a century after its recovery, is still the only diagnostic piece from the early part of the Danish Hamburgian, with all Hamburgian assemblages and stray finds found in Denmark since then dating to the Late Hamburgian. The question is whether pieces like the Bjerlev point, as well as the Scottish Fairnington piece, could have travelled hundreds of kilometres embedded in wounded game animals (reindeer, wild horse?) and therefore have little to offer in terms of defining Late Upper Palaeolithic social territories and human mobility?

We have chosen to apply north-west European terminology (names of industries), and by doing so we follow Pettitt who wrote (2008: 19): 'My perspective is overtly Europeanist and I make no apologies for using Continental names for cultural groupings when I believe British materials can be identified with them'.

The Scottish industries clearly show the closest parallels with those directly across the now submerged Doggerland basin (Ballin 2016c) (Tables 24-25), and given the presence of the Creswellian Complex south of Scotland, any contacts (direct or indirect) across Doggerland at the time are likely to have been with Hamburgian groups in southern Jutland (e.g., Holm 1991; Holm and Rieck 1992; Vang Petersen and Johansen 1991) and north-west Germany (e.g., Grimm and Weber 2008; Grimm *et al.* 2012; Weber 2012), rather than for example with Hamburgian groups in the Low Countries (Johansen and Stapert 2003). In addition, Hamburgian sites and assemblages are known from regions further towards the east, such as southernmost Sweden (Larsson 1996) and Poland (Breest and Veil 1991).

Table 3. The Scottish Late Upper Palaeolithic period and Late Upper Palaeolithic lithic industries identified in Scotland. Dates largely according to Sonia Grimm (*pers. comm.*).

Lithic industry	Onset cal BC	Scottish assemblages	References
Early Mesolithic	9,800		
Ahrensburgian	10,800	Brodgar, Orkney	Ballin & Bjerck 2016
		Tiree, Inner Hebrides	Ballin & Saville 2003
		Shieldaig, Loch Torridon	Ballin & Saville 2003
		Rubha Port an t-Seilich, Islay	Mithen <i>et al.</i> 2015
Federmesser-Gruppen	12,000	Kilmelfort Cave, Highland	Saville & Ballin 2009
Hamburgian	12,700	Howburn	Ballin <i>et al.</i> 2010



## Characterization of the Assemblage

From the excavations at Howburn, 5070 lithic artefacts were recovered. They are listed in Table 4. In total, 85% of the assemblage is debitage, whereas 2% is cores, and 13% is tools (Table 5). A small number of pottery sherds were also retrieved, and they are characterized in Dudds *et al.* (2006) in the following manner: ‘Certainly

some of the pottery sherds recovered in this project are of Bronze Age date, probably Beaker fragments, [whereas] other sherds, while definitely pre-historic, are of less certain date because of their fragmentary state’. These sherds have not been analysed by a specialist yet, and they are not dealt with further in its volume.

Table 4. General artefact list.

	<i>Tr I, 2006</i>	<i>Tr I, 2009</i>	<i>Tr II, Block 2</i>	<i>Tr II, Block 3-4</i>	<i>Other trenches</i>	<i>Total 2006-09</i>
<i>Debitage</i>						
Chips	86	155	136	281	13	671
Flakes	511	475	340	715	37	2,078
Blades	141	212	132	246	10	741
Microblades	26	52	38	113	9	238
Indeterminate pieces	75	83	47	150	7	362
Crested pieces	41	43	29	58		171
Platform rejuvenation flakes	2	4	3	5	1	15
<i>Total debitage</i>	<i>882</i>	<i>1,024</i>	<i>725</i>	<i>1,568</i>	<i>77</i>	<i>4,276</i>
<i>Cores</i>						
Core rough-outs				2	1	3
Single-platform cores	12	2	5	7	1	27
Opposed-platform cores	14	10	5	6		35
Cores with two platforms at an angle	4	1		2	1	8
Irregular cores	7	3	4	5	1	20
Discoidal cores	1	1				2
Flaked flakes	1					1
Bipolar cores	1	1	1	2		5
Core fragments	3	4	2	3		12
<i>Total cores</i>	<i>43</i>	<i>22</i>	<i>17</i>	<i>27</i>	<i>4</i>	<i>113</i>
<i>Tools</i>						
Tanged points, incl. tangs	4	16	6	2	1	29
Angle-backed point	1	1				2
Curve-backed point		1		1		2
Straight-backed point		3	6	10		19
Fragments of indeterminate backed pieces	19	14	4	11		48
Scalene triangles	2	3	2	2		9
Crescents				1		1
Fragments of microliths/backed bladelets	1	2	1	7		10
Backed bladelets			1			1
Truncated bladelets	3		2	1		6
Microburins		1		2		3

## REINDEER HUNTERS AT HOWBURN FARM, SOUTH LANARKSHIRE

Points or microliths				1		1
?Microliths			1			1
Leaf-shaped arrowheads		1	1		1	3
Chisel-shaped arrowheads	1				1	2
Discoidal scrapers				1		1
Blade-scrapers	17	29	11	6	1	64
Blade double-scrapers	2	4				6
Short end-scrapers	17	24	10	11	2	64
Short double-scrapers	6	1				7
Side-scrapers	1	2		3		6
Side-/end-scrapers	2	1				3
Scraper-edge fragments	3	4	1	8		16
Truncated pieces	6	13	8	9		36
Backed knives	2					2
Zinken	1	1	1			3
Piercers	1	1	1	1		4
Becs			5			5
Becs or points		1				1
Burins	3	17	3	11		34
Possible burin spalls	6	8	1	3		18
Combined tools (scraper/tanged point)		2				2
Combined tools (scraper/Zinken)		1				1
Combined tools (scraper/bec)		1				1
Combined tools (scraper/burin)	2		1	2		5
Combined tools (scraper/truncation)				1		1
Combined tools (scraper/strike-a-light)			1			1
Combined tools (tanged point/piercer)				1		1
Combined tools (scraper/piercer/burin)	1					1
Notched pieces	2	5	4			11
Denticulates	1					1
Pieces with edge-retouch	70	96	24	48		238
Flakes from polished flint axeheads				1		1
Flakes/cores from polished stone axeheads		2		4		6
Hammerstones		1				1
Pounders			1			1
Pounders/anvils	1					1
Anvils				1		2
<i>Total tools</i>	<i>174</i>	<i>256</i>	<i>96</i>	<i>149</i>	<i>6</i>	<i>681</i>
<b>TOTAL</b>	<b>1,099</b>	<b>1,302</b>	<b>838</b>	<b>1,744</b>	<b>87</b>	<b>5,070</b>

The definitions of the main lithic categories are as follows:

*Chips*: All flakes and indeterminate pieces the greatest dimension (GD) of which is  $\leq 10$  mm.

*Flakes*: All lithic artefacts with one identifiable ventral (positive or convex) surface,  $GD > 10$  mm and  $L < 2W$  ( $L$  = length;  $W$  = width).

*Indeterminate pieces*: Lithic artefacts which cannot be unequivocally identified as either flakes or cores. Generally the problem of identification is due to irregular breaks, frost-shattering or fire-crazing. *Chunks* are larger indeterminate pieces, and in, for example, the case of quartz, the problem of identification usually originates from a piece flaking along natural planes of weakness rather than flaking in the usual conchoidal way.

Table 5. Main artefact categories.

	Quantity					
	Tr I, 2006	Tr I, 2009	Tr II, Block 2	Tr II, Block 3-4	Other trenches	Total 2009
Debitage	882	1,024	725	1,568	77	4,276
Cores	43	22	17	27	4	113
Tools	174	256	96	149	6	681
<b>TOTAL</b>	<b>1,099</b>	<b>1,302</b>	<b>838</b>	<b>1,744</b>	<b>87</b>	<b>5,070</b>
	Per cent					
	Tr I, 2006	Tr I, 2009	Tr II, Block 2	Tr II, Block 3-4	Other trenches	Total 2009
Debitage	80	78	87	90	89	85
Cores	4	2	2	1	4	2
Tools	16	20	11	9	7	13
<b>TOTAL</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>

**Blades and microblades:** Flakes where  $L \geq 2W$ . In the case of blades  $W > 8$  mm, in the case of microblades  $W \leq 8$  mm.

**Cores:** Artefacts with only dorsal (negative or concave) surfaces – if three or more flakes have been detached, the piece is a core, if fewer than three flakes have been detached, the piece is a split or flaked pebble.

**Tools:** Artefacts with secondary retouch (modification).

#### Raw materials – types, sources and condition

In total, the Howburn excavations yielded 58% chert and 41% flint, with 1% of the finds being in pitchstone (Table 6). A number of rarer raw materials include ‘green chert’, agate/chalcedony, jasper, quartz/quartzite, jet, sandstone, and Cumbrian tuff, all of which amount to less than half a per cent each.

The flint assemblage includes a number of sub-types (Ballin *et al.* 2010), with various grey forms dominating (50% of all flints). Dark-brown and light-brown flint amounts to 11%, cream, yellow and red forms c. 2%, and pink flint c. 0.3%. Although no pink flint is crazed, it is thought that this colour may represent light exposure to heat. One-third of the flint artefacts are too discoloured by weathering (cortication *sensu* Shepherd 1972) to allow safe

determination of their original colours. Most of the grey flints are marbled/mottled (Figure 12), whereas the browns tend to be less extensively patterned (Figure 13).

There are no local primary or secondary flint sources in South Lanarkshire. The sizes and colours (particularly the greys and dark-browns) of the flint artefacts suggest



Figure 12. Mottled grey (Doggerland) flint – tanged arrowheads CAT 2875, 4041; backed point CAT 797 (probably based on the tip fragment of a tanged point); blade-scraper CAT 1545; burin CAT 1572; short end-scrappers CAT 1106, 763; and truncated piece CAT 2337.

Table 6. Raw materials ('present' = less than 0.5%).

	Quantity					
	Tr I, 2006	Tr I, 2009	Tr II, Block 2	Tr II, Block 3-4	Other trenches	Total
Flint	541	904	388	237	21	2,091
Chert	552	391	426	1,473	64	2,906
'Green chert'		3	4			7
Agate/chalcedony	5			3		8
Jasper			4	1		5
Pitchstone	1	1	13	16	2	33
Jet (incl. 'jet or coal')			1	5		6
Quartz/quartzite			2	5		7
Sandstone		1				
Cumbrian tuff		2		4		6
<b>TOTAL</b>	<b>1,099</b>	<b>1,302</b>	<b>838</b>	<b>1,744</b>	<b>87</b>	<b>5,070</b>
	Per cent					
	Tr I, 2006	Tr I, 2009	Tr II, Block 2	Tr II, Block 3-4	Other trenches	Total
Flint	49	70	47	14	24	41
Chert	50	30	51	85	74	58
'Green chert'		present	present			present
Agate/chalcedony	1			present		present
Jasper			present	present		present
Pitchstone	present	present	2	1	2	1
Jet (incl. 'jet or coal')			present	present		present
Quartz/quartzite				present		present
Sandstone		present				present
Cumbrian tuff		present		present		present
<b>TOTAL</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>



Figure 13. Dark-brown (Doggerland) flint – becs CAT 2742, 2434; combined bec/scraper CAT 1399; and bec CAT 2758.

that most of the raw flint may have been imported into South Lanarkshire, with the nearest sources of large-sized, good-quality (in terms of flaking properties) flint nodules being those of the greater Yorkshire area. It is not possible to unequivocally determine whether most of the Howburn flint derives from Yorkshire, but the general character of this raw material is consistent with that of so-called Yorkshire flint exploited during the Scottish later Neolithic period (Ballin 2011b). It is thought (Ballin *et al.* 2010) that some, if not most, of the flint sources exploited by the Howburn settlers may have been located in now submerged parts of the North Sea ('Doggerland'; Ballin 2016c; Coles 1998).

The soft cortex of some flints (42 pieces, or 8% of all cortical pieces) suggests that a proportion of the exotic flint exploited at Howburn derives from primary sources but, as noted by Manby (1979: 71) and Durden (1995: 410), the Yorkshire chalk is generally



Figure 14. Dark-/bluish-grey local chert - edge-retouched pieces CAT 3538, 1116, 2397; backed point CAT 4326; blade-scraper CAT 704; short end-scraper CAT 2273; blade-scraper CAT 5093; and burin CAT 4123.



Figure 15. Rust-brown/grey (local?) chert - blade-scrapers CAT 749, CAT 713, 750; and edge-retouched pieces CAT 745, 1070, 1340, 678.

Sea. This view is supported by the fact that, in the project database, most of the cortex of the grey and dark-brown flint is characterized as 'relatively soft' rather than 'soft' (i.e., it is neither as powdery as the cortex of flint prised from primary chalk deposits, nor as completely abraded and battered as the cortex of flint collected from beach walls). In total, 128 flint artefacts from the excavation are characterized as having 'relatively soft cortex', or 25% of all cortical pieces.

Flint microliths are fairly rare (13% flint/87% chert), and their colours are either grey or cream. The grey colour of the flint microliths is slightly different from that of the Late Upper Palaeolithic pieces, and it is thought that the raw material for the Mesolithic flints was collected in pebble form along the North Sea shores of the time (which would have been roughly where the coastline is today, or slightly further out).

If the economical strategy of Howburn's Hamburgian settlers is taken into account, with the hunting of reindeer probably having formed an integral part (e.g., Vang Petersen and Johansen 1996), following migrating reindeer through the valleys of Lanarkshire and the Scottish Borders would have led the Howburn settlers along an east-west orientated route, and at the eastern end of this route, coming out of the deep valleys of the Scottish Borders, directly onto the Doggerland plain. It is thought that the flint of Doggerland would have been very much of the same type as that available in the general Yorkshire area (Harker 2002).

too hard to mine, and it is quite likely that most of the flint was collected from the boulder clay, which contains unrolled blocks of flint with sharp edges and fresh chalk cortex, which the glacier must have taken straight off outcropping strata on the bed of the North

The assemblage embraces a number of different, mostly radiolarian chert types, with dark-grey and bluish/greenish-grey forms (Figure 14) clearly dominating this raw material (83%). Other common forms are black (5%), rust-brown (4%) and orange pieces (2%), with



Figure 16. 'Complex grey' (exotic) chert - blade-scraper CAT 789; double-scraper CAT 1236; and backed points CAT 795, 799, 735.

greens and reds amounting to approximately 0.5% each. Four percent of the chert artefacts are dull grey, and the fact that roughly half of these pieces are crazed, suggests that the grey colour is a result of these pieces having been burnt, and that it may be diagnostic of exposure to fire. Although some chert forms are fairly homogeneous (such as the black, red, orange, and rust-brown pieces), most of the grey chert artefacts are banded and/or spotted radiolarian forms.

The finds include some chert artefacts in rust-brown/grey colours (4%), many of which were modified into blade-scrapers (CAT 686, 713, 733, 749, 750, 825) (Figure 15). A small group (9 pieces) of artefacts in 'complex grey' colours (an intricately patterned grey chert with a 'wet' lustre), includes blade-scrapers (CAT 789 [Plate 10], 1236 [Plate 11]) and points (735, 795 [Plate 7], 799 [Plate 8]) (Figure 16). Orange chert artefacts were retrieved in small numbers from both parts of Trench I (2006 and 2009), but they are only a prominent feature of the Trench II assemblage (see distribution section) (Figure 17). One orange piece is a backed point (CAT 4847), one is a blade-scraper (CAT 4175), and one is a double-burin (CAT 3279).

It is not entirely certain which cherts are local and which may be exotic. The various greys and blacks,



Figure 17. Orange (exotic) chert - blades CAT 4047, 4046, 4017, 4487; crested piece CAT 3464; backed point CAT 4847; short end-scraper CAT 3895; and blade-scraper CAT 4175.

which are known to dominate Mesolithic and Early Neolithic assemblages in South Lanarkshire (cf. Ballin and Johnson 2005; Ballin and Ward 2013; Paterson and Ward 2013), are without doubt local, whereas the rust-brown, red, and orange forms, as well as the so-called 'complex grey' chert, may be either rare or absent in the local area.

Samples of rust-brown/grey (CAT 713, 750), orange (CAT 4271, 4924) and 'complex grey' chert (CAT 789 [Plate 10], 795) were shown to Dr Alan Owen (Department of Earth Sciences, University of Glasgow), who kindly commented on them. The rust-brown/grey pieces, which Dr Owen characterized as dark red to purple cherts with milky grey areas and microveins, '... are very like some of the red cherts from the Southern Uplands and so may well be local', despite the fact that they are practically absent in South Lanarkshire's Mesolithic and Early Neolithic archaeological assemblages. The orange cherts were characterized as being very homogeneous and without microveins, and Dr Owen '... does not recall seeing anything like these in Scotland'. The 'complex grey' cherts were described as dark and pale homogeneous forms without microveins, which contain well-preserved radiolaria. Despite the fact that they are generally absent from South Lanarkshire's lithic assemblages from the Mesolithic and Early Neolithic periods, they may be local, and Dr Owen found them to be '... similar to the very best of the cherts [he] collected from the Southern Uplands (Berrybush Burn NT 2675 1875)'.

A total of 185 cortical chert artefacts from the 2009 excavation were sub-divided according to the character of their cortex. It was possible to define 125 pieces (or 68%) as vein chert and 60 pieces (or 32%) as pebble chert, based on the different character of the surviving cortex. The former has rough, occasionally even powdery cortex, whereas the latter has clearly abraded cortex. As the chert veins are likely to have provided relatively large amounts of tertiary material from the central parts of the outcrops, and as chert pebbles due to their relatively small sizes probably delivered little tertiary material in relation to the number of cortical flakes struck from them, it is quite possible that substantially more than 68% of the tertiary artefacts are from quarried veins. At Meldon Bridge in the Scottish Borders, chert was most likely procured from the local boulder clay (Ballin 1999b: 82), but in recent years several quarry sites have been reported from southern Scotland (Ballin and Ward 2013; Warren 2007: 146).

Thirteen samples of fine-grained green rock were examined by Drs John Faithfull (the Hunterian Museum, University of Glasgow) and Alan Owen (Department of Earth Sciences, University of Glasgow). As, to a lay person, they appear almost identical, the presence of polished faces and facets on some of the specimens was seen as an indication that they might all be Cumbrian tuff (the most common form of raw material associated with Scottish stone axeheads – 55% of all grouped axeheads from Scotland are in this material; Ritchie and Scott 1988: Table 32), but following examination of the pieces by Drs Faithfull and Owen, and comparison with similar materials in other collections, the following grouping was suggested:

- 1) Pale greenish to buff-coloured, frequently banded silicic rock – *probably* chert, but rhyolite is also a possibility.
- 2) Crystalline tuff or felsite, also pale greenish to buff-coloured. Some pieces contain tiny cubic crystals of pyrite.

Group 1 includes seven pieces (CAT 1437, 1710, 1932, 2695, 2855, 2897, 3057), and Group 2 six pieces (CAT 1536, 1938, 3339, 3413, 3565, 3573). All pieces from Group 2 have one or more polished faces or facets, whereas none from Group 1 has been polished. However, one specimen from Group 1 (CAT 2855) is a piece with an oblique truncation, and it may be the fragment of a Late Upper Palaeolithic tanged or backed point. In this volume, members of Group 1 are referred to as ‘green chert’, and members of Group 2 as Cumbrian tuff (due to the dominance of this tuff form amongst polished stone axeheads in southern Scotland). To identify these pieces unequivocally, thin-sectioning and/or XRF analysis would have to be carried out.

It is uncertain from which sources the green chert was procured, but the six pieces of Cumbrian tuff are thought to represent the remains of cannibalized polished stone axeheads, which were imported from sources in the general Great Langdale area of the Lake District (Bradley and Edmonds 1993).

The 33 pitchstone artefacts are generally in black aphyric pitchstone and probably derive from sources in eastern Arran (Ballin 2009; Ballin and Faithfull 2009). Eight pieces of grey or pink agate/chalcedony and five pieces of red jasper were probably all formed in the volcanic rocks of southern Scotland (Pellant 1992) and collected by prehistoric people as either erratic or riverine pebbles.

Five pieces of white milky-quartz were probably procured locally as either erratic or riverine pebbles (Ballin 2008). Six black pieces have been defined as ‘jet or coal’; the smaller pieces (chips) could possibly be coal, whereas the larger ones are expected to belong to the jet family (jet proper, cannel coal, lignite, oil shale). Jet may have been imported from the area around Whitby in Yorkshire, although Scottish sources of jet-like materials are also known (Watts and Pollard 1998).

A number of lithic artefacts have been exposed to fire, with fire-crazed flints numbering 82 pieces (4%) and fire-crazed cherts 92 pieces (3%). If it is accepted that the dull grey cherts also represent pieces exposed to fire (above), the group of burnt chert grows to 195 pieces (7%). Frost-affected flints are common, and it was possible to refit several groups of frost-shattered artefacts, including three opposed-platform cores (CAT 706/669; CAT 1728-30; CAT 2092/2240), one scraper (CAT 1925/5094-95), and one truncated piece (CAT 2180/2210). The question is whether these pieces disintegrated in prehistory or after deposition (e.g., plough impact)? One part of CAT 2180/2210 (CAT 2210) was clearly modified into a truncated piece *after* disintegration (as a detached dorsal fragment [thermal flake] overhangs the retouched area of the modified flake underneath it), indicating that some of the flint may have been procured by prehistoric people from superficial, frost-affected sources and not from primary outcrops (see discussion above).

Table 7 shows a number of interesting differences between the flint and chert assemblages. The chert includes substantially more debitage than the flint (90% against 76%), whereas the flint includes approximately three times as many tools as the chert (22% against 7%). Although the different trenches and areas (‘blocks’) – and thereby different prehistoric periods and phases – are characterized by different raw material preferences (see distribution section), these differences probably largely reflect differential fracture patterns, where

Table 7. Artefact categories by main raw materials.

	Flint		Chert		Pitchstone		Others	
	Quantity	Per cent	Quantity	Per cent	Quantity	Per cent	Quantity	Per cent
Debitage	1,606	76	2,610	90	31	94	29	73
Cores	33	2	78	3	2	6		
Tools	452	22	218	7			11	27
<b>TOTAL</b>	<b>2,091</b>	<b>100</b>	<b>2,906</b>	<b>100</b>	<b>33</b>	<b>100</b>	<b>40</b>	<b>100</b>

flint generally flakes in a controllable manner, whereas most cherts (not least the local grey forms with their internal fault planes) flake in a less controllable fashion. The main consequence of this is that chert produces substantially more debris per finished tool than flint.

This fact is supported by the two raw materials' different tool : crested piece ratios, where that of the chert assemblage is 2.5 tools for every crested piece and that of flint 5.4 tools for every crested piece. Generally, these different ratios are evidence that it was necessary to correct the shape of the chert cores 2.2 times more frequently than it was necessary to correct the shape of the flint cores.

However, given that some raw materials used at Howburn are exotic raw materials imported into the site due to their excellent flaking properties (Doggerland/ Yorkshire flint) or their spectacular appearance (some cherts), and other local raw materials with relatively poor flaking properties (the grey cherts), it is highly likely that these different ratios may reflect differential curation. It is highly likely that the imported raw materials (for functional and/or symbolic reasons) were considered more precious than the local raw materials, and it is therefore equally likely that the exotic flint and chert would have been exposed to more careful curation. Nodules and cores (representing still useable raw material), as well as intact tools in precious raw materials were probably removed from the Howburn camp when the settlers continued their journey through the landscape, and tools based on precious materials were probably repaired again and again, and occasionally recycled as other tools, until little was left.

The different raw materials are clearly linked to different prehistoric industries. Diagnostic types associated with Late Upper Palaeolithic industries are heavily dominated by Doggerland/Yorkshire flint, supplemented by a number of spectacular chert forms; types associated with the Mesolithic period (e.g., microliths and microburins) and the Early Neolithic period (e.g., leaf-shaped points) are predominantly in local grey chert. In southern and central Scotland, Arran pitchstone (33 pieces, including six blades and seven microblades) is generally associated with the Early Neolithic period, although a small number of pieces

may date to the earliest part of the Middle Neolithic (Ballin 2015). And Cumbrian tuff is also generally associated with the Early Neolithic, and frequently forms parts of the same depositions as Arran pitchstone artefacts and vessels belonging to the Carinated Bowl Tradition (Ballin 2015).

**Debitage**

In total, 4276 pieces ofdebitage were recovered from the site. Apart from 31 pieces in pitchstone and 27 pieces in 'other' raw materials (Table 7), alldebitage is in flint and chert (37% and 61%, respectively). Thedebitage includes 671 chips, 2078 flakes, 741 blades, 238 microblades, 362 indeterminate pieces, 171 crested pieces, and 15 platform rejuvenation flakes (Table 8). The collection's chip ratio is c. 16%, which is quite low. This mainly reflects the fact that no consistent sieving took place during the excavation. As demonstrated in Ballin (1999a), the chip ratio of sieved assemblages from settlement sites usually varies between c. 30% and 55%.

Thedebitage is dominated by flakes (49%), with blades and microblades making up 23%, indeterminate pieces 8%, and preparation flakes 4%. Substantially higher numbers of blades than microblades were retrieved. As shown in Table 8, the flint and chert assemblages differ in several respects, with the former including significantly higher numbers of blades, whereas the latter includes higher numbers of chips and indeterminate pieces. The different blade:microblade ratios of the flint and chert assemblages (86:14 vs 68:42) probably reflect the different chronologies of the two raw material groups, with most of the flint being of Late Upper Palaeolithic date and most of the local chert being of Mesolithic/Early Neolithic date.

The intact flakes measure on average 19 x 17 x 5 mm, and they were primarily manufactured by the application of hard percussion (61%) (Table 9). Pieces with platform collapse (12%) are most probably damaged hard-hammer flakes. Many blades (mean dimensions: 32 x 13 x 5 mm) and microblades (mean dimensions: 17 x 7 x 3 mm) were produced by the application of hard percussion (22%, probably supplemented by 7% with platform collapse, which are likely to have been manufactured in hard-hammer style), but most of the

Table 8. The differential composition of the flint and chert debitage ('present' = less than 0.5%).

	Flint		Chert		Others		Total	
	Quantity	Per cent	Quantity	Per cent	Quantity	Per cent	Quantity	Per cent
Chips	177	11	486	19	8	14	671	16
Flakes	806	51	1248	48	24	41	2078	49
Blades	384	24	347	13	10	17	741	17
Microblades	71	4	159	6	8	14	238	6
Indeterminate pieces	70	4	286	11	6	10	362	8
Crested pieces	83	5	86	3	2	4	171	4
Platform rejuvenation flakes	8	1	7	present			15	present
<b>TOTAL</b>	<b>1599</b>	<b>100</b>	<b>2619</b>	<b>100</b>	<b>58</b>	<b>100</b>	<b>4276</b>	<b>100</b>

blades (59%) were manufactured by soft percussion. The size distribution of the blades is shown in Figure 18 – although most intact blades have L:W ratios between 2:1 and 3:1, some have ratios of up to 4:1. A small number of fragmented blades and some blade tools (e.g., tanged point CAT 1398; Plate 5) have ratios of up to 5:1. Bipolar flakes and blades are all but absent (2%).

Due to the high fragmentation rate (only 11% of the recovered blades/microblades are intact; Plate 1), the mean dimensions of the blades/microblades are not representative. In Ballin (1999a) the assemblage from Lundevågen 21, SW-Norway, was chosen for testing, and the total blade material and the intact blades (12%) were compared. This examination showed that the intact blades were simpler at all levels. The intact blades were broader and thicker, and they had fewer dorsal ridges, more cortex, more acute percussion angles, more direct-percussion indicators, and simpler or no preparation of platform-edge and -surface.

Based on these results, it must be assumed that the intact blades were also the shortest. Or in other words: *as the narrower and thinner blades tend to break before the more robust pieces, the mean dimensions of intact pieces from a heavily fragmented blade assemblage tend to present a heavily biased, and coarsened, picture of that assemblage.* At Howburn, a relatively large number of blade fragments have lengths between 40 mm and 70

mm, widths around 20-22 mm, and thicknesses around 5-10 mm. The largest and most regular of these pieces are thought to have been approximately 100-120 mm long, and in some cases probably even longer, in their original intact state.

Several blanks have finely faceted platform remnants (155 pieces), 50 of which are of the form referred to as *en éperon* (Barton 1990; also see technology section and Plates 1-2); *en éperon* blades are characterized by a small, shaped spur at the centre of the platform remnant, dorsal face (Weber 2012: Figure 23). As shown in Tables 10 and 11, the flint assemblage has significantly higher proportions of finely faceted and *en éperon* blanks than the chert assemblage, and *en éperon* blanks are clearly more common in the assemblage from Trench I (2009) than amongst the finds from Trench I (2006) and Trench II.

These differences are thought to reflect the fact that the finds from Trench I (2009) may represent an almost undisturbed settlement from the Hamburgian period, whereas the other two assemblages probably represent a Hamburgian settlement with an admixture of Late Mesolithic / Neolithic material (Trench I [2006]) and a Hamburgian settlement disturbed by visits to the site in (mainly) *Federmesser-Gruppen* times and (to a lesser extent) the Late Mesolithic / Early Neolithic periods (see technology, distribution and dating sections). Most platforms are plain with trimmed or abraded edges.

Table 9. Applied percussion techniques. All unmodified and modified blanks (proximal ends).

	Flakes		Blades/microblades		Total	
	Number	Per cent	Number	Per cent	Number	Per cent
Soft percussion	171	12	331	59	502	25
Hard percussion	875	61	122	22	997	50
Indeterminate platform technique	178	13	60	11	238	12
Platform collapse	176	12	41	7	217	11
Bipolar technique	24	2	3	1	27	2
<b>TOTAL</b>	<b>1424</b>	<b>100</b>	<b>557</b>	<b>100</b>	<b>1981</b>	<b>100</b>

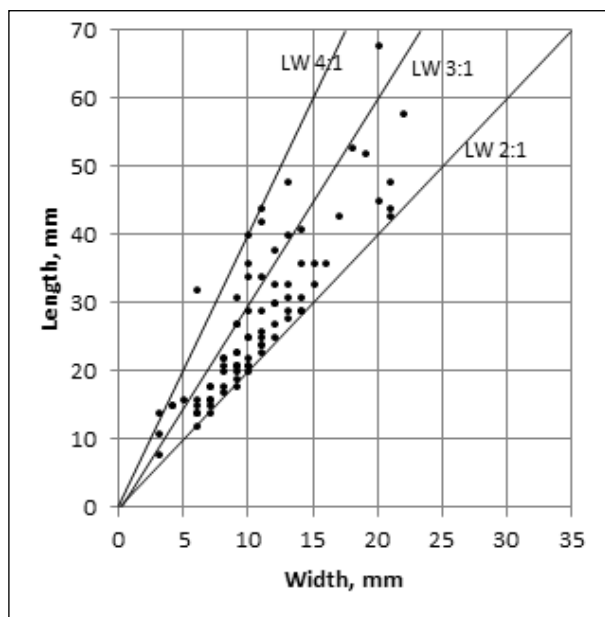


Figure 18. The length and width of intact blades.

The indeterminate pieces measure on average 22 x 14 x 8 mm. At Howburn, the main cause for the formation of indeterminate pieces in flint is probably the effect of frost on the artefacts (discussed in the raw material section), where the main cause of the formation of indeterminate pieces in chert is the presence of numerous parallel or criss-crossing internal fault planes.

The 171 crested pieces (Plate 2) include bilateral as well as unilateral pieces, that is, pieces where a dorsal guide ridge was formed either by the detachment of small flakes to both sides of the ridge, or only to one side. The mean dimensions of intact crested pieces are 31 x 14 x 7 mm (however, see the above comment on fragmentation).

Only 15 platform rejuvenation flakes were recovered. They are all relatively small partial core tablets (mean dimensions 25 x 24 x 9 mm). It is quite possible that some of the platform rejuvenation flakes are simply core tablet 'look-alikes', that is, flakes with finely faceted

Table 10. En éperon and finely faceted flakes and blades by raw material.

	Flint		Chert		Others		Total	
	Quantity	Per cent	Quantity	Per cent	Quantity	Per cent	Quantity	Per cent
En eperon	47	94	3	6		0	50	100
Finely faceted	78	74	26	25	1	1	105	100
<b>TOTAL</b>	<b>125</b>	<b>80</b>	<b>29</b>	<b>19</b>	<b>1</b>	<b>1</b>	<b>155</b>	<b>100</b>

Table 11. En éperon and finely faceted flakes and blades by trench/block.

	Quantity					
	Tr I, 2006	Tr I, 2009	Tr II, Block 2	Tr II, Block 3-4	Other trenches	Total
En eperon	12	26	6	2	4	50
Finely faceted	30	33	27	13	2	105
<b>TOTAL</b>	<b>42</b>	<b>59</b>	<b>33</b>	<b>15</b>	<b>6</b>	<b>155</b>
	Per cent					
	Tr I, 2006	Tr I, 2009	Tr II, Block 2	Tr II, Block 3-4	Other trenches	Total
En eperon	29	44	18	13	67	32
Finely faceted	71	56	82	87	33	68
<b>TOTAL</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>

Table 12. Reduction sequence: flint and chert flakes and blades/microblades.

	Flint		Chert		Total	
	Number	Per cent	Number	Per cent	Number	Per cent
Primary pieces	39	3	23	1	62	2
Secondary pieces	324	26	161	9	485	16
Tertiary pieces	902	71	1570	90	2472	82
<b>TOTAL</b>	<b>1265</b>	<b>100</b>	<b>1754</b>	<b>100</b>	<b>3019</b>	<b>100</b>

platforms where the fine faceting was misinterpreted as dorsal trimming. However, the distribution (see distribution section) of the site's platform rejuvenation flakes largely *outside* the site's main Hamburgian concentrations (where the vast majority of the finely faceted and *en éperon* blanks were found within those concentrations) suggests that they may actually be platform rejuvenation flakes but just not dating to the Hamburgian period.

In general, cortical pieces of debitage (18%) are considerably rarer than cortex-free pieces (82%) (Table 12). There are, however, considerable differences between the composition of the flint and chert assemblages, with the former including approximately one-third cortical pieces, whereas the latter only includes one-tenth. This may be due to several factors, such as chronology (the two assemblages may have been produced by different industries; see technology and dating sections), and – probably more importantly – the character of the raw material. Flint was procured in the form of nodules, either from chalk or from secondary pebble sources, whereas the chert was mainly procured from more extensive veins. As shown in Ballin (2016b), a large nodule has comparatively less cortex in relation to its mass of inner material than a small nodule, and material from a thick vein has even less cortex.

### Cores

During the excavations at Howburn, 113 cores were retrieved (Table 13): three core rough-outs, 27 single-platform cores, 35 opposed-platform cores, eight cores with two platforms at an angle, 20 irregular cores, two discoidal cores, one flaked flake, five bipolar cores, and 12 core fragments. Thirty-three cores are in flint, 78 are in chert, and two are in pitchstone; Table 13 shows notable differences in the typo-technological composition of flint and chert cores, with the former category being

dominated by opposed-platform cores (55%, with single-platform and irregular cores amounting to 15% and 12%, respectively), whereas the latter includes roughly equal numbers of single-platform, opposed-platform and irregular cores (20-27% each).

These numerical differences probably reflect: 1) chronological differences, with Howburn's Late Upper Palaeolithic settlers favouring exotic flint and the site's Mesolithic / Early Neolithic settlers local chert; 2) different flaking-properties, with the procured flint having few flaws and flaking in a controlled manner, whereas the chert is generally somewhat flawed and flakes in a more intricate manner; and 3) as a consequence, the application of different operational schemas (see raw material, technology and dating sections).

The percentage distribution of platform cores: bipolar cores is 94:06, which corresponds well with the fact that the site's unmodified blanks only include 2% bipolar flakes (Table 9).

The dimensions (L x W x T) of cores are measured in the following ways: in the case of platform cores, the length is measured from platform to apex, the width is measured perpendicular to the length with the main flaking-front orientated towards the analyst, and the thickness is measured from flaking-front to the often unworked/corticated 'back-side' of the core. In the case of bipolar cores, the length is measured from terminal to terminal, the width is measured perpendicular to the length with one of the two flaking-fronts orientated towards the analyst, and the thickness is measured from flaking-front to flaking-front. More 'cubic' cores, like cores with two platforms at an angle and irregular cores, are simply measured in the following manner: largest dim. by second-largest dim. by smallest dim.

Table 13. The differential composition of the flint and chert cores.

	Flint		Chert		Others		Total	
	Quantity	Per cent	Quantity	Per cent	Quantity	Per cent	Quantity	Per cent
Core rough-outs			3	4			3	3
Single-platform cores	5	15	21	27	1	50	27	24
Opposed-platform cores	18	55	17	22			35	31
Cores with two platforms at an angle			7	9	1	50	8	7
Irregular cores	4	12	16	20			20	17
Discoidal cores	2	6					2	2
Flaked flakes			1	1			1	1
Bipolar cores	2	6	3	4			5	4
Core fragments	2	6	10	13			12	11
<b>TOTAL</b>	<b>33</b>	<b>100</b>	<b>78</b>	<b>100</b>	<b>2</b>	<b>100</b>	<b>113</b>	<b>100</b>

*Core rough-outs:* Three core rough-outs (CAT 3647, 4125, 5078) were found during the excavations, all of which are in chert. They vary considerably in size, with the largest one (CAT 3647) having a greatest dimension of 55 mm, whereas the two smaller, approximately evenly sized rough-outs have mean dimensions of 33 x 25 x 19 mm. CAT 3647 has had a single crest prepared, CAT 4125 two opposed crests, and CAT 5078 one crest and a striking-platform. They were all clearly intended to become small conical cores, suggesting a Mesolithic or Early Neolithic date for these pieces (cf. Ballin 2014b; Saville 2008). The edge opposite CAT 5078's crest has been pecked, but it is uncertain whether this modification represents a complementary (?expedient) crest or whether the piece may have been used as a small hammerstone in connection with the finer work of lithic reduction.

*Single-platform cores:* This category (Plate 3) includes five cores in flint, 21 in chert and one in pitchstone. Four single-platform cores differ from the remainder of the category in terms of their larger-than-average size (L>50 mm; Figure 19): Flint core CAT 828 (Plate 3) measures 63 x 33 x 22 mm, and it has a regular conical shape. Near the platform it is almost cylindrical, suggesting that it may at an earlier stage of the reduction process have been flaked from opposed platforms. A small number of flakes were detached from its present apex, but they probably represent adjustment of the core-shape rather than actual blank production. The platform and platform-edge were clearly adjusted by fine faceting, indicating a Late Upper Palaeolithic date, and the piece has no platform-edge trimming. CAT 2520 (Plate 3) is also in flint (51 x 43 x 27 mm), and it has one main flaking front, and an intact crest running along one lateral side, from platform to apex. It is thought that this piece may have been abandoned prematurely due to numerous frost-induced cracks. CAT 4844 is a large, relatively flat chert core (58 x 22 x 39 mm), which was reduced in handle-core fashion, that is, with blades being detached from one end of a long narrow platform, but not from the lateral sides. It was abandoned when a fault-plane developed in the central part of the core, preventing further production of long blades (the smaller chert core CAT 3152 was reduced in a similar manner). And CAT 746 is a slender conical chert core (51 x 32 x 26 mm), the 'back-side' of which is defined by the surface of a fault-plane.

The bulk of the single-platform cores are fairly small (mean dimensions 27 x 24 x 22 mm), with some being short and squat (L c. 15-20 mm) and others long and slender (L c. 25-45 mm). The platforms are generally plain, with some having been trimmed and others not. Where the two smallest intact flint cores (CAT 2682, 3719) approach conical shape, the chert cores vary considerably more. The individual pieces are generally relatively chunky, or sub-conical, with their forms

being influenced by the presence, location and number of internal fault-planes. A small number of chert cores (such as CAT 1620 and 3738) are quite flat (width:depth c. 2:1). None of these cores was reduced along the entire circumference, and most have a flat 'back-side', formed by the coated surface of a fault-plane. In most cases, the platforms are plain, and the platform-edges trimmed, but untrimmed specimens are also present. The small size of this group of single-platform cores, in conjunction with the general absence of fine platform-faceting, indicates that most of these pieces are either Mesolithic or Early Neolithic.

*Opposed-platform cores:* A total of 35 opposed-platform cores (Plate 4) were recovered during the excavations at Howburn, distributed evenly across flint and chert specimens. Apart from four relatively small cores (CAT 608, 772, 780, 1905) with lengths of 21-27 mm, most opposed-platform cores in flint have lengths between 35 and 40 mm, with one (CAT 2306; Plate 4) being 51 mm long (Figure 19). The mean dimensions of the intact opposed-platform cores in flint are 35 x 24 x 17 mm. The opposed-platform cores in chert appear to form two metric groups, namely one with lengths between 22 and 32 mm, and one with lengths between 40 and 55 mm. The mean dimensions of the intact opposed-platform cores in chert are 35 x 23 x 18 mm.

Three of the category's flint cores are relatively flat specimens (CAT669/706 [Plate 4], 2234, 3381), but most are rather squat cylindrical pieces. CAT 2977 (Plate 4) is a fairly slender cylindrical core in dark-brown flint, and

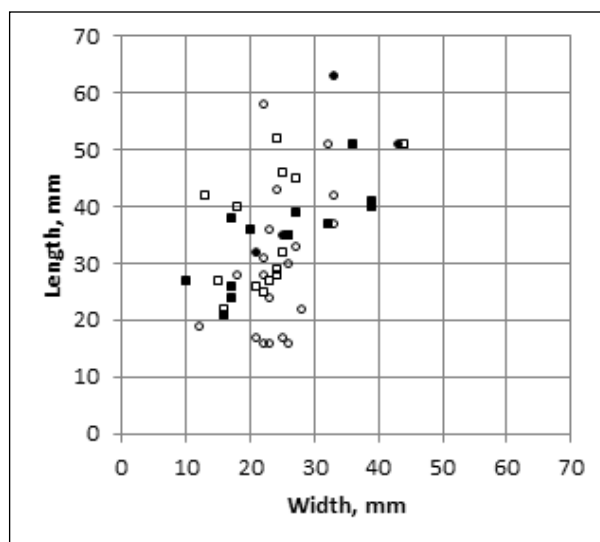


Figure 19. The length and width of intact single-platform (closed circle = flint; open circle = chert) and opposed-platform cores (closed square = flint; open square = chert). A number of trends are notable: Opposed-platform cores are generally larger than single-platform cores, and flint single-platform cores are generally larger than chert single-platform cores.

it was probably based on a robust flake or blade. The group of very small opposed-platform cores mentioned above, as well as fragments CAT 1863 and 2199 (both missing a platform), are completely exhausted cylindrical specimens (greatest dimensions 21-27 mm). CAT 2092/2240 (Plate 4) is a refitted core, consisting of an apex and a broken-off platform; as in so many other cases at Howburn, the damage is frost-induced. Several diminutive cores (e.g., CAT 780, 2199) are so thin (4-7 mm) that they could be mistaken for bipolar cores.

The chert cores are slightly less regular, with several (e.g., CAT 693, 2977, 3230) being comparatively flat (like the flat chert single-platform cores, they have a width:depth ratio of *c.* 2:1) and others short and sub-cylindrical (e.g., CAT 1266, 1501, 4569). However, somewhat larger, slender cores were also retrieved at the site (e.g., CAT 1058, 3671, 3789, 4173). The more mixed formal variation of the chert cores reflects the presence of numerous internal fault-planes in this raw material.

Most of the medium-sized and large opposed-platform cores in flint display fine faceting along the platform-edge, and in several cases it is possible to recognize carefully shaped *en éperon* spurs (e.g., CAT 2234, 2306, 1728-30; the exhausted core CAT 608 also has a notable spur). Due to the more intricate fracture patterns of the local chert it is difficult to precisely characterize the platforms of the chert cores, but several may have been prepared in the same manner as the opposed-platform cores in flint, that is, by finely faceting the striking platform near the edge.

*Cores with two platforms at an angle:* This category includes eight pieces, most of which are in chert, with one piece (CAT 5017) being in pitchstone. One of the chert cores (CAT 4143) is relatively flat (27 x 23 x 9 mm), whereas the others have more even dimensions (mean dimensions 32 x 27 x 21 mm). The pitchstone specimen is relatively flat, measuring 18 x 15 x 8 mm. The platforms are generally plain but, where a secondary platform consists of an old flaking-front, it is faceted. Trimming is common.

*Irregular cores:* A total of 20 irregular cores were recovered, four of which are in flint, and 16 are in chert. These cores are generally fairly cubic or chunky, and they are characterized by having at least three platforms. The flint and chert cores differ somewhat in size, with the four flint specimens having a greatest dimension of 38-61 mm, whereas the chert pieces have a greatest dimension of 30-43 mm. Most likely, these cores represent the final stage of more complex operational schemas (see technology section). Although the preparation of the cores' platforms and platform-edges is somewhat minimalistic (as one would expect from final-stage cores), several do display old trimmed

platform-edges. The flint cores are generally affected by frost-induced fragmentation.

*Discoidal cores:* The assemblage includes two (CAT 662, 1626) diminutive discoidal cores in flint. CAT 662 is a plain unifacial discoidal core (42 x 30 x 20 mm) with a domed conical 'underside' and a relatively flat flaking-front, whereas CAT 1626 (19 x 14 x 10 mm) is more regular and clearly disc-shaped. Despite its regular shape, the latter is unlikely to represent a separate operational schema, and it is most probably the completely exhausted remains of a more common core type. If this is the case, CAT 1626 may simply be a form of irregular core.

*Flaked flakes:* One thick chert flake (35 x 28 x 20 mm) has had its ventral face transformed into a flaking-front (CAT 1055) and is here regarded as simply an expedient idiosyncratic piece. Flaked flakes (with more sophisticated pieces being referred to as Kombewa cores) have been discussed by Ashton *et al.* (1991) and Inizan *et al.* (1992, 57).

*Bipolar cores:* Only five bipolar cores were found at Howburn, with two being in flint (CAT 1477, 3967) and three in chert (CAT 621, 2463, 4988). They are all 'standard' bipolar cores in the sense that they have two opposed flaking-fronts and one reduction axis (one set of opposed terminals). CAT 621, 1477 and 2463 are all intact, with greatest dimensions of 15-24 mm. CAT 3967 and 4988 have both lost one terminal. The former is relatively small (comparable in size to CAT 621 and 1477), whereas the latter is considerably larger than the other three bipolar cores. Its original length may have been approximately 60 mm.

*Core fragments:* Fourteen core fragments were originally recovered from the site, but as two (CAT 1729, 2092) have been conjoined with other parts of disintegrated cores (with the two refitted groups of five artefacts now being classified as two opposed-platform cores), only 12 unspecified core fragments remain. Ten of the 12 fragments are in chert, with two being in flint. The pieces vary greatly in size, with a greatest dimension of 25-55 mm. Most of the core fragments have more than one surviving flaking-front, and these pieces must be fragments of cores with two platforms at an angle or irregular cores.

## Tools

During the excavation of the Howburn site, 681 tools were retrieved (Tables 4 and 14; Plates 5-16): 105 points and arrowheads (100 of which are Late Upper Palaeolithic forms), 32 microliths and microlith-related pieces, 167 scrapers, two backed knives, 36 truncated pieces, 13 piercers/*Zinken*/*becs*, 34 burins, 18 possible burin spalls, 12 combined tools, 12 notched

Table 14. The differential composition of the flint and chert tools ('present' = less than 0.5%).

	Flint		Chert		Others		Total	
	Quantity	Per cent	Quantity	Per cent	Quantity	Per cent	Quantity	Per cent
Tanged/backed implements	86	19	14	7			100	15
Microliths and microlith-related pieces	6	1	26	13			32	5
Neolithic arrowheads	3	1	2	1			5	1
Blade-scrapers	54	12	10	5			64	9
Short end-scrapers (incl. 1 disc scraper)	39	9	25	12	1	10	65	10
Double-scrapers	10	2	3	1			13	2
Side- and side-/end-scrapers	7	2	2	1			9	1
Scraper-edge fragments	10	2	6	3			16	2
Backed knives	2	present					2	present
Truncated pieces	26	6	9	4	1	10	36	5
Piercers/Zinken/becks	10	2	3	1			13	2
Burins	25	6	9	4			34	5
Possible burin spalls	15	3	3	1			18	3
Notched and denticulated pieces	6	1	6	3			12	2
Combined tools	11	2	2	1			13	2
Pieces with edge-retouch	146	32	91	43	1	10	238	35
Flakes/cores from polished axeheads	1	present			6	60	7	1
Hammerstones, pounders, and anvils					4	10	4	present
<b>TOTAL</b>	<b>457</b>	<b>100</b>	<b>211</b>	<b>100</b>	<b>10</b>	<b>100</b>	<b>681</b>	<b>100</b>

and denticulated pieces, 238 pieces with edge-retouch, seven flakes and cores from cannibalized polished stone axeheads, and four coarse stone tools (hammerstones, pounders, anvils). A total of 457 pieces are in flint, 211 pieces are chert, and ten are in other raw materials. Table 14 shows how some tool categories are notably dominated by flint (e.g., Late Upper Palaeolithic points, blade scrapers, truncated pieces and burins) and others by chert (primarily microliths). 'Other' raw materials include 'green chert' (truncated piece CAT 2855 and edge-retouched piece CAT 2897), quartzite and sandstone (short end-scraper CAT 3586 and the hammerstone/pounder/anvil group), and Cumbrian tuff (parts of polished axeheads CAT 1536, 1938, 3339, 3413, 3565, 3573 – one flake from a polished axehead is in flint: CAT 3793).

The 681 tools correspond to a tool ratio of 13%, which is somewhat higher than expected. Statistical analysis of numerous hunter-gatherer sites from southern Norway (Ballin 1999a) showed that the tool ratio of sieved assemblages rarely exceeds 4%, unless the site is a specialized camp where little or no primary knapping took place. In the present case, the high tool ratio may

be explained by the fact that consistent sieving was not undertaken.

*Upper Palaeolithic projectile points:* It is possible to subdivide this category of 100 implements into tanged points (29 pieces) and backed points (71 pieces). The latter category includes 23 implements which are thought to be backed pieces *sensu stricto* (i.e., likely Late Upper Palaeolithic angle-, curve- or straight-backed pieces), as well as a sub-category consisting of fragmented pieces which could only be defined as fragments of either tanged or backed points (48 pieces) (Table 4). Figure 20 was produced to define and characterize the tanged points, and fragments thereof.

Tanged points are pieces with a bilaterally retouched tang (Ballin 2017b), and they differ from Early Hamburgian shouldered points, which frequently (but not exclusively) have unilateral retouch at the base, forming the well-known shoulder which gave these pieces their name (Grimm *et al.* 2012: 255; Hartz 1987: 40). In Figure 20, all fragment forms but Type B are easily recognizable as tanged points or fragments thereof. Broken-off tips (Type B) are only definable by

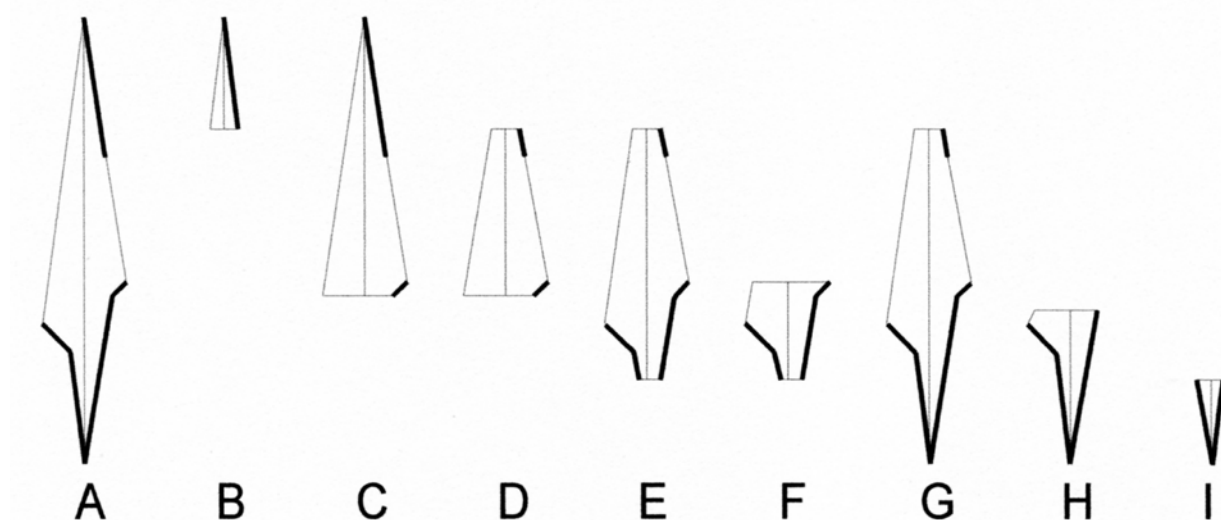


Figure 20. Tanged points - fragment forms: A) Intact piece; B) tip; C) tip to shoulder; D) medial fragment; E) medial to shoulder; F) shoulder; G) medial to tang; H) shoulder to tang; and I) tang. This diagram represents a slightly adjusted version of Holm and Rieck's (1992: Figure 32) fragment classification schema.

Table 15. Tanged points - attributes. Four combined tools (tanged pieces combined with scraper-edges or piercer tips) are included in the table's totals, but not in the general quantifications through the table.

		<i>Tr I, 2006</i>	<i>Tr I, 2009</i>	<i>Tr II, Block 2</i>	<i>Tr II, Block 3-4</i>	<i>Fieldwalking near site</i>	<i>Total</i>
Completeness	Complete	1	1		1		3
	Tip	14 frags of backed and truncated pieces are likely to be tips					
	Tip to shoulder		2	1			3
	Medial to shoulder	1	1				2
	Shoulder			1	1		2
	Medial to tang		3	2		1	6
	Shoulder to tang		1				1
	Tang	2	8	2			12
Raw material	Flint	4	14	6	2	1	27
	Chert		2				2
Blank	Blade	4	15	6	2	1	28
	Uncertain (tang fragment)		1				1
Orientation	Proximal tang		2	4			6
	Distal tang	4	11	2	3	1	21
	Uncertain		2				2
Tang attributes	Asymmetrical (excl 1 unc frag)	1	12	4	2		19
	Propeller retouch	1	6	3	1		11
	Sur enclume		7	1	2		10
	With notch and spur	1	7	4	1		13
	Unmodified		1				1
Tip attributes (Incl. the likely tip frags of other catgs.)	Oblique	2	3	1	2		8
	Curved		1				1
Combined (not incl. above)	Sur enclume	1	2				3
	Tanged point-scraper		2				2
	Tanged point-piercer				1		1
<b>TOTAL</b>	<b>Incl. four combined tools</b>	<b>4</b>	<b>18</b>	<b>6</b>	<b>3</b>	<b>1</b>	<b>32</b>

their modification as probably tips of either tanged or backed points and in this volume, these pieces are defined simply as truncated pieces. In the following presentation, backed pieces are defined as mostly macrolithic pieces ( $W > 8$  mm) with abrupt, usually full, unilateral blunting, occasionally supplemented by basal adjustment of the opposite lateral side. The character of the abrupt lateral modification, which may in some cases have been manufactured on an anvil (*sur enclume*), generally identify fragments as either deriving from tanged or backed points and not simpler edge-retouched forms, but it is frequently difficult to determine whether they should be characterized as fragments of one or the other point form.

In the present volume, pieces have been classified as backed points *sensu stricto* if they are either complete abruptly retouched pieces without tangs, if proximal fragments with similar retouch have intact bulbar ends, or if medial fragments are long enough to make it highly unlikely that they were originally tanged pieces. Angle-backed points pose no classificational problems, as they are defined by one or more marked lateral angles. Curve-backed and straight-backed points, on the other hand, do. There is presently no clear definition of how curved a backed point needs to be to be defined as curve-backed, and in the archaeological literature it is almost 'a toss of a coin' whether a slightly curved piece or a piece with curved terminal(s) is classified as curve- or straight-backed (compare, for example, Barton 1992 and Jacobi 2005). In the present volume only decidedly crescentic pieces have been defined as curve-backed. For definition of backed bladelets and backed knives, see below.

*Tanged points:* As shown in Table 15, only three (CAT 765/1084, 1398, 4041) tanged points are complete, whereas the remainder of the tanged pieces are represented by various fragments (Plates 5-7). The three intact pieces measure 53 x 16 x 6 mm, 79 x 15 x 6 mm and 42 x 12 x 4 mm, respectively, and the entire group has mean widths and thicknesses of 11.8 x 4.4 mm (in general, decimals are not used in this report, but in this case, and in connection with some mean values of the backed points [below] it was found relevant to do so, as this may allow fragments of the two categories to be distinguished from each other). The most intact fragments have lengths of 40-50 mm, and the longest tanged point (CAT 1398; L = 79 mm; Plate 5) probably represents a deviation from the norm.

The most easily recognizable pieces – apart from the complete specimens – are the collection's 19 tang fragments ('medial to tang', 'shoulder to tang', and 'tang' fragments). The remainder are pieces with surviving shoulders, and thereby parts of tangs (seven 'tip to shoulder', medial to shoulder', and 'shoulder' fragments). Twenty-seven pieces are in flint, whereas two are in chert; all combined pieces are in flint (for

characterization of combined pieces in general, see below). As a rule, the tanged points are based on regular macroblades, and more than three-quarters of the implements have distal tangs. Some contemporary Continental sites are dominated by tanged points with proximal tangs (such as Jels 2 in southern Jutland, Denmark; Holm and Rieck 1992: Figure 33; Ahrenshöft in Schleswig-Holstein; Hartz 1987: Tab. 1; Weber *et al.* 2010: Figure 7; also see Grimm *et al.* 2012: 254), whereas others are mixed and include roughly equal numbers of proximal and distal tangs (e.g., Oldeholtwolde in the Netherlands; Johansen and Stapert 2003: 38).

The tangs of nineteen points were identifiable as asymmetrical (Figure 21.a-b), whereas the remainder were too fragmented to allow the character of the tang to be defined with certainty. A total of 11 tangs have propeller retouch, that is, the two lateral sides of the tang were modified from different faces; and ten pieces display *enclume* retouch, that is, the same lateral side of the tang was retouched from both faces (in most cases partially so). Thirteen specimens show the distinct 'notch and spur' retouch (Figure 21.2; Plates 5-7), which is thought to represent a form of hafting device (Grimm *et al.* 2012; Hartz 1987: 9).

Combined, these tang attributes define the Howburn tanged pieces as typical Havelte (that is, Late Hamburgian) points (e.g., following Bohmers 1956: 7). In his discussion of the finds from Ahrenshöft in Nordfriesland, northern Germany, Hartz (1987: Table 1) characterizes Havelte points as pieces with (usually) 1) extensively modified tips, frequently formed by *enclume* retouch; 2) asymmetrical proximal tangs with propeller retouch; and 3) a 'notch and spur' hafting device (see Plates 5-7). The only attribute clearly separating the Howburn Havelte points from their Continental equivalents, is the position of the tang,

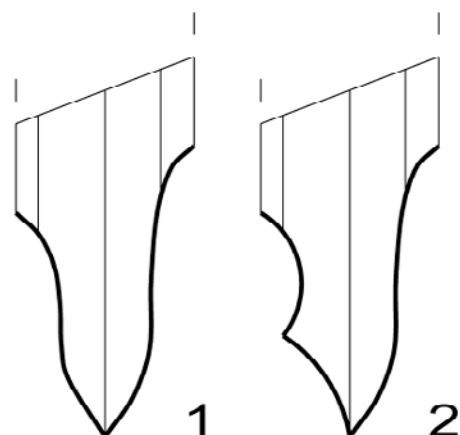


Figure 21. The two dominating tang forms at Howburn: 1) 'Normal' asymmetrical tang, and 2) asymmetrical tang with lateral 'notch and spur'.

where the Howburn pieces mostly have distal tangs and the Continental pieces proximal tangs (above).

The most detailed quantification of an assemblage of Havelte points is that of Jels 2, where Holm and Rieck (1992: Figures 34 and 35) show that the Danish pieces generally have asymmetrical tangs (92%), and that most have tangs formed by propeller retouch (84%). The authors do not mention *enclume* retouch, and it is uncertain whether the Jels 2 tangs may have been formed by partial *enclume* modification. Only CAT 2875 (Plate 6) has attributes suggestive of other types than the Havelte point: approximately half of its tang has broken off, and in its present state (where the tang appears to have been formed by unilateral retouch) it can not be ruled out that it is a shouldered point, thus indicating a visit to the site during the 'Classic' Hamburgian period. However, given the sum of the evidence from the site, it is probably more likely that this is the fragment of a Havelte point, where the asymmetrical tang broke above the shortest lateral retouch.

Weber (2008: 115) and Grimm *et al.* (2012: 255) inform us that a form of microburin technique was commonly used by Hamburgian people in connection with the manufacture of shouldered and tanged points (that is, by Classic Hamburgian and Havelte groups alike), but no macrolithic microburins (i.e., pre-Mesolithic or Early Mesolithic specimens) were found at Howburn. If the application of microburin technique in the Hamburgian period is perceived as a means of detaching thick bulbar blade-ends in connection with the shaping of tangs, the fact that the Howburn points generally have distal tangs may explain why none was found.

Six complete pieces and certain tips ('tip to shoulder'), supplemented by the most likely tip fragments amongst pieces classified as 'fragments of backed or truncated pieces' include the following types: one unmodified tip, eight oblique tips, one curved tip, and three were clearly modified by *enclume* retouch. Four combined pieces (also see general section on combined tools,

below) embrace two tanged points recycled as scrapers (CAT 1242, 1921), and one recycled as a piercer (CAT 4042; Plate 16). Two of these combined pieces have proximal tangs and one has a distal tang; all tangs are asymmetrical, and they all display propeller retouch. Two of the pieces have *enclume* retouch, and one has a distinct lateral 'notch and spur'.

Tang fragment CAT 727, characterized by a distinct lateral 'notch-and-spur', demonstrates how difficult it can be to classify these pieces correctly. It was retrieved during the 2006 excavation and initially defined as the fragment of a piece with oblique retouch, but the recovery in 2009 of many pieces with 'notch and spur' modification made it absolutely clear that this piece is a broken-off tang (cf. Figure 21.2).

*Backed points:* In total, 23 pieces identifiable as backed points *sensu stricto* (or fragments thereof) were recovered, supplemented by 48 fragments of indeterminate backed pieces (Plate 8). The latter may include broken-off parts of tanged as well as backed points. Two of the definable implements are angle-backed points, two are curve-backed points, whereas 19 are straight-backed points.

The backed points/fragments were subdivided according to their degree of completeness as shown in Table 16. Only six pieces are intact, eight are basal fragments, 11 basal-medial fragments, 19 medial fragments, four medial-tip fragments, and 21 tip fragments, with lateral fragments and uncertain fragments being represented by one piece each. Twelve of the backed implements are in chert, with the bulk of the category being in flint. They are all based on regular blades.

*Angle-backed points:* The collection includes one intact angle-backed piece (CAT 1254). It is a small (26 x 12 x 3 mm) trapezoidal implement with a surviving bulbar area. One lateral side is characterized by a proximal and a distal oblique truncation. The distal truncation

Table 16. Backed points/pieces - fragments.

<i>Fragments</i>	<i>Angle-backed</i>	<i>Curve-backed</i>	<i>Straight-backed</i>	<i>Indeterminate frags</i>	<i>Total</i>
Complete	1	2	3		6
Bases			4	4	8
Base-medial frags			10	1	11
Medial frags			2	17	19
Medial-tip frags	1			3	4
Tip frags				21	21
Lateral frags				1	1
Uncertain				1	1
<b>TOTAL</b>	<b>1</b>	<b>2</b>	<b>19</b>	<b>49</b>	<b>71</b>

is relatively robust, whereas the proximal truncation is very fine but continuous. A short lateral stretch between the two truncations has very fine sporadic retouch. However, the refitted piece CAT 781/1103 (Plate 8) is probably more typical in terms of size and execution, and this combined piece measures 39 x 16 x 4 mm. It has an obliquely truncated proximal tip, and its entire left lateral side displays abrupt backing.

Curve-backed points: The two curve-backed points (CAT 1247, 3929) are the only backed points with unequivocal curved lateral backing (i.e., they curve from one end to the other and not just at the two ends). CAT 1247 (Plate 8) is a very small specimen (25 x 9 x 3 mm), with CAT 3929 being considerable larger (39 x 13 x 5 mm). Both pieces are missing the outermost parts of their proximal and distal ends, making it impossible to determine whether they originally had surviving bulbar ends or whether they may possibly have been bi-pointed specimens. CAT 3929 displays partial *enclume* retouch.

Straight-backed points: The site's 19 straight-backed pieces form a relatively homogeneous formal category. At Howburn, a typical straight-backed point is characterized by the following elements: 1) straight backing along one entire lateral side; 2) a surviving bulbar end; 3) a slightly curved distal end; and 4) no, or only discrete, basal retouch of the blank's platform remnant or of the proximal end of the cutting-edge (that is, no *Federmesser* points *sensu stricto* were retrieved; cf. Barton 2005: Figure 128.7; Saville and Ballin 2009). A small number of exceptions were identified, such as CAT 3232, which has only been modified along the proximal half of one lateral side, and CAT 4040 (Plate 8) has basal retouch in the form of straight to slightly convex blunting of its platform remnant. CAT 2721 and CAT 3232 display *enclume* retouch. In terms of dating this group, it may be relevant to note that – despite the many surviving platform-ends – not a single piece was manufactured in *en éperon* technique. Size-wise, the pieces appear as homogeneous as they do in terms of their general shape: the two complete pieces and one almost complete specimen have lengths between 28 mm and 34 mm; the group as a whole has mean widths and thicknesses of 10.0 x 3.5 mm.

One small, and very short, *Federmesser* point in flint was recovered during fieldwalking immediately outside the excavation area (CAT 814; Plate 7). It measures 22 x 9 x 3 mm, and it has straight to slightly convex lateral backing along one lateral side, and a typical *Federmesser* base with an oblique truncation which meets the lateral backing at an acute angle. The distinction between *Federmesser* points and triangular microliths is discussed in more detail in the microlith section below (Figure 22).

Fragments of indeterminate backed pieces: Forty-eight abruptly retouched objects were classified as fragments of indeterminate backed pieces. Due to their level of fragmentation, it was not possible to refer them to more specific backed categories, such as tanged points or angle-backed, curve-backed or straight-backed points. These fragments vary in length between 9 mm and 39 mm. The group's mean widths and thicknesses are 12.0 x 4.0 mm; 42 pieces are in flint and seven in chert; apart from four flake blanks and one indeterminate blank, all blanks are blades; four pieces are basal fragments, one a base-medial fragment, 16 medial sections, four medial-tip fragments, 21 probable oblique and curved tips, one a lateral fragment and one is uncertain. Four have *enclume* retouch.

It is thought that many of the pieces in this category may be fragments of tanged points, as their mean widths and thicknesses correspond most closely to those:

- Tanged points                      11.8 x 4.4 mm
- Indet backed pieces              12.0 x 4.0 mm
- Straight backed points        10.0 x 3.5 mm

As the tanged points are almost exclusively in flint, whereas between one-quarter and one-third of the largest group of backed points (the straight-backed points) is in chert, it is most likely that the present category's chert pieces are fragments of backed rather than tanged points.

CAT 797 (Plate 7) is an intact piece, but its shortness (27 x 12 x 4 mm) suggests that it may be a repaired broken tanged or perhaps angle-backed piece, with concave retouch at the base on what was a snapped break. Two of the longer indeterminate backed pieces (CAT 1252 and CAT 2035) have been referred to this category due to the more irregular delineation of their lateral modification.

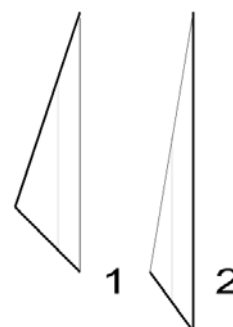


Figure 22. The difference between scalene triangle style modification (1) and *Federmesser* style modification (2). In the former case, both short sides are modified, and in the latter the longest side and the shortest side.

*Neolithic arrowheads:* In total, five Neolithic arrowheads were found, namely three leaf-shaped points, and two chisel-shaped arrowhead. One leaf-shaped point is an undefinable lateral fragment in flint (CAT 5019), whereas the other two are in chert. One of the definable leaf-shaped pieces belongs to Green's (1980: 72) Type 4Aa (CAT 2891), and the other to Type 4Ab (CAT 1669); the former is kite-shaped, and the latter drop-shaped. They are of the same approximate size, with mean dimensions of 20 x 17 x 4 mm. They are probably based on flakes, and both specimens were shaped by bifacial invasive retouch. The chisel-shaped arrowheads (CAT 689, 5091) are basal fragments in flint, and it is not possible to refer them to specific sub-types (Clark 1934b). They were both shaped by the application of traditional edge-retouch.

*Microliths and 'microlith-related implements':* In the present volume, microliths are defined as small lithic artefacts manufactured to form part of composite tools, either as tips or as edges/barbs, and which conform to a restricted number of well-known forms, which have had their (usually) proximal ends removed (e.g., Clark 1934a; Jacobi 1978; for an overview, see Butler 2005). Below, microliths *sensu stricto* (i.e., pieces which have had their proximal ends removed) and backed or truncated microblades are treated as a group, as these types are thought to have had the same general function. Backed bladelets are distinguished from the backed points above by their diminutive sizes, and by their usually more delicate lateral modification.

At Howburn, 32 microliths and 'microlith-related implements' were retrieved, including nine scalene triangles, one crescent, ten fragments of microliths or backed bladelets, one backed bladelet, six truncated bladelets, three microburins, one point or microlith, and one ?microlith. Two of the scalene triangles are in flint (CAT 732, 2827), as is one fragment of a microlith or backed bladelet (CAT 1248), three truncated bladelets (CAT 644, 3155, 4311), and one ?microlith (CAT 2876), whereas all other pieces (four-fifth) in this category are in chert. All microliths and microlith-related implements are based on microblades.

Six (CAT 732, 1337, 1502, 2167, 2827, 4900) of the nine scalene triangles are fragments, and the three intact pieces (CAT 1115, 3188, 3355) are between 11 mm and 16 mm long. The mean width and thickness of the scalene pieces are 5 mm and 2 mm. In six cases, the shortest side is towards the proximal end, and in three cases the distal end. Most commonly, both short sides are fully retouched, whereas the longest side remains unmodified, although some pieces have sporadic retouch of this edge. Only CAT 732 and CAT 1115 have three fully blunted edges.

A small crescent (CAT 3319) is intact and measures 12 x 4 x 3 mm. It has full retouch of the curved lateral side and no retouch of the other; it may be a 'sloppily' executed scalene triangle. Eleven fragmented pieces could only be characterized as segments of either small geometric microliths or backed bladelets, as it was not possible to determine whether they had had their proximal end removed in connection with the modification process. The longest piece is 19 mm long, and the category as a whole has a mean width and thickness of 6 mm and 3 mm. The site's solitary backed bladelet (CAT 3244) is a proximal fragment (20 x 6 x 4 mm) of a piece with full blunting along its right lateral side.

One (CAT 2274) of the three microburins is a traditional distal form (12 x 8 x 2 mm) broken in a lateral notch, and it has a typical oblique microburin facet. The other two microburins (CAT 4275, 4446) are both *lamelles á cran* forms, which had one lateral side fully blunted before an attempt was made at breaking off the bulbar area. However, in both cases, the attempt was unsuccessful, and the pieces snapped centrally, leaving relatively large by-products instead of the usually diminutive microburins. CAT 4275 measures 14 x 7 x 3 mm and CAT 4446 measures 24 x 8 x 4 mm.

This general category includes two implements (CAT 2876, 4770) which do not fit any standard typology. CAT 4770 is a relatively long chert microblade (31 x 7 x 5 mm), which has had the proximal half of the left lateral side, and the distal half of the right lateral side, blunted. It probably dates to the Late Mesolithic and it may be a form of microlith rough-out. The other piece (CAT 2876) is a very narrow (18 x 4 x 2 mm) medial-distal fragment in exotic flint, and it has had its left lateral side fully blunted by *enclume* retouch. At the proximal break there are remains of an oblique basal retouch like that characterizing typical *Federmesser* points (i.e., with the oblique retouch being orientated differently to that characterizing scalene triangles; Figure 22). The flint type and the type of modification suggest that the piece may date to the Upper Palaeolithic period. Being as narrow and acutely pointed as it is, it may have functioned as a needle, but it has been included in the present category due to its formal similarity to microliths.

*Scrapers:* The site's 167 scrapers (Plates 9-12) include one discoidal scraper, 70 blade-scrapers (six of which are double; Plate 10), 71 short end-scrapers (seven of which are double; Plate 11), six side-scrapers, three side-/end-scrapers, and 16 scraper-edge fragments. A total of 120 scrapers are in flint, whereas 46 are in chert, with one being in quartzite (CAT 3586).

One discoidal scraper (CAT 3525) is so small (15 x 14 x 10 mm) that it falls into the category of button-scrapers. Button-scrapers and thumbnail-scrapers are popular terms describing very small discoidal scrapers, and in

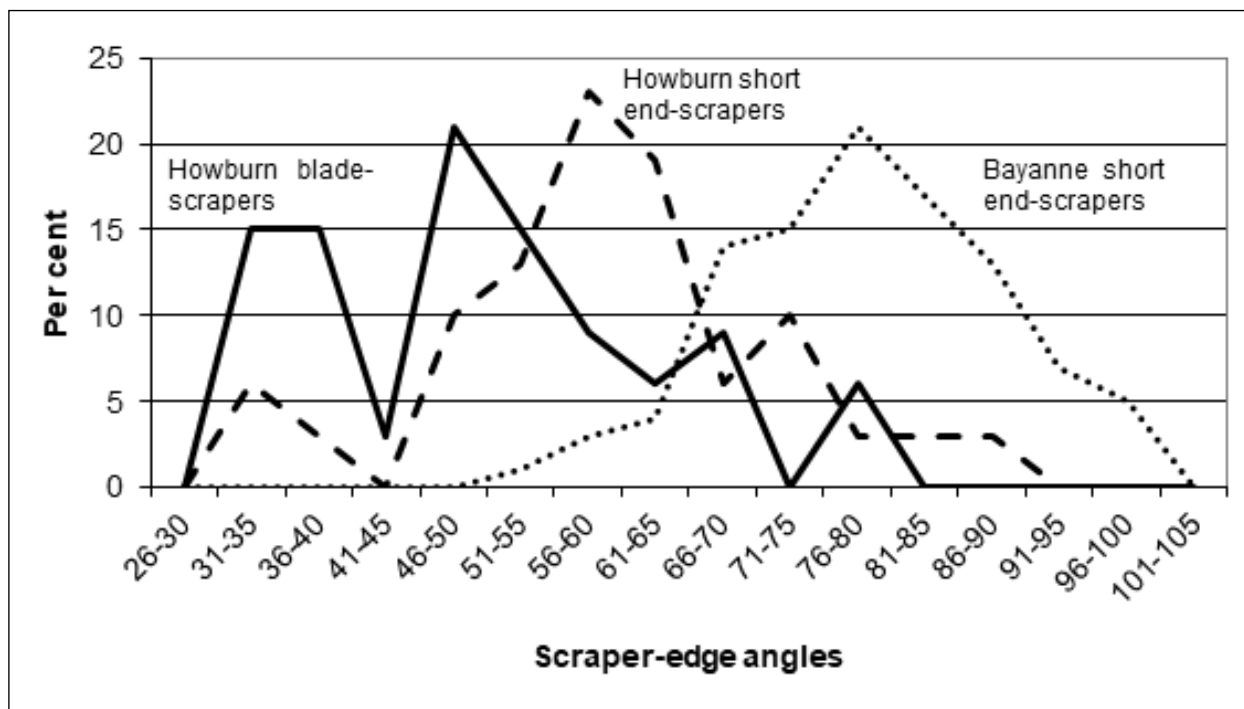


Figure 23. Scraper-edge angles - Howburn blade-scrapers (solid line) and short end-scrapers (dashed line) compared to Middle Bronze Age scrapers (mostly short end-scrapers) from Bayanne, Yell (dotted line) (Ballin 2011b; 2014a).

his report on the lithic finds from the Early Bronze Age site Dalmore on Lewis, one of the authors (Ballin 2002) suggested that thumbnails-scrapers from the Western Isles are generally smaller than 23 mm. No size limit has yet been suggested for button-scrapers, but with a size approximately one-third smaller than the maximum-size of Western Isles thumbnail-scrapers, the term button-scrapers appears appropriate in the present case. CAT 3525 is in chert, modified along its entire circumference, and it is unusually thick. Its relatively uneven shape, in conjunction with fairly plain scraper-edge modification, suggests that it is not related to the well-known Early Bronze Age thumbnail- and button-scrapers, the scraper-edges of which tend to have been made by the application of neat pressure-flaking (e.g., Saville 2005: 108).

Seven of 64 single-ended blade-scrapers (Plates 9-10) are intact, measuring on average 39 x 17 x 7 mm. However, several of the damaged blade-scrapers are broken-off working-ends of longer implements, as nine fragments have lengths of 40-50 mm. The vast majority of this category is in flint (85%), with the remainder generally being in other types of chert than the most common local dark-grey form (either rust-brown, 'complex grey', orange or black chert). Approximately half of all complete blade-scrapers have *en éperon* platform remnants, whereas the other half have finely faceted platform remnants. Five blade blanks have dorsal crests. The delineation of the scraper-edges vary between distinctly convex to slightly convex or almost

straight. The latter tend to have marked shoulders where the working-edge meets the lateral sides. Roughly half of all blade-scrapers have partial to full uni- or bilateral blunting.

Although some scrapers have steep scraper-edges, most are distinctly acute (Figure 23), and this attribute appears to be a diagnostic feature of Scottish as well as Continental Hamburgian blade-scrapers (e.g., CAT 822, 1545; Plates 9-10) this point is also discussed in the dating section). Hartz (1987: 12) writes about the blade-scrapers from Ahrenshöft that they generally have working-edges with angles of less than 60°. Many of the blade-scrapers have worn working-edges with overhanging parts. Approximately half of the blade-scrapers have use-wear along one or both lateral sides from cutting, suggesting *ad hoc* use for other purposes than scraping.

Use-wear analysts Juel Jensen (1988: 70) and Jeppesen (1983: 46) suggest that there is a relationship between the thickness (or angle) of scraper working-edges and function. There is a tendency for pieces with thick working-edges (steep edge-angles) to have been used for the processing of hard materials (such as wood, bone, and antler), whereas pieces with thin working-edges (acute edge-angles) may have been used for the processing of skin and hide. The Howburn blade-scrapers are therefore most likely to have been used to process skin and hide, and the Howburn and Bayanne short end-scrapers probably harder materials.

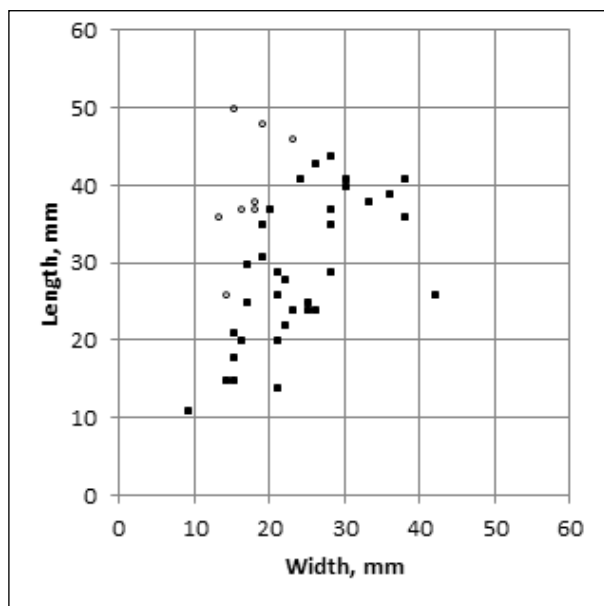


Figure 24. The length and width of intact blade-scrappers (open circles) and short end-scrappers (closed squares).

Four intact double blade-scrappers (Plates 10-11) differ considerably in size, with the smallest (CAT 2235; Plate 11) measuring 25 x 17 x 6 mm, and the largest (CAT 2361) 47 x 26 x 8 mm. One (CAT 1236; Plate 11) is in the so-called 'complex grey' chert which (along with rust-brown/grey chert) has been associated with Hamburgian blade- and double blade-scrappers, as well as with this period's points (Ballin *et al.* 2010); the remainder is in flint. With their relatively acute scraper-edges, full or partial lateral blunting, and occasional lateral use-wear from cutting, these pieces seem to be double-edged versions of the blade-scrappers characterized above.

The 64 short end-scrappers (Plates 11-12) are also dominated by the use of flint, but not to the same degree as the blade-scrappers (flint:chert ratio = 62:38). One specimen is in red quartzite (CAT 3586). Probably due to their being stockier than the blade-scrappers, less than half of all short end-scrappers are fragmented. They tend to be slightly elongated, with mean dimensions of 29 x 24 x 9 mm. Most of these pieces are based on flakes, but one (CAT 1822; Plate 12) is thought to be a re-sharpened (and thereby shortened) blade-scraper, one is based on a thermal flake (CAT 2110), six (CAT 618, 636, 1053, 1104, 1241, 2664) are based on indeterminate pieces, and one chert specimen (CAT 4099) appears to be based on an abandoned cylindrical core. Only one of the intact short end-scrappers has a finely faceted platform remnant and none displays *en éperon* preparation. Eight of the category's flake blanks are crested pieces.

It is possible to subdivide the category along two main axes, namely size/shape and execution. In terms of size

and shape, most of these scrapers form a continuum, from fairly small to fairly large, with length-width ratios between 2:1 and 1:1. However, one group differs from the general appearance of the standard short end-scrappers by being large and squat. These pieces (CAT 1655, 2023, 2255 and 4100 [Plate 12], as well as refitted specimen CAT 1925/5094/5095) are notable as a cluster in the right side of Figure 24, and a proportion of them is based on primary decortication flakes. They could be mistaken for later, for example Neolithic, intrusion, but their raw material is the same grey, frequently frost-damaged flint as that used for the production of other Late Upper Palaeolithic tools at Howburn. In terms of execution, some pieces are fairly regular (this group is dominated by flint), whereas others appear to be expedient implements (mainly chert scrapers). As shown in Figure 23, the site's short end-scrappers tend to have steeper edge-angles than the blade-scrappers. The fact that, in this category, most scraper-edges appear quite worn (overhangs), suggests that most of these scrapers were used to process relatively hard materials.

Like the blade-scrappers, many short end-scrappers have lateral blunting, which may be partial or full, unilateral or double-sided. Pieces like CAT 2333 (Plate 12), for example, have neat double-sided blunting, but most pieces in this category are fairly simple pieces, displaying a minimum of modification. Some fragmented scrapers have had their breaks blunted (repair), probably to protect the user's hand (e.g., CAT 2110, 3895); one piece, however, may have had the break transformed into an additional scraper-edge by rubbing (CAT 3508). Some broken pieces have short stretches of surviving convex retouch at the corners of the break, indicating that they may be fragmented double-scrappers (e.g., CAT 1431, 1513). In addition, seven intact short double-scrappers were found at Howburn, most of which are thought to be re-sharpened blade-scrappers. Apart from one chert specimen (CAT 756), all are in flint, and their mean dimensions are 29 x 22 x 9 mm.

The assemblage recovered in 2006 included three blade-scrappers (CAT 761 [Plate 9], 775, 791 [Plate 10]) characterized by having been resharpened by the detachment of small ventral flakes immediately behind the working-edge (although it is not possible to rule out that this modification may be a kind of use-wear). They formed a homogeneous category and were easy to distinguish as a separate typo-technological group. The collection recovered in 2009 includes four related pieces (all in flint), which form a less homogeneous group. CAT 2281 (Plate 10) is almost identical to the pieces found in 2006, as it is a blade-scraper with ventral re-sharpening or use-wear behind the distal working-edge; CAT 2009 is an expedient flake-scraper with similar, slightly coarser modification; CAT 2413 (Plate 11) is a short regular end-scraper, where the two lateral sides of the piece display modification which would usually be characterized as

bipolar core terminals but, with a thickness of 5 mm, it would have been meaningless to recycle this flake-based tool as a core; and CAT 2259 is a short end-scraper, where the working-edge seems to have been re-sharpened by the detachment of a series of small ventral chips.

Six side-scrapers<sup>1</sup> were retrieved from Howburn, and they constitute a relatively heterogeneous category. Four pieces are in flint and two are in chert. Most of the side-scrapers are based on large, commonly broad flakes (all are fragmented, with greatest dimensions varying between c. 30-50 mm), but one of the chert specimens (CAT 4930) is based on an indeterminate piece and the other (CAT 1101) on a pebble. CAT 2088 is fairly well made and has a regular convex scraper-edge, whereas the remainder are more expedient, with a frequently uneven or straight working-edge along the longest edge of the blank. In some cases this edge is lateral and in some cases distal. It is possible that the scraper-edge of CAT 3379 was formed not by intentional modification, but by repeated use on a hard material. Three side-/end-scrapers (CAT 738, 1063, 2291) are based on relatively small flint flakes (mean dimensions 30 x 29 x 9 mm). They are fairly well-executed pieces, and they are characterized by having one distal working-edge and one lateral. The scraper-edges are generally convex and they vary between acute and steep. The edges of CAT 1063 have several overhangs from use. Sixteen scraper-edge fragments in flint and chert represent too small parts (greatest dimension 10-32 mm) of their parent pieces to be classified more precisely.

*Knives:* Two backed knives (CAT 623, 663) on flint flakes are of approximately the same size (mean dimensions 33 x 19 x 7 mm). These knives have one convex blunted lateral side and, opposed to the modified side, one unworked cutting-edge with flat use-wear from cutting. The retouch of CAT 623 (Plate 13) has distinctly overhanging areas, and it was probably also used as a side-scraper.

*Truncated pieces:* During the excavation, 36 truncated pieces were recovered (Plates 12-13). Twenty-six are in flint, nine are in chert, and one is in 'green chert'. In 23 cases, the truncation is oblique, in 9 cases straight, whereas two are concave (and oblique), and one curved;

<sup>1</sup> An end-scraper is defined by having a working-edge approximately perpendicular to the longest of the two dimensions L and W (L being the dimension proximal end to distal end), whereas a side-scraper has its edge on the longest of the two dimensions. If  $L > W$  (elongated blank) the working-edge of the end-scraper will be distal (sometimes proximal) and the edge of the side-scraper will be lateral. If  $W > L$  (broad blank) the working-edge of the end-scraper will be lateral and the edge of the side-scraper will be either proximal or distal. Or in other words: The classification of end- and side-scrapers is NOT determined by the position of the working-edge in relation to the bulb-of-percussion (a fact that would have little functional value to a Stone Age knapper), but by the extent of the working-edge in relation to the extent of the longest dimension.

CAT 1109 has a curved truncation at either end. The truncated pieces are evenly distributed across proximal and distal forms, with one being uncertain. Although the modification was usually formed by retouch from the ventral face, four specimens have inverse retouch (e.g., CAT 1253). Some have additional lateral blunting (e.g., CAT 1251, 1370 [Plate 13]), but in most instances the modification of the truncated pieces is restricted to the proximal or distal ends.

It is possible to subdivide the collection's truncated pieces into a number of formal sub-categories, such as 1) relatively large/broad flake- and blade-based pieces with regular oblique or straight truncations (two intact pieces, CAT 2158 [Plate 12] and 2337 [Plate 13], measure 50 x 24 x 5 mm and 29 x 16 x 5 mm, respectively); 2) fairly slender blade-based pieces with regular oblique or oblique/concave truncations, occasionally with additional lateral modification (two intact pieces, CAT 3031 [Plate 13] and 3036 [Plate 12], measure 49 x 12 x 4 mm and 43 x 11 x 5 mm, respectively); and 3) more irregular blanks with relatively irregular truncations. Truncated microblades were dealt with above, in connection with microlith-related implements.

Truncated pieces similar to those of Group 1 are regularly found in connection with the examination of Late Upper Palaeolithic sites in north-west Europe, such as Jels 1 and 2 (Holm and Rieck 1992: Figure 25.15-16 and Figure 48.14-15) and Gough's Cave (Jacobi 2004: Figure 17.8). The flat lateral use-wear of CAT 2337 (Plate 13) suggests that they may have been used as knives. The pieces of Group 2 are almost certainly Upper Palaeolithic (as indicated by the *en éperon* preparation of CAT 3031 [Plate 13]), and they may be related to the site's backed points. Group 3 pieces are generally implements of more idiosyncratic shapes, and they may cover a range of dates and functions (e.g., CAT 1260, 1661, 3713, 4230).

It was possible to conjoin an obliquely truncated piece (CAT 2210) with a thermal flake detached from its dorsal face (CAT 2180). The fact that the thermal flake, when refitted to CAT 2210, extends beyond the oblique modification of the implement's working-end, indicates that this tool was manufactured after the partial disintegration of the parent core and, as suggested in the present volume's raw material section, this is evidence that frost-damaged flint (probably from superficial, exposed sources) was collected and used by the inhabitants of the Howburn site. CAT 781 and CAT 1103 (originally classified as an obliquely truncated piece and a fragment of an indeterminate backed piece) were refitted to form one angle-backed point (above and Plate 8).

*Zinken/becks/piercers:* In the present volume, piercing implements (13 pieces) have been divided into three sub-types, namely *Zinken*, *becs* and *piercers* (Plates 13-

14). *Zinken* are robust piercers with a curved tip which is almost always orientated towards the right. At Jels 1 (Holm and Rieck 1992: 27), 93% of 29 *Zinken* have tips orientated in this way, and at Jels 2 (Holm and Rieck 1992: 40) the figure is 92%. The distinction between *becs* and piercers is not very clear. According to Jacobi (2004: 26), 'Both are tools usually formed by converging retouch, but Sonnevile-Bordes and Perrot (1955: 78) suggest that a *bec* is a [...] piercer in that the worked end is thicker and broader'. At Gough's Cave, it was not possible to clearly define a dividing line between piercers and *becs* (Jacobi 2004: 26).

This ought to be an argument for amalgamating the two types, but at Howburn two relatively well-defined types, *becs* and piercers, do seem to exist. In this volume, robust, thick pieces with extensive, correspondingly robust bilateral modification are referred to as *becs*, and small, relatively delicate, more expedient pieces as piercers. The typological distinction between these three types is supported by variation of the preferred raw materials, where the site's three *Zinken* are in either red (CAT 617) or grey flint (CAT 1591, 2554), five *becs* (CAT 2434, 2442, 2654, 2742, 2758; Plates 13-14) are all in dark-brown homogeneous flint, and three of four small piercers (CAT 1622, 2988, 3318) are in dark-grey chert, with the remaining specimen (CAT 632) being in grey flint.

One *Zinken* (CAT 617; Plate 13) is based on a medium-sized flint flake (30 x 21 x 7 mm) with an asymmetrical tip at the distal end, whereas CAT 1591, and 5090 (Plate 13) are based on stout blades (32 x 17 x 8 mm, 29 x 12 x 3 mm, and 29 x 13 x 5 mm). All three *Zinken* are missing their proximal ends, and all have their distal tip orientated towards the right. The *becs* are on thick flakes and one robust blade (mean dimensions 39 x 21 x 11 mm); and the piercers are on a blade (only the distal working-end survives; W x Th = 13 x 4 mm) and three simple flakes (mean dimensions 23 x 16 x 8 mm). One *bec* has two opposed working-ends (CAT 2442; Plate 14), and one *bec* tip is decidedly abraded from use (CAT 2434; Plate 14). One *Zinken* (CAT 1591) and one *bec* (CAT 2758; Plate 14) are burnt.

In terms of dating the *becs* (see dating section), it is significant that three pieces have finely faceted platform remnants (CAT 2434, 2654, 2758; Plate 14). One (CAT 2742; Plate 13) has lost the end opposite the surviving working-end, and the fact that the surviving end is proximal, suggests that this piece may have been a double-*bec* like CAT 2442 (Plate 14). CAT 1399 (Plate 16) is retouched along its entire circumference, and it has been defined as a combined scraper/*bec* (see below).

CAT 2408 (Plate 13) has been defined as 'a *bec* or a point'. It is based on flint, but due to cortication, and subsequent discolouration, it was not possible to determine its

original colour. It is based on a broad blade (33 x 25 x 5 mm), and it has a relatively broad 'tip' formed by two merging retouched lateral sides. Although the angle of the two merging lateral sides corresponds to that expected from a *bec*, a detached ventral flake at the tip resembles impact damage, suggesting use as a point (Fischer *et al.* 1984).

*Burins*: With 34 burins (Plates 14-15) from the two excavations, Howburn is undoubtedly the most burin-rich prehistoric site ever investigated in Scotland. If combined pieces are included (Plate 16), 40 pieces with burin-edges were retrieved from the trenches at Howburn. In addition, 18 burin spalls (Plate 15) were found. Twenty-five of the burins are in flint, and nine in chert; 15 burin spalls are in flint, and three in chert. The burin blanks are mostly robust blades (24 pieces), supplemented by ten flakes and one indeterminate piece. The burins were frequently, if not mostly, manufactured on (probably occasionally deliberately) broken pieces, and their mean size values are 30 x 18 x 8 mm. Figure 25 gives an impression of the lengths and widths of the intact pieces. As burins were intended for processing relatively hard materials, most are fairly thick (5-15 mm).

Traditionally, burins are subdivided according to their number of burin-edges, as well as the way their burin-edges were formed (Table 17; includes combined pieces with burin-edges). During the excavations at Howburn, 29 single-burins were recovered (e.g., CAT 817, 2053; Plate 14), as well as eight double-burins (e.g., CAT 4510, 1454; Plates 14-15) and three triple-burins (e.g., CAT 1835; Plate 15). This adds up to a total of 54 individual burin-edges.

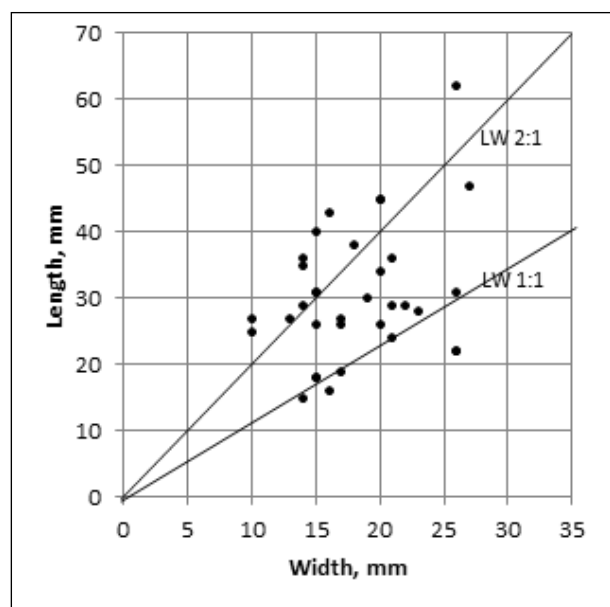


Figure 25. The length and width of all surviving burins.

The most numerous variant is the angle-burin (e.g., CAT 817, 2053; Plate 14), where the working-edge was formed by one or more burin-blows to a transverse break (27 pieces); 16 working-edges were formed by one or more blows to an either concave, oblique, or straight truncation (e.g., CAT 826, 1454, 3867; Plates 14-15); and only five burin-edges were formed by one or more blows to an old burin-facet (dihedral burins). Less common burin forms are those where the burin-edge was made by striking an unprepared edge (CAT 1773, 1835 [Plate 15]) or an old platform (CAT 1616), or where a transverse burin-blow was aimed at a lateral retouch (technically, corresponding to burins on truncations) (CAT 4231). Due to damage to the burin-edge, two burins could not be defined in more detail (CAT 1864, 3394).

This composition differs somewhat from that of the probably roughly contemporary Late Upper Palaeolithic Gough's Cave burins (Jacobi 2004: 32), where burins on truncations outnumber burins on breaks by a ratio of 76:24 (at Howburn the ratio is 38:62). At the Havelte settlements of Jels 1 and 2 (Holm and Rieck 1992: 30, 47), the figures correspond more to those of Gough's Cave, with burin-edges on truncations dominating heavily (89:11 and 93:7, respectively). In some cases, the burin-edges display use-wear from grooving work, and in other cases the lateral sides of the burin facet has been used, probably as a spoke-shave.

The sites 18 burin spalls (Plate 15), 13 of which are intact, are all long and slender pieces (mean dimensions 25 x 7 x 4 mm; greatest dimension 17-47 mm). They mostly have a recognizable ventral face, parts of a dorsal face, and a third face – which would usually form an approximately right angle with the ventral face – representing the contact face with the parent piece. This typically gives these pieces a polygonal cross-section. Seven pieces (CAT 655, 1113, 1826 [Plate 15], 1992, 2239, 2263, 4790 [Plate 15]) have very fine to fine lateral retouch, and one piece (CAT 1832) has lateral use-wear.

CAT 4790 (Plate 15) is an interesting specimen, as this burin spall has a central lateral notch. Most likely, the purpose of this feature was to stop burin spalls from continuing down the entire lateral side, thus detaching the opposite end of the burin by overpassing. An initial burin spall was clearly stopped in this way, but the final burin spall (this piece) *did* remove the entire lateral side as well as the notch. In terms of function, the notch of CAT 4790 corresponds to the notches of Aurignacian *burins busqués*, although the general form (and date) of the parent burin would have differed substantially from that of a typical 'busked' or 'beaked' Aurignacian burin (Pradel 1962; Bordes 1968: 157).

Burins, as well as burin spalls, are frequently difficult to define with certainty, but the refitting of burin spalls onto burins is usually a great help, as this increases the understanding of the formation of these pieces.

Table 17. Burins - attributes.

		Tr I, 2006	Tr I, 2009	Tr II, Block 2	Tr II, Block 3-4	Total 2009
Raw mat.:	Flint	6	15	3	6	30
	Chert		2	1	7	10
Blank:	Flake	4	2	1	5	12
	Blade	2	14	3	7	26
	Indet. piece/chunk		1		1	2
No. burin-edges:	One	6	11	4	8	29
	Two		4		4	8
	Three		2		1	3
	Total no. burin-edges		25	4	19	54
Burin platform: (based on no. of burin-edges)	Natural edge/old platform		3			3
	Break	3	11	3	10	27
	Truncation	2	9	1	4	16
	Old burin-facet (dihedral)	1	1		3	5
	Lateral retouch				1	1
	Uncertain/fragmented		1		1	2
Combined: (included above)	Scraper/burin	2		1	2	5
	Scraper/piercer/burin	1				1
<b>Total burins:</b>	<b>Incl. combined tools</b>	<b>6</b>	<b>17</b>	<b>4</b>	<b>13</b>	<b>40</b>

From the artefacts recovered in 2009, it was possible to conjoin three burin spalls with their parent burins, namely CAT 1826/1864 (not refitted; Plate 15), CAT 1992/2008, and CAT 3629/3715 (refitted; Plate 15).

*Combined tools:* With 13 pieces, tools combining different functional categories are quite prolific at Howburn (Plate 16). Scraper/burins (five pieces: CAT 741 [Plate 16], 1072, 3205 [Plate 16], 3394 [Plate 16], 4570) and scraper/tanged points (two pieces: CAT 1242, 1921) are the most common forms, supplemented by one scraper/*Zinken* (CAT 2335; Plate 16), one scraper/*bec* (CAT 1399; Plate 16), one scraper/truncation (CAT 4147), one scraper/strike-a-light (CAT 2433; Plate 16), one scraper/piercer/burin (CAT 792), and one tanged point/piercer (CAT 4042; Plate 16). Apart from the latter piece, all combined tools include a scraper-end, and in most cases this working-end has been heavily used and displays notable overhangs (e.g., CAT 741, 3205; Plate 16). Only two pieces are in chert (CAT 4147, 4570), with the remainder being in flint.

Generally, the combined tools are fairly robust pieces, but the specific dimensions vary somewhat between sub-categories, due to the different sizes of the original implements. The scraper/burins, for example, have mean widths of c. 20 mm and thicknesses between 6 mm and 13 mm (robust scrapers transformed into burins), whereas combined tools involving a tanged part usually have widths of c. 12 mm and thicknesses of c. 5 mm (delicate tanged points transformed into mainly scrapers). Depending on the level of fragmentation, the length varies between 27 mm and 45 mm.

The five scraper/burins include a variety of burin-edges, such as burin-blows to breaks, old burin facets and truncations, and they are all single-burins. The scrapers/tanged points both have an asymmetrical tang at one end. One of these is fairly narrow (11 mm), corresponding in width to the most common type of tanged point found at Howburn (CAT 1921), but the other specimen (CAT 1242) is fairly robust and resembles the refitted point CAT 765/1084 (Plate 5). The category's scraper/burins and scraper/tanged points are also discussed above as part of the characterization of the site's tanged points and burins.

One piece in chert (CAT 4147) is based on a relatively delicate blade (39 x 17 x 6 mm), and it has an oblique truncation at the distal end (probably indicating that it functioned partly as a knife) and a regular convex scraper-edge at the proximal end. The modification of the implement is generally relatively delicate. CAT 2433 (Plate 16) is a stout blade (42 x 21 x 11 mm), which has a regular convex scraper-edge at the proximal end, and a heavily abraded/rounded point at the right corner

of a distal break. It is thought that this end was used for making fire by striking a piece of pyrite (Stapert and Johansen 1999). Flint strike-a-lights are quite common in British Late Upper Palaeolithic contexts, and the assemblage from Gough's Cave includes pieces with simple edge-retouch and rounding (Jacobi 2004: Figure 29), as well as composite tools with rounded ends (Jacobi 2004: Figure 15). Similar pieces were also recovered from the slightly later site of Hengistbury Head (Barton 1992: Figures 4.27-28). CAT 4042 (Plate 16) is a small tanged point (38 x 12 x 4 mm), which has had a piercer tip manufactured at its proximal end. The piercer tip was formed by merging two steep retouches at approximately 65°.

CAT 1399 (Plate 16) is a robust piece measuring 38 x 19 x 10 mm. It is in dark-brown flint like the *becs* (above), and it was defined as a scraper/*bec*. It has a robust tip at one end (the outermost part has broken off), steep retouch along both lateral sides, and a convex, steep scraper-edge at the proximal end. CAT 792 is the site's only triple combined piece. It is based on a broad crested blade (44 x 21 x 11 mm), and it is thought that steep retouch at either end may be *ad hoc* scraper-edges. A piercer tip was formed at the proximal right corner, and modification at the distal right corner was interpreted as a burin-edge.

*Notched and denticulated pieces:* The assemblage embraces 11 notched pieces, distributed evenly across specimens in flint and chert. In most cases, the notches are shallow and the chords generally measure 5-9 mm. The function of the notches is uncertain, but most are probably hafting notches. One broken flint blade (CAT 1506; 38 x 10 x 4 mm; Plate 15) has two retouched notches in one lateral side, and some blunting along the opposite side. One chert flake (CAT 710; 27 x 25 x 6 mm) has three adjacent single-removal notches at the distal end, which gives the piece its denticulated appearance.

*Pieces with edge-retouch:* This category comprises 238 pieces (e.g., CAT 764; Plate 16), 146 of which are in flint, whereas 91 are in chert; one piece (CAT 2897) is in 'green chert'. They differ considerably in shape and size (mean dimensions of intact pieces: 27 x 17 x 6 mm; greatest dimension 8-44 mm). This tool group probably includes artefacts and fragments of artefacts with different functions.

*Flakes from polished flint axeheads:* One flake from a polished flint axehead (CAT 3793) was retrieved from the Howburn site. It measures 15 x 11 x 2 mm, and its dorsal face displays fine, although striated, polish, as well as unpolished scars from the original shaping of the piece. This probably indicates that the flake was detached from an axehead with partial polish of the edge area. CAT 3793 has a slight dorsal

facet at one end, suggesting that the piece may have been detached from the edge area of a polished flint axehead.

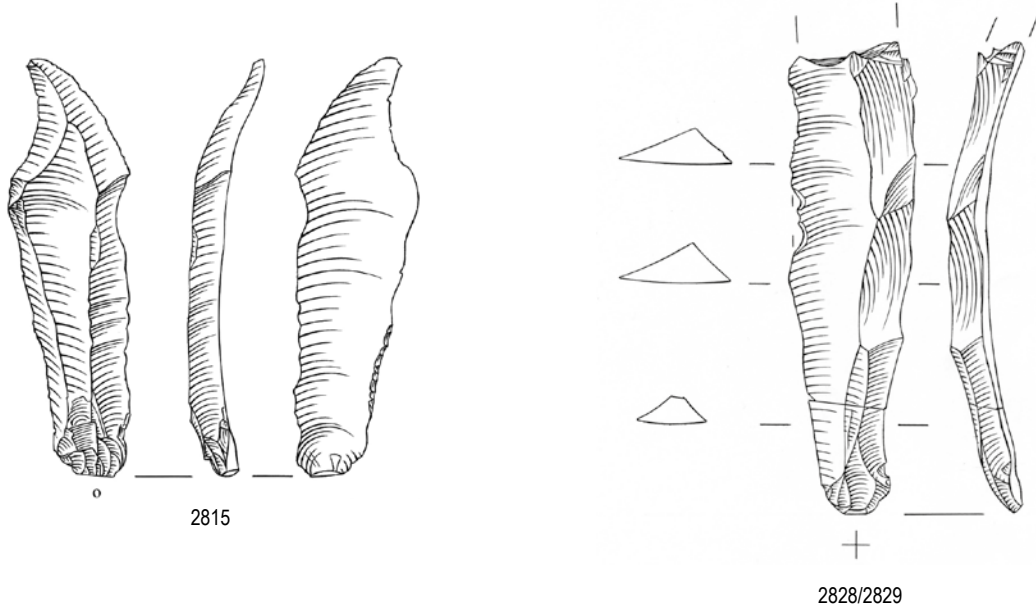
*Flakes/cores from polished stone axeheads:* Five flakes and flake fragments (CAT 1536, 1938, 3339, 3565, 3573) and one irregular core (CAT 3413) are from cannibalized polished stone axeheads. Following suggestions by Drs Faithfull and Owen from University of Glasgow (see raw material section), the raw material of these pieces is probably Cumbrian tuff, although they emphasize that certainty in terms of raw material determination would require closer scrutiny, such as thin-sectioning or XRF analysis. Their colours vary between light-green and dark-green. The flakes and flake fragments have greatest dimensions of 19-31 mm, and the core measures 54 x 38 x 28 mm. The extension of the polish vary between total dorsal coverage (e.g., CAT 3573) and the presence of one or two surviving specks (e.g., CAT 3413).

*Coarse stone tools:* This group includes four pieces, namely one hammerstone (CAT 5097), one pounder (CAT 5098), one pounder/anvil (CAT 303), and one anvil (CAT 3541). They were scattered across the site: CAT 5097 was found in Trench I (2009), CAT 5098 in Trench II (Block 2), CAT 303 in Trench I (2006), and CAT 3541 in Trench II (Block 3-4).

The hammerstone (CAT 5097) is an elongated cobble in sandstone, measuring 151 x 59 x 35 mm. It was shaped by flaking and pecking, almost like a slender, thin axehead, but with peck- and crush-marks at one end. The pounder (CAT 5098) is a large and heavy cobble in quartzite, measuring 142 x 120 x 67 mm. It has slight pecking at its most pointed end, and some pecking along one lateral side. It has been heavily used at the broader end, pecked and ground, developing notable facets, and some shiny surfaces (other than the natural sheen of this water-worn cobble). The pounder/anvil (CAT 303) is also based on a quartzite cobble, measuring 61 x 47 x 32 mm. A c. 100 mm long elongated cobble was split in two, and one end was then used as a pounder. The piece shows notable peck-marks at its pointed end; at the other end (the break facet), it has been heavily pecked and ground, resulting in the development of a convex, smooth working surface with notable facets against the lateral sides and the broad-sides. One broad-side has a typical pecked anvil pit at its centre. CAT 3541 is a fragmented anvil in quartzite, and it measures 83 x 40 x 48 mm. Before it split along its long axis, it was a flat-ish, oval cobble, and both broad-sides display peck-marks from the use as an anvil. Given the rarity of bipolar flakes and cores at Howburn, the presence of anvils is slightly surprising. In the surviving lateral side, CAT 3541 has a more carefully shaped hollow, but the purpose of this feature is unclear.

Debitage

Blades



Blades from opposed-platform core

En eperon blades

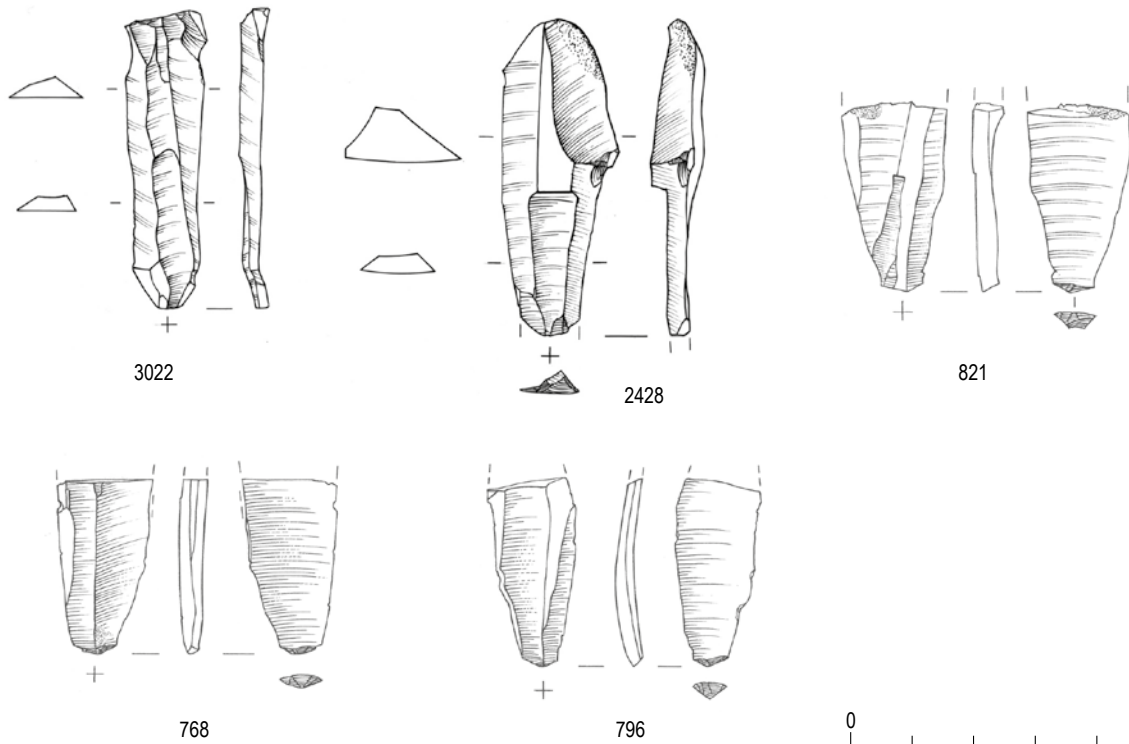
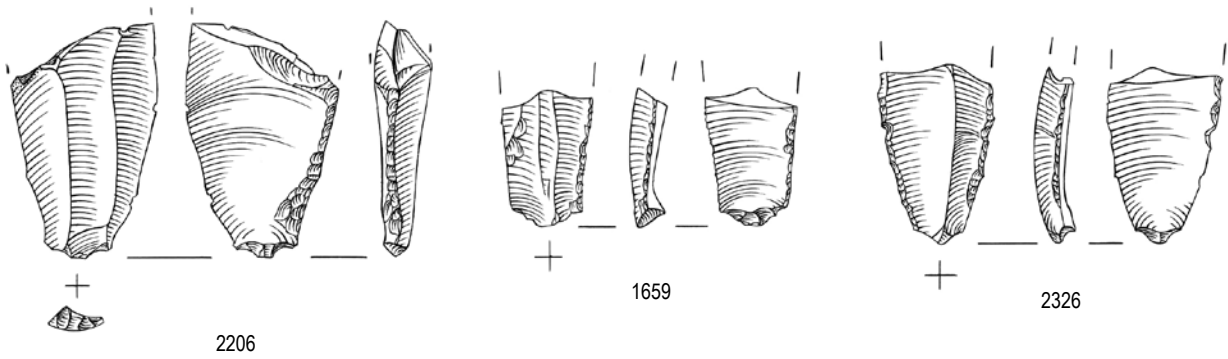


Plate 1. Blades, blades from opposed-platform cores, and *én eperon* blades  
(drawn by Marion O'Neil and Hazel Martingell).

Debitage

En eperon blades w retouch



Crested pieces

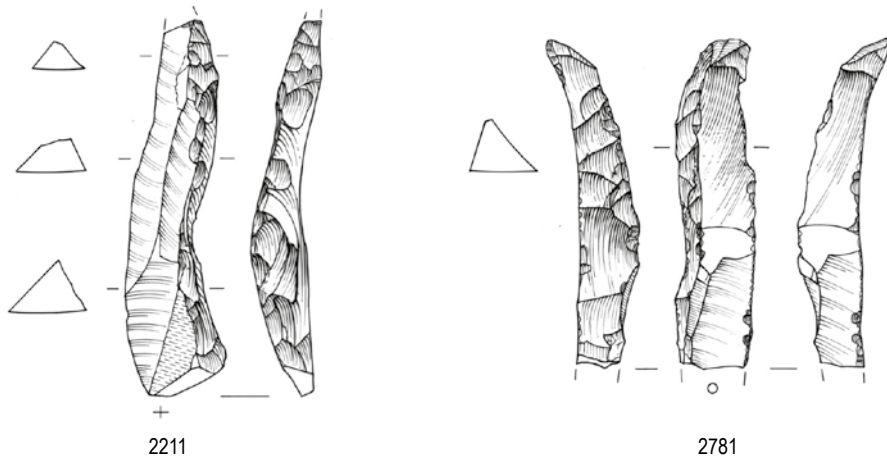


Plate 2. Modified *én eperon* blades and crested pieces (drawn by Marion O'Neil and Hazel Martingell).

Cores

Single-platf cores

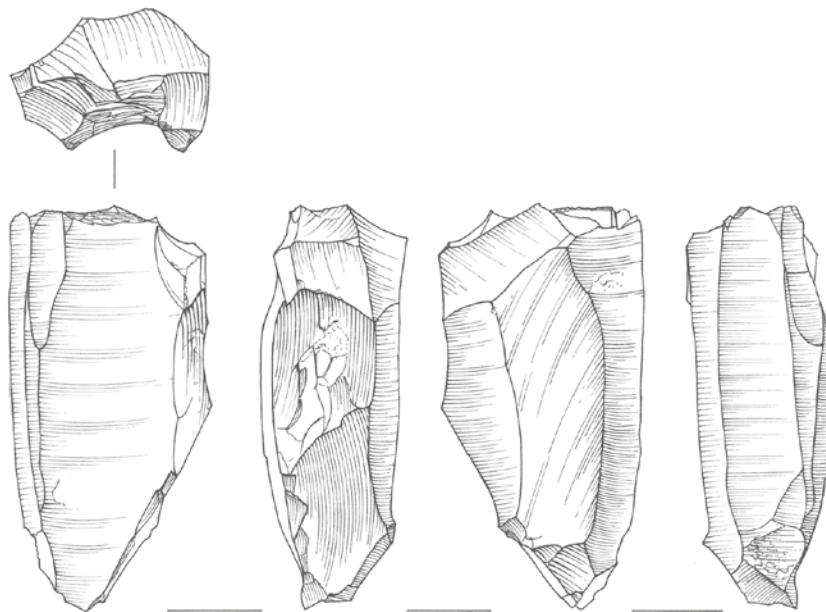
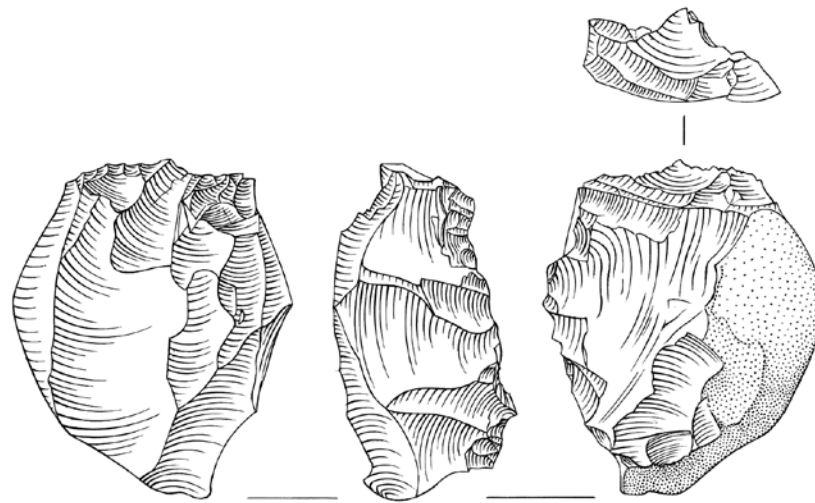


Plate 3. Single-platform cores. CAT 828 may be an exhausted opposed-platform core (drawn by Marion O'Neil and Hazel Martingell).

Cores

Opposed-platf cores

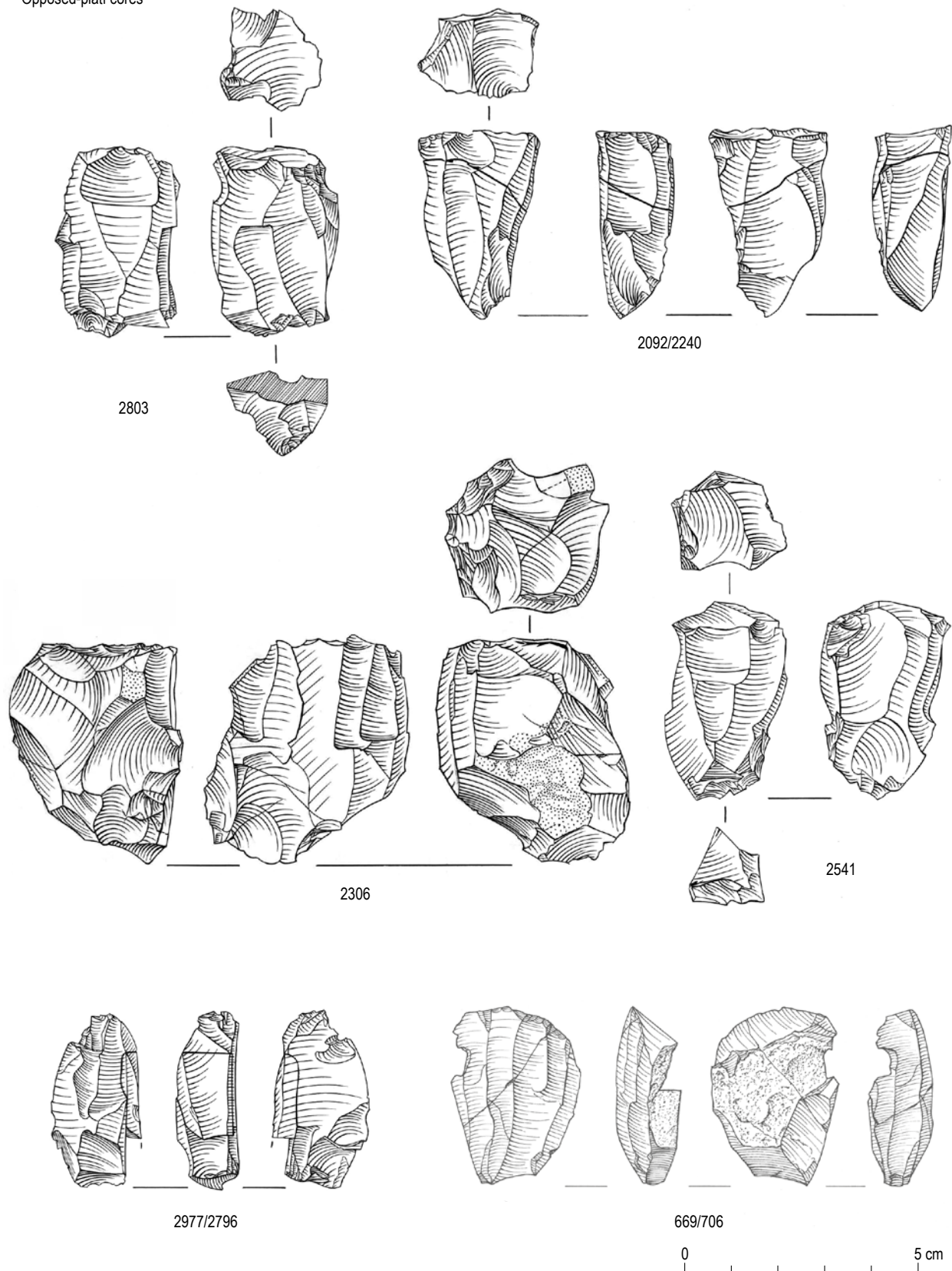
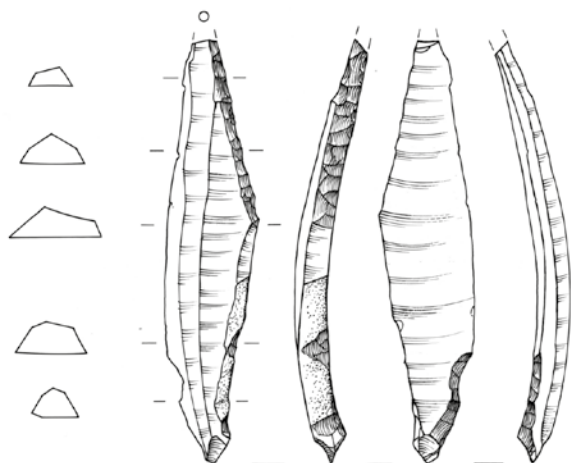


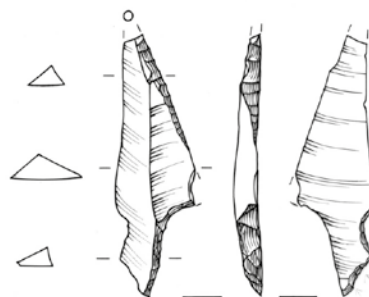
Plate 4. Opposed-platform cores (drawn by Marion O'Neil and Hazel Martingell).

Tools

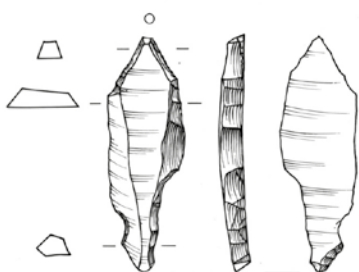
Tanged points, intact



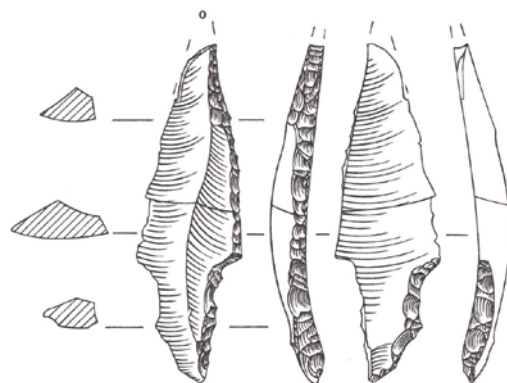
1398



4041

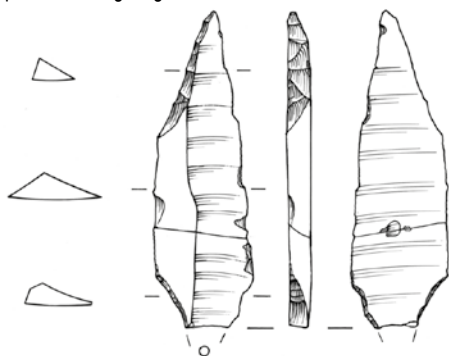


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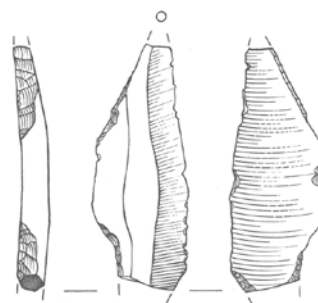


765/1084

Tanged points, missing tang



1243/1964



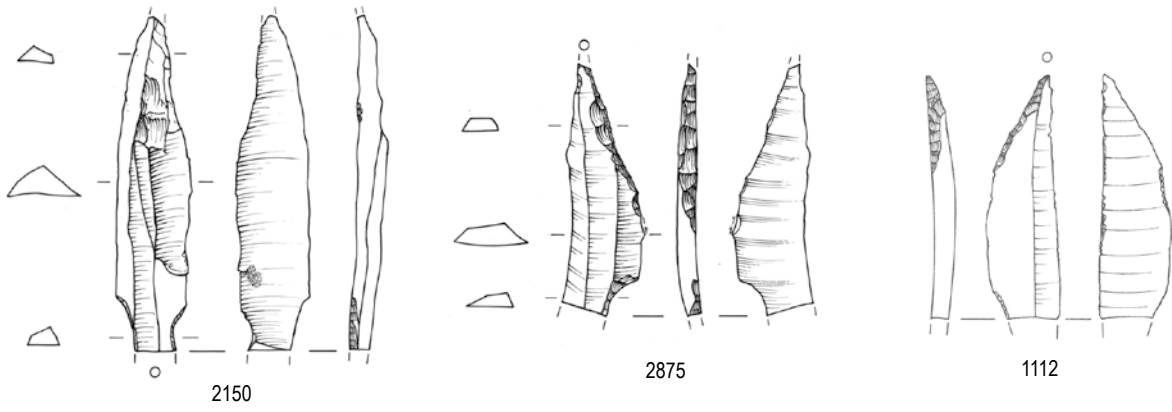
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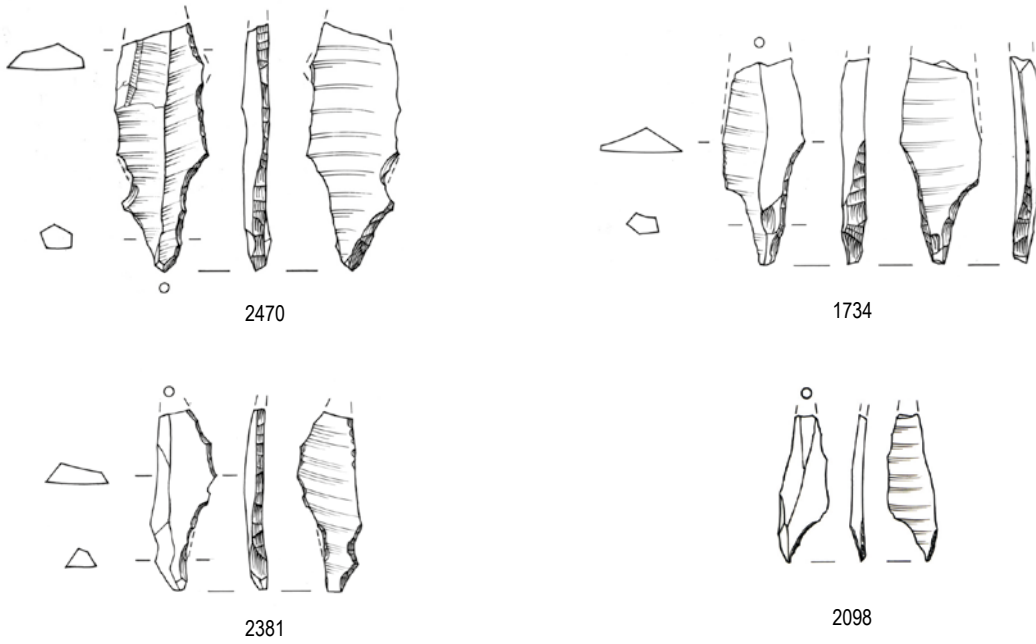
Plate 5. Intact tanged points and tanged points which have lost their tang (drawn by Marion O'Neil and Hazel Martingell).

Tools

Tanged points, missing tang



Tanged points, missing tip



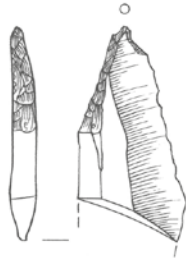
Tanged points, missing tang and tip



Plate 6. Tanged points which have lost their tang, tip or both (drawn by Marion O'Neil).

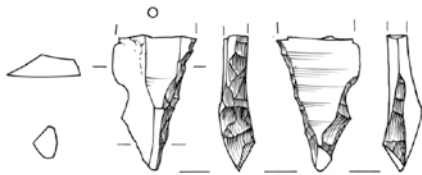
Tools

Tanged points, tip frags



795

Tanged points, tang frags



1526



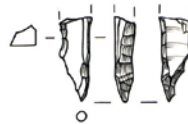
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2262

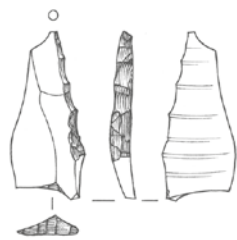


1716

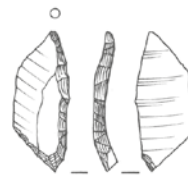


2720

Other intact points



797



814



Plate 7. Tip and tang fragments of tanged points, and 'other' points (drawn by Marion O'Neil).

Tools

Various backed points

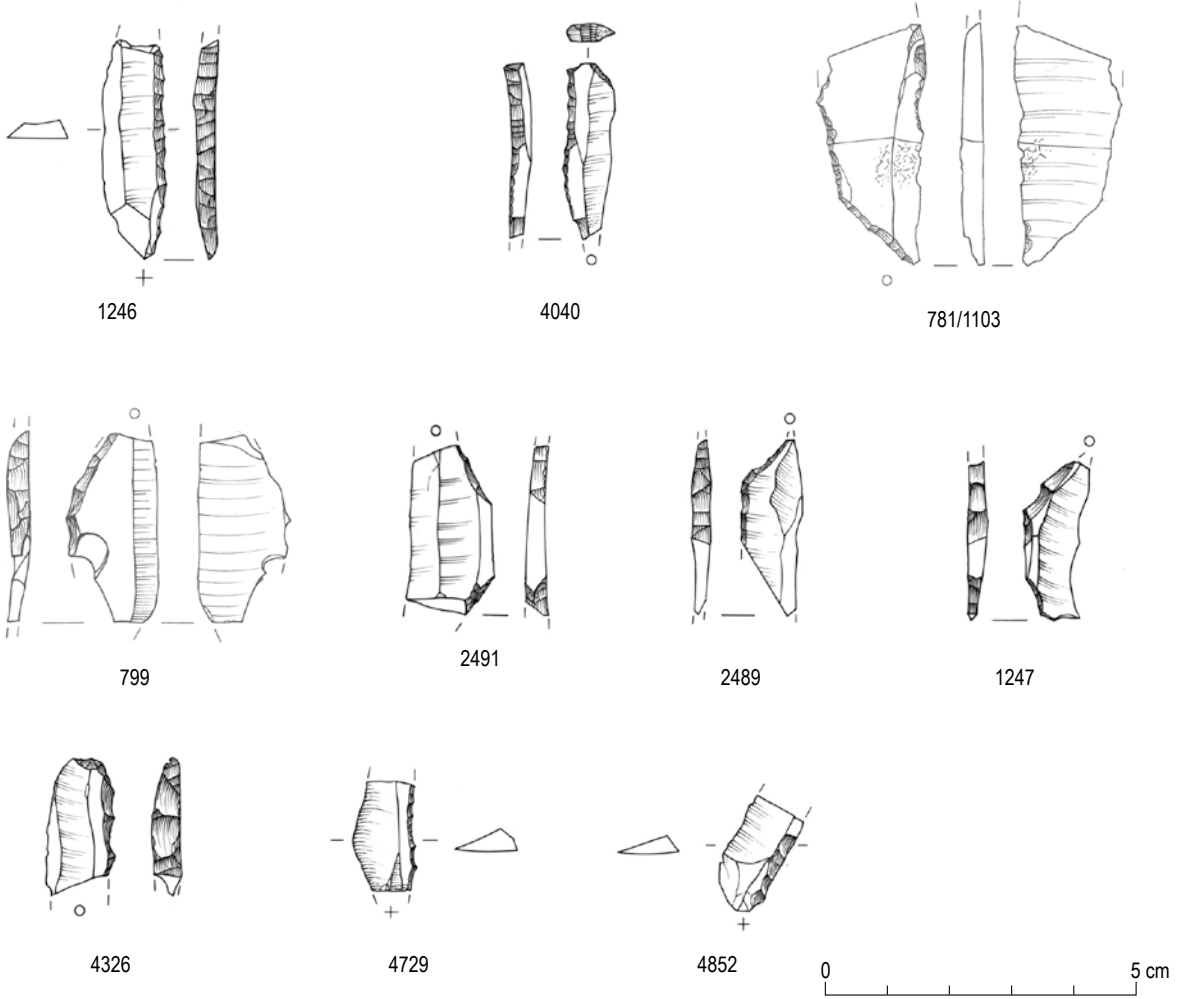
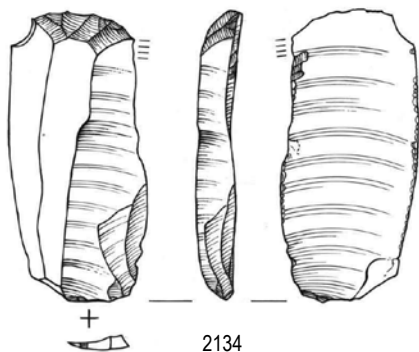


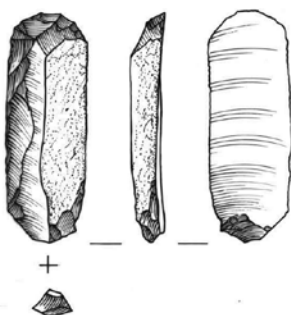
Plate 8. Backed points and fragments of backed points (drawn by Marion O'Neil).

Tools

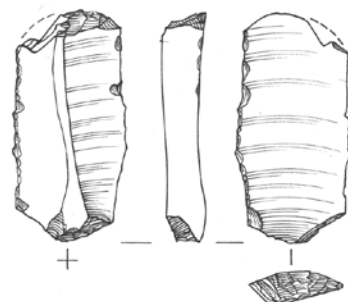
Blade-scrapers, intact



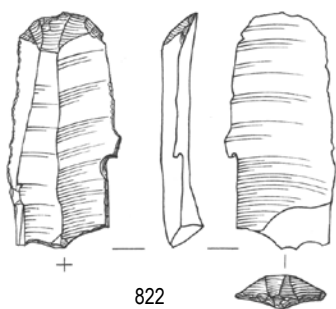
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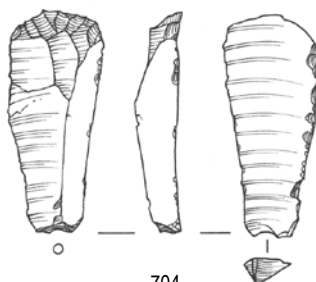
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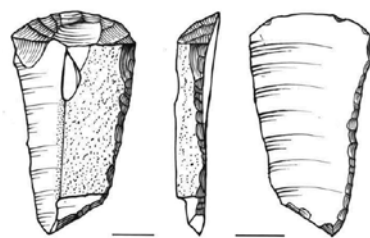
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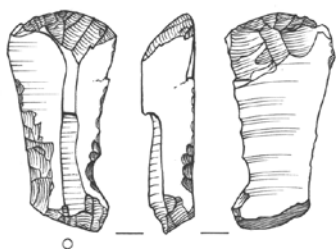
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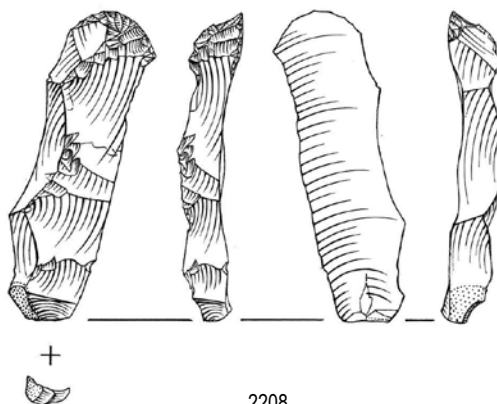
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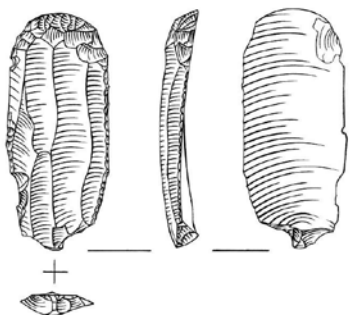
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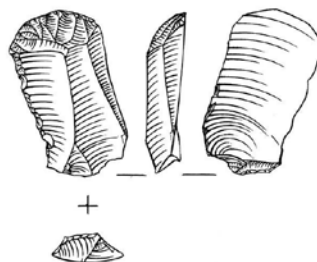
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2208



2734



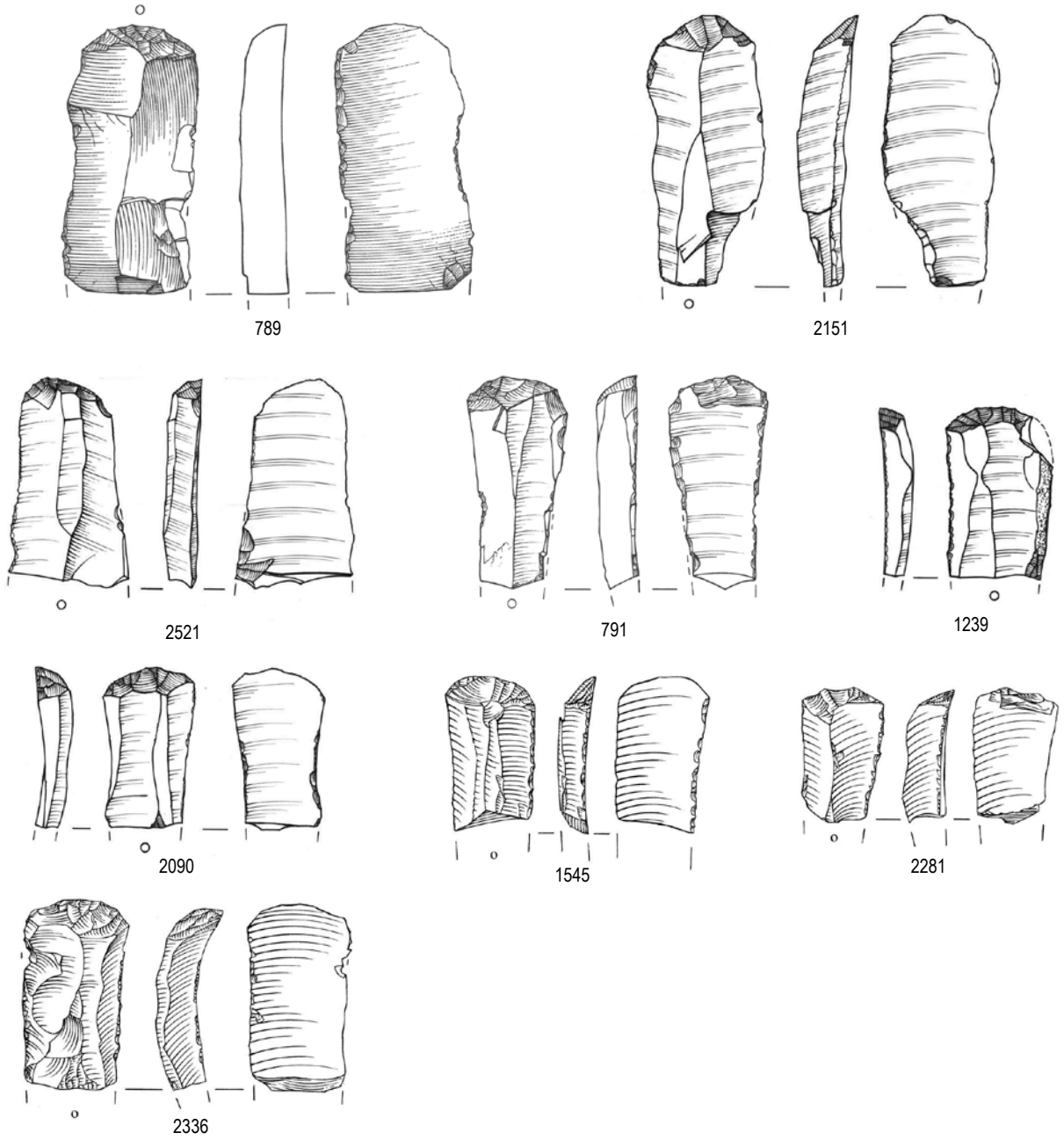
1824



Plate 9. Intact blade-scrapers (drawn by Marion O'Neil and Hazel Martingell).

Tools

Blade-scrapers, broken



Double-scrapers

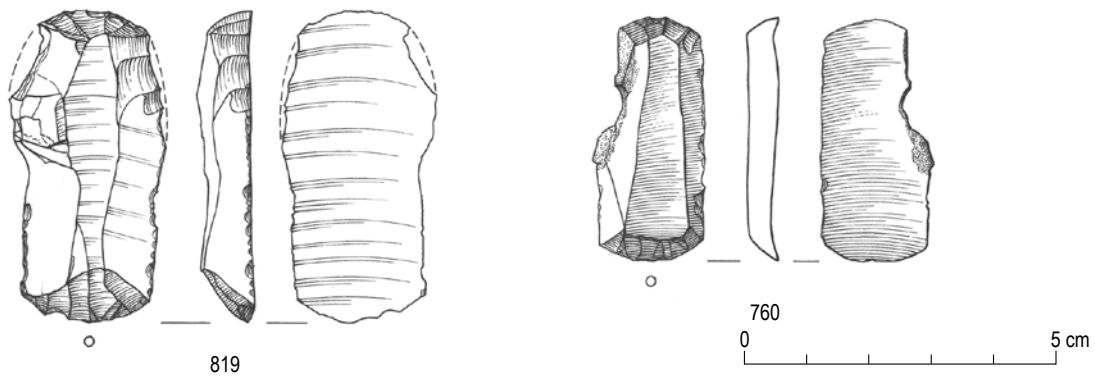
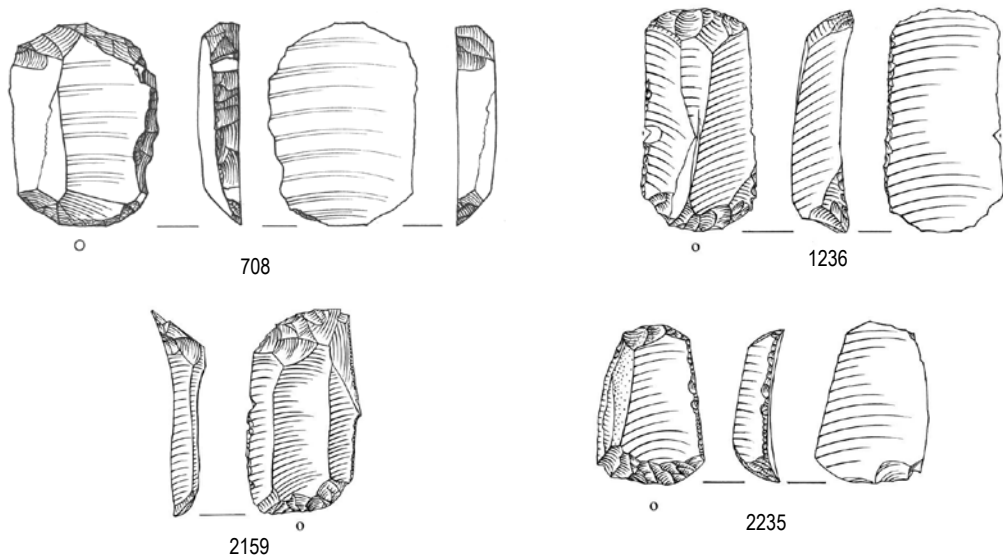


Plate 10. Broken blade-scrapers and double-scrapers (long) (drawn by Marion O'Neil and Hazel Martingell).

Tools

Double-scrapers



Short end-scrapers

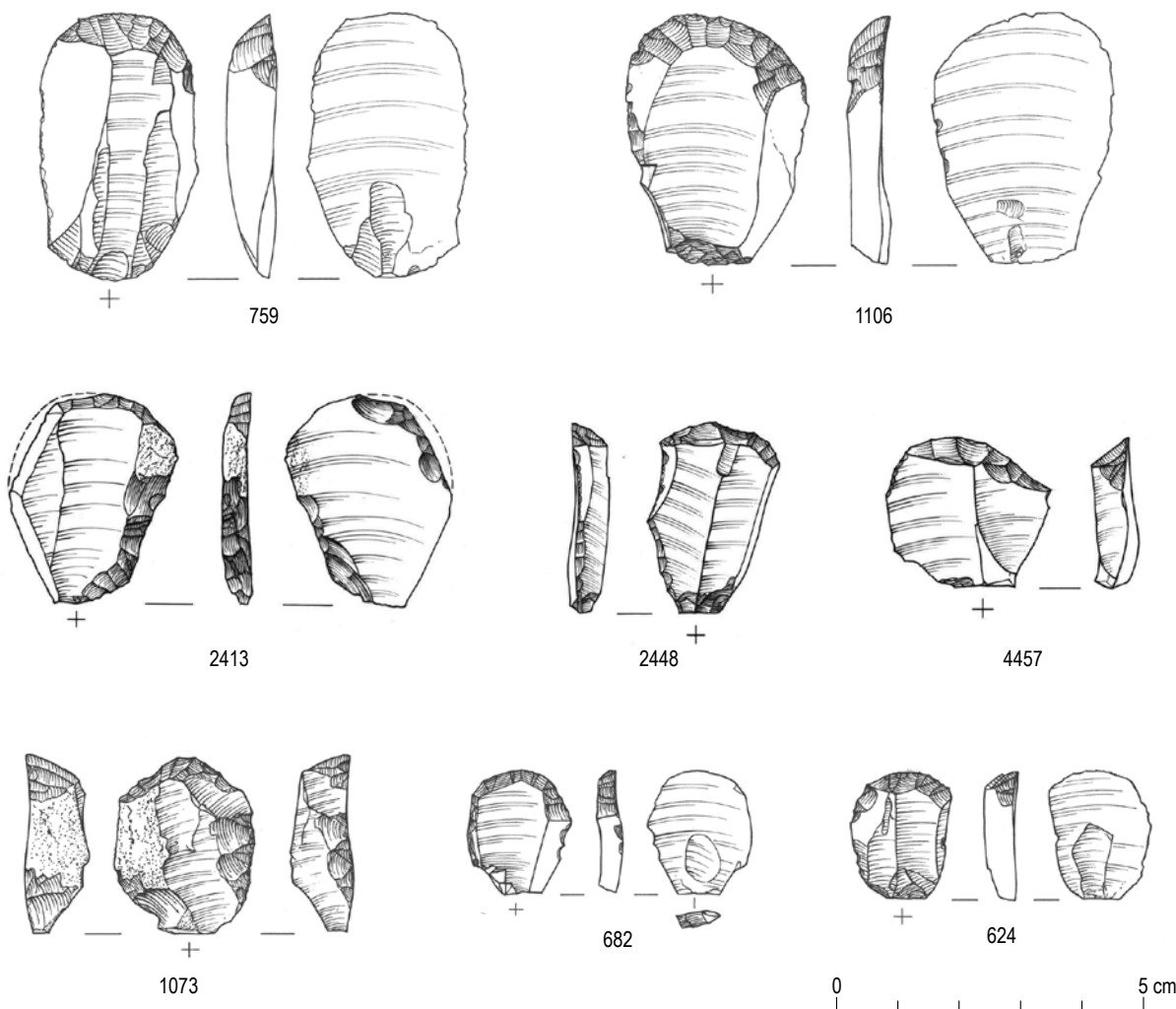
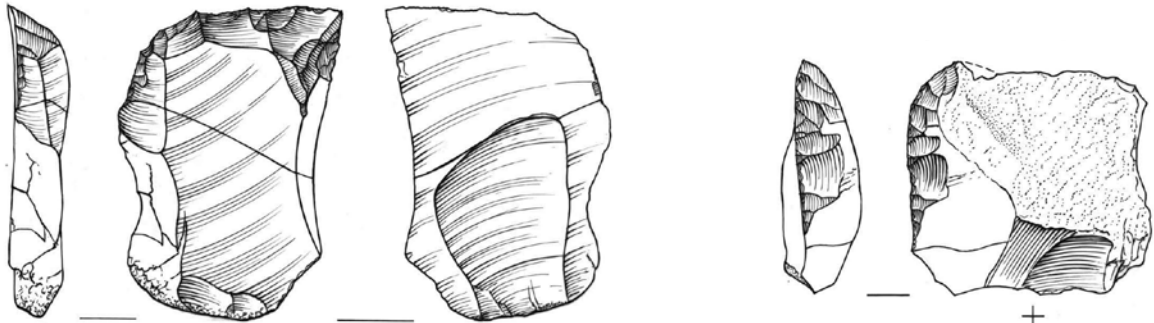


Plate 11. Double-scrapers (short) and short end-scrapers (drawn by Marion O'Neil and Hazel Martingell).

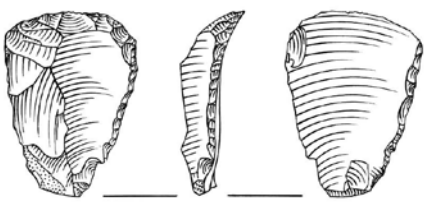
Tools

Short end-scrapers

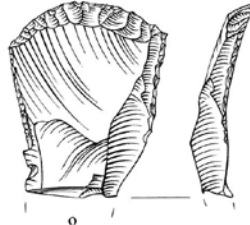


2451/2668

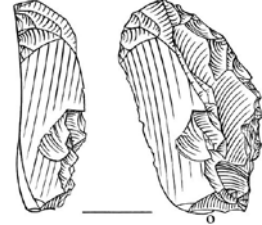
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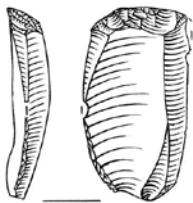
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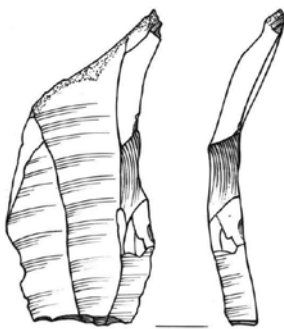


5037

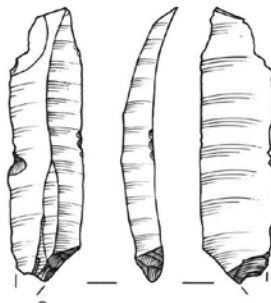


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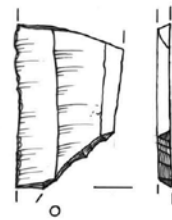
Truncations



2158



3036



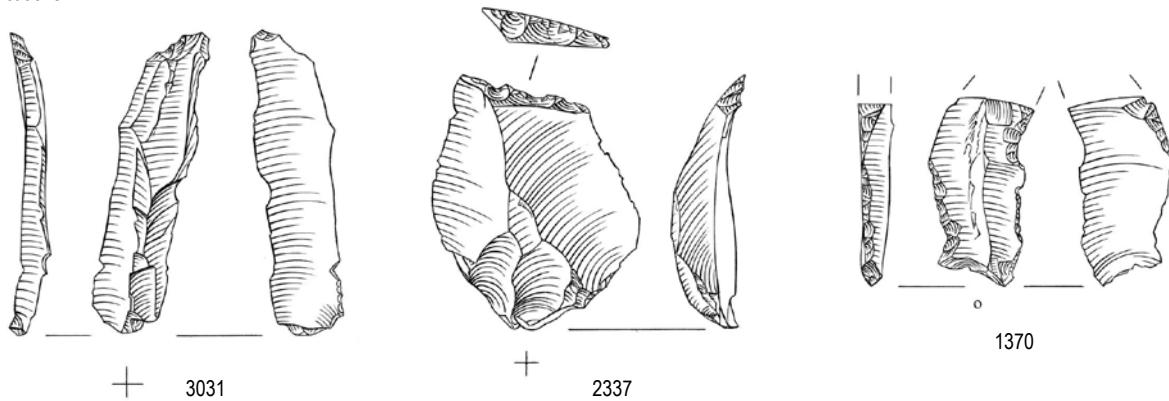
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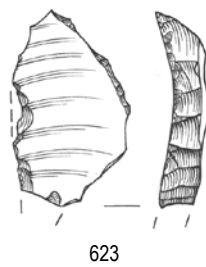
Plate 12. Short end-scrapers and truncated pieces (drawn by Marion O'Neil and Hazel Martingell).

Tools

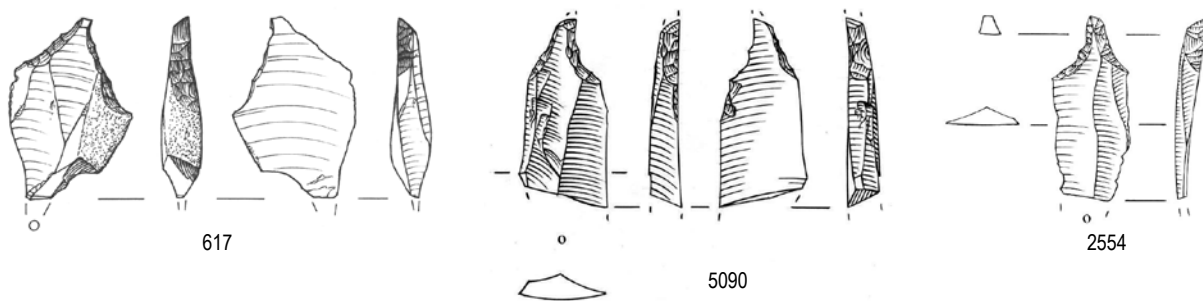
Truncations



Backed knives



Zinken



Becs

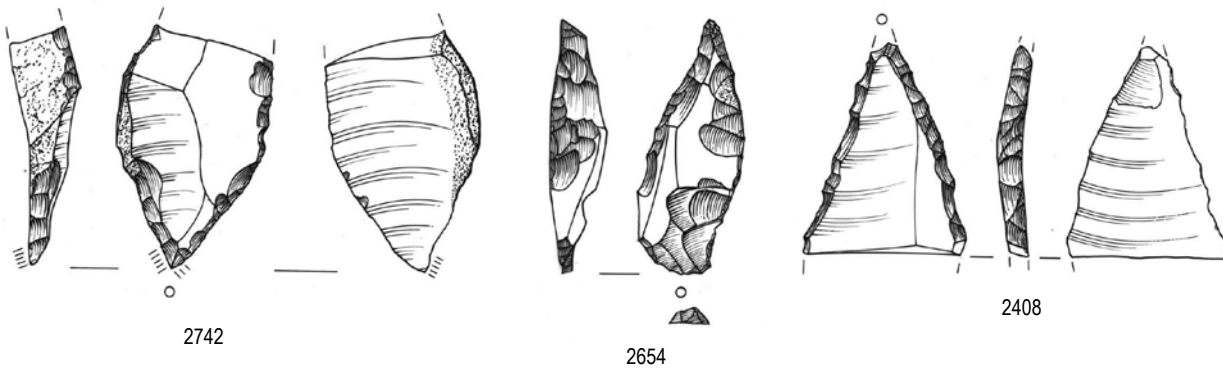
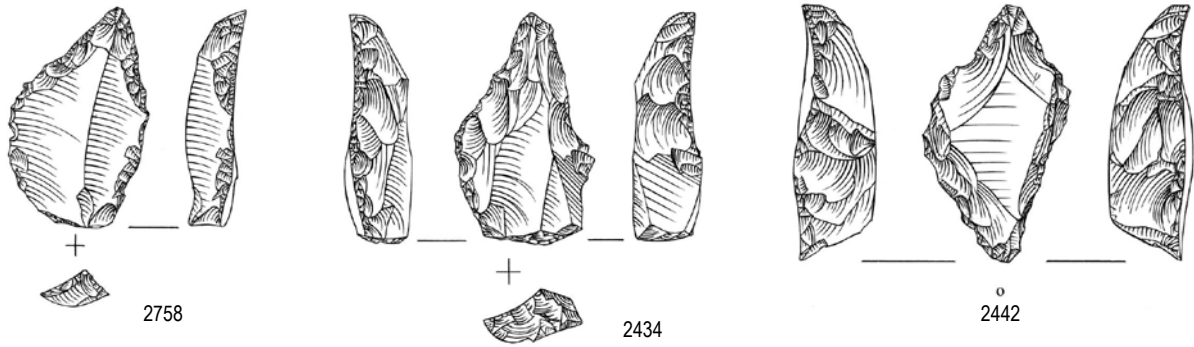


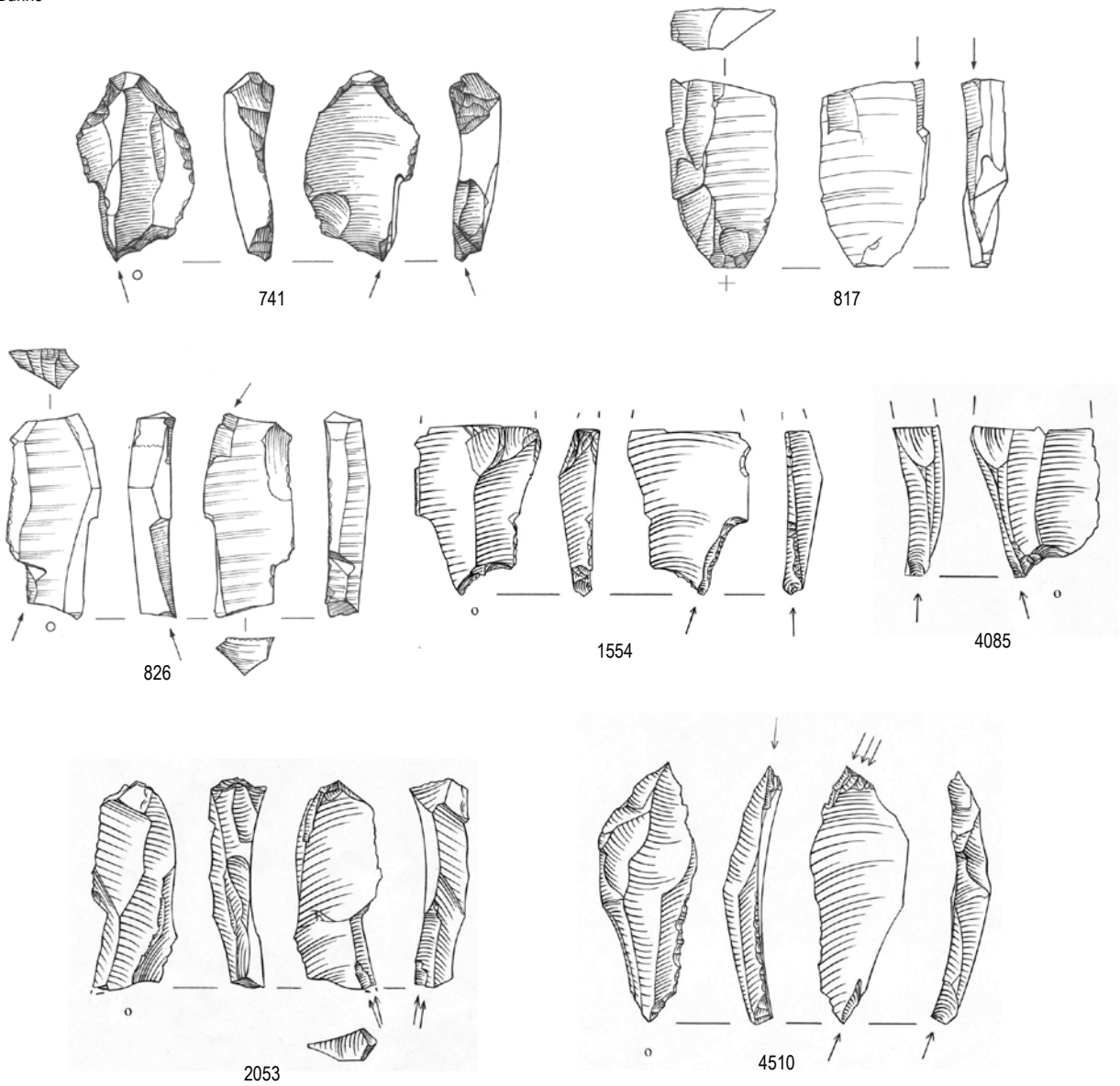
Plate 13. Truncated pieces, backed knives, Zinken, and becs (drawn by Marion O'Neil and Hazel Martingell).

Tools

Becs



Burins

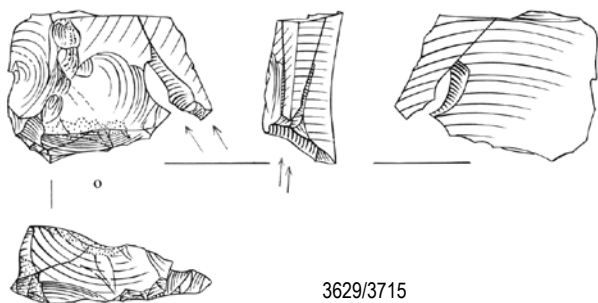
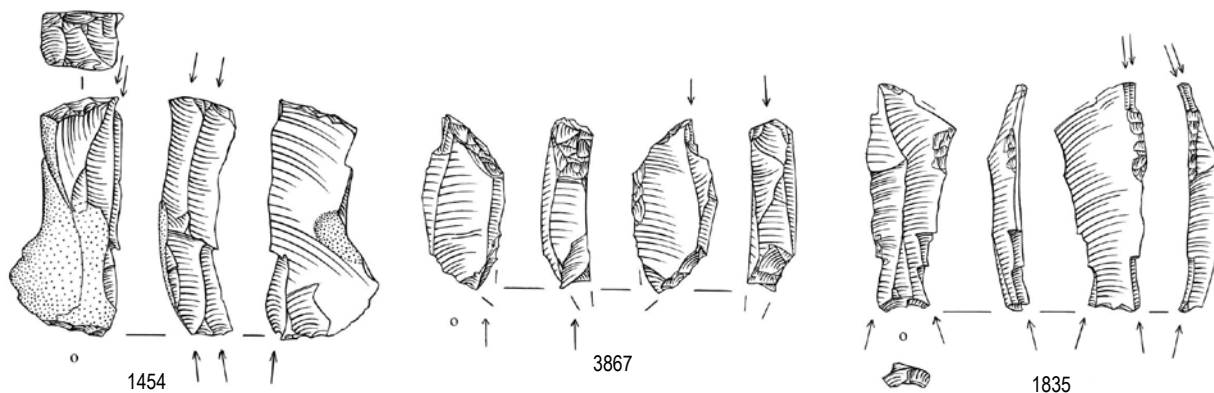


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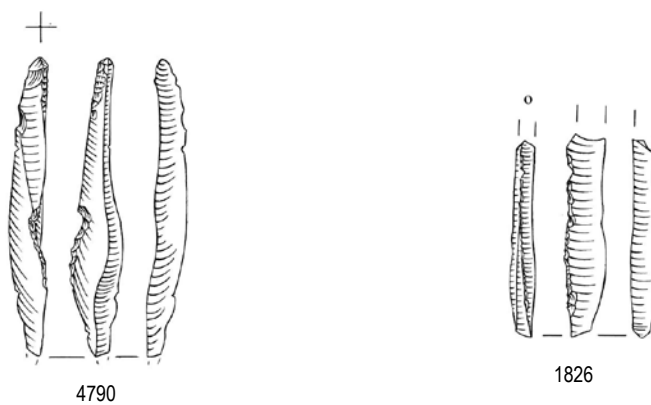
Plate 14. Becs and burins (drawn by Marion O'Neil and Hazel Martingell).

Tools

Burins



Burin spalls



Notched pieces

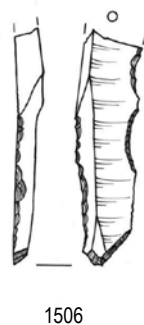
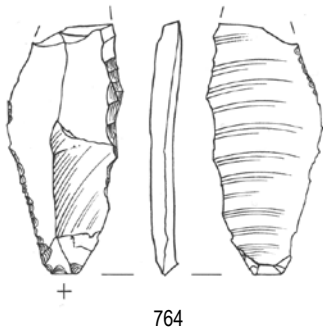


Plate 15. Burins, burin spalls and notched pieces (drawn by Hazel Martingell).

Tools

Edge-retouched pieces



Combined tools

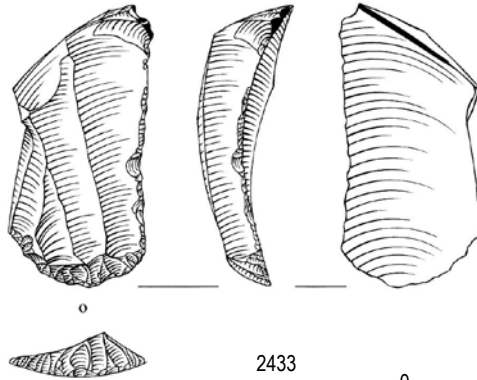
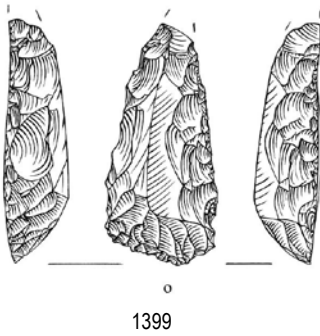
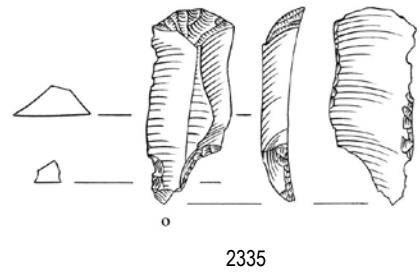
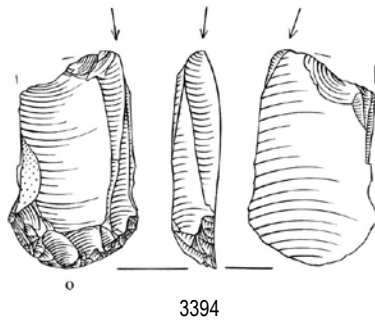
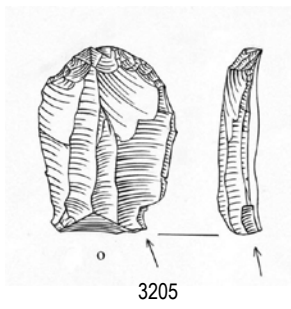


Plate 16. Edge-retouched pieces and combined tools (drawn by Marion O'Neil and Hazel Martingell).

## Late Upper Palaeolithic Technological Approaches

Most likely, the assemblage from Howburn includes finds from two different Upper Palaeolithic periods (discussed in more detail in the distribution and dating sections), namely finds from the Late Hamburgian (or Havelte) period and finds from the *Federmesser-Gruppen* period. The Hamburgian finds clearly dominate the Late Upper Palaeolithic component of the collection, and they were recovered from a number of more or less discrete concentrations. Some of these concentrations appear almost devoid of later elements, such as the southern concentration in Trench I (2009), and, slightly less so, the main concentration in Trench II (Block 2). Below, the Late Hamburgian technological approaches are characterized primarily on the basis of these two concentrations, supplemented by the finds from Trench I (2006). Finds probably dating to the *Federmesser-Gruppen* period are found throughout the site, but they seem to be most prolific in Trench II (Blocks 3-4). Although this cluster includes some earlier (Havelte) and later (Late Mesolithic and Neolithic) finds, it is thought to be dominated by material from the *Federmesser-Gruppen* period, and the finds from Trench II (Blocks 3-4) form the foundation of the technological profile suggested for this material (below).

### The Late Hamburgian (Havelte) finds

A number of elements are central to the definition of a technological profile for the Hamburgian material, namely: 1) raw material preferences; 2) the broadblade:microblade ratio; 3) the applied percussion technique (hard/soft); 4) the initial core preparation, as well as the preparation of the cores' platforms and platform-edges; and 5) general core shape.

*Raw material preferences:* Due to the more mixed character of the finds from the first excavation at Howburn, it was difficult then (Ballin *et al.* 2010) to define precisely the raw material preferences of the Late Hamburgian visitors to the site. However, with the addition of new material in 2009, this became somewhat easier. Table 18 reveals the flint ratios of the main areas:

Table 18. Flint ratios of the main areas.

Area	Flint ratio
Trench I (2006)	49
Trench I (2009)	70
Trench II (Block 2)	47
Trench II (Blocks 3-4)	14

Trench I (2006) is thought to include considerable proportions of later elements (Ballin *et al.* 2010); Trench I (2009) is probably the least disturbed concentration and may present a relatively realistic representation of the Late Hamburgian visitors' raw material preferences; Trench II (Block 2), which is dominated by Late Hamburgian finds, is probably affected by later and *Federmesser-Gruppen* elements from the neighbouring Blocks 3-4; and Trench II (Blocks 3-4), is thought to be heavily dominated by *Federmesser-Gruppen* elements, supplemented by small numbers of Havelte and post Palaeolithic finds (see distribution and dating sections).

Some diggers probably found it difficult to recognize the less find-rich subsoil (which only differs from the actual sterile moraine by slight colour and texture differences), and finds from the subsoil may therefore be under-represented. However, this does not make the difference between the finds from the topsoil and the subsoil less significant. It is quite clear that practically all finds from the subsoil (60% from the southern concentration in Trench I [2009] and 40% from Trench II [Block 2]) are datable to the Late Hamburgian (see distribution and dating sections), with these finds being heavily dominated by flint. Of 433 pieces from the subsoil, only ten are in chert, with the remainder being in flint (98%).

The assemblage from Trench I (2006) includes diagnostic Late Upper Palaeolithic artefacts in unusual forms of chert, such as the so-called rust-brown/grey and 'complex grey' cherts. These diagnostic artefacts are primarily large blade-scrapers with acute edge-angles and fragments (particularly tips) of backed points. The latter are thought to most likely be tips of Havelte points.

*Broadblade:microblade ratio:* As indicated in the characterization of the assemblage, broad blades clearly dominate microblades (76:24% in general; 81:19% in the least disturbed area, Trench I [2009]). It was originally thought that the site's Late Upper Palaeolithic element was characterized largely by the focused production of broadblades, whereas most microblades were datable to the Late Mesolithic or earliest Neolithic periods (Ballin *et al.* 2010). There is no doubt that many microblades from Howburn are late, as indicated by the presence of narrow microliths and backed bladelets. However, the distribution of microblades (Plate 20) within the well-defined southern concentration in Trench I (2009) (perfectly overlapping the distribution of broadblades, Plate 19), as well as the fact that some narrow microlith-like implements (e.g., CAT 1247 [Plate 8] and 2876, characterized as a curved-backed piece and a ?microlith, respectively) are in exotic grey flint, suggests that a small

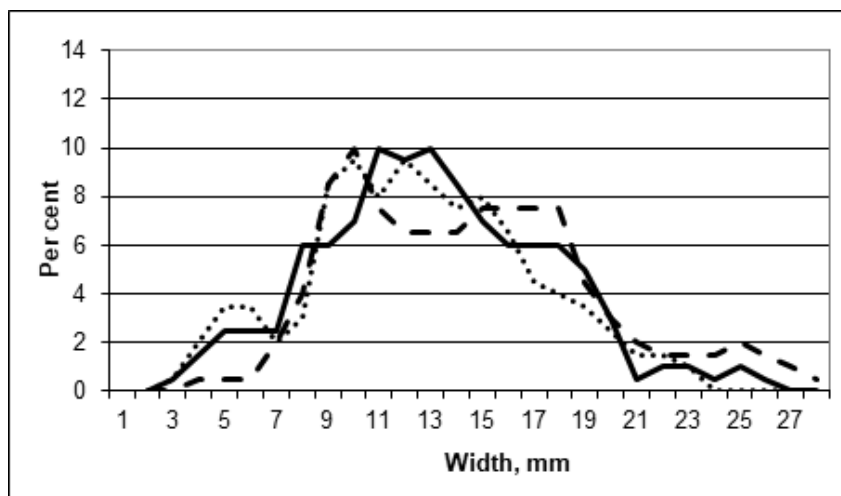


Figure 26. The width of flint blades and Upper Palaeolithic chert blades (rust-brown/grey and 'complex grey' chert) from Trench I (2006) (solid line), flint blades from Trench I (2009) (dashed line), and flint blades from Trench II (Block 2) (dotted line).

number of microblades were produced and used by the Late Hamburgian visitors at Howburn.

Figure 26 supports this view, showing that although most Late Hamburgian blades are broad (widths between 8-20 mm), some microblades were probably also manufactured. As shown by the analyses of southern Scottish Late Mesolithic/Early Neolithic assemblages (e.g., Ballin and Johnson 2005; Ballin and Ward 2013; Saville 2008), in this area microblade assemblages are predominantly in local grey chert, for which reason Figure 26 is based on flint blades and blades in 'unusual' cherts. It is possible that some of these early microblades are not 'target' (i.e., intentional) blanks, but instead small microblade-like spalls detached in connection with the removal of salient points along the cores' platform-edges. This, however, is not very likely, as the purpose of the *en éperon* technique (see below) is to produce salient points as part of a specific form of platform isolation (e.g., Barton 1990; Weber 2012: 109). The broad, plateau-like peaks of Figure 26's three curves may be due to 1) the fact that the site was visited several times during the Late Upper Palaeolithic period and therefore represents a number of different Late Upper Palaeolithic industries; and 2) the removal of some blades and tools from the site.

In British prehistory, broad blades were only produced systematically in the Upper Palaeolithic, Early Mesolithic and later Neolithic periods (Butler 2005; Ballin 2011a; 2017b). The specimens from Howburn are generally larger, more robust, and slightly more irregular than those from well-known Scottish Early Mesolithic (e.g., Morton Site A, Glenpatrick Waterhole, An Corran, Weston; Ballin and Barrowman 2013; Coles 1971; Mercer 1974; Saville *et al.* 2012) and later Neolithic sites (Ballin 2011b). Blade size and execution suggest that the blades from the areas

represented in Figure 26 are indeed Upper Palaeolithic. The mean width and thickness of all flint blades from Howburn are 14 x 5 mm; due to the collection's fragmentation ratio, it was not possible to calculate a reliable mean length for this group of finds, but the longest blade fragments are 70-80 mm long, suggesting that flint blades of up to 100 mm may have been produced.

*Percussion technique:* As shown in Table 9, approximately 60% of all blades from Howburn were produced by the application of soft percussion, with 22% being hard-percussion blades; the remainder are indeterminate blades or blades characterized by platform collapse.

This means that, at Howburn in general, soft-hammer blades dominate hard-hammer blades by a factor of 3 to 1. Amongst the likely Hamburgian flint blades, this factor is 4 to 1. Soft-hammer reduction has been seen as the dominant mode of blade production during the earlier part of the Late Upper Palaeolithic in contrast to the more mixed-hammer technique during the remainder of the Late Upper Palaeolithic (Hartz 1987: 27; Jacobi 2004: 17).

*Core preparation:* Most likely, the cores were at least partially decorticated at the source to reduce the weight of the raw material during transportation. This process probably involved the production of crests, or guide ridges. During the reduction process, the cores were adjusted by the production of new crests, as evidenced by numerous crested flakes and blades (Plate 1). The low number of platform rejuvenation flakes recovered at the site, in conjunction with the fact that those were mainly found outside and between the main Havelte concentrations, suggests that, at Howburn, rejuvenation of the platforms may have been an ongoing process, covered by the continuous fine faceting of the platforms, and that the detachment of core tablets did not form an integral part of the operational schema of the Havelte period settlers.

Through most of British earlier prehistory, the preparation of blade cores involved trimming and abrasion of the platform-edges, and the platform surfaces were mostly plain or crudely faceted (from the detachment of partial core tablets). However, during the Late Upper Palaeolithic and the later Neolithic periods, core platforms were frequently finely faceted. The earlier part of the Late Upper Palaeolithic is characterized by the application of *en éperon* technique (Plates 1-2), where a distinct spur is left at the front of the individual blades' platform remnant (Barton 1990). Some sites from the latest part of the British Upper Palaeolithic include cores with a cruder form of fine

faceting (e.g., Titchwell: Barton 1992: Figure 4.67/2), which probably involved the removal of small hinged flakes from the platform, most likely to adjust the platform-edge and, not least, to create a seat for a punch.

Whilst the Howburn *en éperon* blanks almost certainly date to the Late Upper Palaeolithic, it was difficult to date the finely faceted blades from the 2006 excavation (Ballin *et al.* 2010). However, the on-site distribution of *en éperon* and finely faceted blades from the 2009 excavation (Plate 22) shows that, in Trench I, these two types of blades generally occur together. In the almost circular artefact cluster in the southern corner of Trench I (2009), pieces with *en éperon* and finely faceted platforms overlap perfectly, with only a small number of pieces having been recovered outside the cluster.

In the main artefact cluster in Trench II (Block 2), the two forms of platform preparation also overlap perfectly. It is therefore suggested that, at Howburn, fine faceting of the platform is the main Late Hamburgian approach for the preparation of platform-edges and -surfaces, with the *en éperon* technique being applied specifically to create the platform-edge spurs reported from Late Magdalenian, Creswellian and (less commonly) Hamburgian sites. As only two fragmented chisel-shaped arrowheads have been found at the location, and no other typical later Neolithic core or implement forms (cf. Ballin 2011b), it is thought that the Howburn assemblage as a whole includes very low numbers of later Neolithic lithic artefacts and that, subsequently, practically none of the finely faceted blades is datable to this period. In the artefact cluster in Trench I (2009), southern corner, *en éperon* and finely faceted blades are almost equally numerous.

The common occurrence of *en éperon* blades across the Howburn site sets the Late Hamburgian element of this location apart from Late Hamburgian assemblages from the Continent. Although *en éperon* blades have been recovered from NW European Hamburgian sites (Hartz 1987: 27; Weber 2012: 109; Weber *et al.* 2010: 18), this form of core preparation is generally quite rare. The various technological attributes were quantified in the publication of the two Danish Jels sites (Madsen 1992: 110), and *en éperon* blades are present at Jels 1, albeit in negligible numbers. The rarity of *en éperon* blades in Hamburgian contexts is also confirmed by Mara-Julia Weber (pers. comm.).

*Core types:* At Howburn, opposed-platform cores (Plate 4) are slightly more common than single-platform cores (Plate 3) (35 against 27 pieces), but amongst the flint cores, opposed-platform cores dominate single-platform cores by a factor of almost 4 to 1. As some of the flint single-platform cores are cylindrical, such as the long slender CAT 828 (Plate 3), it is suggested that some of those may also have been worked from two platforms. However, the Late Hamburgian cores

from Howburn were probably reduced in stages, with one platform and striking direction dominating at any one time, and with the cores then being occasionally rotated to adjust the core shape (i.e., to retain an approximate cylindrical shape). If a platform was then lost, for example due to overpassing blades (as in the case of CAT 2092/2240; Plate 4), the surviving core then attained single-platform shape. The single-platform cores in chert are slightly chunkier than the flint variants, and most of these have a flat rear face.

The majority of the opposed-platform cores in flint are approximately cylindrical, and although the opposed-platform cores in chert do include cylindrical pieces, most are considerably chunkier than their flint counterparts. Long, slender, cylindrical opposed-platform cores are a characteristic element of many north-west European assemblages from the earlier part of the Late Upper Palaeolithic (e.g., Hartz 1987: 27; Madsen 1992: Figure 2; Weber 2008; 2012: 133) but, compared to those, the Hamburgian opposed-platform cores from Howburn are probably somewhat shorter (mean dimensions of intact pieces 35 x 24 x 17 mm). This may be due to the specific way cores were reduced in the flint-poor southern regions of Scotland (in comparison to the more flint-rich areas of Continental NW Europe), or the specific frost-affected flint types used, which needed constant adjustment and repairs.

The preference for cylindrical cores in many NW European Late Upper Palaeolithic industries is probably due to the fact that cylindrical core techniques secured the production of relatively straight blades for points. It is suggested by Weber (2008: 110) that straight blades have greater resistance at impact. This view is supported by Scandinavian evidence, where cylindrical cores return at the transition between the Middle Neolithic Funnel-beaker and Pitted-ware Cultures (after having been absent since the Palaeolithic/Mesolithic transition), at a time when tanged blade points are re-introduced after a long period characterized by the use of minuscule microliths and small transverse arrowheads (e.g., Wincentz Rasmussen 1991).

#### **Finds relating to visits during the *Federmesser-Gruppen* period**

The following account is based on the finds from Trench II (Blocks 3-4). For a discussion of the general date and character of this concentration, see the monograph's distribution and dating sections.

*Raw material preferences:* As shown in Table 18, the assemblage from Trench II (Blocks 3-4) has a flint ratio of only 14% (with most of the remaining 86% being chert), which is considerably lower than the ratio of the least disturbed Havelte concentration in Trench I (2009) (70%); one-third of the tools are in flint. In addition

to the bulk of finds from this area, which are in local dark-grey chert, a considerable number of artefacts (39 pieces) are in fine-grained, almost flawless orange chert (Figure 17). As mentioned by Dr Owen, University of Glasgow (raw material section), this form of chert may be exotic to the local area, and it does not form part of any known later assemblages from the area.

The possibility of the site's *Federmesser-Gruppen* element being heavily dominated by chert is further supported by the raw material composition of the concentration's backed points. Almost half of the backed points are in chert, with one (CAT 4847) being in orange chert. A series of proximal (basal) fragments of apparently standardized straight-backed points are in local dark-grey chert. This raw material composition indicates a marked difference to the Late Hamburgian finds from Howburn, which are heavily dominated by the use of flint (see discussion section).

The probably contemporary assemblage from Kilmelfort Cave on the Scottish west-coast (Saville and Ballin 2009) represents an interesting comparative case. Most of the tools from this site are in flint, but more than half of all debitage is in quartz, as is one-third of the cores. This suggests that, with time, the Late Upper Palaeolithic settlers in Scotland gradually learnt to work the local raw materials – chert in the south and quartz in the west – although flint was still very much used for tools. In connection with her discussion of *Federmesser-Gruppen* sites in the Vale of Pickering, Yorkshire, Conneller (2007: 227) made the same observation: 'Typically Final Palaeolithic [i.e., *Federmesser-Gruppen*] sites in Britain are characterized by the use of more local sources than the Creswellian [contemporary with the Scottish Hamburgian]' (also see Barton and Roberts 1996: 261).

*Broad blade:microblade ratio:* Although Trench II (Blocks 3-4), includes more microblades than the site in general (and definitely more than the least disturbed Havelte concentrations), it is still heavily dominated by broad blades (c. 70%). Despite the fact that some of the microblades may date to later periods, Scottish blades from the *Federmesser-Gruppen* period are likely to be considerably narrower than their Havelte period counterparts (Figure 27). The double-peaked character of the curve describing Howburn chert blades may be explained in a number of

ways, such as by the inclusion of later material from microblade-producing industries, or by the removal of the most regular *Federmesser-Gruppen* blades from the site. That some exportation of blades/blade tools occurred is supported by the authors' attempt at refitting artefacts in orange chert, which was less successful than hoped. As this chert is characterized by subtle colour differences and differences in terms of patterning, it should have been easy to conjoin pieces from the same parent cores, but it was only possible to refit a small number of artefacts in orange chert.

*Percussion technique:* As shown above, the Havelte period blades are composed of approximately 80% soft-percussion blades against 20% hard-percussion blades. In Trench II (Blocks 3-4), the soft-/hard-percussion ratio is exactly the same. At Kilmelfort Cave in Argyll (Saville and Ballin 2009), the ratio of soft percussion blades (based on the sum of definite hard- and soft percussion blanks) is precisely 80%. At the well-known *Federmesser-Gruppen* site Schalkholz in Ditmarschen, northern Germany (Bokelmann 1978: 41), most blades were also manufactured by the application of soft percussion.

*Core preparation:* The distribution of preparation flakes (Plate 37) across Trench II (Blocks 3-4), implies that the operational schema of the *Federmesser-Gruppen* period may have included the detachment of crested pieces, as well as platform rejuvenation flakes, during the reduction process. Although no core tablets were recovered from the probably contemporary site of Kilmelfort Cave near Oban (only four crested pieces were found; Saville and Ballin 2009), some blades with coarsely faceted

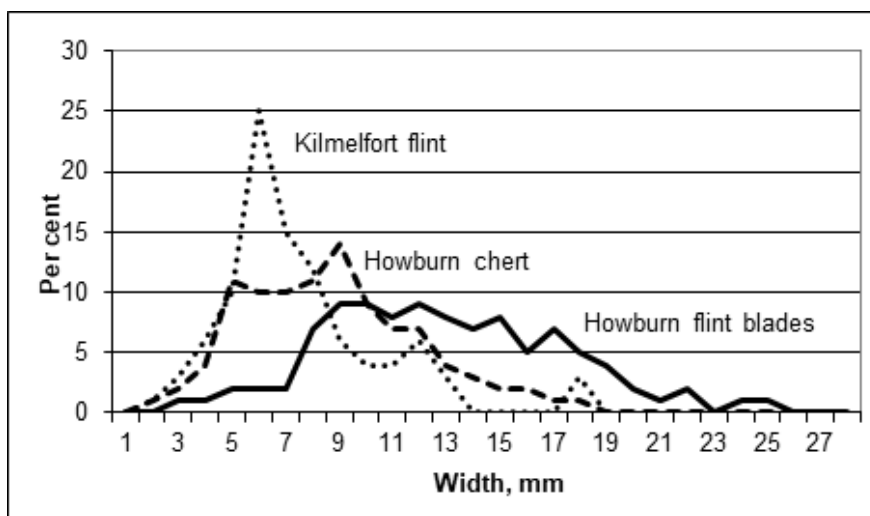


Figure 27. The width of probable Howburn Havelte flint blades (solid line), probable Howburn *Federmesser-Gruppen* chert blades (dashed line), and Kilmelfort *Federmesser-Gruppen* flint blades (dotted line). The chert blades from Howburn all derive from Trench II (Block 3-4).

platform remnants were interpreted as evidence of the detachment of partial core tablets.

Although the percussion technique applied by the *Federmesser-Gruppen* settlers responsible for most of the finds in Trench II (Blocks 3-4) corresponds exactly to the one applied by the Howburn Havelte groups, there are distinct differences between the two industries' platform and platform-edge preparation. Where the Havelte groups favoured fine faceting of the platforms, occasionally combined with the production of *en éperon* spurs along the platform-edge, this approach does not seem to form part of the *Federmesser-Gruppen* approach to lithic reduction (Table 19). Instead, most platforms were left plain, and the platform-edges were trimmed and/or abraded. This is most clearly demonstrated by the series of proximal fragments of backed points from Blocks 3-4, which all display this form of platform/platform-edge preparation. At the probably contemporary site of Kilmelfort Cave in Argyll (Saville and Ballin 2009), most platform-edges had been carefully prepared, with 48% of all edges having been trimmed and 45% abraded; only 7% had no preparation of the platform-edge. The platforms were generally plain (93%), supplemented by some (7%) coarsely faceted platforms (probably formed by the detachment of partial core tablets).

*Core types:* Trench II (Blocks 3-4) is characterized by the same parity between single- and opposed-platform cores as the site in general. The cores are dominated by chert (flint:chert = 10:90), and although it cannot be ruled out that some of the concentration's shorter chert cores date to post-Palaeolithic times, some have a distinctly Palaeolithic appearance. Two opposed-platform cores (CAT 3789, 4173) are long and slender, and they almost certainly date to the Upper Palaeolithic period. As they are both in local chert, they are more likely to date to the *Federmesser-Gruppen* period than to the Havelte period. The production of blades from long and slender opposed-platform cores corresponds well to the operational schemas of contemporary English (Barton 1992; Barton *et al.* 2009; Conneller 2007) and Continental (Clausen and Hartz 1988: 25) *Federmesser-Gruppen* sites.

Table 19. Ratio of finely faceted pieces (including *en éperon* pieces), as a percentage of the areas' total blade populations, and as a percentage of all macroblades.

Area	Faceted ratio based on all blades	Faceted ratio based on all macroblades
Trench I (2006)	25	30
Trench I (2009)	22	28
Trench II (Block 2)	19	25
Trench II (Blocks 3-4)	4	6

### Other Late Upper Palaeolithic finds

In addition to its main Havelte concentration, Trench II (Block 2), also includes an interesting cluster in its north-eastern corner. This sub-assembly is defined by the almost exclusive use of dark-brown, highly vitreous homogeneous flint, which (in this part of northern Britain) is mostly associated with Grooved Ware settlements (see dating section). The inclusion in this sub-assembly of one slender cylindrical blade-core (CAT 2977, with a refitting blade terminal CAT 2796; Plate 4), three backed pieces (CAT 2951, 3194, 3449) and one burin (CAT 4129), however, dates the assemblage to the Upper Palaeolithic. As six pieces have finely faceted platform remnants and one piece an obvious *en éperon* spur (CAT 2428; Plate 1), these finds most probably date to the Late Hamburgian period.

The assemblage acquires a somewhat deviant appearance by the inclusion of five (CAT 2434, 2442, 2654, 2742, 2758; Plates 13-14) broad and thick, heavily modified *becs* in dark-brown flint (a combined scraper-*bec* [CAT 1399] was recovered from Trench I [2009]), a formal type not generally associated with Havelte or *Federmesser-Gruppen* assemblages from Britain or the Continent. Three of the *becs* have finely faceted platforms. This assemblage is probably best understood as the remains of a small specialized camp, where a few nodules of high-grade flint were reduced.



# On-site Distribution and Activity Patterns

## Vertical distribution (stratigraphy)

As mentioned in the technology section, it is thought that, during the excavation, the cryoturbated subsoil was not recognized throughout the site, but that some diggers may have interpreted this relatively find-poor layer as sterile moraine and therefore stopped further digging when they reached this layer. However, it was recognized consistently in Trench I (2009), southern corner (i.e., the least disturbed Late Hamburgian concentration), as well as in Trench II (Block 2) (i.e., the other relatively well-preserved Late Hamburgian concentration). Although finds from the subsoil are thought to be under-represented in the total assemblage, this context is probably unaffected by later visits to the site, and it is therefore extremely significant in terms of demonstrating the character of the site's earliest finds.

The lithic finds from the subsoil are characterized by: 1) a heavy reliance on flint (only ten of 433 pieces are in chert, and they are all from Trench II); 2) a focused production of blades (45% of all unmodified and modified flake and blade blanks are blades); 3) the blade population includes a relatively large proportion of microblades (15%); 4) no cores; 5) the points are mostly asymmetrical tanged points (nine pieces); 6) the backed points (five pieces) are all in flint; 7) most scrapers are based on blade blanks (58%); 8) the recovery of microlith-like implement CAT 2876 (in grey exotic flint), but no other microliths; and 9) the presence of other early types, such as seven blade-based truncated pieces, three double-scrapers, three burins, two combined tools (scraper-*Zinken* CAT 2335 and scraper-strike-a-light CAT 2433; Plate 16), and two *becs*. The context also included 11 *en éperon* blades, and 23 finely faceted pieces.

Comparison between this sub-assemblage and the main assemblage above the subsoil provides a measure for the number of later intrusive elements, such as the flint:chert ratio: In for example Trench I [2009], chert makes up 30% in general (Table 6), but only 2% in the assemblage from the subsoil. Most likely, all finds from the subsoil date to the Late Hamburgian period (see dating section). The distribution of the finds from the subsoil in Trench I (2009) and Trench II (Block 2) was compared with the distribution in the topsoil, and the spatial patterns were almost identical. A similar result was obtained by Andersen (1972: Figures 10-11) when he compared the spatial patterns from topsoil and subsoil on the Late Upper Palaeolithic Brommian site Bro on Funen, Denmark. Apparently, horizontal displacement by ploughing is negligible when sites are situated on roughly level ground (also see Roper 1976).

## Horizontal distribution: Trench I

In the distribution maps from Trenches I and II, contour mapping was only used when the mapped categories were numerous enough to make this approach meaningful (cf. Czesla 1990); otherwise individual artefact plotting was used. The distribution maps presenting the scatters of flint and chert in Trench I operate with slightly different contour intervals in the 2006 and 2009 sections, as it was thought that denser contours were necessary in the 2006 section to allow some less find-rich (but still important) clusters to become visible.

The distribution of flint (Plate 17) in the two sub-areas (2006 and 2009) differ considerably, with the southern corner of Trench I (2009), probably representing the outline of a Late Hamburgian dwelling (c. 5-6 x 5-6 m) like the Hamburgian and *Federmesser-Gruppen* dwellings known from Jels (Holm and Rieck 1992: 21) and, more clearly, Slotseng (Holm 1991: 11, 13; this volume's Figure 28). The fact that the outline of the Slotseng dwelling is star-shaped, probably indicating the presence of structural posts like those in a typical tepee, and the Howburn outline not, is probably due to different excavation forms (cf. Fischer *et al.* 1979), where Slotseng was excavated in 0.5 x 0.5 m grids (Fischer *et al.* 1979), whereas Howburn was excavated in full square metre

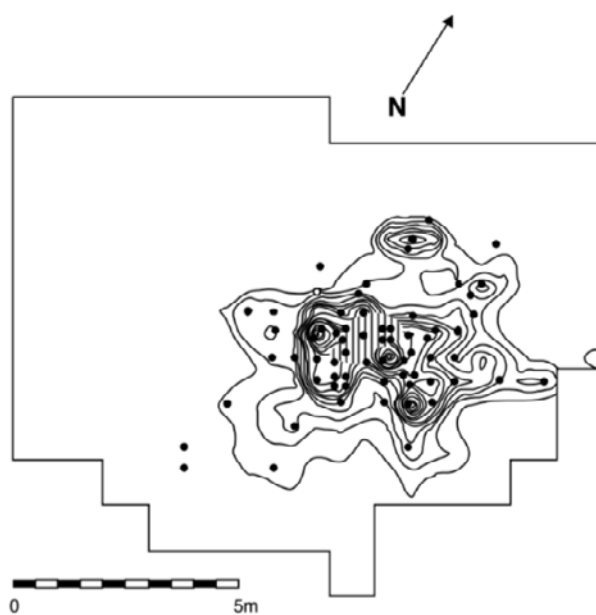


Figure 28. The *Federmesser-Gruppen* settlement at Slotseng in southern Jutland, Denmark. The spread of *Federmesser* points is shown with filled circles. In addition, density curves for flakes/blades and the putative fireplace (vertical hatching) are shown. (courtesy of Jørgen Holm).

grids (Dudds *et al.* 2006; Ward 2010). In the southern corner of the 2006 section, another dwelling *may* be indicated by four closely situated flint-dominated concentrations, but the outline of this possible dwelling is less coherent, probably due to later disturbances.

These possible disturbances are first and foremost indicated by the distribution of chert (Plate 18), with some chert probably dating to the *Federmesser-Gruppen* period (along with some flint; see technology section), and some (probably most) to the Mesolithic and Early Neolithic periods (where local dark-grey chert was used almost exclusively; e.g., Ballin and Johnson 2005; Ballin and Ward 2013; Paterson and Ward 2013). The *Federmesser-Gruppen* presence is suggested by small numbers of backed pieces (particularly the chert specimens; the finds from the subsoil suggest that some backed pieces were also produced during Hamburgian times) (Plate 25), whereas the Mesolithic and Neolithic presence is indicated by microliths, arrowheads, pieces of Arran pitchstone and fragments of polished stone axeheads (Plate 28).

In Ballin *et al.* (2010), it was suggested that the complete absence of blade-scrapers, combined with dominance of short end-scrapers, in Trench I (2006), eastern corner (Plate 26), may identify this and possibly the neighbouring eastern concentration as Mesolithic or Early Neolithic. It is important to note that these concentrations consist almost exclusively of local dark-grey chert, whereas the chert in the suggested disturbed dwelling in Trench I (2006), southern corner, is to a large extent rust-brown/grey and 'complex grey' chert, that is, forms of chert which are fairly uncommon in South Lanarkshire's post-Palaeolithic assemblages.

The presence of a dwelling in Trench I (2009), southern corner, is further outlined by clusters of other artefact categories, such as burnt lithics (Plate 21), blades/microblades (Plates 19 and 20), *en éperon*/finely faceted blanks (Plate 22), preparation flakes (Plate 23), opposed-platform cores (Plate 24), tanged/backed points (Plate 25), scrapers (Plate 26) and burins/burin spalls (Plate 27). The concentration of the burnt pieces clearly indicates that this structure had an internal (probably central) hearth, like that suggested for the Slotseng dwelling (Figure 28); the presence of preparation flakes and cores suggests that primary lithic reduction most likely took place here; and the presence of points, scrapers and burins inside the dwelling implies that these tool forms may have been either produced, stored or used within the structure. The vast number of predominantly blade-scrapers is probably evidence that these implements were used here (most show distinct use-wear), and the almost mutually discriminating distribution of burins and burin spalls implies that burins were produced within the dwelling, but mostly used immediately outside it.

It is quite possible that the scattering of burins immediately inside and outside (north of) the structure identifies an entrance area, as well as an outside activity area. Small activity areas are frequently found outside hunter-gatherer dwellings, near entrances (e.g., Binford 1983: Chapter 7). This may also explain a weak cluster of *en éperon*/finely faceted blanks, cores and tanged points in this area.

The less certain, but still likely, dwelling in Trench I (2006), southern corner, is not defined by the same clear-cut distribution patterns, with burnt pieces (Plate 21), blades/microblades (Plates 19 and 20), *en éperon*/finely faceted blanks (Plate 22), preparation flakes (Plate 23), cores (Plate 24), and tools (Plates 25-27) displaying much 'looser' distribution patterns. This may partly be due to this dwelling having had most of its activity areas outside the structure (for example if the dwelling in the 2009 section was associated with settlement during winter, and the one in the 2006 section during summer), which particularly the blade- and double-scrapers north of this concentration indicate. The scarcity of burins in the 2006 section indicates that the two Late Hamburgian settlements may have had slightly different economical *foci* and activity patterns.

However, the 'looser' distribution patterns in Trench I (2006), is probably partly an artefact of later (Mesolithic and Early Neolithic) visits to, and traffic across, the area, as well as some scavenging and recycling of Palaeolithic flint.

#### Horizontal distribution: Trench II

Trench II includes two main artefact concentrations (Block 2 and Blocks 3-4), indicated most clearly by the distribution of the site's main raw materials. A flint-dominated concentration is clearly discernible in Block 2 (Plate 29). This concentration consists of two central clusters, which appear to be contemporary (the presence of *en éperon*/finely faceted blanks). However, as this concentration was truncated by the northern trench margin, it is not certain whether these two clusters formed part of a dwelling like the one in Trench I (2009), southern corner, or whether they may be the remains of two different visits to the site within the Late Hamburgian period.

A scatter of dark-brown flint (Plate 34) in the north-eastern corner of Block 2 is probably datable to the same general period (see technology and dating sections), but it is unclear whether it represents a separate visit to the site, or whether it is an activity area associated with one or both of the two main Block 2 clusters. All three Block 2 clusters are characterized by the presence of *en éperon*/finely faceted blanks (Plate 36), but the concentration of dark-brown flint is first and foremost defined by the presence of a number of distinctive *becs*.

The fact that this material is associated with a separate concentration of burnt pieces (Plate 35) may indicate that it represents a separate (possibly slightly earlier or later) event.

Blocks 3-4 are primarily set apart by a heavy reliance on chert (Plate 30), with flint being quite scarce. This area consists of one main concentration, supplemented by a series of small satellite scatters which may, or may not, be contemporary. The presence in the main cluster of a number of backed points (Plate 39) suggests that it probably dates to the Late Upper Palaeolithic period. It is thought that its predominant curve- and straight-backed points, many of which are in chert, indicate a slightly later date (the *Federmesser-Gruppen* period) than the Late Hamburgian with its distinct flint dominance and tanged points (see dating section). This proposal is further supported by a scarcity (Plate 36) of *en éperon* and finely faceted blanks (4% against *c.* 20-25% in all other areas; Table 19). The two tanged flint points in Block 3 may simply represent a small activity area associated with the Block 2 assemblage.

It is highly interesting that a concentration of unusual (probably non-local) orange chert (Plate 33), including several backed pieces, overlaps the main Block 3-4 concentration perfectly. This suggests that the orange and common dark-grey cherts in this area may be contemporary. A small number of refit lines ties two of the small chert satellite clusters to the area's main scatter.

The recovery in the main Block 3-4 concentration of many blades/microblades (Plates 31 and 32) and preparation flakes (Plate 37) is evidence that primary production took place at this location. The cores (Plate 38) have a distinctly peripheral distribution in relation to the preparation flakes, and they probably represent a toss zone, where large-sized lithic waste was disposed of immediately in the form of preventive maintenance (Binford 1983: 189). This may indicate that the Block 3-4 concentration is the remains of an open-air site, rather than an actual dwelling (here, and below, the term 'open-air' is used consistently to define non-dwelling concentrations, and not, as commonly on the Continent, to define non-cave concentrations). This view is further supported by the distribution of scrapers (Plate 40) and, in particular, burins (Plate 41) around the concentration, rather than in it, indicating the spatial separation of tasks commonly observed in connection with Upper Palaeolithic open-air sites (e.g., Stapert 1992; also Ballin 2013): primary production and point production/retooling tended to take place around the central hearth, whereas piercers, scrapers, burins and knives were used further away from the fireplace.

As shown in Plate 42, the area around Trench II was visited on a number of occasions in post Palaeolithic times. Fourteen microliths indicate a probably later Mesolithic presence, whereas 28 pitchstone objects, one leaf-shaped point, one fragment of a polished flint axehead, and five objects in Cumbrian tuff indicate a (probably Early) Neolithic presence.

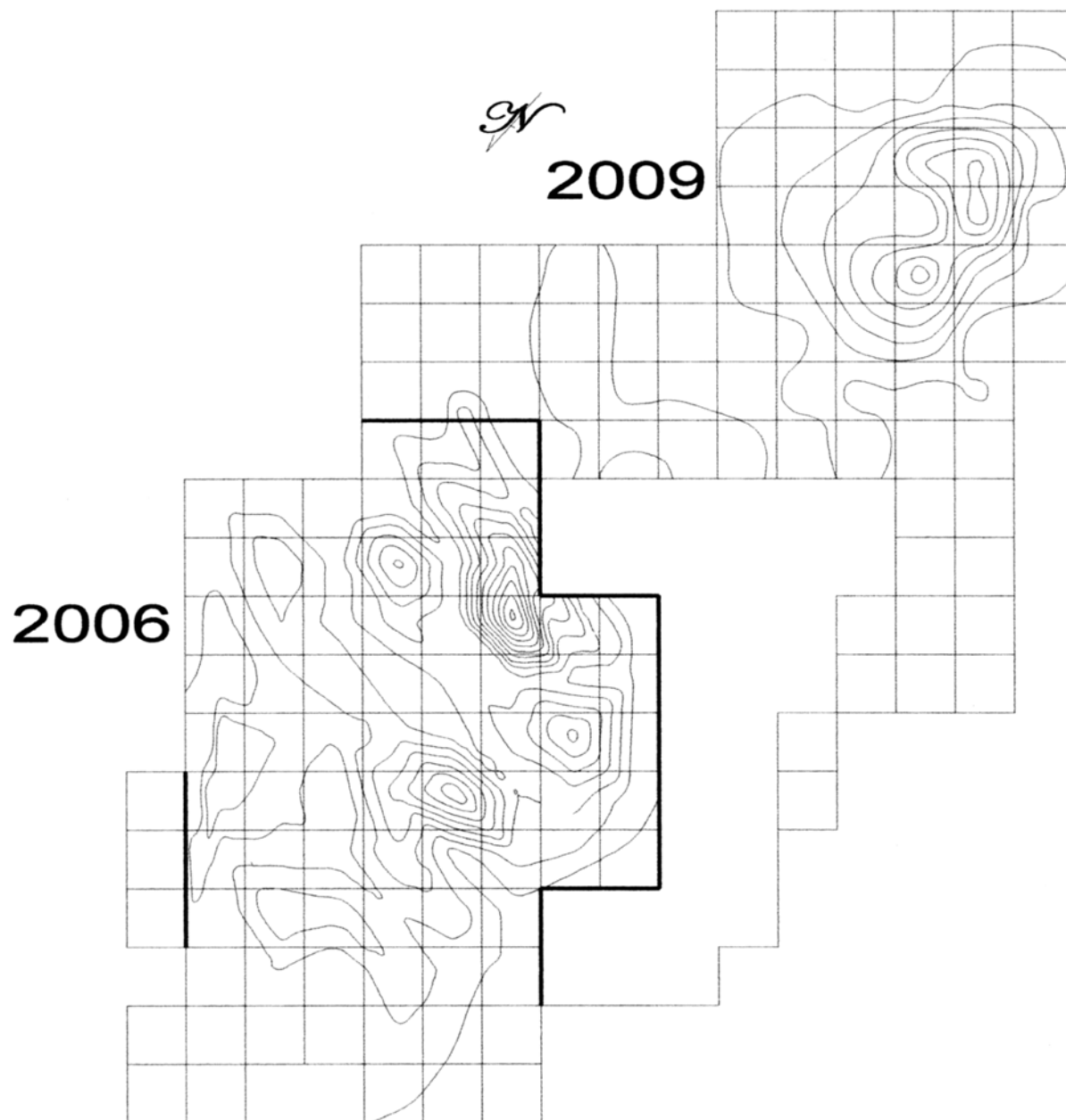


Plate 17. Trench I. Distribution of all worked flint.

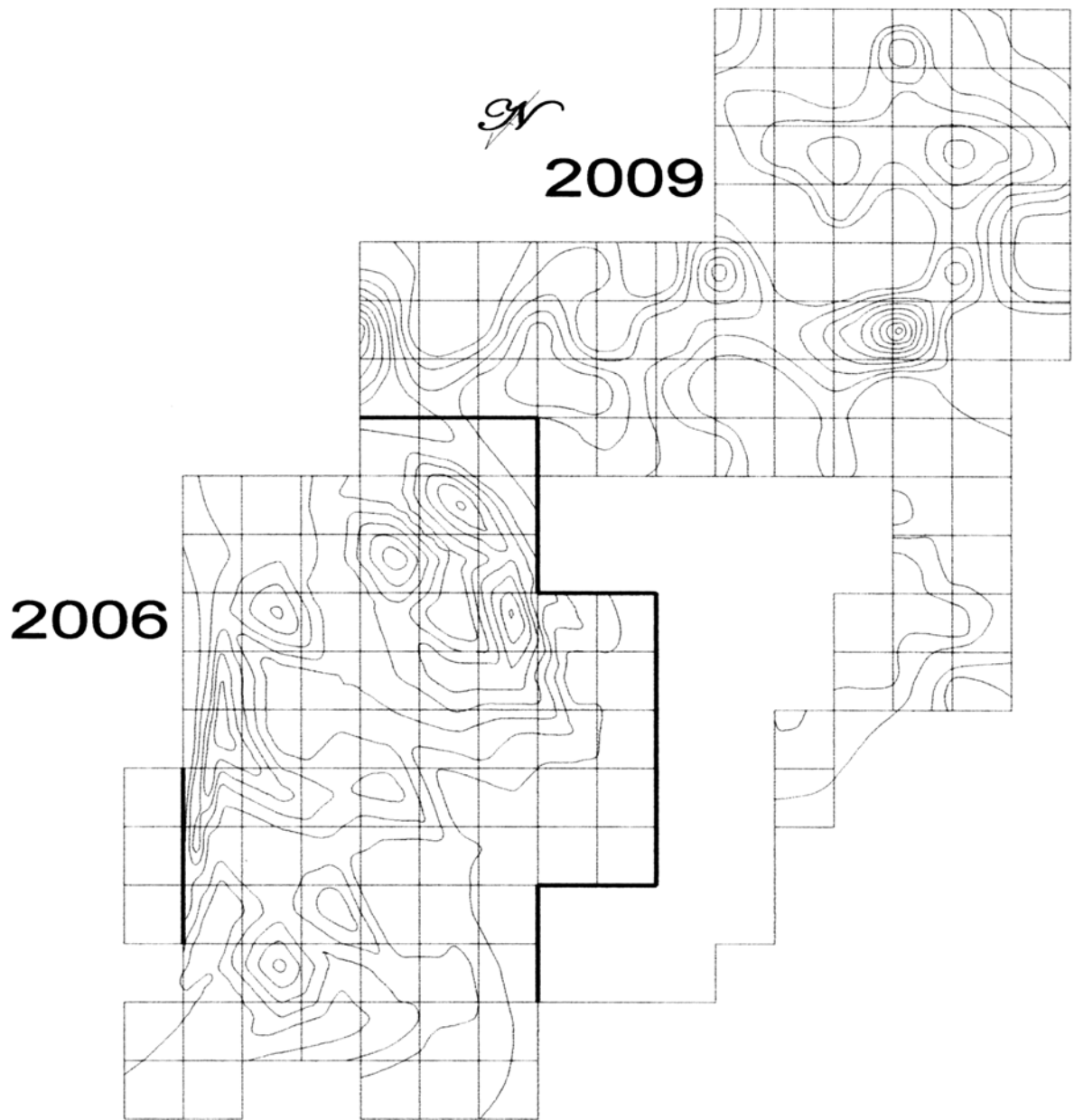


Plate 18. Trench I. Distribution of all worked chert.

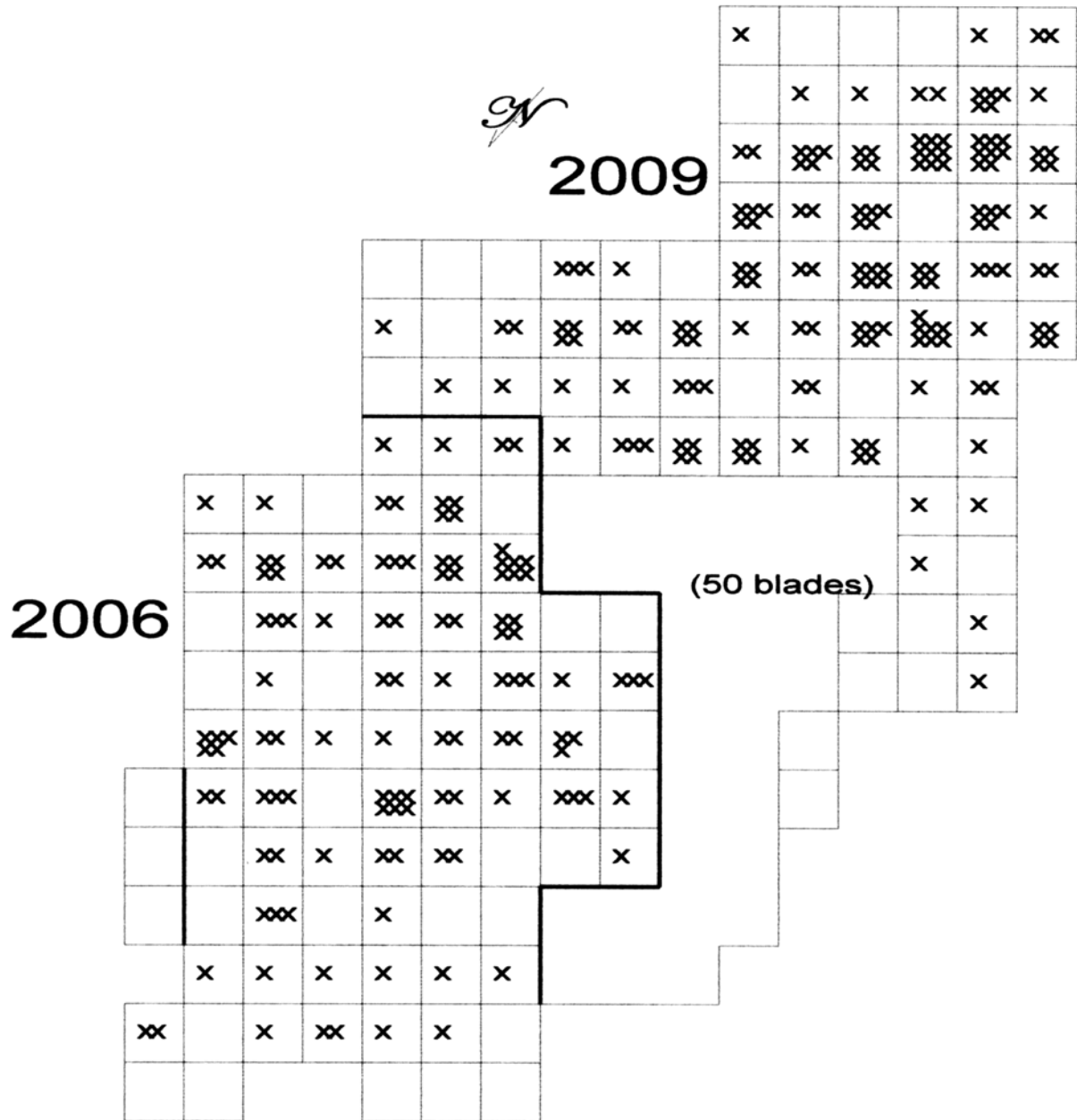


Plate 19. Trench I. Distribution of all blades.

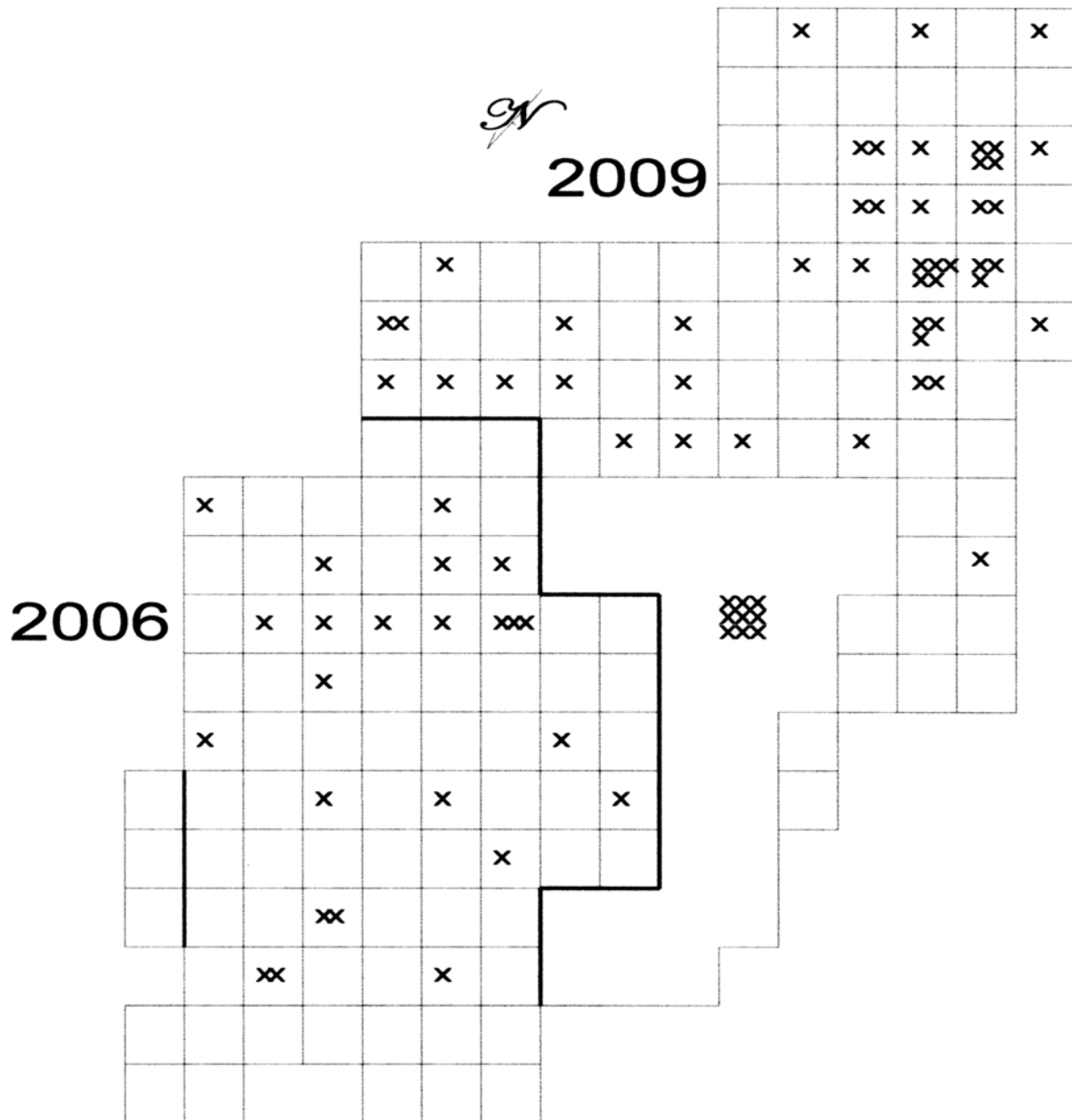


Plate 20. Trench I. Distribution of all microblades.

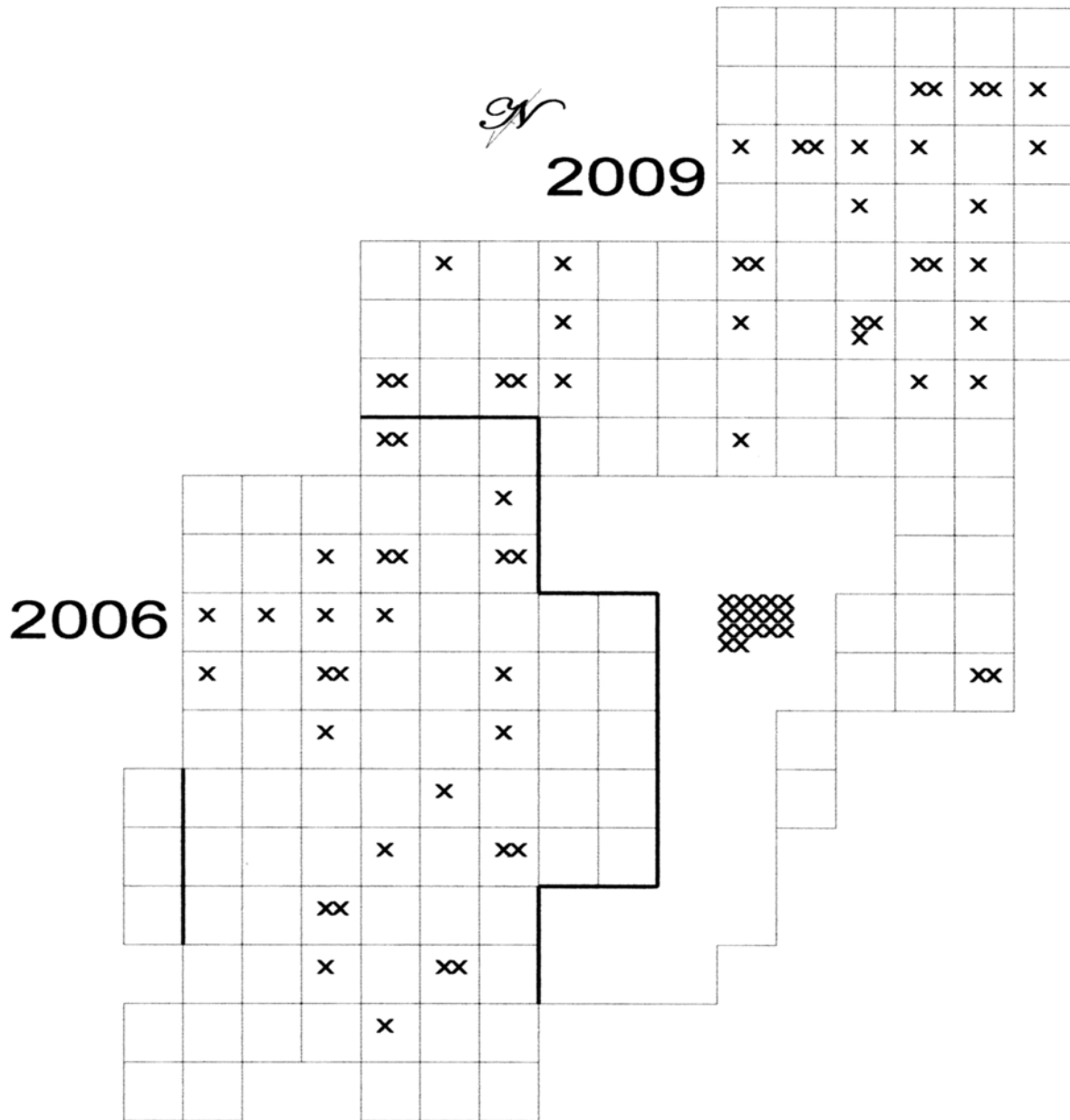


Plate 21. Trench I. Distribution of all burnt lithic artefacts.

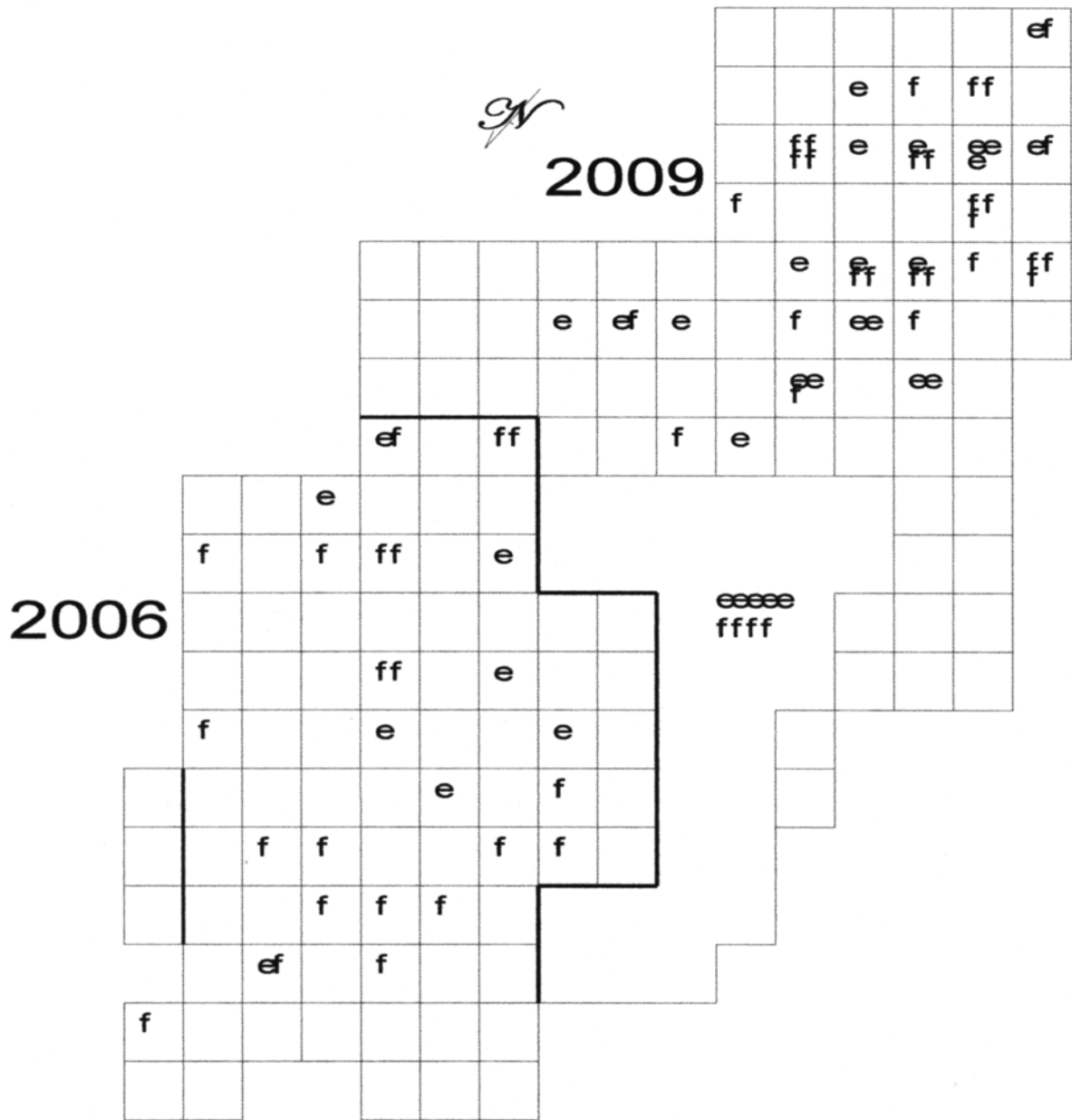


Plate 22. Trench I. Distribution of all blanks with en éperon spurs (e) or finely faceted platform remnants (f).



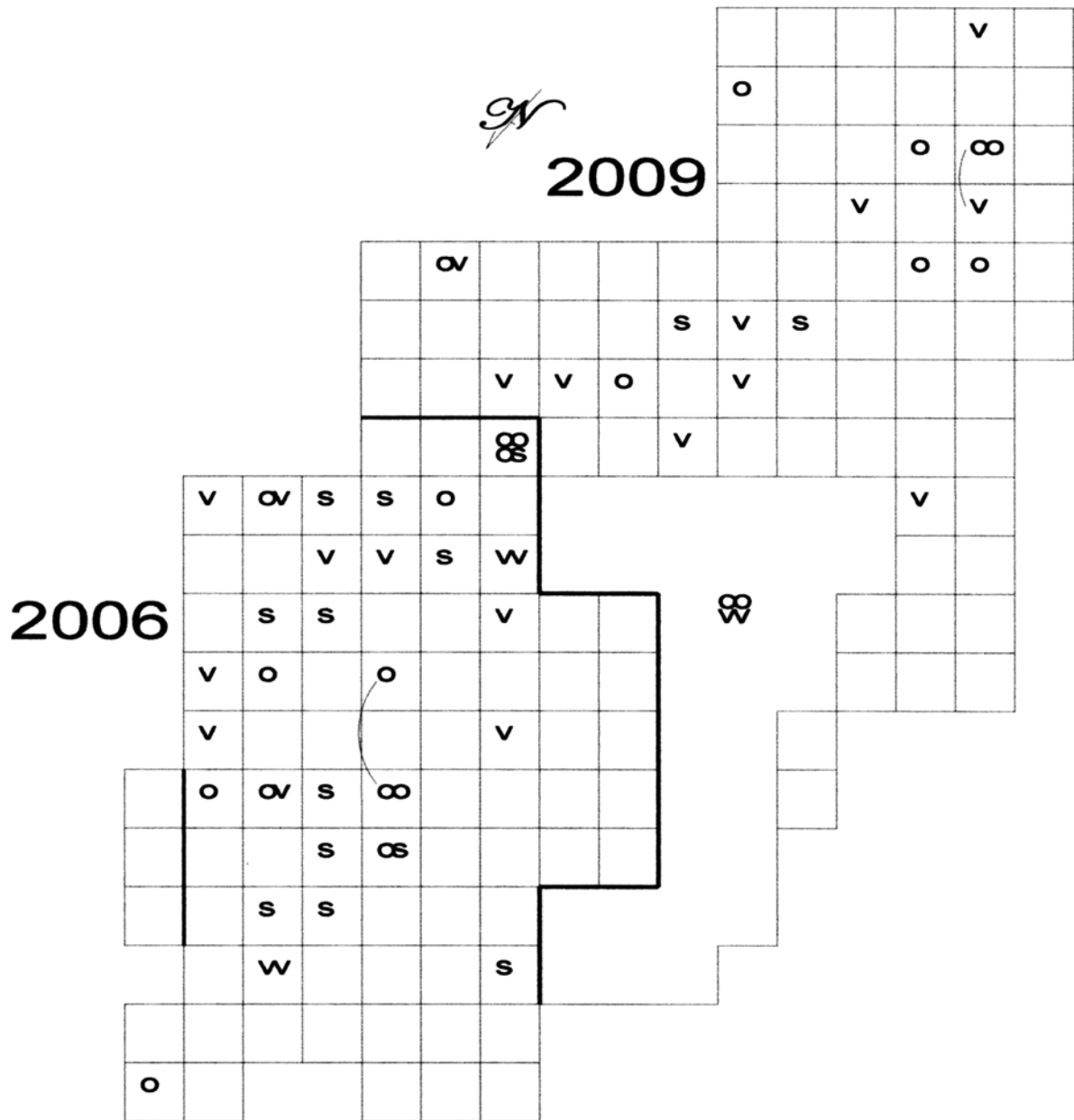


Plate 24. Trench I. Distribution of all cores: single-platform cores (s), opposed-platform cores (o) and various cores (v).

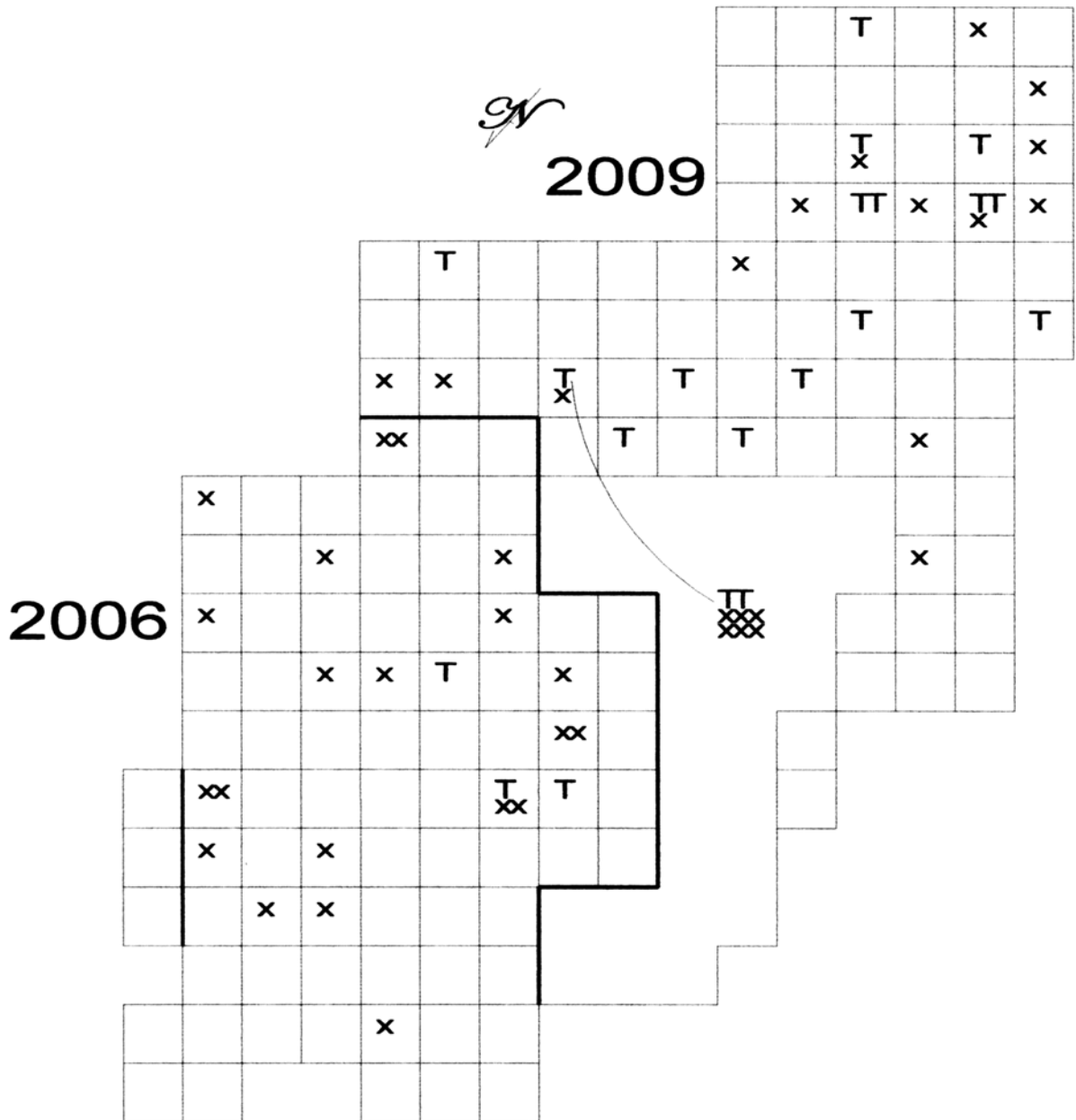


Plate 25. Trench I. Distribution of all tanged points (T) and backed points (x).



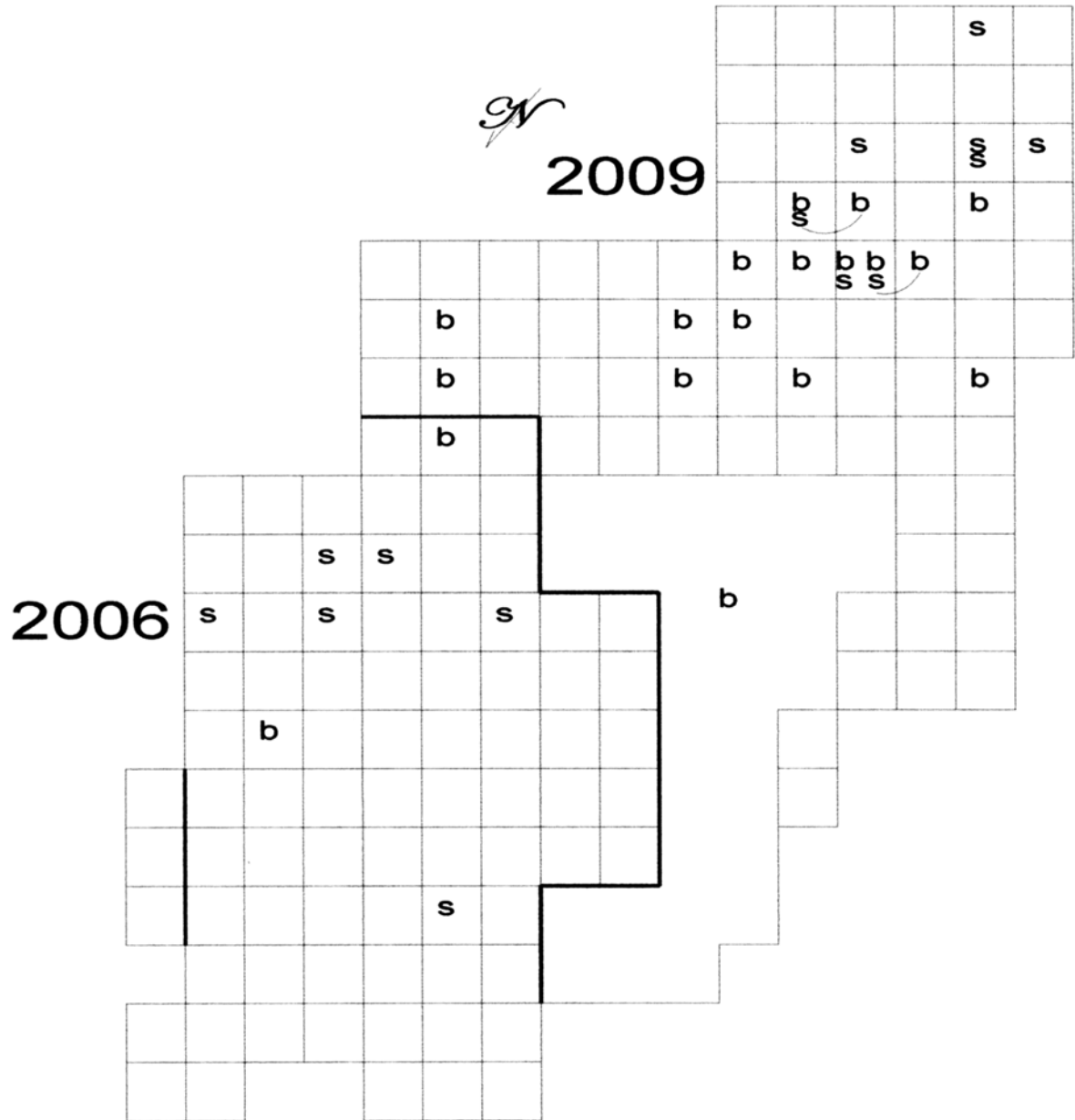


Plate 27. Trench I. Distribution of all burins (b) and burin spalls (s).

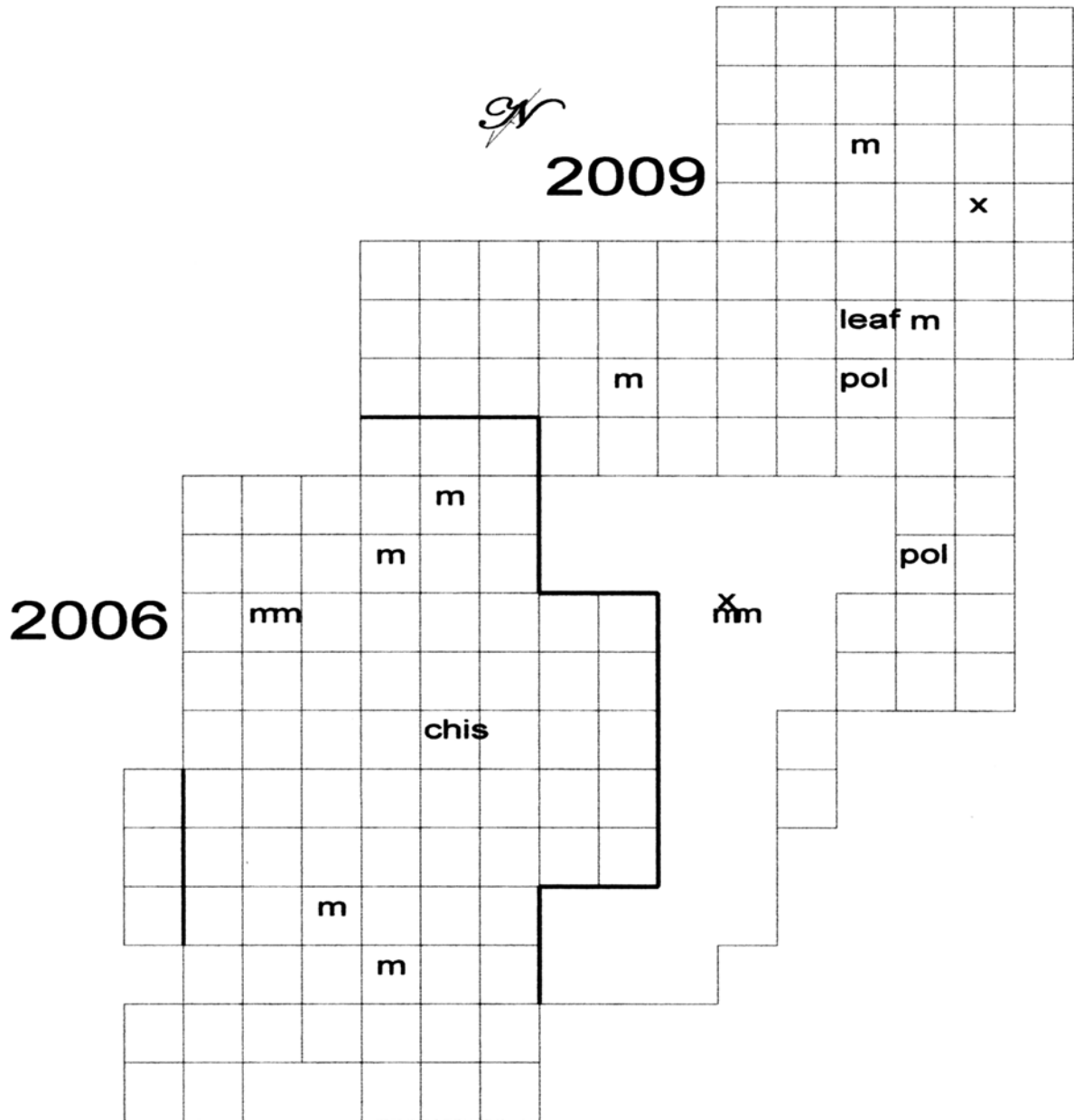


Plate 28. Trench I. Distribution of all post-Palaeolithic objects: microliths (m), pitchstone artefacts (x), leaf-shaped arrowheads (leaf), chisel-shaped arrowheads (chis) and polished stone axehead fragments (pol).

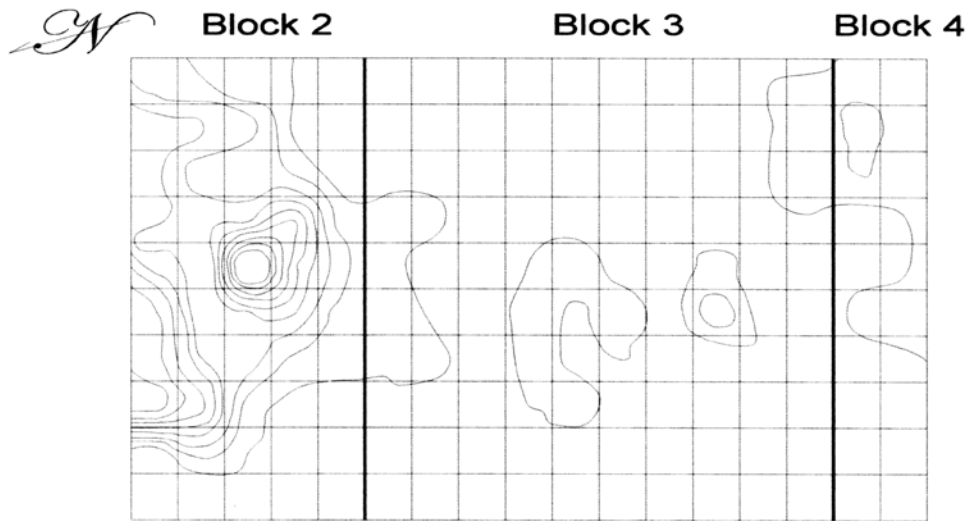


Plate 29. Trench II. Distribution of all worked flint.

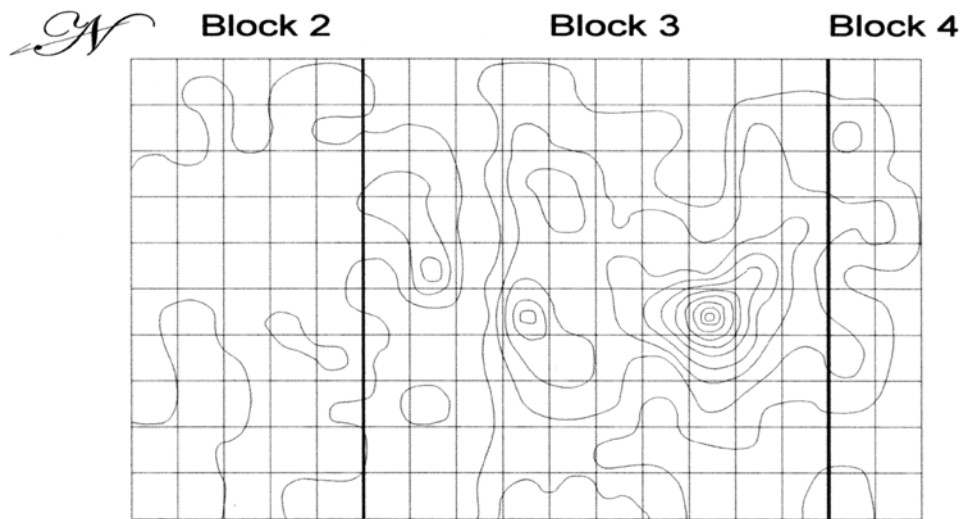


Plate 30. Trench II. Distribution of all worked chert (includes all local grey and brown cherts, but not orange and red cherts).

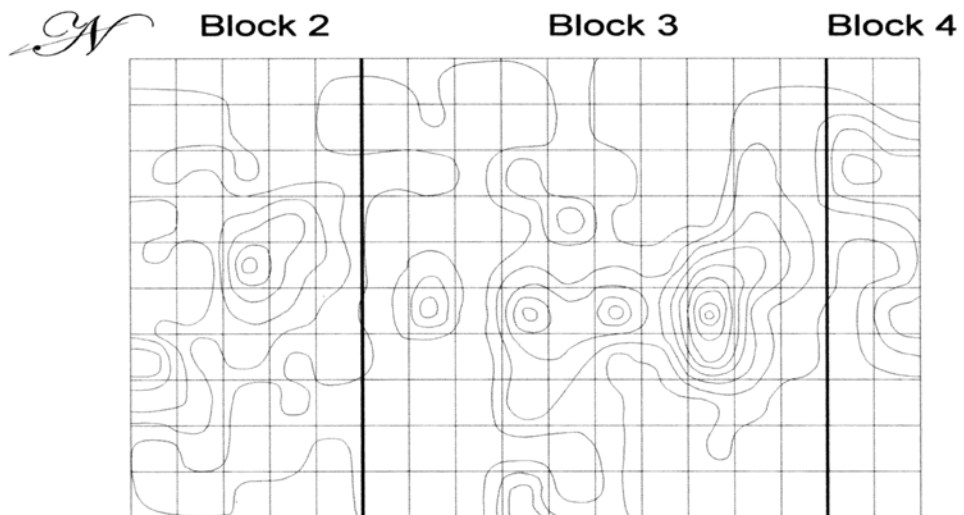


Plate 31. Trench II. Distribution of all blades.

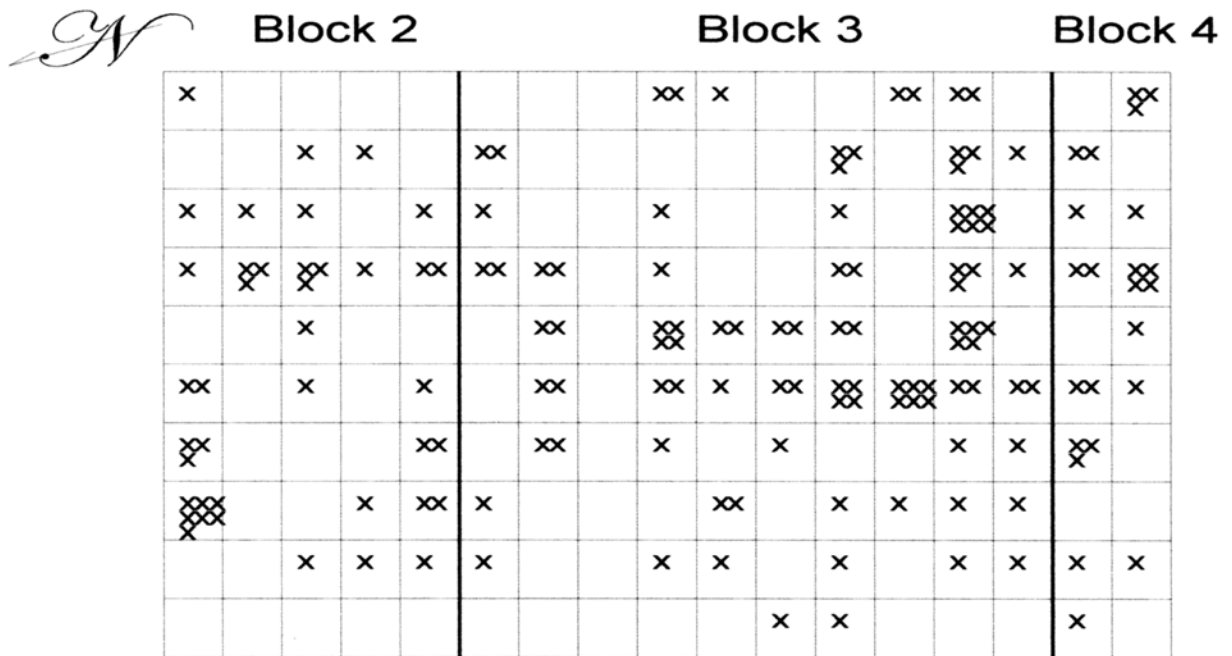


Plate 32. Trench II. Distribution of all microblades.

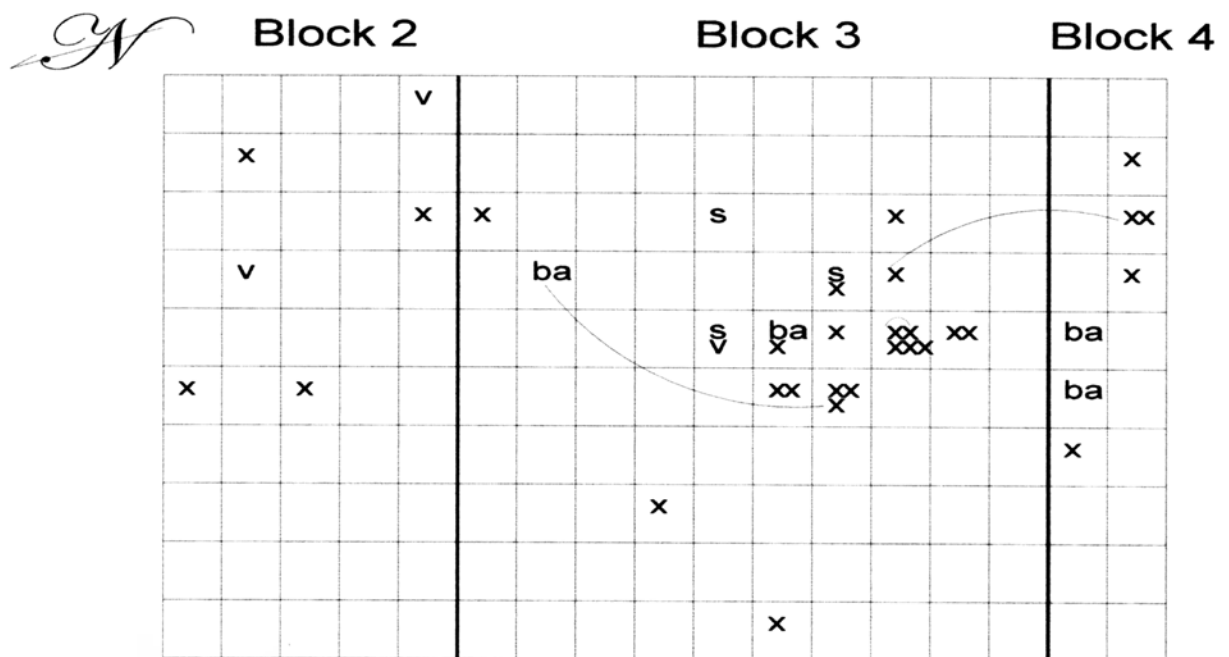


Plate 33. Trench II. Distribution of all worked orange chert: flakes and blades (x), backed points (ba), scrapers (s) and various (v).

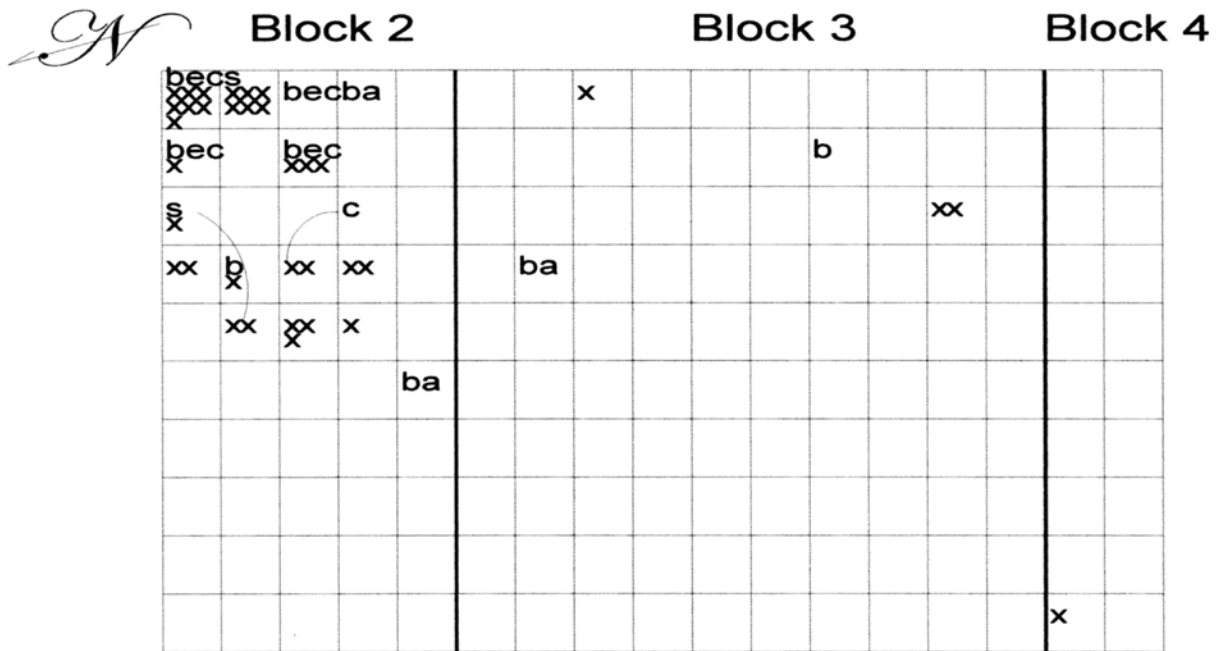


Plate 34. Trench II. Distribution of all worked dark-brown flint: flakes and blades (x), cores (c), backed points (ba), scrapers (s), becs (bec) and burins (b).

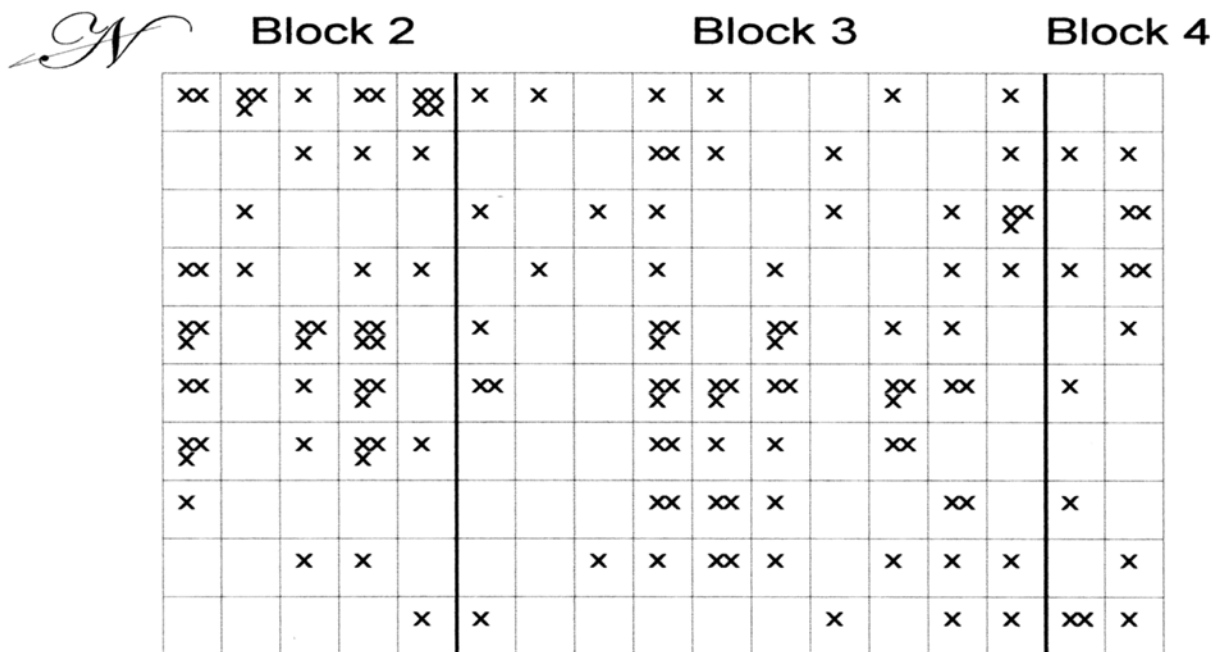


Plate 35. Trench II. Distribution of all burnt lithic artefacts.

*SN*      **Block 2**                      **Block 3**                      **Block 4**

ff				f			f										
		ff	f				ff					e					
		f															
			f									f	f	f			
ff		f	e					e									
ef	f	f		f								f					
f	f	f					f		f								
ff	f							ff									
	ff																
		ff															

Plate 36. Trench II. Distribution of all blanks with en éperon spurs (e) or finely faceted platform remnants (f).

*SN*      **Block 2**                      **Block 3**                      **Block 4**

	c			c				c									
c				pc	cc			cc					cc				c
c	c	cc	p		c			cc	c				c	p	c		
		cc	c			c	c	c	cc	c				c	c	c	
c		cc	cc	c						c	cc	c	c				
cc	c		c			c		pc	c	cc	pc	ccc					c
		c	c		c			p	c	c		cc	c				c
cc	c								c	c				c			
											c		cc				c
								c		c							

Plate 37. Trench II. Distribution of all preparation flakes: crested pieces (c) and platform rejuvenation flakes (p).





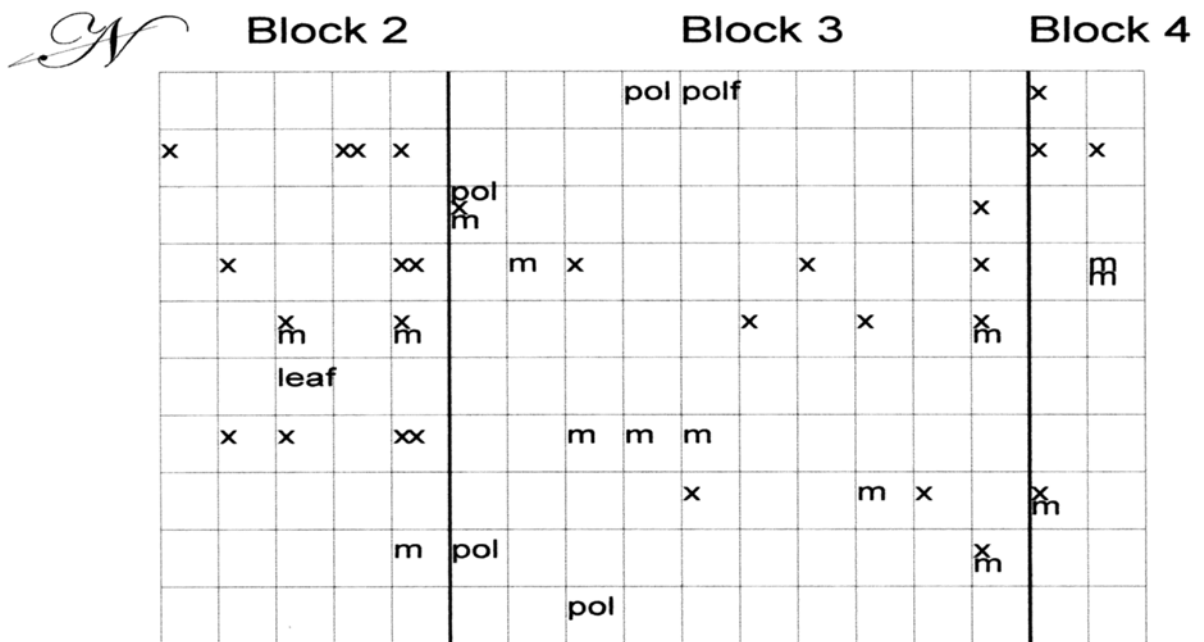


Plate 42. Trench II. Distribution of all post-Palaeolithic objects: microliths (m), pitchstone artefacts (x), leaf-shaped arrowheads (leaf), polished stone axehead fragments (pol) and polished flint axehead fragments (polf).

## Dating

Although the Howburn assemblage as a whole is clearly chronologically mixed, scrutiny of diagnostic elements has allowed it to be subdivided into meaningful spatial units, each of which is thought to be dominated by Late Upper Palaeolithic material. These units are characterized by different debitage, core and tool compositions, as well as by the application of different technological approaches, and different raw material preferences and procurement strategies.

As shown in Plates 28 and 42, the Howburn site was evidently visited in post-Palaeolithic times, and the assemblage includes Mesolithic (33 microliths and microlith-related implements) as well as Neolithic artefacts (three leaf-shaped points, two chisel-shaped points, seven fragments of polished stone or flint axeheads, and 33 pieces of Arran pitchstone). These later pieces were mostly found scattered across the site, rather than accumulating in clusters, and only a small number of peripheral concentrations dominated by local dark-grey chert (Trench I [2006]) are thought to date to the Mesolithic or Early Neolithic periods (Ballin *et al.* 2010). The present and following sections focus on the site's Late Upper Palaeolithic finds, and the Mesolithic and Neolithic finds are not discussed further.

In total, four main Upper Palaeolithic areas were defined, namely Trench I (2006) southern corner, Trench I (2009) southern corner, Trench II (Block 2), and Trench II (Blocks 3-4). The former three areas are all thought to date mainly to the Late Hamburgian or Havelte period, whereas the latter area may date primarily to the following *Federmesser-Gruppen* period. Below, the dating evidence of the Late Upper Palaeolithic areas are discussed one by one with reference to diagnostic raw material preferences, typology, technological attributes, and distribution patterns.

### Trench I (2006)

The Late Upper Palaeolithic finds of this spatial unit are mainly concentrated in three to four flint and chert concentrations in the southern corner of the trench, supplemented by more loosely scattered material across the northern section of the trench (Plates 17 and 18). It is thought that the concentrations in the southern corner combined represent the remains of a tent-like structure, and that the distribution patterns of this dwelling, as well as those representing possible exterior activity areas, may have been disturbed by later Mesolithic and Neolithic settlement in the area (see distribution section).

The Late Upper Palaeolithic finds recovered from Trench I (2006) are generally dominated by grey exotic flint as well as chert forms which, in the Southern Uplands, are unusual or absent in later contexts. The grey flint was initially thought to derive from north-east England (in popular terms referred to as Yorkshire flint), and it is common in Scottish later Neolithic assemblages (Ballin 2009). However, the Howburn assemblage generally includes few later Neolithic finds, and the fact that most of the flint is characterized by extensive frost-damage sets it apart from later collections. Most probably, the Late Upper Palaeolithic settlers at Howburn collected thermally damaged surface flint when passing through either parts of north-east England or (more likely) Doggerland (following the region's reindeer herds?), whereas later Neolithic people in Scotland received Yorkshire flint by exchange, with the flint having been procured in less damaged form from deposits eroding out of sea-cliffs or from the till (cf. Manby 1979: 71; also Durden 1995: 410).

Although a single blade-scraper in dark-grey chert (CAT 704) may be an indication that local chert was used by the earliest settlers, most diagnostic early chert artefacts from Trench I (2006) are in either rust-brown/grey chert or so-called 'complex grey' chert (rust-brown chert: seven blade- or double-scrapers; 'complex grey' chert: one blade-scraper and three fragments of backed points – as well as double-scraper CAT 1236 (Plate 11) from the immediately adjacent parts of Trench I [2009]). These chert forms are practically never seen in post-Palaeolithic assemblages in central southern Scotland, and diagnostic tool forms in these materials are also absent from the other Late Upper Palaeolithic clusters at Howburn. The latter fact probably indicates a temporal difference between this spatial unit and the site's other Havelte concentrations.

Diagnostic tool types include four tanged points, one angle-backed point, 19 fragments of indeterminate backed points, 19 large blade-scrapers, one flake-based *Zinken*, three burins, and three scraper-burins. The small number of tanged pieces are generally asymmetrical Havelte points (dating to c. 12,300-12,000 cal BC; Grimm and Weber 2008 and this volume's Table 3), whereas the remaining fragments of backed pieces may be either fragments of tanged points or backed points *sensu stricto*. The area's blade-scrapers are mostly pieces with acute scraper-edge angles (Figure 23), which set them apart from not only later Neolithic blade-scrapers in similar flint forms, but also from the present site's short end-scrapers (Figure 23). This feature appears to be diagnostic of Late Upper Palaeolithic blade-scrapers. Although only one *Zinken* was found in this part of the site, this piece supports a Hamburgian date; *Zinken*

are strictly datable to the Early and Late Hamburgian periods (e.g., Holm and Rieck 1992: 53), and they are generally absent from other contemporary material cultures, such as the Late Magdalenian (Breest and Veil 1991) and the Creswellian (Jacobi 2004). The area's three burins and two combined burins only date the finds to the pre-Neolithic period.

Technologically, the settlers in Trench I (2006) relied mainly on the reduction of flint and 'deviant' chert forms by the application of opposed-platform blade-technology, and platforms were prepared by fine faceting and formation of *en éperon* spurs along the platform-edge. Although opposed-platform cores are quite common in Late Mesolithic/Early Neolithic chert assemblages, those later cores are usually short and stocky, whereas several opposed-platform cores at Howburn are long and slender. Some of the single-platform cores in Trench I (2006) clearly represent later stages in the reduction of opposed-platform cores (e.g., CAT 828). Although fine faceting of platforms also forms part of the later Neolithic Levallois-like approach (Ballin 2011a; 2011b)], the combined use of fine faceting and *en éperon* technique is a distinct Late Upper Palaeolithic feature (Barton 1990).

### Trench I (2009)

Where the potential Late Upper Palaeolithic dwelling in Trench I (2006) may have been affected by a notable post-Palaeolithic presence at the location, the Late Upper Palaeolithic finds in Trench I (2009) were mainly recovered from a tight circular to oval cluster in the trench's southern corner (e.g., Plate 17). The delimitation of this cluster is so neat and tight that there is little doubt that it represents the remains of a dwelling, most likely a tent structure similar to those known from the roughly contemporary sites at Jels and Slotseng in southernmost Denmark (Holm 1991; Holm and Rieck 1992).

Although a small number of diagnostic post-Palaeolithic artefacts indicate that this area was visited after the abandonment of the Upper Palaeolithic settlement, this did not affect the spatial patterns significantly. The clearest indication of these later visits to this part of the site is the difference in the composition of the area's topsoil assemblage and its subsoil assemblage. The former includes approximately 30% chert, whereas the latter only includes 2% chert. This suggests that the Upper Palaeolithic settlers in this part of the site almost exclusively relied on flint, and this flint is almost entirely frost-damaged, so-called Yorkshire or Doggerland flint. Trench I (2009) includes small amounts of brown chert, but generally no rust-brown/grey or 'complex grey' chert. The only implement in the latter raw material is double-scraper CAT 1236 (Plate 11) from the area immediately next to the potential dwelling in Trench I (2006) and away from the cluster in the area's southern corner.

Diagnostic Late Upper Palaeolithic implements include 16 tanged points, five angle-, curve- or straight-backed points, 14 fragments of indeterminate backed points, 33 blade-scrapers, one blade-based *Zinken*, one combined scraper-*Zinken*, one combined scraper-*bec*, 17 burins, and two combined scraper/tanged points. The tanged points (as well as the two combined tanged points) are generally asymmetrical Havelte points, with a substantial proportion of those being pieces with a lateral notch and spur. On the European continent, the notch and spur feature seems to be a characteristic element of Late Hamburgian assemblages (Hartz 1987: 9).

As shown below – in connection with the discussion of the date of the assemblage from Trench II (Blocks 3-4) – backed points post-dating the Havelte period may to a large extent be made of chert. The fact that the angle-, curve- and straight-backed pieces from Trench I (2009) are all in flint implies that these pieces may be contemporary with the area's Havelte points. The blade-scrapers and blade-based double-scrapers are mainly pieces with acute scraper-edges like those from Trench I (2006). As stated above, these acute working-edges are a diagnostic trait, suggesting that the assemblage from this area generally dates to the Late Upper Palaeolithic. The solitary blade-based *Zinken*, as well as the combined scraper-*Zinken*, are datable to the Hamburgian period in general. The many burins are only datable to the pre-Neolithic period, although their high number and the fact that many are manufactured on truncated pieces suggest an Upper Palaeolithic date (Hartz 1987: 10-21). One *bec* (CAT 1399) is of a type similar to those found in Trench II (Block 2). Several of those *becs* are manufactured on finely faceted blanks, and as the concentration including most of the site's *becs* also embrace one *en éperon* blade, one cylindrical blade core, three backed pieces and one burin, it is almost certain that the site's *becs* are datable to the Late Upper Palaeolithic (probably Havelte) period.

Like the settlers of Trench I (2006), the group visiting Trench I (2009) represents a blade industry dominated by opposed-platform blade cores and platform preparation by fine faceting and formation of *en éperon* spurs along the platform-edge. In contrast to the settlers of Trench I (2006), the Late Hamburgian settlers of Trench I (2009) most likely relied almost exclusively on the use of flint (as demonstrated by the composition of the subsoil assemblage). This difference in raw material preferences may indicate a temporal difference between the two Trench I assemblages.

### Trench II (Block 2)

As the main concentration in this area has been truncated by the northern trench boundary (e.g., Plate 29), it is not possible to determine with any degree of certainty whether these finds represent a dwelling or

not. A concentration of dark-brown flint artefacts in the area's north-eastern corner (Plate 34), characterized *inter alia* by a number of almost standardized *becs*, may represent a slightly earlier or later visit to this part of the site (discussed separately below).

The fact that Trench II (Block 2) is defined by a comparatively high proportion of flint probably indicates a relatively early date in the Late Upper Palaeolithic (see Trench II [Blocks 3-4 below]). Although the area as a whole has an almost equal representation of flint and chert, the finds from the subsoil are, as in Trench I (2009), almost exclusively in flint. It is thought that the occurrence of much chert in the area is due partly to the general scattering of Late Mesolithic and Early Neolithic material across the Howburn site, and partly to overspill of slightly later *Federmesser-Gruppen* material from Trench II (Blocks 3-4). As in Trench I (2009), all tanged and straight-backed points are in flint, and artefacts in the characteristic rust-brown/grey and 'complex grey' cherts retrieved from Trench I (2006) are absent.

The typological composition of this spatial unit corresponds largely to that of Trench I (2009). The assemblage includes diagnostic tools such as six tanged points, six straight-backed points, four fragments of indeterminate backed pieces, 11 blade-scrappers, three burins, one scraper/burin and – from the concentration of dark-brown flints – five *becs*. The tanged points are generally asymmetrical Havelte points, some with a lateral notch and spur. As mentioned above, the area's straight-backed points are all in flint, possibly indicating contemporaneity with the concentrations tanged pieces. The blade-scrappers are mostly pieces with acute edge-angles, suggesting a Late Upper Palaeolithic date.

The general composition of the dark-brown flint concentration implies that the well-executed, apparently standardized *becs* may date to the Havelte period. This concentration includes one *en éperon* blade, one cylindrical blade core, three backed pieces and one burin, and three of the *becs* have finely faceted platform remnants. The fact that the cluster of dark-brown flints seems to have its own concentration of burnt flint, separated from the scatter of burnt flint associated with Block 2's main artefact concentration, supports the notion of the dark-brown flint representing a separate visit to the site (or possibly the corner of a larger, as yet undiscovered, Upper Palaeolithic concentration in the vicinity).

Technologically, the Trench II (Block 2) assemblage corresponds to that of Trench I (2009) – it is based on the focused exploitation of frost-damaged Yorkshire/Doggerland flint; it represents a blade industry manufactured by opposed-platform technique, but with some stages of the production being carried out

mainly from one platform, resulting in the manufacture of some single-platform cores; and the platforms of these cores were prepared mainly by fine faceting and formation of *en éperon* spurs along the platform-edge. These technological attributes all suggest a Late Upper Palaeolithic date, and some of these attributes (such as the application of *en éperon* technique) date the finds more specifically to the Havelte period.

#### Trench II (Blocks 3-4)

The finds from this area differ substantially from those of the other three areas, as most finds are in chert (Plate 30). The artefacts were recovered largely from one central cluster, with some deriving from a number of small satellite concentrations. With most of the finds being in chert (and most of the chert being dominated by the local dark-grey form), it was initially thought that this material represented either Late Mesolithic or Early Neolithic settlement in the area, which was supported by the recovery of several microliths, pitchstone artefacts and axehead fragments from Blocks 3-4 (Plate 42). This, however, is not supported by the bulk of the dating evidence.

As mentioned in the distribution section, the concentration in this area of backed points (Plate 39) indicates a Late Upper Palaeolithic date, and the fact that many of these are in chert probably implies a slightly later date than the site's Late Hamburgian finds. The location's Havelte period assemblages are generally characterized by an almost exclusive use of flint, and the points are mainly tanged forms. This proposal is further supported by a scarcity of *en éperon* and finely faceted blanks (4% against c. 20-25% in all other areas; Table 19). The small assemblage of *en éperon* and finely faceted blanks, as well as two tanged points, probably represent 'overspill' from the Block 2 assemblage, such as a small peripheral activity area.

The fact that a cluster of unusual (probably exotic) orange chert (Plate 33), including several backed pieces, overlaps the main Block 3-4 concentration perfectly may suggest that the orange and some of the common dark-grey cherts in this area are contemporary. A small number of conjoined orange chert artefacts link several small chert clusters to the area's main scatter.

As demonstrated in the distribution section, it is quite likely that many narrowblades were produced as part of the production of Late Upper Palaeolithic broadblades, and the maps showing the distribution of blades and microblades in Blocks 3-4 overlap precisely (Plates 31 and 32). As shown in Figure 27, there are considerable similarities between the Block 3-4 chert blades and the blades from the *Federmesser-Gruppen* site Kilmelfort Cave on the Scottish west-coast, and it appears that, in Scotland, *Federmesser-Gruppen*

blades are generally quite narrow. The double-peaked character of Figure 27's curve for the Block 3-4 blades may indicate the mixing of Late Mesolithic and *Federmesser-Gruppen* blades, with one peak around a blade width of 5 mm (Late Mesolithic?) and one around 9 mm (*Federmesser-Gruppen*?) – unless the best blades produced by the area's *Federmesser-Gruppen* visitors were removed from the site? This latter option is supported by the shape of the Kilmelfort blade curve, which has its peak around 6-7 mm, although it is quite likely that flint blades at this time were smaller and narrower on the west-coast, far from the sources of good quality flint in large nodules on Doggerland and in Yorkshire.

Typologically, this area is composed differently to the Havelte-dominated Howburn areas, with backed points (ten straight-backed pieces and one curve-backed piece) being substantially more numerous than tanged forms (two pieces). In addition, 11 fragments of indeterminate backed points were recovered. This assemblage also includes six blade-scrapers (many with acute edge-angles), 11 burins, two scraper/burins, and one combined tanged point/piercer. Although it is possible that some of the area's 11 short end-scrapers may represent later intrusion, dominance of short end-scrapers over blade-scrapers is also a characteristic attribute of the Kilmelfort Cave assemblage (Saville and Ballin 2009), where all 25 flint scrapers are short forms, but the small size of the scrapers from Kilmelfort cave may also be an effect of a different raw material procurement situation.

Technologically, the most important detail is the almost complete absence of fine faceting and *en éperon* technique, and the reliance on traditional trimming/abrasion instead. This suggests a different, probably

later, date to that suggested for the three Late Hamburgian areas at Howburn.

In connection with the artefact presentation above, the site's truncated pieces were subdivided into a number of categories, namely 1) relatively large/broad flake- and blade-based pieces with regular oblique or straight truncations; 2) fairly slender blade-based pieces with regular oblique or oblique/concave truncations, occasionally with additional lateral modification; and 3) more irregular blanks with relatively irregular truncations. It was suggested that truncated pieces of Group 1 may mainly have functioned as knives; that pieces of Group 2 may be related to the site's backed points; and that pieces of Group 3 may cover a range of functions. Similarities with implements from sites such as Jels 1 and 2 (Holm and Rieck 1992) and Gough's Cave (Jacobi 2004) indicate that truncated pieces of Group 1 may generally be diagnostic of the Hamburgian and contemporary industries, and the fact that one of the Group 2 pieces (CAT 3031; Plate 13) displays *en éperon* platform-edge preparation suggests that this group may be datable to the same Late Upper Palaeolithic period. Regular truncated pieces are generally quite rare in Scottish post-Palaeolithic assemblages.

As mentioned in the introduction, a piece of *Betula* (birch) charcoal from a pit provided the site's only radiocarbon date (SUERC-17872/GU-16472: 1855±35 BP or cal AD 70–240), indicating a visit to the site in the Roman Iron Age. In radiocarbon years, the Hamburgian period is usually dated approximately to 12,700–12,000 cal BC, and the *Federmesser-Gruppen* period to c. 12,000–10,800 cal BC. Recent research (e.g., Grimm and Weber 2008; Terberger 2006; Weber and Grimm 2009; this volume's Table 3) indicates a date of c. 12,300–12,000 BP for the Late Hamburgian, or Havelte, phase.

## The Palaeo-environmental Context of the Site<sup>2</sup>

### Introduction

'Loch Howburn' is one of a number of former lakes in the Southern Uplands which are thought to have been dammed by contemporary ice-fronts (Figure 4). Conventional wisdom (e.g., Bennett *et al.* 2007; Price 1961; Thomas and Montague 1997), though not supported by dating controls, sees these lakes as pre-dating by some time the period in the Windermere Interstadial when hunters visited Howburn. This chapter will focus on the sediments in-filling 'Loch Howburn' and their dating, to test the assumed chronology.

### Methodology

Aerial photographic interpretation, geomorphological mapping of landforms and interrogation of commercial borehole logs held by the British Geological Survey (<http://www.bgs.ac.uk/geoindex>) provided the framework for further investigations. Sediments were described in the field from 94 boreholes along seven transects (Figure 5) using a 300 mm diameter, 1 m long Eijelkamp peat gouge: boreholes were not surveyed to OD but the ground surface is broadly level at c. 242 m above OD. Sediments for laboratory analyses were

retrieved from boreholes 30a, 50, 50a and 56a (Figure 29), typical deep stratigraphies, using a closed-chambered Russian-type corer of 600 mm diameter and 1 m length, with c. 500 mm overlaps. These were prepared and described in more detail in the laboratory the day after sampling: particle size distributions were estimated, and Munsell colours determined on moist sediment under artificial light. Contiguous digital photographs, each c. 12 cm in length, of mineral sediment units at boreholes 30a (141.0-411.0; 424.0-518.0 cm), 50 (448.0-874.0 cm), 50a (750.0-974.0 cm) and 56a (250.0-600.0 cm) were taken under laboratory conditions using a Panasonic Lumix DMC-FZ18 digital camera, with c. 100 mm overlaps, the scale provided by a 1 m ruler. Changes in lamina thickness, colour, conformity and the inclination of the lamina were systematically recorded. Thin-sections were prepared at the University of Stirling (<http://www.thin.stir.ac.uk/>) from 80 x 50 x 30 mm Kubiena tins gently pushed into Russian core samples in the field, from boreholes 50 (694.0-702.0 cm; 705.0-713.0 cm), 50a (920.5-928.0 cm), 56a (498.5-506.0 cm) and 30 (396.0-404.0 cm; 363.0-371.0 cm; 215.0-223.0 cm). They were examined using an Olympus BX51 polarizing microscope: images of thin-sections were taken using a Leica DC300 MTV-3

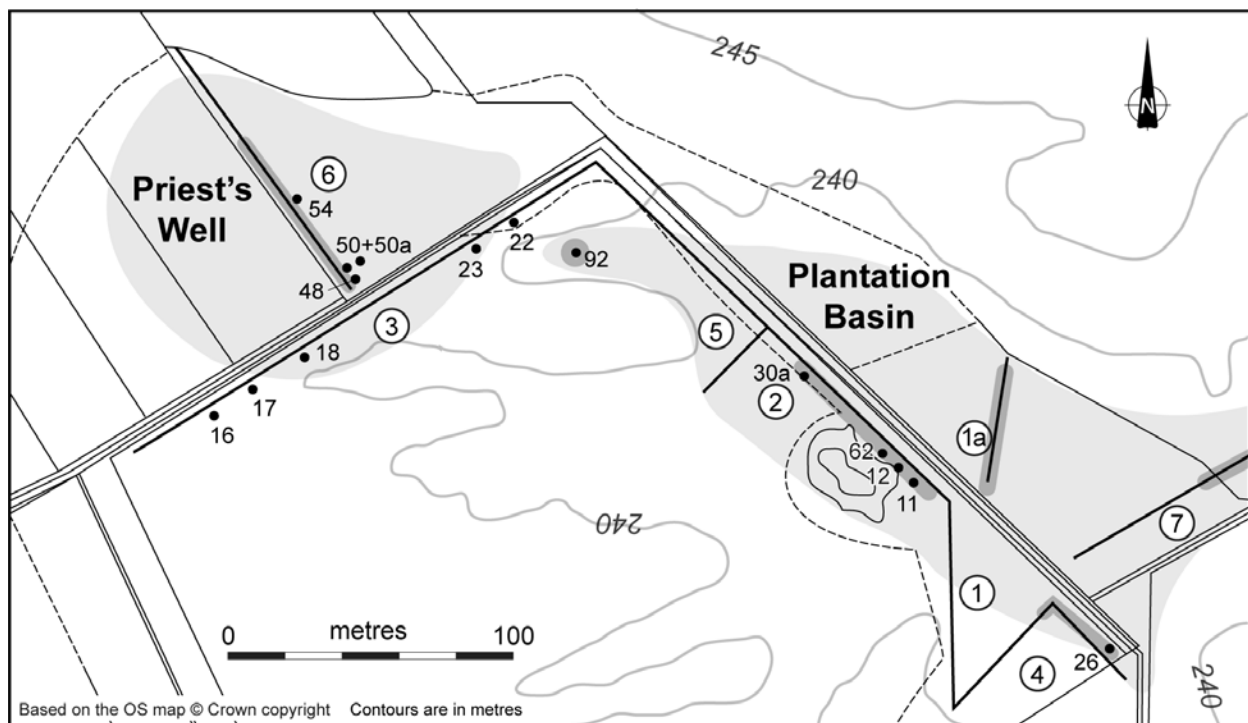


Figure 29. The south west part of the valley floor at Howburn showing contours, field boundaries and drains, numbered transects (circled) and selected boreholes. The extents of surface peat in the Priest's Well and Plantation Basins are shaded.

<sup>2</sup> A simplified version of this chapter was published as Tipping *et al.* (2016).

microscope camera through analySIS. The criteria of Ringberg and Erlström (1999) were used to explore the origin of the laminated sediment. Contiguous 10 mm thick samples of sediment were removed from cores at borehole 50 between 4.84 m and 8.74 m depth (deeper sediments in borehole 50a were sampled only later): moisture content (%) was recorded by weight loss after oven-drying at 105°C for 8 hours, carbon content (%) by weight loss after furnacing at 550°C for 4 hours and carbonate content (%) by weight loss after furnacing at 950°C for 2 hours (Dean 1974; Heiri *et al.* 2001). The residue remaining from these last analyses is the silica content (%).

Pollen analyses were made from sediment in borehole 50 at 8.58 and 8.52 m depth, and at 100 mm intervals from 6.94 m to 4.84 m depth in borehole 50 from 5.0 mm thick sediment slices, treated by physical and chemical techniques (Moore *et al.* 1991), stained in safranin and counted to 300 total land pollen (tlp) using an Olympus BX40 binocular microscope at magnifications x400, and x1000 under oil immersion, to establish the likely ages of sediments at these depths.

AMS <sup>14</sup>C dating was undertaken on four samples of short, <20 mm long stems of a very short-lived aquatic moss, *Calliergon* cf. *C. cuspidatum*, delicately preserved with intact leaves lying horizontally within laminae or structureless sediment in boreholes 50, 54 and 30. Table 20 summarizes the results: depths of samples in different boreholes are correlated by sediment stratigraphies to the equivalent depth in borehole 30. Geochemical analyses of tephra in borehole 50a are described next.

### Tephrochronology of borehole 50a in the Priest's Well Basin

#### Methodology

The sediment sequence in borehole 50a in the Priest's Well Basin was scanned for tephra shard content (cryptotephra: ash layers invisible to the eye and usually <125µm in size) from three core sections sampled by a 1 m long, 6 cm Russian peat corer: 7.00-8.00 m, 8.00-9.00 m and 8.97-9.97 m.

Processing involved the laboratory screening of samples of 2 to 5g dry weight from contiguous c. 5 cm long sediment blocks. Samples were immersed in 10% HCl acid for 2 hours to remove carbonates, and sieved to retain the 80 to 15µm fraction, before being subjected to heavy-liquid floatation using Sodium Polytungstate (SPT) to remove organic matter and extract any tephra (Blockley *et al.* 2005, with modifications). Tephra glass shards from the supernatant of the extraction float were identified and counted under high-powered polarizing light microscopy. Where significant numbers of glass

Table 20. Details of the AMS <sup>14</sup>C assays obtained on sediment in the Plantation and Priest's Well Basins.

701.5-702.0 cm: weakly developed colour-laminated sub-mm thick couplets of 10YR2/1 black organic fine detrital mud and 5Y4/1 dark grey silt with clay; gradual to
702.0-753.0 cm: 5Y4/1 dark grey silt with clay, seemingly structureless but with indistinct particle-size defined mm-thick silt and clay laminae; gradual to
753.0-756.0 cm: structureless 5Y5/2 olive grey clay with very rare moss stems; gradual to
756.0-829.0 cm: 5Y4/1 dark grey silt with clay, clay with silt between c. 798 and c. 822 cm, seemingly structureless but with indistinct particle-size mm-thick silt and clay laminae; gradual to
829.0-842.0 cm: 5Y4/1 dark grey structureless silt with one diffuse band of darker matter; gradual to
842.0-849.0 cm: 5Y4/2 olive grey structureless clay; sharp to
849.0-851.0 cm: strongly developed colour-laminated mm-thick couplets of 5Y2.5/1 black and 5Y4/1 dark grey silt; all internal boundaries sharp; sharp to
851.0-855.0 cm: 5Y2.5/1 black structureless silt; sharp to
855.0-860.75 cm: strongly developed colour-laminated mm-thick couplets of 5Y2.5/1 black and <<1 mm-thick 5Y4/1 dark grey silt; all internal boundaries sharp; sharp to
860.75-874.0 cm: 5Y4/1 dark grey structureless silt with four strongly colour-laminated mm-thick 5Y2.5/1 black and mm-thick 5Y4/1 dark grey silt at 869.0-870.0 cm; all internal boundaries to these sharp; sharp to
874.5-907.0 cm: 5Y5/1 grey particle-size laminated clay and silt and rare 10YR7/6 yellow fine-medium sand at 876, 878, 888, 898.5, 902-902.5 and several 905-907 cm, each lamina very well sorted with sharp upper and lower boundaries; clay = silt but with great variation, clay plus silt << sand; black lamina at 902.5 cm; sharp to
907.0-974.5 cm: 5Y5/1 grey particle-size laminated clay and silt, each lamina very well sorted with sharp upper and lower boundaries; clay = silt but with great variation; 10YR7/6 yellow fine-medium sand laminae at 932, 938, 942-943 cm; bottomed on bedrock.

shards were recorded, a second contiguous series of 1 cm-long sub-samples was prepared to precisely define the tephra distribution and shard concentration. All samples were dried and weighed to allow quantification of the number of glass shards per gram of dry sediment.

Once detected, tephra shards were extracted from what were considered to be peaks in concentration

and therefore separate eruptive events. These were then prepared for single-grain chemical analysis by mounting shards on epoxy stubs and then analysed using micro-analytical techniques. The Priest's Well Basin sequence underwent two programmes of major and minor element chemical analysis:

1. The 7.20-7.30 m section of borehole 50a was analysed with a five-spectrometer Cameca SX-1000 wavelength-dispersive electron microprobe (WDS-EPMA) in the University of Edinburgh's Tephra Analytical Unit (01/09/2011). The instrument was calibrated using standard calibration blocks and vitreous secondary standards. Analyses were performed using an accelerating voltage of 15keV, beam current of 2nA for Na, Al, Si, Fe, K, Ca and Mg and 80nA for F, Mn, Cl, P, S and Ti. The operational beam diameter was 5 $\mu$ m.
1. The 7.78-7.79 m part of the same borehole was analysed using the Jeol JXA8600 electron microprobe, equipped with four-spectrometers and SamX software, at the Research Laboratory for Archaeology and the History of Art, University of Oxford (18/10/2012). The instrument was calibrated using standard calibration blocks and vitreous secondary standards. Accelerating voltage of 15keV, beam current of 6nA, defocused (10 $\mu$ m) beam to minimize Na migration. Count times: 30s on each peak, except for Na (10s), and Cl (60s).

The ATHO-G, Gor-132-G, LIPARI and StHs6/80-G fused glass secondary standards from the MPI-DING collection (Jochum *et al.* 2006) were analysed between and within the WDS-EPMA analytical runs to check precision and accuracy. Reference to databases of chemical signatures (Tephabase; Newton *et al.* 2007; RESET; Bronk Ramsey *et al.* 2015) provided correlation to known tephra horizons.

### Results and Interpretation

Volcanic ash was detected in varying quantities in the cores spanning 8.97-9.97 m and 7.00-8.00 m depth in borehole 50a. Slides from the section 8.00-9.00 m were assessed but no tephra was observed.

*8.97-9.97 m depth:* very few shards were obtained from this part of the sequence. Those that were observed were predominantly colourless shards and appear angular to sub-angular in morphology. Note was taken of some shards that had perhaps been subject to reworking as they displayed rounding and surface crystallisation within vesicles. The shard concentration profile (Figure 30) demonstrates no clear concentration of volcanic glass with very low values throughout (less than one shard per gram of dry sediment). Absence of

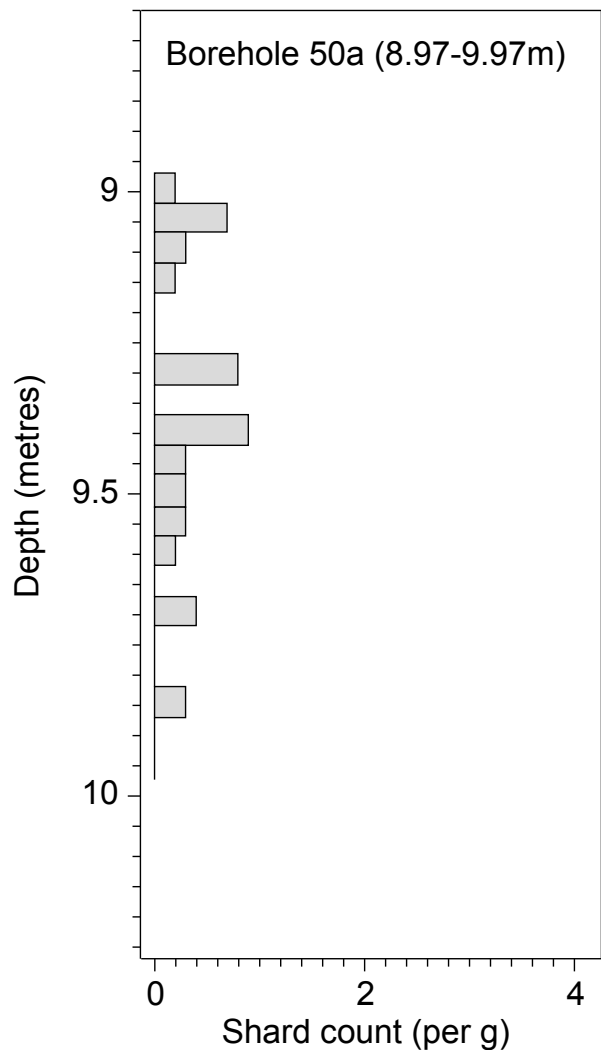


Figure 30. Shard concentration profile from 5 cm scan samples in borehole 50a, depths 8.97-9.97 m. No clear peak can be identified and shard numbers are extremely low.

clear tephra 'peaks' prevented re-extraction of 1 cm contiguous sections. An attempt was made to obtain tephra for element chemical analysis by combining two 5 cm sediment blocks (9.27-9.32 m; 9.32-9.37 m), however no glass shards were recovered. In the absence of microprobe chemistry, it is not possible to say whether the very low concentrations represent the products of one, or more, eruptions. The intermittent presence of very low numbers of tephra shards over nearly 1 m of core could represent the reworking of earlier tephra(s) in an active sedimentary environment, but what they are and where they originate cannot be resolved.

*7.00-8.00 m depth:* the 5 cm scan samples showed that this section contained abundant tephra shards which are predominantly colourless and fluted to platy in their morphology and a smaller component of shards which are vesicular in morphology. Shards span the full size range defined by the sieve mesh, they are angular,

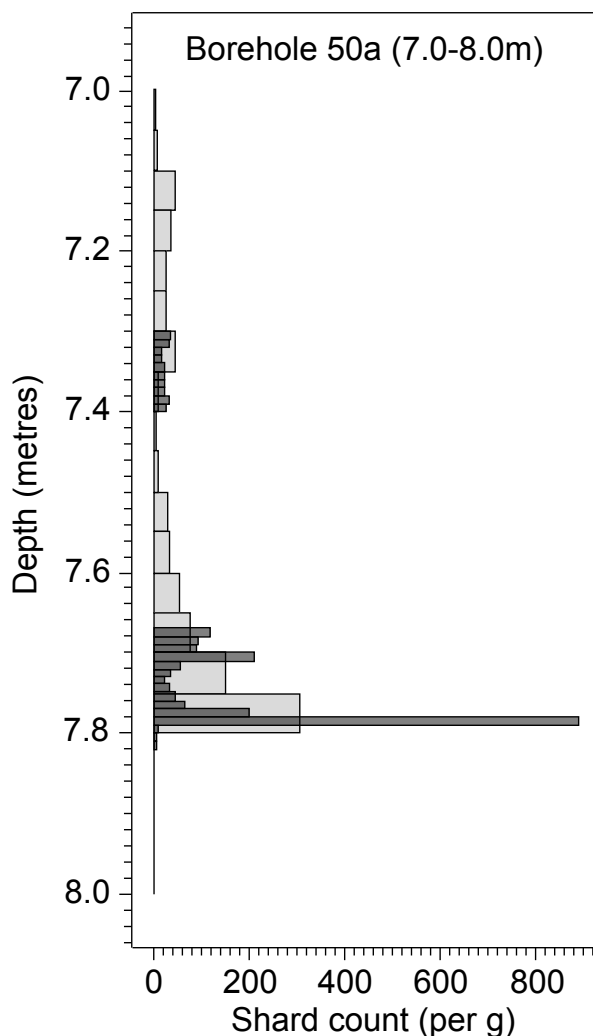


Figure 31. Shard concentration profile from 7.00-8.00 m in borehole 50a. Blue histograms are the 5 cm scan samples; green histograms the 1 cm higher resolution samples. The main tephra isochron is located at 7.78-7.79 m. The upward-trending tail of remobilised shards continues to c.7.10 m. Only selected levels were counted at 1 cm resolution.

and some display evidence of hydration rims around the edge. The latter may be related to alteration in the depositional environment and therefore caution was exercised when obtaining WDS-EPMA microprobe analyses. The scan profile showed a major tephra peak between 7.75-7.80 m (c. 300 shards  $g^{-1}$ ) and secondary peaks at 7.30-7.35 m (c. 44 shards  $g^{-1}$ ) and 7.10-7.15 m (c. 44 shards  $g^{-1}$ ).

To further refine the pattern of distribution, contiguous samples of 1 cm vertical length and 0.3 to 0.6g were taken from the following depths: 7.30-7.40 m and 7.67-7.82 m (25 samples in total). The shard concentration profile for the upper 1 m section of the borehole (Figure 31) incorporates the 5 cm vertical length scan samples (displayed as light-grey histograms) and the 1 cm vertical length higher resolution samples (dark-

grey). The 1 cm samples show that the main isochron (the ash fall event, with a maximum of c. 890 shards  $g^{-1}$ ) is located at a depth of 7.78-7.79 m. There is very little remobilisation of ash below this point, but considerable reworking of glass shards is evident in the overlying sediments.

A total of 20 analyses were obtained from 7.20-7.30 m and 19 analyses from 7.78-7.79 m (Tables 21-22). Seventeen of the analyses from the higher level share a similar chemical composition to those from the lower. Comparisons to existing data sets suggest the shards originate from the Icelandic volcano Katla (Figures 32), which erupted several times during the Late Glacial and early Holocene (e.g., Lane *et al.* 2012). As a result, there are a number of possible correlatives.

An age-depth model from the Plantation Basin constrains the possible tephra correlatives in the Priest's Well Basin. A P-Sequence deposition model in Oxcal 4.3 (Bronk Ramsey 2008) was constructed based on three radiocarbon determinations from boreholes 62, 12 and 26 (Table 20): the model uses inferred depths to link the two basins (c. 7.60 m in borehole 50/50a for SUERC-34256:  $10295 \pm 40$  BP; c. 7.70 m for SUERC-29723:  $10505 \pm 30$  BP; c. 8.50 m for SUERC-29722:  $11035 \pm 35$  BP) and the depths and stratigraphic positions of the radiocarbon dates. An additional constraint on the model was the accepted calendar age of the Vedde Ash based on the ice core GICC05 age (converted to years BP) of  $12,121 \pm 57$ . The model was also run using automatic outlier detection and this reported that the Vedde Ash age used had an 8% possibility to be outlying, but 92% of the Vedde age was used in the model (see Bronk Ramsey 2009). The resulting age-depth model (Figure 33) shows that the tephra shard concentration at 7.785 m depth is situated between two 95% probability age ranges: 12,448-11,980 and 13,020-12,745 cal BP. This locates the tephra to the time period of the Loch Lomond Stadial (Younger Dryas). On the basis of the age model, two possible Katla correlatives - the Greenland Stadial GS-2 Dimna Ash (Koren *et al.* 2008) and the early Holocene Suđuroy Tephra (Wastegård, 2002) - may be excluded. The model provides reasonable grounds to correlate the 7.78-7.79 m Priest's Well tephra with the Vedde Ash. The Vedde Ash is a mid GS-1 eruption which has been previously reported from the neighbouring Scottish site of Whitrig Bog (Turney *et al.* 1997) and from numerous more distal sites across north-west Europe. While there are other eruptions with Vedde like chemistry, none of these date to the time period indicated by the model (Lane *et al.* 2012).

The Greenland Stadial GS-1 Abernethy Tephra (MacLeod *et al.* 2015; formerly the 'AF555' of Matthews *et al.* 2011) is potentially present in the sediments from the Priest's Well Basin. In support of this contention are three factors:

Table 21a-b. Major and minor element data, from WDS-EPMA, for cryptotephra samples from core 50a in the Priest's Well basin. 21a) Stratigraphic level 7.20-7.30m; 21b) Stratigraphic level 7.78-7.89m. Data are presented as non-normalised weight percent oxide (wt %) values. Associated secondary standard glass analyses (listed as batches a-b in 'Std batch' column) are reported in the Supplementary Information Table 22. Data points marked by 'Y' in column 'Excl.' are identified as outliers (contaminants or detrital glass) and have been omitted from Figures 32 and 34.

Table 21a. Stratigraphic level 7.20-7.30m (WDS-EPMA data)

DataSet/Point	SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	FeO	MnO	MgO	CaO	Na <sub>2</sub> O	K <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	SO <sub>2</sub>	Cl	F	Total	Facility	Std batch	Correlation
HBf720-730_1	71.76	0.28	13.07	3.69	0.13	0.22	1.21	5.07	3.46	0.03	0.02	0.17	0.24	99.33	Edinburgh	a	Vedde Ash
HBf720-730_2	72.33	0.28	13.34	3.66	0.14	0.19	1.19	5.17	3.58	0.03	0.01	0.16	0.24	100.32	Edinburgh	a	Vedde Ash
HBf720-730_3	70.95	0.28	12.88	3.80	0.14	0.22	1.32	4.95	3.33	0.04	0.03	0.17	0.20	98.30	Edinburgh	a	Vedde Ash
HBf720-730_4	72.04	0.29	13.20	3.83	0.14	0.17	1.26	5.05	3.85	0.04	0.01	0.17	0.21	100.27	Edinburgh	a	Vedde Ash
HBf720-730_5	71.29	0.27	13.11	3.60	0.11	0.23	1.26	5.22	3.54	0.04	0.03	0.19	0.25	99.14	Edinburgh	a	Vedde Ash
HBf720-730_6	72.08	0.28	13.17	3.41	0.16	0.15	1.29	5.29	3.77	0.03	0.00	0.17	0.26	100.07	Edinburgh	a	Vedde Ash
HBf720-730_7	70.11	0.30	12.97	3.73	0.16	0.20	1.35	5.09	3.60	0.04	0.02	0.17	0.20	97.94	Edinburgh	a	Vedde Ash
HBf720-730_8	71.52	0.28	13.11	3.83	0.12	0.19	1.23	5.16	3.58	0.04	0.01	0.15	0.19	99.40	Edinburgh	a	Vedde Ash
HBf720-730_9	70.50	0.28	13.26	3.78	0.17	0.19	1.14	5.21	3.48	0.02	0.02	0.15	0.21	98.41	Edinburgh	a	Vedde Ash
HBf720-730_10	70.83	0.27	13.16	3.63	0.14	0.18	1.17	5.37	3.55	0.03	0.02	0.15	0.21	98.73	Edinburgh	a	Vedde Ash
HBf720-730_11	71.00	0.29	13.12	3.97	0.16	0.22	1.30	5.42	3.49	0.04	0.02	0.17	0.25	99.45	Edinburgh	a	Vedde Ash
HBf720-730_12	72.60	0.28	13.68	3.68	0.15	0.19	1.26	5.08	3.59	0.03	0.02	0.17	0.23	100.97	Edinburgh	a	Vedde Ash
HBf720-730_13	72.44	0.28	12.92	3.87	0.15	0.19	1.42	5.31	3.63	0.04	0.01	0.16	0.24	100.67	Edinburgh	a	Vedde Ash
HBf720-730_14	71.54	0.28	13.27	3.73	0.15	0.20	1.26	5.06	3.57	0.04	0.01	0.17	0.23	99.51	Edinburgh	a	Vedde Ash
HBf720-730_15	72.11	0.28	13.30	3.66	0.16	0.23	1.21	5.29	3.85	0.04	0.03	0.17	0.23	100.56	Edinburgh	a	Vedde Ash
HBf720-730_17	73.11	0.12	11.93	1.51	0.04	0.07	0.75	4.25	3.73	0.01	0.01	0.12	0.14	95.78	Edinburgh	a	cf Borrobol
HBf720-730_18	72.43	0.12	11.97	1.34	0.04	0.06	0.72	4.20	3.92	0.01	0.00	0.12	0.13	95.06	Edinburgh	a	cf Borrobol
HBf720-730_19	73.30	0.12	12.24	1.49	0.05	0.06	0.74	4.29	3.74	0.01	0.00	0.12	0.15	96.30	Edinburgh	a	cf Borrobol
HBf720-730_20	71.78	0.27	13.61	3.80	0.15	0.19	1.24	5.23	3.40	0.03	0.01	0.16	0.25	100.11	Edinburgh	a	Vedde Ash
HBf720-730_21	71.70	0.27	13.25	3.67	0.13	0.21	1.27	5.23	3.63	0.03	0.01	0.17	0.20	99.77	Edinburgh	a	Vedde Ash

Table 21b. Stratigraphic level 7.78-7.89m (WDS-EPMA data)

DataSet/Point	SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	FeO	MnO	MgO	CaO	Na <sub>2</sub> O	K <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	SO <sub>2</sub>	Cl	F	Total	Excl.	Facility	Std batch	Correlation
RH0467_1	70.85	0.32	13.18	3.81	0.09	0.17	1.28	5.20	3.54	0.03	n.a.	0.20	n.a.	98.67		Oxford	b	Vedde Ash
RH0467_2	70.47	0.27	13.12	3.63	0.19	0.17	1.26	5.48	3.58	0.08	n.a.	0.17	n.a.	98.42		Oxford	b	Vedde Ash
RH0467_3	71.16	0.28	13.01	3.68	0.18	0.19	1.21	5.32	3.56	0.03	n.a.	0.17	n.a.	98.79		Oxford	b	Vedde Ash
RH0467_4	70.57	0.31	13.25	3.88	0.10	0.18	1.25	5.47	3.57	0.08	n.a.	0.18	n.a.	98.84		Oxford	b	Vedde Ash
RH0467_5	70.04	0.34	12.93	3.82	0.16	0.18	1.29	5.37	3.60	0.08	n.a.	0.19	n.a.	97.98		Oxford	b	Vedde Ash
RH0467_6	67.52	0.29	12.55	3.56	0.16	0.15	1.15	5.21	3.30	0.08	n.a.	0.23	n.a.	94.19		Oxford	b	Vedde Ash
RH0467_7	69.60	0.25	12.92	3.62	0.12	0.16	1.24	5.46	3.66	0.08	n.a.	0.16	n.a.	97.27		Oxford	b	Vedde Ash
RH0467_8	70.22	0.34	13.39	3.64	0.19	0.17	1.21	5.24	3.44	0.04	n.a.	0.22	n.a.	98.10		Oxford	b	Vedde Ash
RH0467_9	63.46	0.25	11.67	3.21	0.12	0.17	1.04	4.43	3.14	0.08	n.a.	0.29	n.a.	87.86	Y	Oxford	b	
RH0467_10	67.53	0.27	12.56	3.41	0.16	0.19	1.17	4.88	3.39	0.05	n.a.	0.22	n.a.	93.82		Oxford	b	Vedde Ash
RH0467_11	65.07	0.29	12.92	3.36	0.23	0.15	1.24	4.84	3.20	0.07	n.a.	0.26	n.a.	91.63		Oxford	b	Vedde Ash
RH0467_12	69.37	0.29	13.49	3.65	0.09	0.18	1.32	5.31	3.48	0.07	n.a.	0.19	n.a.	97.42		Oxford	b	Vedde Ash
RH0467_13	70.78	0.25	13.11	3.85	0.10	0.20	1.21	5.53	3.55	0.06	n.a.	0.20	n.a.	98.85		Oxford	b	Vedde Ash
RH0467_14	65.98	0.25	12.27	3.59	0.12	0.18	1.15	5.03	3.28	0.03	n.a.	0.22	n.a.	92.09		Oxford	b	Vedde Ash
RH0467_15	61.91	0.20	11.55	3.04	0.11	0.16	1.04	4.44	3.11	0.02	n.a.	0.33	n.a.	85.90	Y	Oxford	b	
RH0467_16	67.71	0.28	12.80	3.42	0.10	0.17	1.24	5.14	3.49	0.07	n.a.	0.23	n.a.	94.64		Oxford	b	Vedde Ash
RH0467_17	69.03	0.26	12.84	3.66	0.14	0.18	1.26	5.56	3.47	0.06	n.a.	0.19	n.a.	96.65		Oxford	b	Vedde Ash
RH0467_18	69.04	0.31	12.87	3.66	0.11	0.19	1.26	5.16	3.46	0.06	n.a.	0.18	n.a.	96.30		Oxford	b	Vedde Ash
RH0467_19	68.57	0.30	12.85	3.58	0.20	0.17	1.16	5.10	3.55	0.05	n.a.	0.20	n.a.	95.72		Oxford	b	Vedde Ash
RH0467_20	69.43	0.29	13.06	3.58	0.12	0.20	1.25	5.06	3.58	0.06	n.a.	0.19	n.a.	96.80		Oxford	b	Vedde Ash
RH0467_21	69.55	0.23	13.25	3.54	0.10	0.18	1.31	5.08	3.58	0.05	n.a.	0.19	n.a.	97.08		Oxford	b	Vedde Ash

Table 22. WDS-EPMA secondary standard glass data, including preferred values (Jochum et al. 2006).

Batch	Standard	SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	FeO	MnO	MgO	CaO	Na <sub>2</sub> O	K <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	SO <sub>2</sub>	Cl	F	Total	Facility
(a)	LIPARI	74.42	0.08	13.08	1.55	0.07	0.04	0.74	4.04	5.21	0.01	0.00	0.37	0.18	99.79	Edinburgh
(a)		2σ	0.01	0.24	0.17	0.02	0.02	0.06	0.15	0.15	0.01	0.01	0.01	0.02		
(b)	StHs6/80	63.72	0.72	17.62	4.43	0.07	1.95	5.31	4.52	1.32	0.18	n.a.	0.03	n.a.	99.88	Oxford
(b)		(average n=7)														
(b)		2σ	0.10	0.20	0.11	0.03	0.05	0.05	0.14	0.04	0.02		0.01			
(b)	ATHO-G	75.54	0.26	12.20	3.24	0.13	0.11	1.74	4.08	2.74	0.03	n.a.	0.07	n.a.	100.14	Oxford
(b)		2σ	0.21	0.14	0.16	0.04	0.01	0.03	0.06	0.06	0.02		0.01			
(b)	GOR132-G	45.98	0.30	10.97	10.16	0.16	22.01	8.52	0.82	0.03	0.03	n.a.	0.02	n.a.	98.98	Oxford
(b)		2σ	0.13	0.17	0.19	0.06	0.06	0.14	0.11	0.01	0.01		0.01			

## Preferred Values

Standard	SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	FeO	MnO	MgO	CaO	Na <sub>2</sub> O	K <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>
ATHO-G	75.6	0.255	12.2	3.27	0.106	0.103	1.7	3.75	2.64	0.025
	95% cl	0.7	0.016	0.1	0.005	0.01	0.03	0.31	0.09	0.004
GOR132-G	<b>45.5</b>	<b>0.306</b>	<b>11.0</b>	<b>10.1</b>	<b>0.154</b>	<b>22.4</b>	<b>8.45</b>	<b>0.83</b>	<b>0.0308</b>	<b>0.036</b>
	95% cl	0.4	0.013	0.1	0.007	0.2	0.12	0.04	0.0034	0.012
LIPARI	<b>73.94</b>	<b>0.09</b>	<b>12.95</b>	<b>1.5</b>	<b>0.07</b>	<b>0.05</b>	<b>0.73</b>	<b>4.25</b>	<b>5.1</b>	n.a.
	95% cl	0.2	0.03	0.07	0.04	0.02	0.04	0.04	0.07	n.a.
StHs6/80-G	63.70	0.703	17.8	4.37	0.076	1.97	5.28	4.44	1.29	0.164
	95% cl	0.50	0.021	0.2	0.004	0.04	0.09	0.14	0.02	0.018

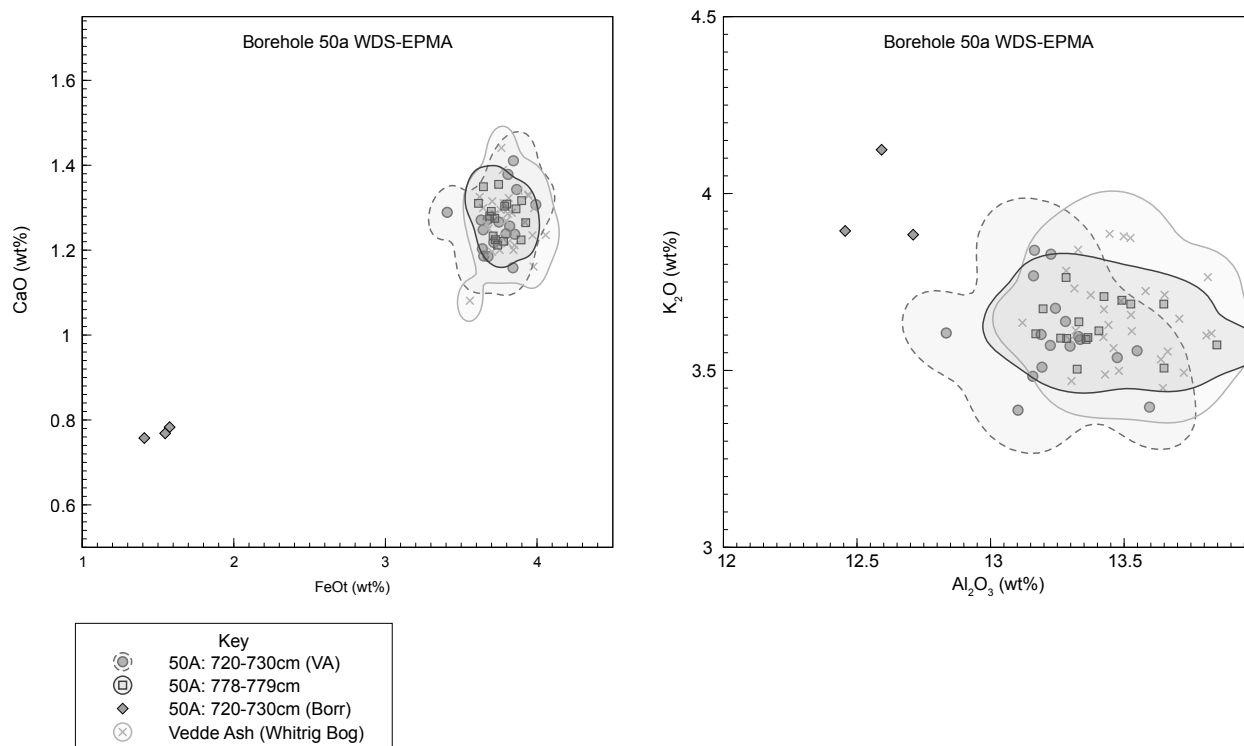


Figure 32.  $\text{CaO-FeOt}$  and  $\text{K}_2\text{O-Al}_2\text{O}_3$  bi-plots showing the 7.78-7.79 m analyses in comparison to those from 7.20-7.30 m at Howburn/Priest's Well. Also shown are published WDS-EPMA data from Turney *et al.* (1997) for the Vedde Ash in Whitrig Bog. Three non-Vedde Ash glass shards in 7.20-7.30 m (dark blue) have a significantly different chemical composition (see Figure 34).

1. The WDS-EPMA data set from 7.20-7.30 m shows a tephra originating from an eruption of Katla.
2. The stratigraphic position – above the Vedde Ash but prior to the onset of the Holocene c. 6.96 m – would be consistent with the Abernethy Tephra.
3. The shard concentration profile exhibits similarities to those reported from Borrobol in Scotland and Lake Madtjärn in Sweden where MacLeod *et al.* (2015) have argued for the presence of this tephra.

In the case of the Priest's Well Basin, no clear hiatus in shard presence separates the higher concentration, stratigraphic-lower, first peak from the lower concentration, stratigraphic-higher, second peak. It is likely that the degree of reworking of the Vedde Ash in the Priest's Well Basin may be hiding a second ash fall of tephra from Katla, with the minor peak at c. 7.20-7.30 m representing a muted signature for the Abernethy Tephra. Similar sedimentary processes to those observed in this study have been reported by Palmer *et al.* (2015) from Lake Flixton with the reworking of the Vedde Ash interpreted as pulsed influx into the basin, coupled with high sedimentation rates in the latter part of the stadial. Other sites in Scotland have a clearer record of the Abernethy Tephra, for example Muir Park Reservoir, Loch Etteridge, Abernethy Forest, and Lochan an Druim (Lowe and Roberts 2003; Lowe *et al.* 2008a; Matthews *et al.* 2011; Ranner *et al.* 2005).

Three of the analysed shards from 7.20-7.30 m have a different geochemical composition, with  $\text{FeOt}$  (%wt) values <2% and  $\text{CaO}$  (%wt) values <1%. They are unlikely to be from the Vedde Ash and probably represent a small second population of tephra. No shards with similar glass chemistry were observed in the WDS-EPMA analyses from 7.78-7.79 m. The position in the Priest's Well Basin, in late GS-1 sediments associated with the Abernethy Tephra, rules out a correlative with the early Holocene 'Borrobol-type' tephtras reported by Lind *et al.* (2013) and Timms *et al.* (2016). A possible source is shown in Figure 34, the distal-only Icelandic eruptions referred to as the Borrobol and Penifiler Tephra. The dating of these tephra is not as well resolved as the Vedde Ash but stratigraphically they are known to be widely present in Scottish Late Glacial Interstadial sediments (Pyne-O'Donnell *et al.* 2008). If indeed associated with one or more of these Greenland Interstadial eruptions, the three non-Vedde Ash shards from 7.20-7.30 m in borehole 50a must be in a reworked position, possibly coming from older sediments washed into the basin from actively eroding land surfaces in the catchment.

#### The environmental context: results and interpretations

Figure 29 is a map of the south west end of the former 'Loch Howburn', almost surrounded by glaciofluvial gravel (Figure 5), showing the positions of six of the

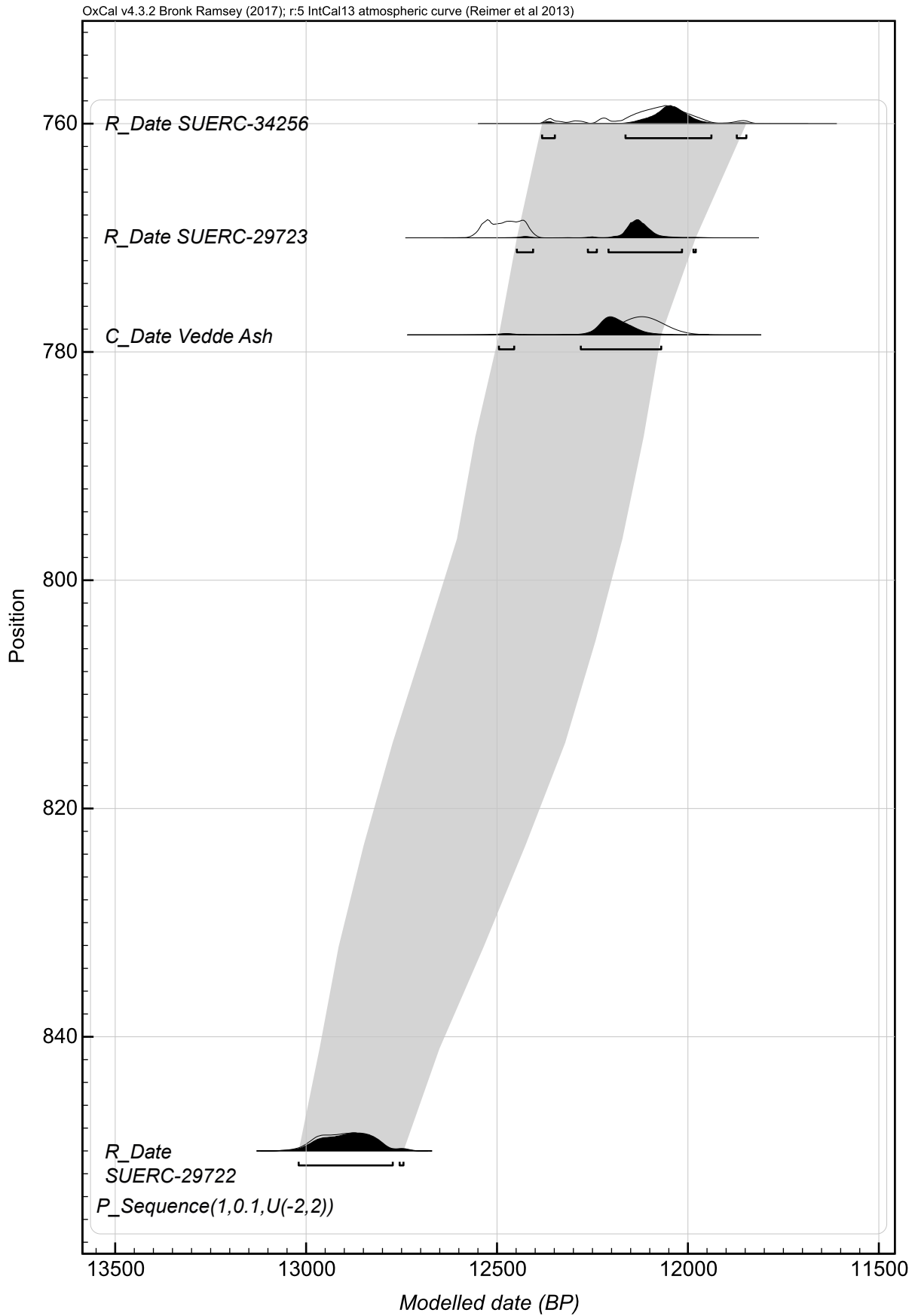


Figure 33. Bayesian depositional model for Priest's Well based on three terrestrial plant radiocarbon dates (in text). The age model was refined using the 'P\_Sequence' function in OxCal v4.3.2 (Bronk Ramsey 2008) and the IntCal13 atmospheric curve (Reimer et al., 2013).

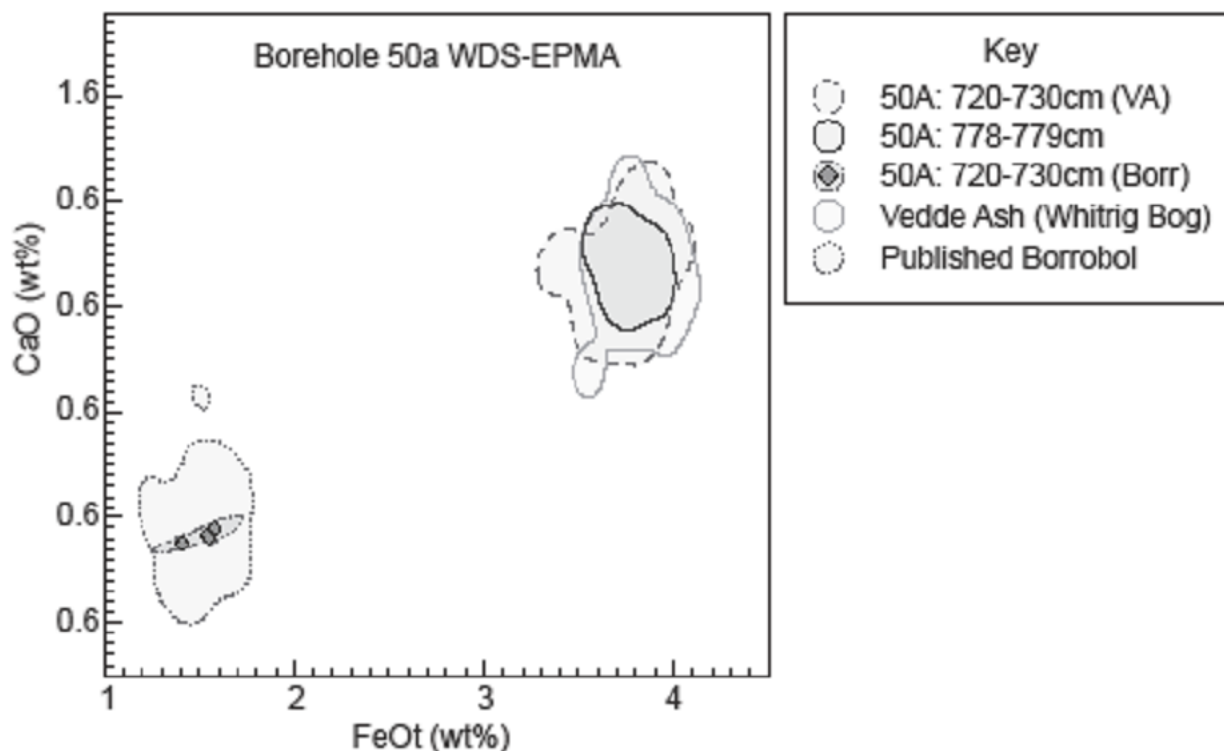


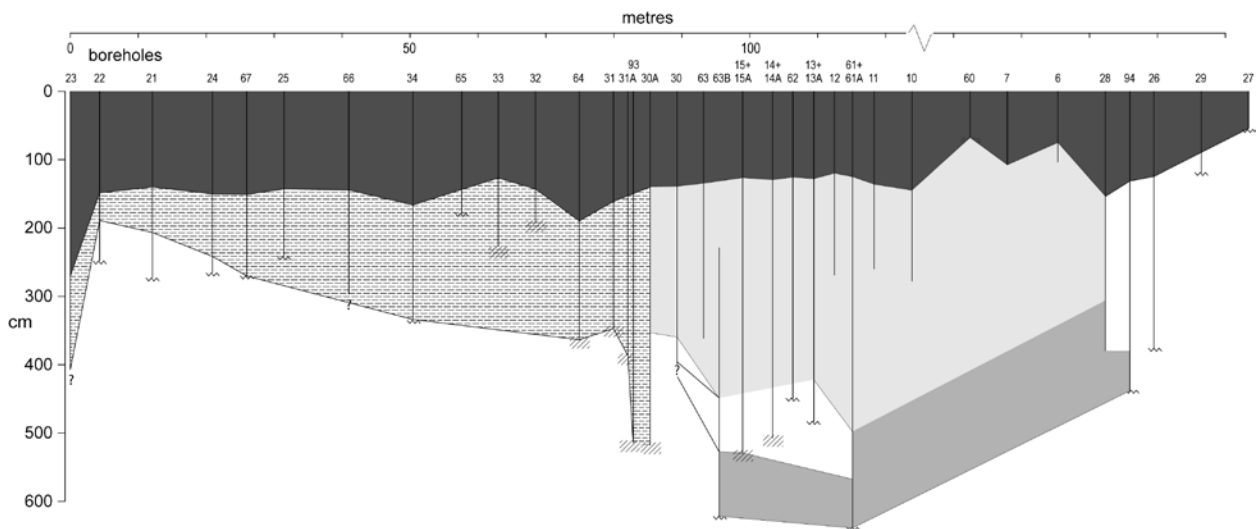
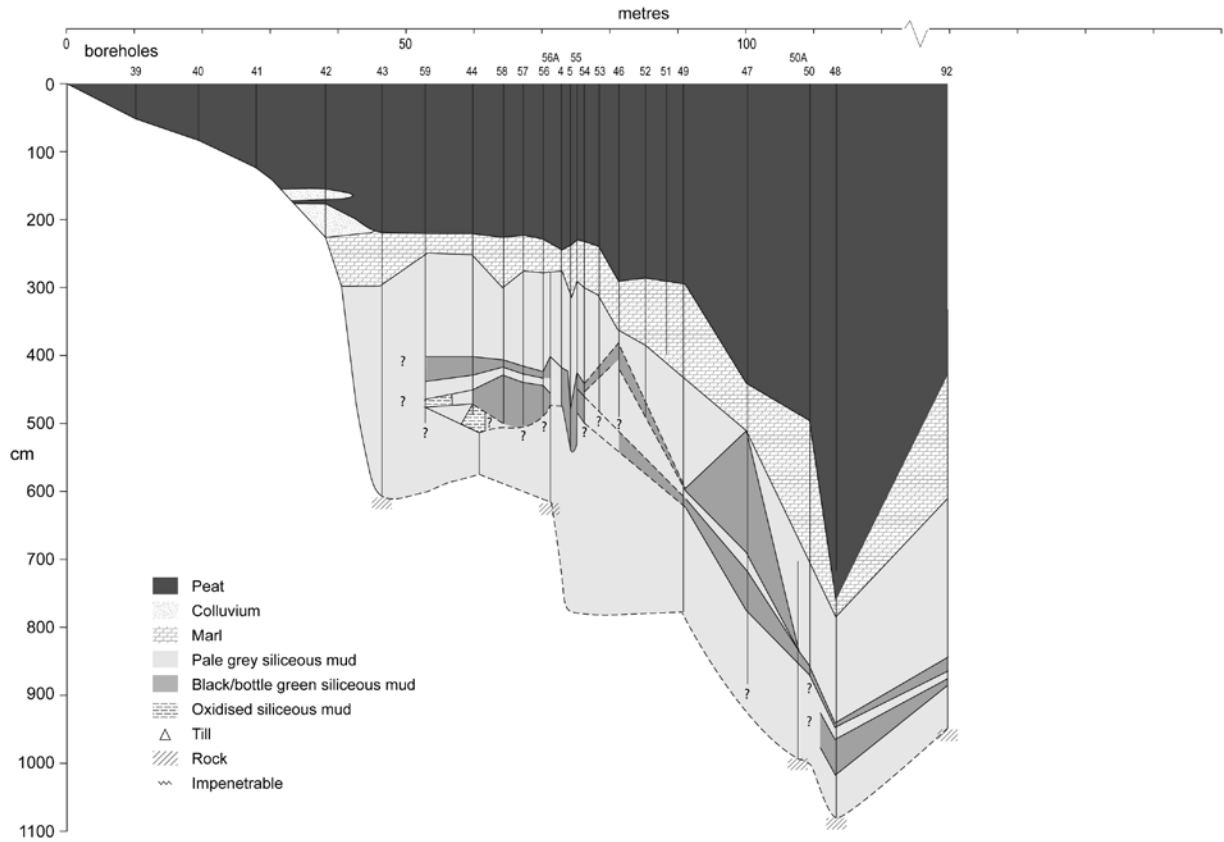
Figure 34. CaO-FeOt bi-plot showing that the three remobilised non-Vedde Ash shards in 7.20-7.30 m (dark blue) match well to published Borrobol and Penifiler WDS-EPMA data.

seven sediment-stratigraphic transects (Transect 7 continues north-east for 1250 m; Figure 4), and selected boreholes. Very dense conifer trees prevented the extension of Transects 6 and 5, but gravel underlies the trees. Transect 3 is dominated by fluvial sediments from the in-flowing Candy Burn (Figure 5) and is not considered further.

Two basins were identified from coring: the Priest's Well Basin and the Plantation Basin. Figure 35 is the simplified sediment stratigraphy of Transect 6 from the west at borehole 39 along the centre of the Priest's Well Basin to borehole 48. Borehole 92 is almost at right-angles to this, representative of a very narrow outlet to the Plantation Basin, with borehole 23 at the eastern side. The Priest's Well basin is a steep-sided basin east of borehole 42, where it is bedrock-lined, but the eastern side is gravel-lined and rises even more steeply. The basin reaches nearly 11 m deep in borehole 48. The basal sediments are pale-grey siliceous mud, or pinkish-grey when fine sand content is comparatively high. These are overlain by one or several bands of black, very dark-grey, bottle-green, and sometimes olive-green siliceous mud that were, on sampling, strongly sulphurous in scent. Figure 37 is a photograph from a prepared Russian core showing a gradual change from pale-grey to black and bottle-green mud between 405.5-415.0 cm depth in borehole 56a. Black and bottle-green colours are stratigraphically distinct from each

other in most boreholes. Several thin bands of this sediment are found in Borehole 50 between 850 and 874 cm depth (55-63% of the siliceous muds; see the explanation of Figure 41 below). Pale-grey siliceous muds overlie these. Siliceous mud can in total be c. 5 m thick. Stones are recorded in these at boreholes 44 (444 cm depth) and 45 (520 cm depth), interpreted as dropstones, but recorded rarely because the Eijelkamp gouge can sample only small stones. Siliceous mud rises between boreholes 42 and 46 at the edge of the basin to a consistent c. 3 m depth (c. 239 m above OD), representing an almost in-filled sediment surface. East of this, open water would have persisted. Overlying the siliceous mud is marl, a calcareous lacustrine sediment derived from carbonates within the Biggar Formation andesitic lavas. This too is usually delicately laminated, with colours changing within the same unit from cream-white to pale-grey, probably determined by its mineralogical purity. An amorphous or herb-rich peat overlies the marl. Colluvial sediment was washed into the peat at the western basin edge.

Figure 36 is a composite simplified sediment stratigraphy of Transects 2, 1 and 4, on the same line as Transect 6 (Figure 5), though dog-legged (Figure 4), from the west at borehole 23, probably part of the Priest's Well Basin, to the outlet of the Candy Burn in the south-east. The Plantation Basin at its south-western end is much shallower than the Priest's Well Basin, and the boreholes in Figure 36 are often shallow



Figures 35-36.

Figure 35. The simplified sediment stratigraphy of Transect 6 from the west at borehole 39 along the centre of the Priest's Well Basin to borehole 48.

Figure 36. Composite simplified sediment stratigraphy of Transects 2, 1 and 4 across the Plantation Basin.

as a shelf of gravel intrudes below c. 2.0-3.5 m depth in the west to borehole 32 and east of borehole 10. Between is a deeper arm of the lake, unevenly floored as lake sediment in-filled pre-existing gullies, but in places exceeding 6 m in depth. Pale-grey siliceous

mud is the basal sediment everywhere. Black/dark-grey and bottle-green siliceous mud is found either as single thick bands or several thinner bands in the deeper boreholes between boreholes 63 and 61, between c. 570 and 445 cm depth. Closely adjacent



Figure 37. Photograph of the prepared surface of sediment sampled by a Russian corer at borehole 56a between 405.5 and 415.0 cm depth showing a transition from pale grey to black and bottle-green mud.

boreholes 93-30 record bands of black/dark-grey and bottle-green mud between c. 400 and 310 cm depth, but not the deeper band.

However, sediment colours towards the base of boreholes west of borehole 30 are not those originally deposited: colours are now stained orange, distorted by post-depositional changes related to the chalybeate spring in the eastern corner of the Priest's Well Basin. In the outlet channel, boreholes 28-26 record this higher band at c. 400-310 cm depth. One band is recorded in Borehole 30a between 355 and 375 cm (56-61%) depth. These darker sediments are overlain by pale-grey siliceous mud which rises to c. 150 cm depth (c. 240.5 m above OD), higher than in the Priest's Well Basin. Dropstones were again recorded at boreholes 12 (260 cm depth), 31 (253 cm depth) and 75 (337 cm depth). Marl is everywhere absent. Pale-grey laminated siliceous mud is overlain in most boreholes by structureless pale-/mid-grey sand which thickens eastward from around borehole 30/30a. Peat overlies this structureless sand. This sediment stratigraphy is replicated in the four boreholes of Transect 1a (Figure 5) and the 20 boreholes that comprise Transect 7, extending to the north east end of the valley (Figure 4), so these are not illustrated, black to bottle-green



Figures 38-39.

Figure 38. Photograph of the prepared surface of sediment sampled by a Russian corer at borehole 56a between 500.0 and 508.5 cm depth.

Figure 39. A scan of a thin-section from borehole 56a between 498.5 and 506.5 cm depth.

siliceous mud in deeper boreholes are sandwiched between thick pale-grey siliceous mud rising to <1 m below the surface, which is overlain by peat.

The siliceous muds are laminated. Space means that this can be illustrated here only by three images at different magnifications. Figure 38 is a photograph taken in the laboratory of the prepared surface of sediment in a Russian core at borehole 56a between 500.0 and 508.5 cm, orientated with the top of the sediment towards the top of the page, selected to allow comparison with Figure 39, a scan of the thin-section prepared from sediment at approximately the same depth (498.5-506.5 cm), orientated in the same way, but from a different Russian core so that the sediments are not precisely replicated. In particular, the distortions in the sand laminae in Figure 38, interpreted as small-scale syn-depositional load structures, are not seen in Figure 39. The sand laminae, though distinctive, are atypical of the laminae, which here are predominantly couplets of slightly darker silt and pale-grey clay. Figure 40 is a microscopic image (see the scale [2 mm] at bottom right) of two couplets from a thin-section at borehole 30 (215.0-223.0 cm depth). Paler laminae are much coarser in particle size than dark laminae, which

contain more amorphous organic matter. Boundaries from pale to dark laminae at this scale are gradual, those from dark to pale sharp and often abrupt. Dark laminae can contain  $\text{FeS}_2$  crystals, and these can occur also as single-grain laminae.

Figure 41 expresses the total thickness of siliceous sediments at boreholes 50/50a and 30a as percentages to facilitate easier comparison: photographs in borehole 30a were described only to 411 cm depth, c. 70% of the stratigraphy, because deeper sediment was sampled only later. Individual laminae in photographs from borehole 50 in the Priest's Well Basin have dominantly pale-/mid-grey colours (see also Figure 42, where lamina colours in borehole 50/50a are plotted against depth). Black to very dark-grey laminae are common in the basal 50%, below 850 cm depth. Dark brown laminae are also common below 43% (820 cm) depth. Individual laminae from borehole 30a in the Plantation Basin were more commonly dark-brown, and these are abundant throughout. Pale-grey laminae give way to mid-grey laminae in the uppermost 20% of the stratigraphy. Thin-sections are too few to describe changes systematically, but most show that individual coarse-grained laminae are poorly sorted, clast sizes

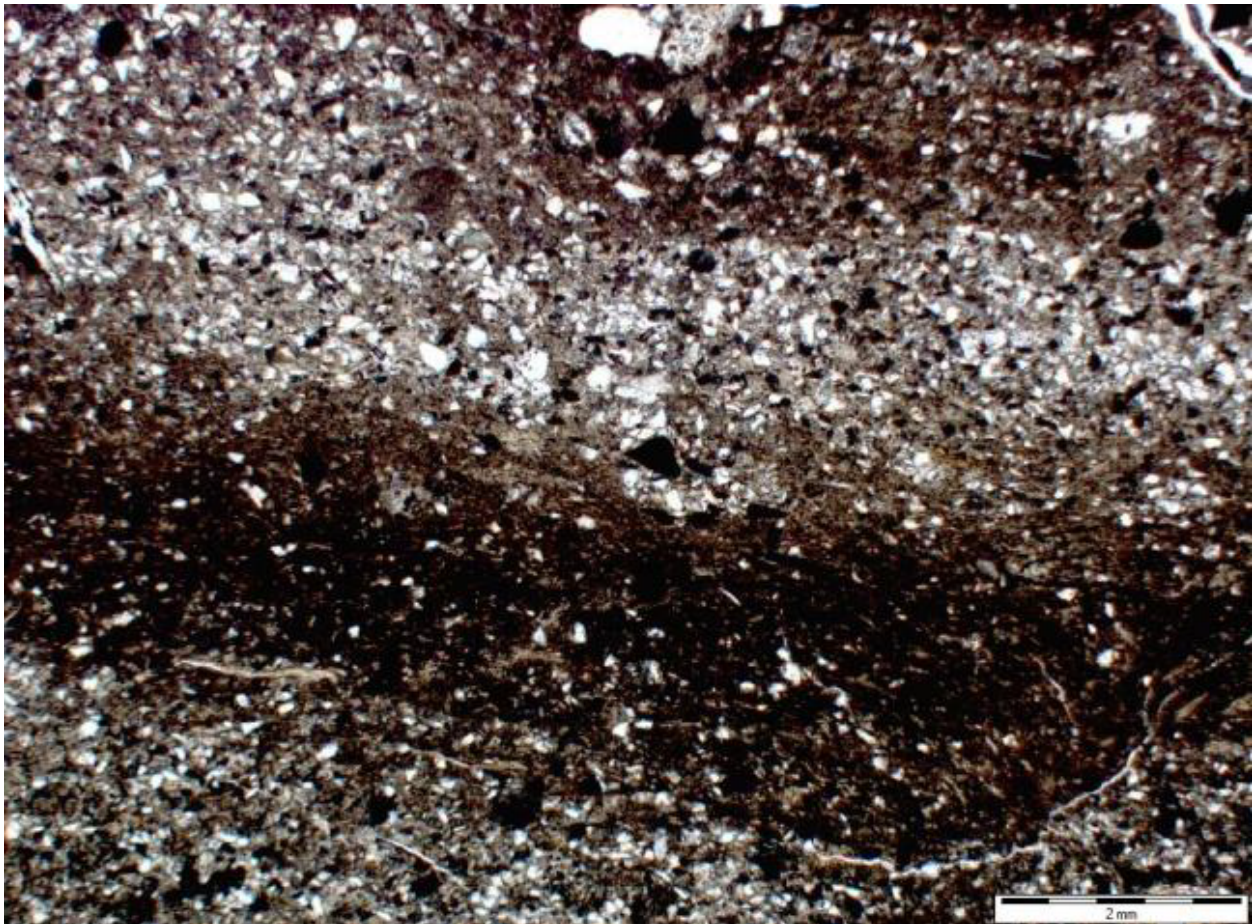


Figure 40. A microscopic image of four laminae in a thin-section from borehole 30 (215.0-223.0 cm depth).

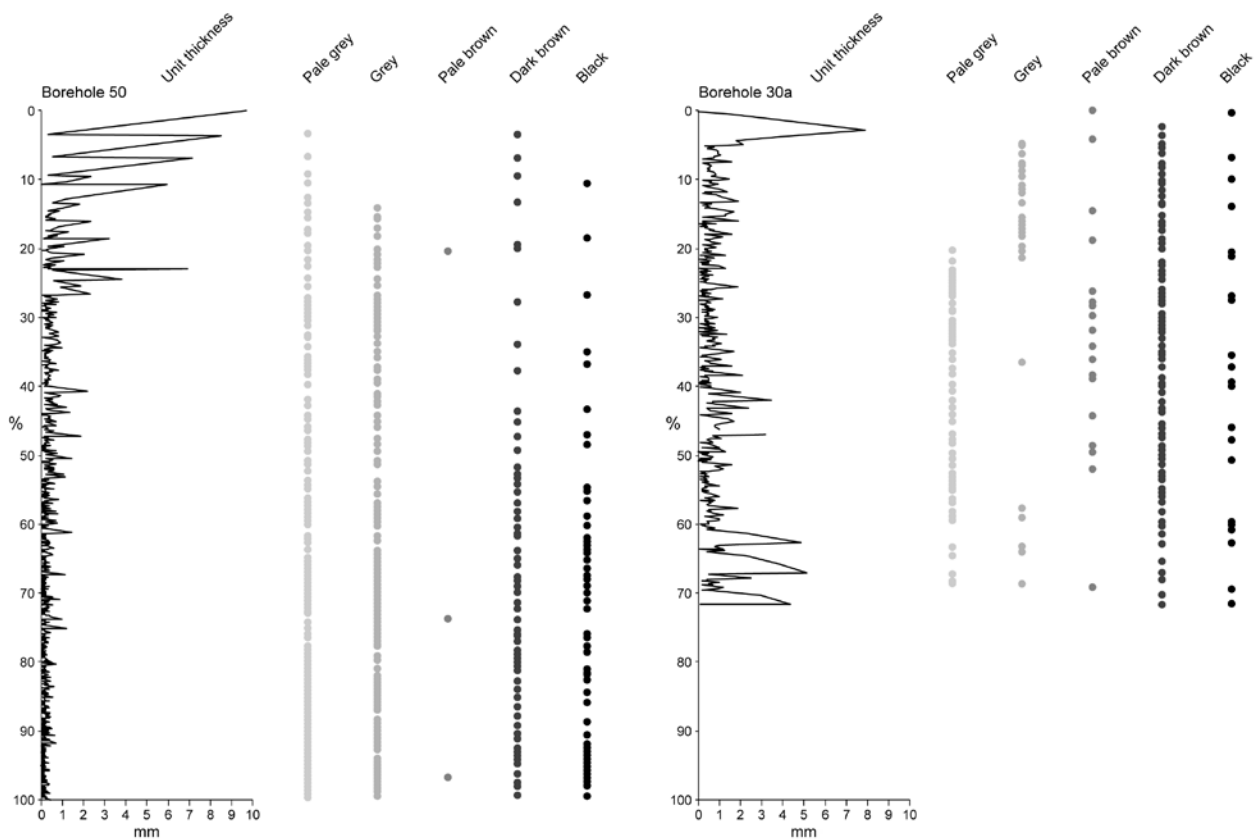


Figure 41. An estimate of lamina thickness in the total thickness of siliceous sediment at borehole 50/50a (700-972 cm depth) expressed as % to allow direct comparison with that at borehole 30a (150-411 cm depth), and the patterns of lamina colours in these sediments.

between <1-6 microns, with rounded to sub-rounded clasts, clast:matrix ratios between 2% and 70% and boundaries sharp to abrupt but conformable.

Figure 41 also presents data from the photographic records on lamina thickness for boreholes 50/50a and 30a. These must be tentative as some sediment units are structureless, others weakly stratified, laminae in some photographs are indistinct and measurement was made in relation to the 1.0 m rule scale, which is imprecise at this magnification. There are 1310 laminae recorded in borehole 50/50a from the Priest's Well Basin. Laminae are very narrow, with mean thickness  $0.2 \pm 0.5$  mm, and  $0.16 \pm 0.5$  mm below 770 cm (27%). There are only minor fluctuations in thickness until 27% (c. 780 cm) depth. Laminae >1.0 mm are found above 75 % (906 cm) depth and are common between 54% and 40% (840-810 cm) depth: most are of silt or clay rather than sand. The full record for borehole 30a in the Plantation Basin is unavailable. There are 430 laminae recorded in the upper 70% of the full stratigraphy. Their mean thickness is  $0.61 \pm 0.74$  mm. The very thick laminae below 60% (369 cm) comprise, from photographs, clay-sized sediment and they are best seen as structureless. Excluding these, the mean thickness of laminae is  $0.55 \pm 0.61$  mm, much thicker

than laminae in boreholes 50/50a, which is attributed to the Plantation Basin being more proximal to the contemporary ice-front than was the Priest's Well Basin. Despite this, there are very good correlations in relative lamina thickness, with probably synchronous changes in borehole 50/50a at 53.7% and in borehole 30 at 52.4%, in borehole 50/50a at 47.6 and in borehole 30 47.8%, in borehole 50/50a at 31.7% and in borehole 30 at 32.1%, in borehole 50/50a at 27.1%, and in borehole 30 at 26.1%, respectively. There were close connections between the basins over this period.

Figure 42 presents the results of quantitative analyses on sediment in Borehole 50 between 874 and 600 cm depth. The siliceous mud below 700 cm depth has comparatively low moisture contents, a consequence of high packing density in the silt- and clay-sized particles. Sediments below 820 cm depth, that are described as having a greater abundance of mineral matter coarser than silt, have higher moisture contents. Carbon and carbonate contents are negligible below 700 cm depth. Black to dark-grey sediments between 860 and 850 cm depth have carbon contents exceeding 5%. The rapid increase in lamina thickness above 770 cm depth (Figure 41) has no corresponding quantitative sedimentological change.

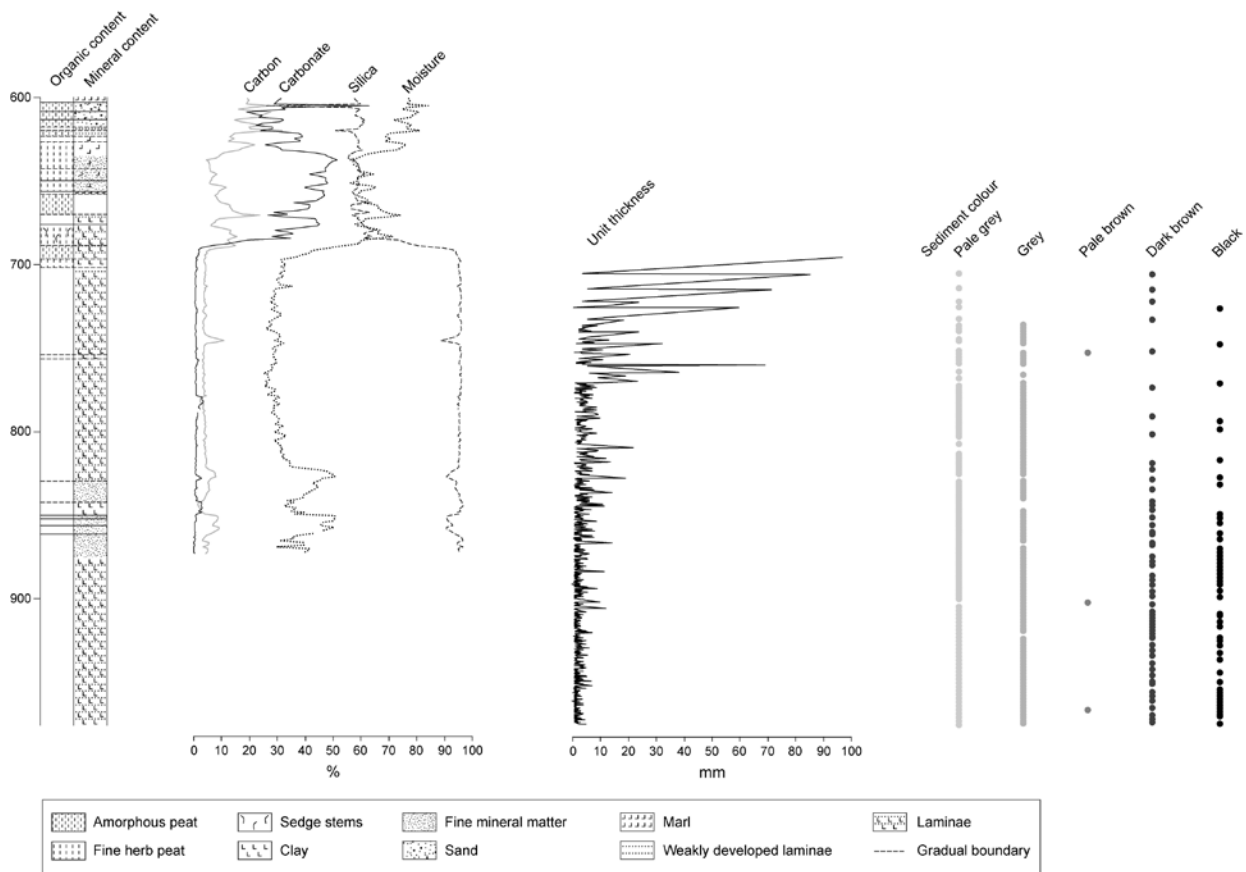


Figure 42. Quantitative analyses on sediments at borehole 50 between 600 and 874 cm depth, related to the sediment stratigraphy and lamina thickness.

Above 700 cm depth, when siliceous mud deposition is succeeded by thin peats and then marl, moisture contents (packing density) decreases and carbon and carbonate contents increase. Fluctuations in these last two measures thereafter reflect switches between peat and marl.

Figure 43 is a pollen record expressed as percentages of total land pollen at borehole 50/50a in the Priest's Well Basin, principally of organic-rich sediments above 700 cm depth, but two analyses at 858 and 852 cm depth are from the black to dark-grey silt. Both spectra record *Betula* (birch) at c. 12% tlp, Poaceae (grasses) at c. 50% tlp and *Juniperus* (juniper) and *Empetrum* (crowberry) at low proportions. The low values of the last two taxa are suggestive, by comparison with modern-standard pollen data at the Whitlaw Mosses, near Selkirk (Webb and Moore 1982) and Whitrig Bog, near Kelso (Mayle *et al.* 1997), of plant communities either at an early or late stage in the Windermere Interstadial.

Dating of the sediments at borehole 50 above the increase in carbon and carbonate contents at 700 cm depth (Figure 42) was made by pollen-stratigraphic correlation with the British record. Figure 43 is the

pollen record of dryland taxa relevant to dating the sediment at borehole 50 above 700 cm depth. Sediments initially record a herb-rich calcicolous grassland with *Helianthemum* (rock-rose), *Thalictrum* (meadow-rue), *Rumex* (docks, sorrels), *Oxyria* (mountain sorrel) and *Plantago maritima* (sea plantain). *Salix* (willow), *Juniperus* and *Empetrum* were probably already established. Proportions of *Betula* and *Juniperus* rise as values of *Rumex* decline and those of *Empetrum* cease to be recorded. These features are characteristic of the Windermere Interstadial and also of the early Holocene period (Walker *et al.* 1994), but given that peat rises to the ground surface (Figure 35), the sediments above 700 cm depth (0% in Figure 41, at an equivalent depth in borehole 30 of c. 140 cm) are unambiguously of earliest Holocene age, commencing close to c. 9,750 cal BC.

The siliceous mud also contains stems, and occasionally dense mats, of the moss *Calliergon* cf. *C. cuspidatum*. Figure 44 shows the black stems of the moss within sediment between 287.5 and 295.0 cm in borehole 56a. Stems are preserved horizontally within laminae or structureless sediment. When gently extracted, some are <2 cm long with very fragile

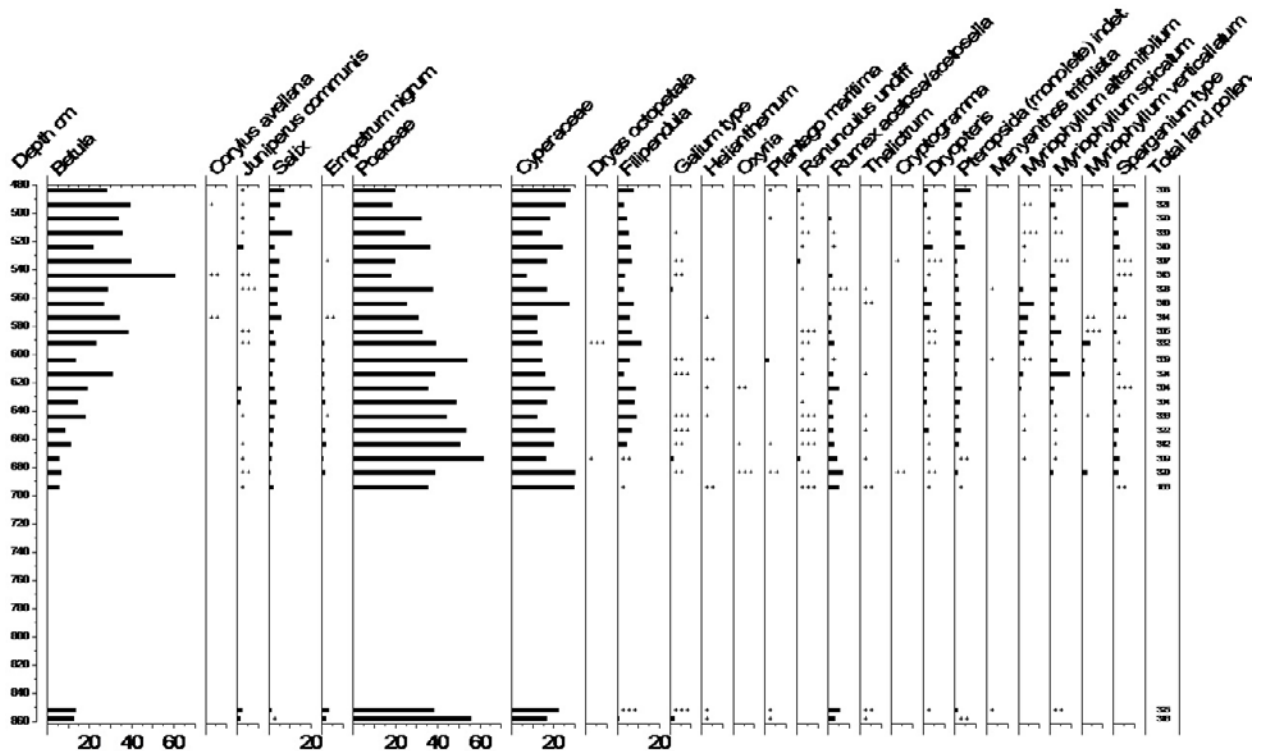


Figure 43. The pollen record of sediments between 480 and 695 cm depth in borehole 50 calculated as % total land pollen.



Figure 44. Photograph of the prepared surface of sediment sampled by a Russian corer at borehole 56a between 287.5 and 298.0 cm depth showing moss stems in pale grey siliceous mud below the 42 cm mark.

leaves surviving, strongly suggesting preservation in life position or with minimal transport. Stems were common-abundant only in deeper boreholes, east of borehole 59 along Transect 6 in the Priest’s Well Basin, between boreholes 31 and 61 in the Plantation Basin and boreholes 26, 28 and 94 in the outlet (Figure 5), and in all boreholes along Transect 1a (Figure 29). The moss probably grew in shallow water, in swamp and lake-edge fen communities (Rodwell 1995), in water warmed in single summers. There is no pattern to the representation of stems with sediment depth: they seem equally well-represented throughout.

The occurrence in ‘Loch Howburn’ of this moss and its autecology have been detailed as the <sup>14</sup>C dating strategy was concentrated on this identified, single-entity, very short-lived and presumed *in situ* macrofossil. Relevant data are presented in Table 20. Dating focused on the Plantation Basin as this was the basin most relevant to the archaeological site (Figure 5). One sample was from the Priest’s Well Basin. Because of the steeply sloping floor of this basin, an equivalent depth at borehole 50/50a was obtained from sediment-stratigraphic correlation (Figure 35). To aid comparison with Figures 41, equivalent % depth is also given. Moss stems were able to be concentrated from narrow sediment slices, apart from sample SUERC-29723.

The siliceous mud at 778-779 cm depth in borehole 50a (29% in Figures 41, at an equivalent depth in borehole 30/30a of c. 180 cm depth) was also dated by tephro-chronology (Section 6.2.2): geochemistry of the shards allowed the recognition of tephra of the Vedde Ash, with an age-range of 12,163-11,965 cal BP (10,213-10,015 cal BC).

The much deeper Priest's Well Basin maintained lacustrine sedimentation in the marl of the earliest Holocene, but the structureless sand in the Plantation Basin, the temporal equivalent of the marl, is interpreted to represent the rapid drainage of water in this basin down the Candy Burn outlet.

### **The formation and age of siliceous sediments in 'Loch Howburn'**

The two basins that contain the sediments of 'Loch Howburn' share the same sediment stratigraphy (Figures 35-36). Basal sediments are, overall, pale to mid-grey siliceous laminated clays and silts, the majority very thin in borehole 50a below c. 900 cm depth (Figures 41), with some fine sand laminae. They have almost no carbon or carbonate (Figure 42). There are 862 laminae recorded below the stratigraphic change to black-coloured sediment at 874 cm depth. Many of these are black (Figure 41) and some at least are characterised in thin-section by FeS<sub>2</sub> crystals, suggesting seasonal anoxia. Dark-brown laminae, perhaps organic-rich, are common to 820 cm depth. Largely structureless clay is found below the comparable stratigraphic change to black-coloured sediment in borehole 30a at 375 cm depth.

These pale sediments are overlain by black, dark-grey or bottle-green sediment (Figure 37). This spans almost precisely the same % depths in boreholes 50/50a and 30a and is regarded as the same band in both boreholes. This darker sediment was not described in any borehole as organic-rich. It is slightly but not appreciably more carbon-rich than overlying sediment (Figure 42). It remains laminated in borehole 50/50a (Figure 41), with lamina on average slightly thicker than in underlying sediment. Comparatively thin laminae commence at this time in borehole 30a. There are 134 laminae in several bands in borehole 50/50a, and 31 recorded in borehole 30a, a difference thought to relate to poorer-quality photographs of sediment in the latter borehole. <sup>14</sup>C assay SUERC-29721 is from a mat of concentrated moss stems c. 1.5 cm thick, centred on 445.25 cm depth in borehole 54, immediately above two thick bands of black sediment, 85 m west of borehole 50/50a in the Priest's Well Basin, corresponding in borehole 50/50a to 55% (850 cm) depth. The age estimate (Table 20) places the black sediment to the boundary between Greenland Stadial (GS)-2a

and Greenland Interstadial (GI)-1e (Rasmussen *et al.* 2008), close to, but before the beginning of, the thermal amelioration in the British Isles at the beginning of the Windermere Interstadial (Lowe *et al.* 2008b). The dark sediment is not, however, thought to be represent the Windermere Interstadial, or at least its thermal maximum, because of its pollen content (Figure 43) and negligible carbon and carbonate contents. At other Devensian Late Glacial stratigraphies in southern Scotland, Windermere Interstadial sediments have carbon contents by l-o-i exceeding 15% (e.g., Mayle *et al.* 1997). The dark sediment at Howburn may represent a prolonged phase or phases of anoxia, although individual lamina in borehole 30a, as opposed to the sediment matrix, are not dominantly black (Figure 41).

Black to bottle-green sediment occupies a similar stratigraphic position and depth to borehole 30a in boreholes from the outlet channel. <sup>14</sup>C assay SUERC-29722 (Table 20) is of moss stems concentrated from a 5 cm thick sediment slice centred on 307.5 cm depth at borehole 26, in the outlet channel. As with assay SUERC-29721, the moss stems are close to the top of the black band, but the age-estimate is c. 2000 years younger (Table 20), close to the end of the Windermere Interstadial/GI-1a. The age estimate implies that bands of similar black to bottle-green mud formed at two different times in the Plantation Basin, though this is not observed in the sediment stratigraphy (Figures 35-36), or that one or both age estimates so far discussed are insecure.

Black, dark-grey and bottle-green sediment is overlain by more, finely laminated, inorganic siliceous sediment (Figures 41 and 42). There are 314 laminae recorded between 55 and 0% (850-700 cm) depth in borehole 50, and 372 laminae recorded on corresponding sediment in borehole 30a. This reasonable agreement suggests that the correlations in relative lamina thickness between the two boreholes at c. 53, 47.7, 31.9 and 26.5% depths (above) are strong. Laminae in borehole 30a are thicker, assumed to be because the Plantation Basin was nearer the sediment source. Laminae in borehole 30a are more commonly dark-brown, perhaps organic-rich, possibly because the shoreline was closer to borehole 30a than it was to borehole 50/50a, and possibly because water depth in the Plantation Basin was shallower than the deeper parts of the Priest's Well Basin around borehole 50/50a. This sediment has been dated by two AMS <sup>14</sup>C assays and by tephro-chronology. Shards extracted from borehole 50a in the Priest's Well Basin, at 778-779 cm depth (29% depth), are of the Vedde Ash (Section 6.2.2). In the Plantation Basin at borehole 62, a 1.0 cm thick mat of six moss stems at 240.5 cm, estimated to be close, at 25% (Table 20) to the equivalent % depth of

the Vedde Ash in the Priest's Well Basin, yielded a closely comparable age estimate of 10200-9,850 cal BC. Moss stems lying in discrete bands c. 1-1.5 cm apart within laminated mud between 208 and 233 cm depth in borehole 12, also in the Plantation Basin, were combined to provide <sup>14</sup>C assay SUERC-29723, 10,680-10,430 cal BC. This age estimate is an average and imprecise unless, as is assumed as there are 151 laminae recorded at borehole 30a in this interval, the sedimentation rate was rapid. The resultant assay, however, is significantly older than assay SUERC-34256, from a borehole only twelve metres away, as well as of the Vedde Ash, recorded in the Priest's Well Basin. The three age estimates together suggest an age for these upper siliceous muds within GS-1, the Loch Lomond Stadial. The earliest peat in this basin, above 700 cm depth, is dated in borehole 50/50a by pollen analyses to the earliest Holocene (Figure 43).

In summary, the oldest <sup>14</sup>C assay suggests a date within GS-2a for the formation of the lower pale-grey siliceous mud, although their inception commenced some time before this. The limited pollen record from the black silt at borehole 50/50a can support this, but can also argue for an immediately pre-Loch Lomond Stadial age for this sediment (above). Tipping *et al.* (2016) rejected this <sup>14</sup>C assay because of the absence above it of sediment of demonstrably Windermere Interstadial sedimentological or palynological characteristics. It remains the only age estimate supportive of 'Loch Howburn' existing prior to the Late Upper Palaeolithic archaeological activities attested in the north east of the lake basin. It may be that organic-rich Windermere Interstadial sediment is absent because of its dilution in what appears to have been a sediment-charged turbid lake that filled with dominantly inorganic structureless and delicately laminated siliceous sediment, but this is 'special pleading' and would be a unique circumstance in the British Isles. What this sediment represents is at present unclear. Tipping *et al.* (2016) suggested the laminae were seasonal glacio-lacustrine varves but this needs to be clarified. If correct, the 1310 laminae recorded at borehole 50/50a in the Priest's Well Basin cannot represent the Devensian Late Glacial in its entirety. Eighty nine laminae are recorded above the Vedde Ash and below the earliest Holocene sediment in borehole 50/50a when some 400 laminar couplets might be expected if laminae were seasonal. However, it seems very likely that 'Loch Howburn' was receiving laminated siliceous sediment within the Loch Lomond Stadial, so that open water existed or persisted after the Windermere Interstadial.

### Windermere Interstadial palaeogeography of the Howburn catchment

The sediment-stratigraphic analyses have confirmed that there was once a lake, 'Loch Howburn', on the valley floor. The largest expanse of the lake lay in the north-east, below the archaeological site. The lake narrowed to little more than a channel downstream of Hen Burn where the gravel ridge lay across the basin. The embayments of the Priest's Well Basin and the north-side of the Plantation Basin define the lowest part of the lake. There is no lake at present, and today the water drains down the Candy Burn gorge. Creating 'Loch Howburn', then, requires this lowest exit to have been blocked. There is no evidence in the gorge or downstream towards Biggar for a dam to have formed by rockfall or other geological instabilities: the sides of the gorge are cut in rock rather than soft deformable sediment and there are no signs of present or past rock or slope failure. Besides, much of the lacustrine sediment in 'Loch Howburn' comprises delicately laminated clays and silts which are likely to have formed in a lake blocked by the snout of a glacier. The absence of lacustrine sediment south-east of Borehole 26 in the Plantation Basin (Figure 36) suggests that the ice-dam was near this location.

Radiocarbon and tephra dating controls strongly suggest that 'Loch Howburn' was formed in the Loch Lomond or Younger Dryas Stadial (above). This is difficult to reconcile with the currently understood deglacial chronology of southern Scotland which sees complete deglaciation by around 13,600 cal BC (Finlayson *et al.* 2010; Hubbard *et al.* 2009), and Younger Dryas glaciers constrained to the highest plateaux (Figure 4), discussed more fully by Tipping *et al.* (2016).

What does this mean for the Late Upper Palaeolithic, Windermere Interstadial landscape and the hunting group/s at Howburn? There may have been open water in the much deeper Priest's Well Basin, though sediment pre-dating the end of the Windermere Interstadial has not been found in 54 boreholes from that basin. If there was open water, it was comparatively distant from the hunters at Howburn. Ice pushing up the Candy Burn gorge in the Loch Lomond Stadial must have had its source in the Southern Uplands. It seems most reasonable to think that in the Loch Lomond Stadial an existing ice sheet was re-activated.

If Southern Uplands ice persisted through the Late Glacial we need to envisage a very different geography around Howburn. Ice blocked the Tweed Valley, not only in the Biggar 'gap' but further east. Herds of animals would have been constrained in their migrations along the southern edge of the Pentlands. Hunting groups would also have been similarly constrained in their movement.

## Discussion

### Brief summary

The Howburn site was excavated in a number of stages and, by coincidence, the various excavation units correspond rather neatly to individual Late Upper Palaeolithic concentrations:

1. Trench I (2006), southern corner
2. Trench I (2009), southern corner
3. Trench II (Block 2)
4. Trench II (Blocks 3-4)

Units 1 and 2 probably both represent tent-like dwellings of Slotseng-style (Holm 1991: 11, 13; this volume's Figure 28) dating to the Havelte period (the centuries just prior to 12,000 cal BC; Grimm and Weber 2008; this volume's Table 3); Unit 3 includes one main (although truncated) concentration defined by artefacts similar to those in Units 1 and 2, as well as one concentration defined by dark-brown ('black') flint which probably also dates to the Havelte period; and Unit 4 may represent an open-air site dating to the subsequent *Federmesser-Gruppen* period (c. 12,000-10,800 cal BC; Table 3). The horizontal layout of all these clusters is affected by later visits to the site, but – apart from a number of peripheral Mesolithic or Early Neolithic concentrations in Trench I (2006) – most of the later finds were recovered as individual stray pieces rather than in concentrations. The effect of the later visits on the Late Upper Palaeolithic assemblages are probably best demonstrated by the difference between the composition of the topsoil assemblage and the subsoil assemblage, where the former includes relatively high proportions of local dark-grey chert, with the latter being almost entirely in flint.

Although the Havelte assemblages are generally dominated by the use of flint, the collection from Trench I (2006) does include artefacts in unusual forms of chert (rust-brown/grey and 'complex grey' forms), which are datable to this period (for example points and blade-scrappers). The absence of such pieces in the site's other Late Upper Palaeolithic concentrations may be an indication of temporal differences, and it may, with time, be possible in Scotland to define sub-phases within the Havelte period, characterized by, *inter alia*, different raw material preferences. Unit 4, probably dating to the *Federmesser-Gruppen* period, is defined by an increased reliance on local chert, as well as the use of high-grade exotic orange chert.

Technologically, all four units represent blade industries, where blades were struck from opposed-platform cores, predominantly by the application

of soft percussion. Most likely, the operational schema of the Late Hamburgian industries included a number of stages, within which blades were predominantly detached from one end at a time, which led to some waste cores having one platform, and some two opposed platforms. The cores may have been decorticated at the source, to reduce the cores' weight prior to transportation, followed by the formation of one or more platforms and several crested guide ridges. The platforms were then prepared by fine faceting and the formation of *en éperon* spurs along the platform-edges. Faceting of the platforms may have been a continuous process, constantly rejuvenating the platforms, and in addition the occasional core tablet was detached to renew entire platforms (Table 4). Serial renewal of platforms has been demonstrated by refitting at Poggenwisch (Weber 2012: Figure 17).

Since the excavations at Howburn, an almost certain Late Upper Palaeolithic assemblage has been recovered at Milltimber in Aberdeenshire (Ballin forthcoming), and the assemblage from Lunanhead in Angus, which was re-examined recently (Ballin 2017a), probably also dates to the pre Mesolithic era. Although the precise date of these two assemblages within the Late Upper Palaeolithic is uncertain, their operational schemas display similarities with the Havelte material from Howburn: Impressively large (in a Scottish context) broadblades (Figure 45) were detached from opposed-platform cores which had been carefully prepared by decortication and serial cresting. In addition, the operational schema relating to the Milltimber assemblage also includes serial detachment of core tablets, as demonstrated by refitting at the Classic Hamburgian site of Poggenwisch in northern Germany (Weber 2012: Figure 17). The Milltimber schema did not include fine faceting of the platform remnant, possibly defining it as Hamburgian, but dating to a different part of this period, whereas two blades from Lunanhead have faceted or finely faceted platform remnants, suggesting possible contemporaneity with the Havelte concentrations at Howburn. As shown in Figure 45, the flint blades from Lunanhead and Milltimber are generally considerably larger than those from Howburn, and it is almost certain that the raw flint for those blades was procured from sources on Doggerland (Figure 45). It should, however, be borne in mind that the two East of Scotland assemblages are numerically small (19 crested and uncrested blades each), and that the much larger Howburn assemblage (574 unmodified and modified flint blades) also includes finds from other periods, although most of the flint is thought to be Late Upper Palaeolithic.

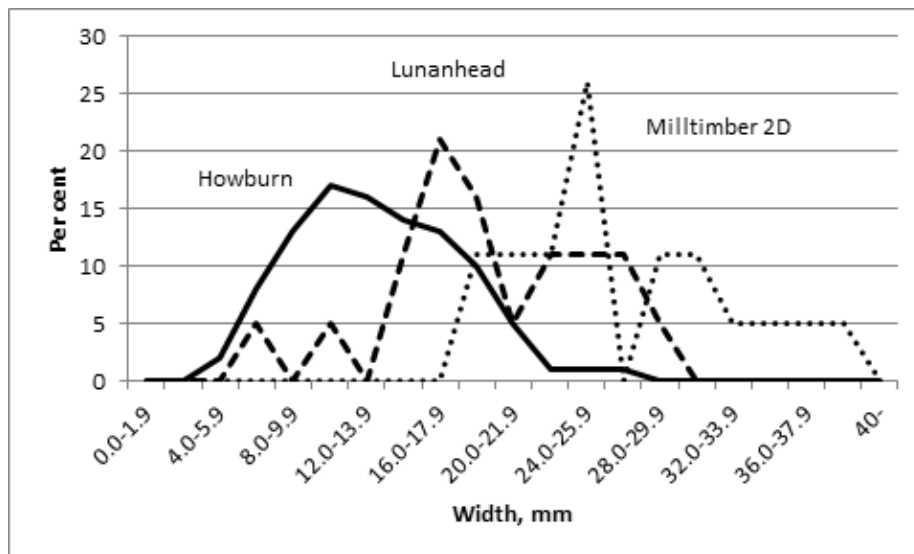


Figure 45. The blade width of all flint blades from Howburn in South Lanarkshire (solid line), Lunanhead in Angus (dashed line), and Milltimber Site 2D/Concentration 4 in Aberdeenshire (dotted line).

The *Federmesser-Gruppen* period industry characterizing Trench II (Blocks 3-4) is also characterized by opposed-platform technique and the application of soft percussion. It does, however, differ significantly from the Havelte period industries by its core preparation techniques. Instead of finely faceting the core platforms and producing *en éperon* spurs along the platform-edges, platforms were usually left plain, and the platform-edges were trimmed or abraded, removing all salient points. On key points, this technological approach corresponds to that witnessed at Kilmelfort Cave, apart from the fact that the blades of this site appear to have been detached from single-platform cores instead of opposed-platform cores. An overview of the operational schemas of the north-west European Hamburgian, *Federmesser-Gruppen*, Brommian, and Ahrensburgian industries is presented in Hartz (1987: Figure 9)

Typologically, the site's Havelte (Units 1-3) and *Federmesser-Gruppen* (Unit 4) assemblages differ on a number of points. The Havelte assemblages are first and foremost defined by their presence of asymmetrical tanged points, many of which have a lateral notch and spur to facilitate hafting. Some of the angle-, curve- and straight-backed pieces of flint may also be datable to this period. In addition, the assemblages embrace large numbers of blade-scrappers (matched numerically by short end-scrappers, some of which may be re-sharpened and thus shortened blade-scrappers), as well as significant numbers of burins (many on truncations) and combined tools (usually a combination of a scraper-end with other functional ends [tanged point, *Zinken*, piercer, *bec*, burin, truncation, strike-a-light]). In the individual concentrations, *Zinken* occur at most as solitary specimens, whereas one unusual cluster of dark-brown flint includes several standardized robust *becs*.

In Scotland, burins have traditionally been associated with the Mesolithic period, but in Scottish Mesolithic assemblages burins are usually either present as single specimens or, more commonly, they are absent. It seems that, in Scotland, burins are considerably more numerous in Late Upper Palaeolithic assemblages, where Howburn yielded 34 pieces (40 if combination tools are included; Table 17) and the likely *Federmesser-Gruppen* site of Kilmelfort Cave near Oban (Saville and Ballin 2009) four

specimens (6% and 4% of the tools, respectively). It should also be noted that where Scottish Mesolithic burins are almost exclusively burins on breaks, the Late Upper Palaeolithic ones are frequently on truncations (at Howburn, 40% of all burin-edges)

In comparison, the points of the *Federmesser-Gruppen* assemblage are dominated by straight-backed pieces, with two tanged points probably being residual Hamburgian specimens. Just as the assemblage as a whole is characterized by the widespread use of chert, many of the straight-backed points are in this raw material. This assemblage also includes some blade-scrappers (only half as common as short end-scrappers), many burins (some on truncations), and some combined tools. All categories incorporate specimens in chert.

#### Howburn in its British and European contexts

The British Upper Palaeolithic period began when modern humans entered Europe approximately 40,000 years before the present day, and it embraces the last Ice Age, the Devensian (Barton 2005: 18). It ended around 9,800 cal BC, when the climate became considerably warmer and more stable, resulting in significant changes to vegetation and fauna. According to deep ocean cores and Greenland cores, the height of the glacial period occurred around 16,000 cal BC (Terberger 2006: 28), and approximately 13,000 cal BC temperatures rose abruptly, although a number of significant later climatic fluctuations have been recognized (interstadials and stadials) (Terberger 2006: 28). This interval of fluctuating temperatures are generally referred to as the Late Glacial period, corresponding to the later part of the Upper Palaeolithic (Figure 46). In southern Scandinavia, the Late Glacial (c. 13,000-9,800

cal BC) is the period when the glacial ice had retreated so much that the landscape was open to human pioneer settlers (e.g., Eriksen 2002), and Scotland may represent a parallel case.

Pettitt (2008: 23) and Pettitt and White (2012: 422) have proposed a Late Glacial chronological schema based on north-west European material cultures (LUP I-III). The framework presented here as Figure 46 is – due to the fact that Scottish Late Upper Palaeolithic research is still in its infancy – in simplified form.

Yrs cal BC		Chrono-zones	Climatostratigraphic units	Industries
9,800	Late Upper Palaeolithic (LUP)	LUP III	Loch Lomond Stadial	(Fosna-Hensbacka) Ahrensburgian
10,800		LUP II		Windermere Interstadial
12,000		LUP I	Bølling	
12,700				

Figure 46. Chronozones, climato-stratigraphic units and industries (also see Table 3).

The periods Bølling to Younger Dryas were originally formed as pollen zones I-III (e.g., Jessen 1934; Mangerud *et al.* 1974), but as the pollen zones and their dates have been redefined, following ongoing research, these periods developed into chronozones with fixed dates (e.g., Eriksen 2002: 26). The British climato-stratigraphic subdivision of the period 13,000 to 9,800 cal BC has traditionally been slightly simpler than that suggested for north-west Europe (e.g., Barton 2005: 123), but recent results from, for example, Greenland ice-cores (Björck *et al.* 1998; Terberger 2006: 28) seem to fit the traditional British units rather well. Greenland Interstadial 1 (GI-1) corresponds to the Windermere Interstadial (and the period immediately preceding it), and Greenland Stadial 1 (GS-1) corresponds to the Loch Lomond Stadial or Readvance.

In terms of British material cultures, the time-frame embraced in Figure 46 has traditionally been associated with the Creswellian (Garrod 1926), but over the last few decades it has become clear that it would be possible to subdivide the period further (e.g., Campbell 1977; Jacobi 1988). Barton and Roberts (1996) suggested that the Creswellian (c. 13,000-12,000 cal BC) might have been followed by a period characterized by the activities of *Federmesser-Gruppen* (c. 12,000-11,000 cal BC), and Barton (1998) later proposed a later Upper Palaeolithic phase characterized by Long (Bruised) Blade industries (c. 11,000-10,000 cal BC).

This general tripartite chronology has been confirmed by recent discoveries, but as the latest finds include many (primarily lithic) objects of forms paralleled in well-known Continental European industries, Pettitt (2008: 23) suggests the implementation of a chronology and terminology which should benefit inter-European comparison. This 'Europeanist' view (Pettitt 2008: 19)

has been adopted by the authors of this volume (Table 3; Figure 46). At this point in time, diagnostic lithic material from the Scottish Late Upper Palaeolithic includes:

- An angle-backed (Creswellian?) point from Fairnington in the Scottish Borders (Saville 2004: 213) – as the Fairnington point is the only Scottish piece possibly dating to the Creswellian, it should be considered whether this object arrived in Scotland shot into a deer which survived; a similar interpretation has been suggested to explain why the Bjerlev Hede (Becker 1970; Holm and Rieck 1992: 15) Classic Hamburgian shouldered point in central Jutland is still the only object known in Denmark from this period.
- Several Havelte-period concentrations at Howburn (this volume).
- The probably *Federmesser-Gruppen* period site of Kilmelfort Cave near Oban (Saville and Ballin 2009).
- One probably *Federmesser-Gruppen* period concentration at Howburn (this volume).
- Two Ahrensburgian points from Tiree and Shildaig in the Scottish Highland (Ballin and Saville 2003; Edwards and Mithen 1995: 359).
- One possible Ahrensburgian site at Rubha Port an t-Seilich, Islay (Mithen *et al.* 2015) – a tanged point of late Upper Palaeolithic affinity has recently been recovered from this location (Wicks, pers. comm.), but final definition of the site's obliquely blunted points as either Ahrensburgian *Zonhoven* points or Early Mesolithic obliquely blunted points depends on the publication of a more detailed characterization of these pieces (e.g., were they produced by the application of microburin technique or not).

- A small group of single-edged and tanged points from Orkney (Ballin and Bjerck 2016; Livens 1956) display similarities with pieces usually associated with the Scandinavian Fosna-Hensbacka Complex (Kindgren 2002).
- Two assemblages of impressively large broadblades from East of Scotland – Milltimber Site 2D/Concentration 4 in Aberdeenshire (Ballin forthcoming) and Lunanhead in Angus (Ballin 2017b) – are defined by their raw material, typological composition and operational schemas as being almost certainly Late Upper Palaeolithic, and very likely Hamburgian (above).
- In addition, individual probably Late Upper Palaeolithic pieces have been identified as residual parts of larger mixed assemblages, such as those from Nethermills Farm (Ballin and Wickham-Jones 2017), Blackdog (Ballin *et al.* 2017), and Wester Clerkhill (Cameron and Ballin forthcoming), all Aberdeenshire.
- An assemblage from Clachan Harbour on Raasay, the Inner Hebrides (Ballin *et al.* 2011), was published as possibly Early Mesolithic, but this assemblage – recovered below a lens of peat in the Harbour basin – includes no strictly diagnostic pieces. The finds embrace a number of broadblades in tuff, and these pieces differ somewhat (in terms of raw material and form) from known Early Mesolithic assemblages from West of Scotland. Two radiocarbon-dates from the peat above the lithic-bearing silt falls within the range 7598-7,084 cal BC (GU-17165-6), but this later Mesolithic date clearly does not date the artefacts (broadblades, where assemblages from this period are generally defined by diminutive microblades). The radiocarbon-date should be seen as a *terminus ante quem*, and it is possible that the finds are indeed of Late Upper Palaeolithic date.

It has been possible to subdivide the Hamburgian period into two phases, namely an early ‘Classic’ period and the later so-called Havelte period. The former is characterized mainly by its shouldered points, and it is traditionally associated with sites in northern Germany, such as Meiendorf, Stellmoor, Poggenwisch and Teltwisch (e.g., Weber 2008), whereas the latter period is characterized mainly by its asymmetrical tanged points and named after the Dutch site Havelte-Holtingerzand (Grimm and Weber 2008; Weber and Grimm 2009); much light has been shed on the Late Hamburgian by more recent excavations of sites in northern Germany, southern Denmark and Holland, such as Ahrenshöft, Jels 1 and 2, Slotseng c, and Oldeholtwolde (Hartz 1987; ; Holm 1991; Holm and Rieck 1992; Johansen and Stapert 2004; Weber 2010). In recent papers, it has been suggested to date the Havelte phase to the centuries immediately prior to 12,000 cal

BC (e.g., Grimm and Weber 2008; Terberger 2006; this volume’s Table 3).

The composition of the tanged and backed points from Howburn’s four main concentrations clearly defines three of those concentrations as the remains of settlement in the Havelte period (asymmetrical tanged points, probably supplemented by some backed pieces) and the fourth as probably dating to the *Federmesser-Gruppen* period (backed points). The chronological separation of these two material groups is emphasized by their distinctly different raw material preferences, with the former being defined by an almost exclusive use of flint, and the latter by a preference for local dark-grey chert and exotic orange chert, supplemented by small amounts of flint (e.g., Table 18).

Most probably, this difference reflects different procurement patterns, with a Havelte period pioneer population being accustomed to the use of flint (with good flint in large nodules being available on Doggerland and in Yorkshire; Ballin 2011b; 2016c), and a later ‘acclimatized’ *Federmesser-Gruppen* population having more detailed knowledge of local Scottish resources. The situation finds a parallel in post-glacial Norway, where the first pioneers relied heavily on flint, whereas later, more settled populations exploited a wider variety of local raw materials (Table 23).

This gradual process of becoming accustomed to local resources is also supported by the composition of another Scottish probably *Federmesser-Gruppen* assemblage from Kilmelfort Cave in Argyll (Saville and Ballin 2009), where the authors suggested that a sub-assemblage of quartz may be contemporary with the site’s more numerous flint component. A heavier reliance on local resources during the *Federmesser-Gruppen* period than during the preceding period has also been suggested by other authors (Barton 1992; Barton *et al.* 2009; Conneller 2007).

Although the numerous asymmetrical tanged points clearly define the dominant chronological assemblage from Howburn as having affinities with the Continental Havelte Group, the applied technological approach, the orientation of the tanged points, as well as the composition of the tool category in general, just as clearly define this material as uniquely Scottish. In terms of technology, the Havelte period finds from Howburn are characterized by a combination of fine faceting of the striking platform and *en éperon* technique, where Continental Havelte sites seem to be characterized by an absence of *en éperon* blades or they are relatively rare (Hartz 1987: 27; Weber 2012: 110). Weber *et al.* (2010: 18) write:

‘This platform preparation method is characteristic of the Magdalenian (e.g., Pigeot 1987; Vermeersch

Table 23. Raw-material chronology for the Mesolithic and Neolithic periods of western Norway (Bruen Olsen 1992: 84). The Norwegian Early and Middle Neolithic periods represent a prolonged hunter-gatherer period.

	Total dominance	Dominance	Frequent appearance	Appearance	Absence
<b>Early Mesolithic</b>	<i>Flint</i>			Quartz White quartzite Blue mylonite	Various stone Rhyolite Slate
<b>Middle Mesolithic</b>		<i>Flint</i>	Quartz White quartzite	Blue mylonite Rock crystal Various stone	Rhyolite Slate
<b>Late Mesolithic</b>		<i>Flint</i> Quartz White quartzite	Blue mylonite Rock crystal	Yellow mylonite Green mylonite Various stone	Rhyolite Slate
<b>Early Neolithic</b>		Rhyolite Var. mylonites	<i>Flint</i> Quartz Var. quartzites Slate	Various stone	
<b>Middle Neolithic</b>		Quartz Var. quartzites	<i>Flint</i> Slate	Rhyolite Var. mylonites Various stone	

*et al.* 1987; Valentin 1995; Floss and Terberger 2002) and was used in low percentages for obtaining blades in the classic Hamburgian. This technique has not been previously described for the Havelte Group (Madsen 1992; 1996) [but has now been recognized in the assemblage from Ahrenshöft LA58D]’.

Most of the Howburn tanged points have distal tangs, where Continental tanged points usually have proximal tangs (cf. Hartz, 1987: Table 1; Holm and Rieck 1992: Figure 33), although some assemblages are mixed, with roughly equal amounts of the two forms (e.g., Oldeholtwolde; Johansen and Stapert 2003: 38).

In terms of tool composition, Continental Havelte sites are generally defined by many tanged points, scrapers (mostly blade-scrapers), burins and *Zinken* – with the

latter being considered one of the most important diagnostic elements – whereas the Howburn Havelte assemblages are defined by many tanged points, scrapers (mostly blade-) and burins, but exceedingly low numbers of *Zinken*! In Table 24, the most iconic tool types from Jels 1 and 2 (Holm and Rieck 1992: 59), Slotseng c (Holm 1991), and Ahrenshöft LA58D (Weber *et al.* 2010) are compared with those from Howburn Trench I (2006), Trench I (2009), and Trench II (Block 2).

It should be borne in mind that the latter three assemblages are somewhat affected by later intrusive material, whereas the finds from Jels and Slotseng c are almost exclusively from the Havelte period. The high proportions of scrapers in the Howburn assemblages is probably largely due to this fact. However, other interpretations are also possible, such as 1) the

Table 24. Percentage distribution of the tool types most commonly associated with Havelte period sites (Holm 1991:13; Holm and Rieck 1992: 59; Weber *et al.* 2010: 16; the present Howburn report). Trench II (Block 3-4) has been included for comparison, although the finds are thought to date mainly to the Federmesser-Gruppen period.

	Jels 1	Jels 2	Slotseng c	Ahrenshöft LA58D	Trench I, 2006	Trench I, 2009	Trench II, Block 2	Trench II, Block 3-4
Tanged points	9	26	26	9	7	16	19	5
Scrapers (flint)	36	26	31	34	86	66	69	69
Burins	9	24	16	31	5	17	9	26
Zinken	46	24	27	26	2	1	3	
<b>TOTAL</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>

Table 25. Summary of Table 24 – the percentage range of the main Hamburgian tool forms.

	DK/N Germany	Howburn
Tanged points	9-26	7-19
Scrapers (flint)	26-36	66-86
Burins	9-31	5-17
Zinken	24-46	1-3

function of the typical Continental *Zinken* was in Scotland covered by other tool forms; 2) due to climatic, topographical, botanical and/or faunal differences between the Continent and Scotland, Scottish Havelte groups followed a different economical strategy, and *Zinken* were simply needed to a lesser extent; or 3) the finds from Howburn only represent a small segment of a more varied economical strategy, such as specialized activities during one part of the year, and finds of more Havelte sites in Scotland may bring about assemblages where *Zinken* are more numerous. It should be noted, though, that particularly the double *Zinken* is such an easily recognizable form that it would probably have been commented on, even if such pieces had been found as stray objects or mixed into assemblages from palimpsest sites. In Denmark, the recovery of typical *Zinken* by an enthusiastic lay archaeologist led to the discovery of the Havelte sites at Jels (Holm and Rieck 1992: 17).

However, no matter how the almost complete lack of *Zinken* at Howburn is interpreted, the application of *en éperon* technique, which is usually an approach associated with Late Magdalenian and Creswellian groups (Barton 1990; Weber *et al.* 2010: 18), in conjunction with the orientation of the tanged points, indicates that the finds from Howburn Trench I (2006 and 2009) and Trench II (Block 2) represent regional variation within the Late Hamburgian Havelte group. The existence of regional differences within the Hamburgian – stretching from Poland to Scotland – is a likely possibility, with the differences representing what Madden (1983) referred to as ‘differentiation due to distance’.

On the Continent, it has been possible to distinguish between earlier and later Havelte assemblages by the presence or absence of a particular type of scrapers (‘small, sturdy pieces with edge retouch and almost tang-shaped base, the Wehlen type’; Holm 1991: 14; also Clausen 1998; Madsen 1983: 18; Grimm and Weber 2008). These scrapers appear to be particularly common around the transition between the Havelte period and the following *Federmesser*/Brommian periods (c. 12,000 cal BC), with Jels 1 probably representing late Havelte settlement (Holm and Rieck 1992: Figure 25), Slotseng b early

*Federmesser-Gruppen* settlement (Holm 1991: Figure 9), and Løvenholm (eastern Jutland) early Brommian settlement (Madsen 1983: Figure 6).

The fact that none of the Howburn Havelte concentrations includes any *Wehlen* scrapers may either indicate that such scrapers are rare or absent in Scottish Havelte and *Federmesser-Gruppen* contexts, or that the presently available collections do not cover the transition between these two periods. The *Federmesser* collection from Kilmelfort Cave near Oban (Saville and Ballin 2009) does not include any *Wehlen* scrapers either, nor does the roughly contemporary assemblage from Howburn Trench II (Block 3-4). But again, it should be borne in mind that Late Upper Palaeolithic Scottish sites and assemblages are still scarce, and new excavations may alter the picture drastically.

Recent years have seen many useful overviews and discussions of British Late Glacial archaeology, which has been the focus of growing research interest (e.g., Barton 2005, 2009; Barton and Roberts 1996; Barton *et al.* 2003; Conneller 2007; David 2007; Jacobi 2004; Jacobi and Higham 2009; Pettitt 2008; Pettitt and White 2012). Inevitably, since southern British finds dominate the Late Glacial record, most researchers have looked to parallels and connections in adjacent parts of the Continent, particularly France and the Low Countries. Given Scotland’s location at the northern extreme of the British Isles, however, Scandinavian and German research of the period may prove more relevant (e.g., Eriksen 2002; Grimm and Weber 2008; Grimm *et al.* 2012; Holm 1996; Street *et al.* 2006; Terberger 2006; Weber 2008; 2012; Weber and Grimm 2009; Weber *et al.* 2010).

In northern Germany and Denmark, it has been common to associate the main Late Glacial stages with the key prey of the time, which in the Bølling-Older Dryas period would have been reindeer, rather than horse as in the British Creswellian (Jacobi and Higham 2009) and the Magdalenian central Rhineland (Street *et al.* 2006). The Allerød time Brommian, as well as the *Federmesser-Gruppen* period, are associated mainly with Elk. Faunal remains of the Late Glacial in Scotland are rare, but radiocarbon dates from cave deposits in the Inchnadamph area of Sutherland confirm the presence of both reindeer and horse in the Late Glacial, with the former in the Bølling and the latter in the Allerød (unpublished dates: Steven Birch and Ivan Young, pers. comms). It is tempting, therefore, to associate Howburn with visits by mobile reindeer hunters. Vang Petersen and Johansen (1991: 26) suggested that, on the Continent, reindeer would spend the summer on the north-west European plains, south-west of the Elbe, and the winter in northern areas, such as Schleswig-Holstein, Denmark, and southernmost Sweden. If a similar scenario was envisaged for the areas west of the North Sea plain, this would define the Howburn

site as, most likely, a winter settlement. Along the way, the reindeer hunters would have passed outcrops of flint and chert at which they would have ‘stocked up’ on raw materials before entering the Scottish Southern Uplands, where it would have been known or suspected that high-quality flint would be scarce or non-existent.

In terms of fully understanding the Late Upper Palaeolithic Howburn site, and the lives of its settlers, it is pertinent to ask why groups of Palaeolithic hunter-gatherers repeatedly returned to this terrace on the lower west-facing flank of Broomy Hill (the location is described in detail in the introduction and palaeo-environmental sections). In this context, it is relevant to compare Howburn’s place in the landscape with that of other Havelte and *Federmesser-Gruppen* sites in north-west Europe.

In southern Jutland and southern Zealand, a number of Havelte locations have been discovered and excavated, such as the sites of Jels (Holm and Rieck 1992), Slotseng (which includes Havelte as well as *Federmesser-Gruppen* material; Holm 1991), and Sølbjerg (Vang Petersen and Johansen 1991). The Danish sites lie on terraces on the southern banks of lakes (Jels) or elongated depressions (Slotseng and Sølbjerg), which have been proven by coring to have been Late Glacial lakes (Fischer Mortensen *et al.* 2011). These *loci* are thought to have been strategically positioned in relation to the reindeer migration routes (e.g., Grønnow 1987; Johansen 1978; Vang Petersen and Johansen 1991). At Ahrenshöft in Nordfriesland, Hamburgian sites were, like the Danish sites, situated on the edge of a fossil Late Glacial lake (Hartz 1987: Karte 2; Weber *et al.* 2010: Figure 1).

Following the excavations in 2006 and 2009, it was thought that the Howburn site’s position in the

landscape might have mirrored that of the Continental Havelte sites, that is, situated on a terrace overlooking a Late Glacial lake (‘Loch Howburn’), which later drained away. This lake would have been a focal point where game would have gathered and where it could have been intercepted. This interpretation, however, is not supported by the presently available evidence (see palaeo-environmental section), which suggests that there was at some stage a Late Glacial lake on the valley floor, but that it post-dates not only the Hamburgian settlement, but also the *Federmesser-Gruppen* occupation at the site. Most likely, ‘Loch Howburn’ dates to the Loch Lomond stadial (Figure 46).

However, it is highly likely that, during the Hamburgian and *Federmesser-Gruppen* occupation, there was a stream at the bottom of the valley, and it is possible (although admittedly conjectural) that the Howburn terrace would have overlooked a ford where reindeer could have crossed on their trek. As shown in Table 25, tanged points are as common at Howburn as they are at Jels, Slotseng, and Ahrenshöft, probably indicating that the main focus at Howburn, as at these other Havelte sites, was hunting, with the inclusion in the assemblage of numerous scrapers and burins suggesting that processing of killed prey also took place here. As mentioned above, it is presently uncertain what the low number of *Zinken* signifies, and new Havelte sites and assemblages are necessary to test whether the low *Zinken* ratio reflects a regional difference within the Hamburgian (many in the Continental assemblages and few in Scottish ones) or whether this reflects economical differences within the Scottish Hamburgian (for example linked to seasonal movements), where some Scottish sites have notable numbers of *Zinken* and others (like Howburn) barely any.



## Future Perspectives

Approximately half a century ago, the only Late Upper Palaeolithic finds from Scotland were three points published by Livens (1956), but unfortunately he suggested that ‘... *there is no question of any [of the three points] being of Palaeolithic date*’. This, in conjunction with the fact that the three points almost immediately ‘disappeared’, only to be rediscovered recently, meant that an opportunity was lost, and that research into possible Scottish Late Upper Palaeolithic settlement is still only in its infancy, although progress is now being made at a rapid pace.

It is now generally accepted that all three pieces are of Late Upper Palaeolithic date, with one piece from Tiree representing a well-known type of Ahrensburgian tanged arrowhead (Ballin and Saville 2003); another, found on mainland Orkney, is a typical single-edged point of Scandinavian Fosna-Hensbacka affinity (Ballin and Bjerck 2016); and the third piece, from Stronsay, Orkney, is a technologically unsophisticated tanged point of a type also associated with the Fosna-Hensbacka Complex (Anderson-Whymark forthcoming; Ballin and Bjerck 2016). The latter corresponds to a similar tanged point found recently in connection with the investigation of a Mesolithic settlement on Orkney (Lee and Woodward forthcoming).

Investigations over the last two decades have increased the number of certain or likely Scottish Late Upper Palaeolithic artefacts and assemblages notably and, above, a list of those finds was presented. Disregarding the possibly Creswellian point from Fairnington (which could have arrived in Scotland shot into, but not killed, a deer), and a possible Classic Hamburgian shouldered point from Howburn (the tang of which has broken, making it impossible to rule out that this may have been a Havelte point with an asymmetrical tang), the Scottish finds include 1) material from the later Hamburgian Havelte Phase (Howburn Trench I (2006) southern corner, Trench I (2009) southern corner, and Trench II [Block 2]); 2) the *Federmesser-Gruppen* period (Kilmelfort Cave and Howburn Trench II [Blocks 3-4]); 3) the Ahrensburgian (two stray points from Tiree and Shildaig in Loch Torridon and possibly Rubha Port an t-Seilich, Islay [pending full and detailed publication of the lithic assemblage]); and 4) the Scandinavian Fosna-Hensbacka Complex (stray and residual finds from Orkney).

The assemblages from Milltimber Site 2D/Concentration 4 in Aberdeenshire and Lunanhead in Angus are defined by the character and raw material of their blades, as well as their operational schemas and some diagnostic pieces, as certainly Late Upper Palaeolithic, but whether they date to the Hamburgian or for example the

Ahrensburgian, immediately prior to the Palaeolithic-Mesolithic transition, is uncertain. Some assemblages from the latter period (Lewis and Rackham 2011: 181) have been referred to as ‘long blade’ assemblages or, due to a common form of use-wear on these blades, ‘bruised blade’ assemblages (in northern Germany traditionally referred to as *Riesenklingen* or ‘giant blades’; e.g., Rissen Site 14a, Schwabedissen 1954: 35), indicating that these assemblages occasionally include impressively large blades. However, it may not be appropriate to use these terms as period labels, as the size and use-wear of some blades in some Ahrensburgian assemblages may reflect site economy/activities rather than being general attributes of assemblages from this part of the Late Upper Palaeolithic. Other Late Upper Palaeolithic finds from Scotland are not precisely datable within this general period, due to their stray or residual character.

At present, there is a growing interest amongst archaeologist in the Scottish Late Upper Palaeolithic period, and attempts are being made at finding more sites, assemblages and individual pieces from this time-frame. Although Late Upper Palaeolithic lithics have now been found in most parts of Scotland, finds relating to the individual sub-periods of the Late Upper Palaeolithic are few and in some cases restricted to individual regions. To increase our understanding of Scotland’s main Upper Palaeolithic periods – the Hamburgian, *Federmesser-Gruppen* period, Ahrensburgian, and the Fosna-Hensbacka Complex – attempts should be made to ‘fill in the blanks on the map’. Apart from increasing our understanding of the periods’ lithic production (differences in terms of raw material preferences and procurement strategies, operational schemas, and core and tool typologies), this might also help us to better understand adaptation over time to environmental changes, economical strategies, as well as mobility and settlement patterns.

It would probably be helpful if a clear break with the past was made, in the sense that it should once and for all be accepted that the Scottish Late Upper Palaeolithic is a reality. This fact could then form the basis of the development of future research strategies for the investigation of the Scottish Late Upper Palaeolithic – that is, how do we find and explore what we know is ‘out there’. The existence during the period, as well as during the earliest part of the Mesolithic, of Doggerland, and the specific extent and form of this landmass, is highly relevant.

As all the known Scottish Late Upper Palaeolithic assemblages seem to represent local branches of the period’s well-known Continental industries,

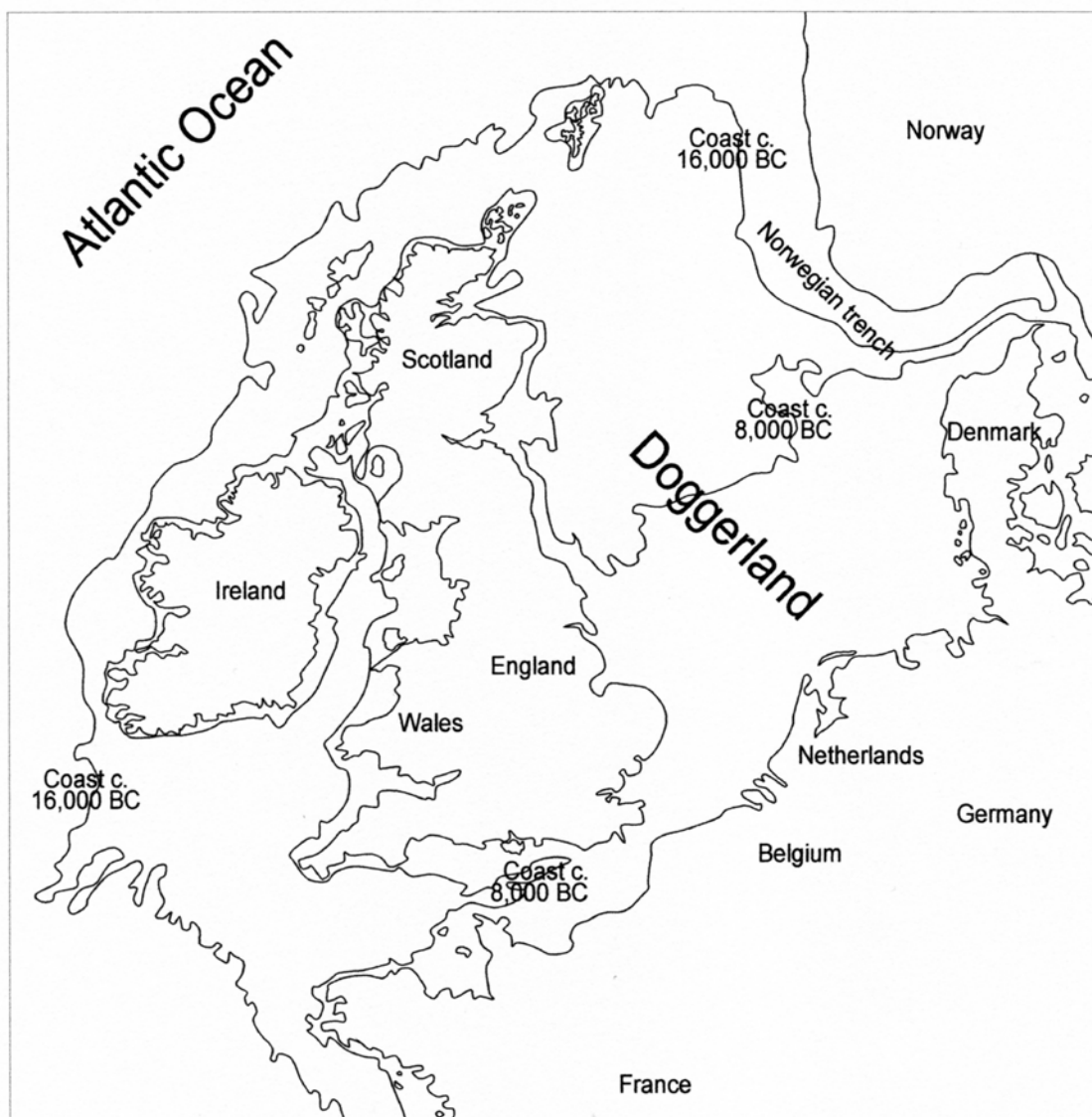


Figure 47. Map of Doggerland based on Spinney (2012). A number of other interpretations of Doggerland’s shape and size exist (e.g., Brooks et al. 2011; Grøn 2005; Pettitt 2008; Sturt et al. 2013; Weber 2012). Reproduced from Ballin (2016c).

there would at some stage have been contacts across Doggerland, if not directly, then in the form of contact networks joining local branches within geographically extensive techno-complexes, in the Hamburgian case stretching from Poland to Scotland. This means that, in terms of the Hamburgian, it should be possible to find sites dating to this period from Howburn in South Lanarkshire, through the valleys of the Scottish Borders, and eventually reaching the present North Sea shores. It should be possible to find sites dating to the *Federmesser-Gruppen* period and the Ahrensburgian from known sites on the west-coast (e.g., Kilmelfort Cave, Tiree, Shildaig and Islay), from these locations due south along the Atlantic coast [as this route is more likely than a route across the highland mountain ranges] and then again across central and/or southern Scotland. And depending on the specific age of the

Orcadian points of Fosna-Hensbacka affinity and the specific location of Doggerland’s northern coast at that time (Figure 47), possibly south along the Scottish east-coast and then due east towards what is now Norway.

At the present early stage of the investigation of the Scottish Late Upper Palaeolithic, any addition to the existing limited evidence would be a benefit to the research. So far, the search has mainly focused on the discovery of obvious diagnostic tool types, first and foremost in the form of tanged or backed points. Research into the period would benefit from the expansion of this narrowly focused strategy into a multi-pronged approach, first and foremost concentrating on raw material preferences, raw material procurement, and economy, as well as technological approaches (Ballin 2017b).

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