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ARO36: Freeland Farm, Perth and Kinross – a mainly late Mesolithic carnelian assemblage from the Lower Strathearn

by Sophie Nicol and Torben Bjarke Ballin

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In memory of Tony Simpson who passed away on the 24 February, 2018.

This project would not have been the same without his mapping expertise and huge passion for all things archaeological. This paper is dedicated to his invaluable support and commitment to the project.

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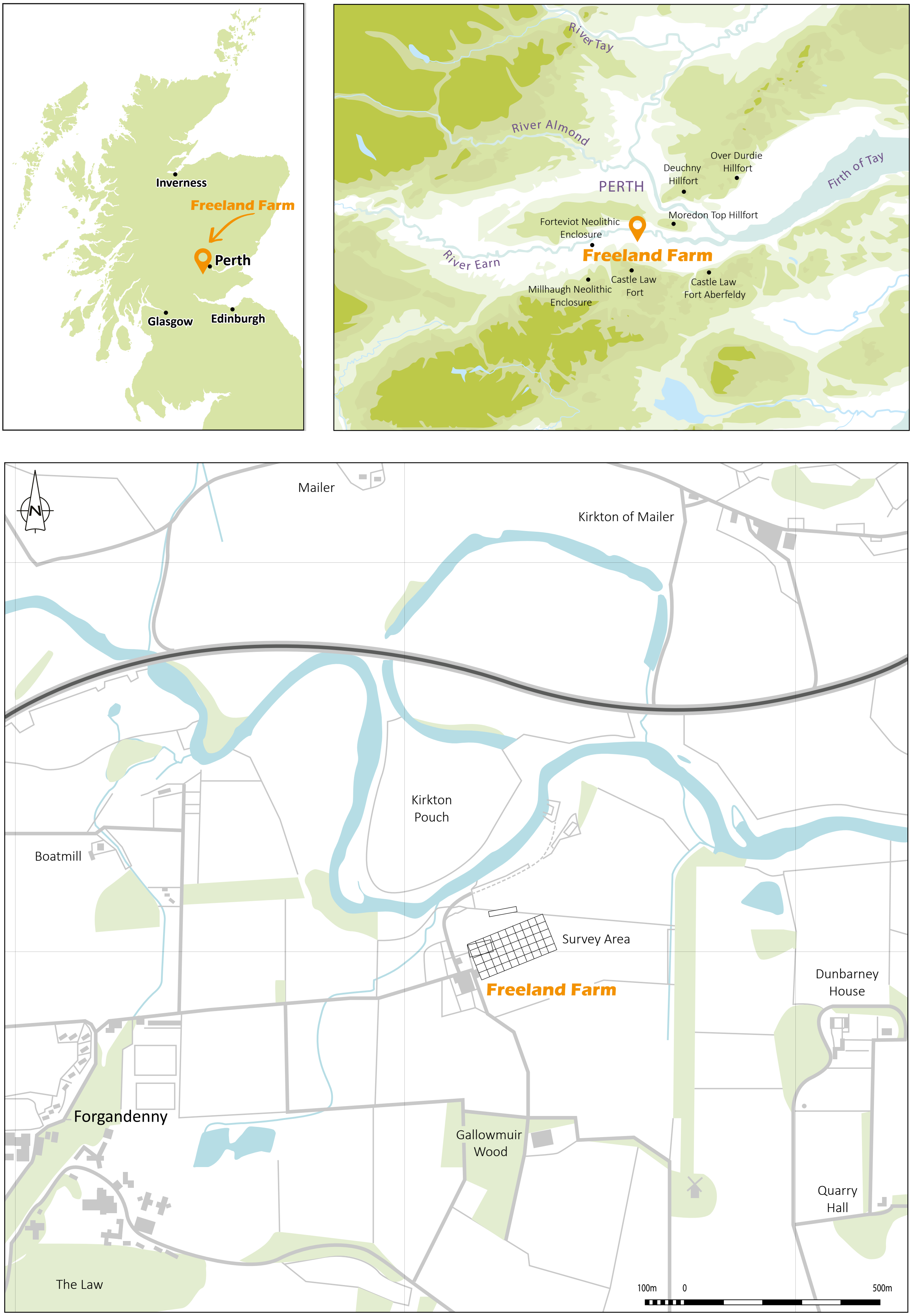

Figure 1: The location of Freeland Farm, Perth and Kinross.

Introduction

Mesolithic sites have been found throughout Scotland, but some Scottish regions have only yielded a small number of hunter-gatherer sites, such as the area around the River Tay estuary. At present, the only site of relevance to the understanding of the Tay estuary during early prehistory is the combined early and late Mesolithic settlement of Morton, which is located in the Tentsmuir area of Fife (Coles 1971), where the estuary meets the North Sea. In connection with the recent *Early Settlers Project* (2014-2017; see below), another late Mesolithic site at Freeland Farm was discovered, situated in the inner part of the estuary just south of Perth (Figure. 1). Where the lithic assemblage from Morton included significant proportions of bluish-grey chalcedony, the Mesolithic finds from Freeland Farm are dominated by the use of brown carnelian, another member of the chalcedony family (see Raw Material section below).

Although the lithic assemblage from Freeland Farm includes some finds from periods other than the late Mesolithic, the focus of the present paper is the dominating late Mesolithic evidence and in particular the use of carnelian during this period (8,400-4,000 cal BC). The site's early Neolithic finds (4,000-3,5000 BC) appear to be dominated by the use of local flint, the later Neolithic finds (3,500-2,500 BC) include pieces in exotic flint from north-east England, and a small probably Roman period shale workshop was also identified (Roman Britain is usually defined as the period 43-410 AD; Palmer and Palmer 1992).

Background

The *Early Settlers Project* and the *Tay Landscape Partnership*

The *Early Settlers Project* formed part of the *Tay Landscape Partnership* (Tay LP) and in particular the Tay LP's community participation programme, which aimed to get local people working together to shed new light on the area's early prehistory through fieldwalking. The Tay LP is a Heritage Lottery funded partnership led by Perth and Kinross Heritage Trust (PKHT) with various additional funders and supporters (see www.TayLP.org for more details).

As part of securing this funding the project was developed by David Strachan of PKHT, who commissioned a series of studies to give some context to form the aims and objectives of the project. This included the post glacial shoreline study undertaken by Dundee University (see Figure 2) which used height data and find spots to accurately plot the likely water level of the lower sections of the rivers Tay and Earn. In addition, a baseline study of known artefacts already discovered from the area was undertaken by Dr Dene Wright, which highlighted the lack of evidence for Mesolithic populations within the Tay LP area at that time (Wright 2012). This study identified Ben Lawers as the only location in Perth and Kinross where Mesolithic material had been found, and showed that fieldwalking as an approach may be successful in identifying new sites as seen in projects undertaken in South Lanarkshire during the 1970s.

It is also worth noting that during this development stage and throughout the delivery of the Tay LP, the Strathearn Environs and Royal Forteviot (SERF) project was undertaking a series of fieldwalking sessions, geophysics and excavations looking at early prehistoric settlement further west into Strathearn. The results of these sites are due to be published soon but some of the lithic material identified appears to have utilised the same raw material as covered in this paper (Wright 2014, 2015, 2016 and 2017).

Once funding was secured, the fieldwork began in the winter of 2014, and was carried out during the winter/early spring of three consecutive seasons until spring 2017. The time spent fieldwalking varied from year to year, depending on the weather, planned ploughing regimes and crop choice for each individual field.

Aims and objectives of the Tay LP

The primary aim of the project was to involve the local community, interest groups and school children in archaeological discovery, through fieldwalking of ploughed fields to shed light on early prehistoric settlement, and the changing environment in this area within which people existed at that time. Although the main focus was community involvement the project also had a strong research agenda, focusing on recovering prehistoric evidence from the Tay estuary region, and each fieldwork season informed the plans for subsequent work. Due to the unexpected discovery in 2015 of a carnelian-based late

Mesolithic industry at Freeland Farm, which held a high level of research potential, this site was visited more frequently than any other sites within the estuary.

Plate 1: Fieldwalking in the Tay estuary at Freeland Farm (photo: George Logan).

Methodology

The project investigated large parts of the lower-lying fields of the Tay LP area, specifically targeting the areas affected by shoreline displacement during the Mesolithic period (c. 9800-4000 BC) as identified in the preliminary study by Dundee University. Within this part of the estuary (the present flood plains), the team identified areas which were likely candidates for the activities (hunting, fishing and gathering) of a mobile Mesolithic population.

As mentioned previously, the farming schedule for crops on individual fields dictated when sites could be investigated and how long these fields would be available for fieldwalking. The aim was to walk the sites approximately two weeks after the fields had been ploughed to allow the soil to weather, revealing any finds within the soil. This methodology was employed from the outset after discussions with, and support from, Dr Wright on his methodology employed as part of the SERF project by Glasgow University.

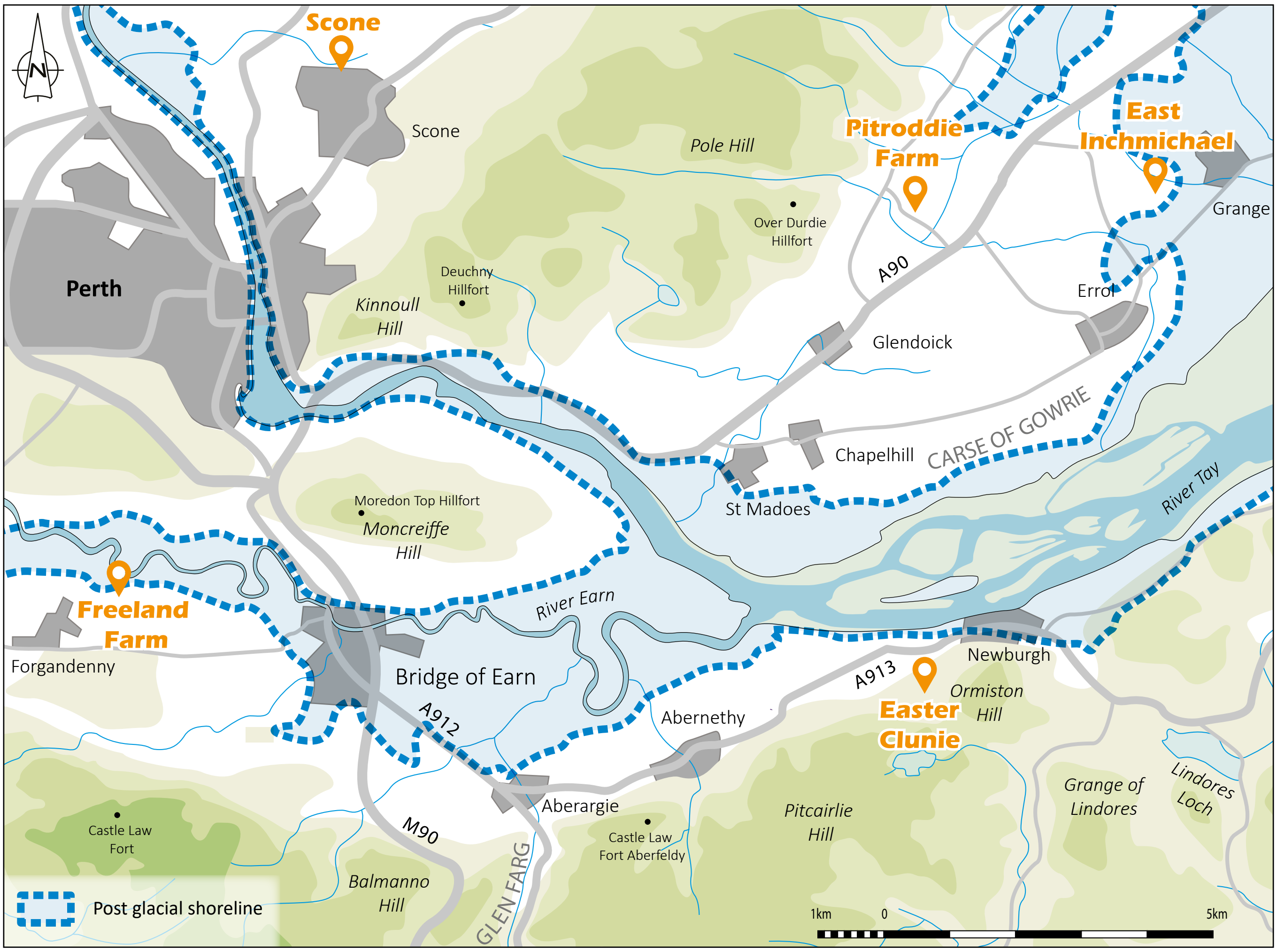

Figure 2: Post-glacial shoreline location, data from study by Dundee University

The members of the site team systematically walked 2-5 m apart over recently ploughed fields, flagging and bagging possible finds. When artefacts had been flagged and preliminarily assessed, their position was subsequently recorded in plan by Tony Simpson. A grid was laid out based on 20 m squares, and the line walked by each volunteer was marked at intervals to keep the lines as straight as possible. The supervisor (Sophie Nicol) followed the team's path by zig-zagging across the area, looking for any missed finds and helping to bag them. Each corner of fieldwalked sections was recorded by handheld GPS, as well as plotted in relation to nearby roads, electrical lines and other landmarks.

Plate 2: A recovered carnelian artefact being inspected and bagged (photo: George Logan).

The process of fieldwalking was generally slow and methodical, but it was particularly slow at Freeland Farm, due to the small size of artefacts produced by the microlithic industry. At this site, the team's approximate speed was 30-40 linear metres per day, less than 10 metres per hour.

The project focussed on finding evidence of early prehistoric people through the presence and collection of lithic and stone artefacts, but not all other types of material was collected. All worked lithic and stone tools were kept, as was all prehistoric pottery. For large quantities of more modern material – such as medieval and post medieval pottery – a sample was kept of each type, in order to report on its presence. All finds were recorded in a finds database and plotted on an area plan to show relative location. The data was then entered into a GIS system by volunteer Tony Simpson to allow detailed distribution plans to be produced.

Plate 3: Tony Simpson recording the finds in the field (photo: George Logan).

Following the fieldwork and cleaning of the finds assisted by Catherine Smith of Alder Archaeology, the lithic material was then analysed annually after each season by lithics specialist Dr Torben Bjarke Ballin.

The Tay Estuary

To understand the prehistoric settlement at Freeland Farm, as well as settlements elsewhere in the Project area, it is necessary to understand the development of the River Tay estuary (Dawson et al. 2014). Why are the sites located where they are (e.g. height above OD), and what does this tell us about, for example, site activities and economical and mobility strategies of the settlers.

Approximately 30,000 years ago, the Late Devensian glaciation reached its maximum, coverage, in eastern Scotland extending from the Grampian Highlands and well into what is now the North Sea. At this time, the sea level was generally c. 100 m lower than it is today, allowing the glaciers to carve out the main Scottish valleys, such as the River Tay valley and estuary, which were gradually filled by glacial and fluvioglacial deposits. Approximately 20,000 years ago, the ice sheets began to retreat, slowly revealing the landscape beneath them. The Tay valley was affected by a subsequent marine incursion, during which glacio-fluvial sediments were deposited (the Errol Clay Formation). The Tay and Earn valleys were finally cleared of ice c. 15,000 years ago.

Dawson et al. (2014) list three distinct episodes of late glacial and Holocene sea level changes in the Tay area. The first phase was associated mainly with the initial deglaciation of the ice-sheets and the submergence of the landscapes of coastal eastern Scotland. The second phase was associated with the melting of the last ice sheets of the northern hemisphere and further sea level rises. The final phase concerns the remainder of the Holocene, which saw a fall in sea levels and the creation of Holocene raised beaches.

The event most relevant to the interpretation of the Freeland Farm site, and other prehistoric sites in the Tay estuary, is the Main Holocene Transgression, which occurred towards the end of the Mesolithic period around 5630-5440 cal BC (Ballantyne and Dawson 1997, 39). In the Tay valley this event was associated with an exceptionally rapid rise in relative sea level which, according to Cullingford et al. (1980), led to a rise of c. 9 m, whereas Dawson and Cressey (2010) suggest a rise of at least 12 m. Considering the fact that Freeland Farm is situated just above the 15 m contour line, and as it is thought that this settlement – probably focusing on hunting, gathering and fishing – would have been coastal, the latter suggestion may be correct. The fact that this settlement is situated at c. 15 m OD may indicate a date for the site's main late Mesolithic element of around the time of the Main Holocene Transgression and the highest Holocene shoreline level in the River Tay valley.

This is further supported by the fact that the assemblage includes low numbers of water-rolled lithic artefacts (12 pieces or 1.7%) that may owe their abraded character to high tides

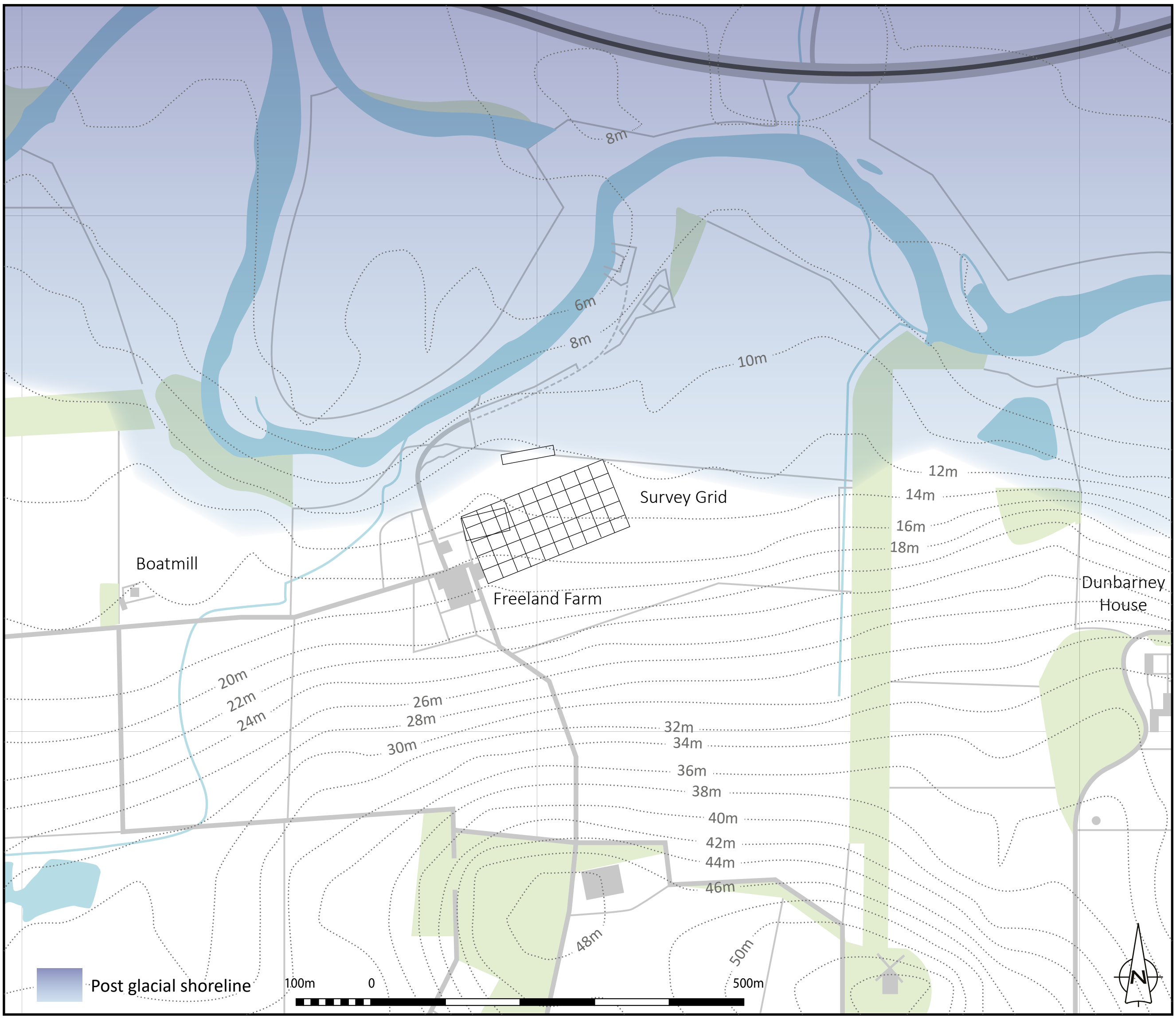

Figure 3: Maximum inundation at the time of the Main post-glacial Transgression at Freeland Farm site

and storm surges affecting the site. Ten pieces from East Inchmichael Farm (19.2%) and two from Pitroddie (2.8%) are also rolled, and these pieces are generally more rolled than those from Freeland Farm. As both sites are at lower levels in the landscape than Freeland Farm, they are likely to predate the Main Holocene Transgression, and they may date to the early Mesolithic or the first two-thirds of the late Mesolithic. Unrolled artefacts from topographic levels below Freeland Farm may date to times after the Main Holocene Transgression, either the final third of the late Mesolithic or post-Mesolithic times. At Pitroddie, for example, probably Neolithic chambered cairns were recorded in 1904 just on the edge of the flood plain (Cowan 1904; according to CANMORE, there are no visible traces of these cairns today) and may indicate the expansion of early farming communities onto the now dry plain of the Tay estuary.

The finds from other sites than Freeland Farm

In addition to Freeland Farm, which was fieldwalked in connection with field seasons 2015-17, a number of other locations were also investigated. They are (see map, Figure 1):

1. Pitroddie, fieldwalked in 2014-15.
2. East Inchmichael Farm, fieldwalked in 2015-16.
3. Easter Clunie, fieldwalked in 2015-16.
4. Scone Estate, fieldwalked in 2017.

In total, 70 lithic artefacts were recovered from Pitroddie, 47 from East Inchmichael Farm, and 12 from Scone Estate, whereas only six lithics were retrieved from Easter Clunie. The finds from the former three sites are listed in Table 1. The finds from Easter Clunie include three flints, one piece of worked quartz and two pieces of worked igneous material. Apart from CAT 59, which is a bipolar core in flint, all pieces from Easter Clunie are unworked hard-hammer or bipolar flakes.

Pitroddie and East Inchmichael Farm

Table 2 shows the raw material composition of the assemblages from Pitroddie and East Inchmichael Farm (the raw materials are characterized and discussed in connection with the presentation of the finds from Freeland Farm). The composition of these two collections differ considerably from that of the Freeland Farm assemblage (below). The main differences are the ratios of the jasper/carnelian, chalcedony/agate, flint, and quartz/quartzite sub-assemblages. The two sites from the estuary's northern sites include 17.1% jasper/carnelian (where Freeland Farm has a ratio of 57.3%); 26.5% chalcedony/agate (where Freeland Farm has a ratio of 1.6%); 13.7% flint (where Freeland Farm has a ratio of 20.7%); and 36.8% quartz/quartzite (where Freeland Farm has a ratio of 8.8%). Where the most common raw material in the Freeland Farm assemblage is jasper/carnelian, it is quartz/quartzite in the collections from the northern sites, and where chalcedony/agate is almost absent amongst the finds from Freeland Farm, it is more common than jasper/carnelian in the other two assemblages.

Raw Material	No.	%
Jasper/carnelian	20	17.1
Chalcedony/agate	31	26.5
Flint	16	13.7
Chert	1	0.8
Fossiliferous chert	2	1.7
Quartz/quartzite	43	36.8
Others	4	3.4
TOTAL	117	100.0

Table 2: Pitroddie and East Inchmichael Farm. Raw material composition.

Some of these differences may represent random statistical fluctuations due to the fact that the assemblages from the northern sites are numerically small, the participation of different fieldwalkers, different weather during the fieldwork etc., but some of the differences are so notable that they must reflect reality. It is difficult to explain these differences without further fieldwork (for example of other sites in the estuary between the level of the Main Holocene Shoreline and the present shoreline), but some explanations are likely: 1) The partial replacement on the northern side of the Tay of jasper/carnelian with chalcedony/agate may indicate procurement from different sources, and that the latter are more common on the northern side, with the former being more common in the area around Freeland Farm; and 2) as indicated by the raw materials used at Freeland Farm for different sizes of blades and different tool forms, it is likely that chronology could play a part.

	Pitroddie								East Inchmichael Farm					Scone Estate				
	Jasper/ carn.	Chalc/ agate	Flint	Chert	Foss. chert	Quartz	Others	Total	Jasper/ carn.	Chalc/ agate	Flint	Quartz	Total	Chalc/ agate	Flint	Quartz	Pitchstone	Total
Debitage																		
Chips		1				1		2	2				2					
Flakes	13	5	3		2	19	2	44	1	6	2	19	28		2	2		4
Blades			2					2								1		1
Indeterminate pieces	1	5	1			1		8	1	3	1	1	6	1		1		2
Total debitage	14	11	6		2	21	2	56	4	9	3	20	36	1	2	4		7
Cores																		
Single-platform cores			1	1				2									1	1
Irregular cores	1	5						6	1	3	1		5					
Bipolar cores															1			1
Total cores	1	5	1	1				8	1	3	1		5		1		1	2
Tools																		
Short end-scrapers		1						1		2			2					
End-/side-scrapers			1					1										
Scale-flaked knives/fire-flints															1			1
Pieces w edge-retouch											1	1	2					
Fire-flints			2					2			1		1		1			1
Gunflints															1			1
Polished stone axehead							1	1										
Hammerstones							1	1										
Pounders												1	1					
Total tools		1	3				2	6		2	2	2	6		3			3
TOTAL	15	17	10	1	2	21	4	70	5	14	6	22	47	1	6	4	1	12

Table 1: General artefact list for Pitroddie, East Inchmichael Farm, and Scone Estate.

The assemblages from Pitroddie and East Inchmichael Farm both contain more rolled artefacts than the collection from Freeland Farm (below). Where the latter only includes 1.7% rolled lithic objects, Pitroddie includes 2.8% and East Inchmichael as much as 19.2%. It is also important to note that the rolled pieces from Freeland Farm are generally lightly rolled, whereas some of those from the other two assemblages are heavily rolled. Most likely, notably rolled artefacts from Pitroddie and East Inchmichael Farm predate the Main Holocene Transgression (above), whereas the unrolled pieces may date to times after this event. At Pitroddie, for example, probably Neolithic chambered cairns were recorded in 1904 just on the edge of the flood plain (Cowan 1904) and may indicate the expansion of early farming communities onto the now dry plain of the Tay estuary.

The assemblage from Pitroddie includes two flint blades but not microblades. The cores include two single-platform cores in flint (CAT 22) and radiolarian chert (CAT 65), the former of which being a highly regular conical core from which narrow blades were struck (25 by 19 by 16 mm). A group of small irregular cores are almost exclusively based on chalcedony/agate. The tools embrace one small thumbnail-scraper in flint (CAT 6; 20 by 17 by 5 mm), one end-/side-scraper in flint (CAT 1), two fire-flints (CAT 7 and 38), one flake struck off a polished axehead in an indeterminate type of green rock (CAT 24), and one hammerstone in an igneous material (CAT 62).

The fact that some of the material is rolled indicates that some of the material (such as the small thumbnail-scraper) may predate the main Holocene Transgression, whereas the axe head fragment clearly post-dates this event. The two fire-flints would have been used with a steel strike-a-light, and they may date to a time between the Iron Age and the post medieval period (Ballin 2005; 2007; and 2014c).

The assemblage from East Inchmichael Farm includes no unmodified blades at all, but one flint with edge-retouch (CAT 250) is based on a hard-hammer blade. All cores are irregular specimens, most of which are chalcedony/agate. The tools embrace one small thumbnail-scraper (CAT 297; 14 by 10 by 8 mm) and one short end-scraper (CAT 262), both in chalcedony/agate, two pieces with edge-retouch (CAT 250, 273), one of which is flint and one quartz, one fire-flint (CAT 286), and one pounder in quartzite (CAT 309). Some rolled pieces may predate the main Holocene Transgression, whereas unrolled pieces may post-date this event.

With 12 pieces, the assemblage from Scone Estate is numerically small, but it includes a wide variety of informative pieces. In addition to seven pieces of debitage in chalcedony/agate, flint and quartz, it also includes one small, highly regular conical microblade-core in pitchstone (CAT 861; 14 by 15 by 14 mm) and one bipolar core in flint (CAT 859). The tools embrace one scale-flaked knife/fire-flint (CAT 865; 49 by 34 by 17 mm), one fire-flint (CAT 857), and one gunflint (CAT 862).

CAT 865 has a scale-flaked cutting-edge along its left lateral side, as well as faint gloss along this edge from cutting vegetable matter (Juel Jensen 1994). It also displays heavy-duty damage to the distal end and the right lateral side from being struck repeatedly with a steel strike-a-light. This damage is fresher than the scale-flaking. CAT 862 is a flake-based British gunflint with a rounded heel. Interestingly, the piece displays notable powder-burn at one corner, which is an indicator of heavy use (Ballin 2014a).

The small assemblage includes pieces of very different ages. Conical microblade-cores like CAT 861 are likely to date to either the late Mesolithic or the early Neolithic (e.g. Ballin 2014b; and 2017b), but the use of Arran pitchstone narrows this date down to the early Neolithic period (Ballin 2015). The scale-flaked cutting-edge of CAT 865 suggests that this piece was first modified and used during the Neolithic or early Bronze Age periods, but then picked up later (Iron Age to post medieval period) and struck with a steel strike-a-light. The fire-flint can only be dated broadly to the Iron Age to post medieval period. The gunflint is dated typo-technologically to the time c. 1650-1800 (Ballin 2013a).

Freeland Farm

During field seasons 2015 and 2016, Freeland Farm was identified as probably the richest and the most interesting of the sites investigated during the Tay Landscape Partnership project, and it was decided to focus entirely on this location during field season 2017 (see: Aims and objectives, above). During the post excavation process, it was also decided to make the assemblage from this site the focus of the present paper, as the numerical size and composition of the finds from Freeland Farm would allow light to be shed on the late Mesolithic of the Tay estuary. Before the initiation of the Tay Landscape Partnership project, the only excavated Mesolithic finds from the area was Morton (Coles 1971) just outside and south of the mouth of the estuary, where the assemblage includes an early Mesolithic sub-assemblage as well as a late Mesolithic one.

The site of Freeland Farm was situated a few kilometres south of Perth, approximately 200 m south of the present River Earn (Plate 4). Today, the river is c. 30 m wide, but in the Mesolithic period, the river would have been a substantial arm of the inner Tay estuary, and the branches of the rivers Earn and Tay would have joined the main estuary near Abernethy and Glencarse, c. 8 km east of Freeland Farm. Immediately in front of the site, the Earn branch of the estuary would have been approximately 1 km wide at the time of the Main Holocene Transgression around 5630-5440 cal BC (Ballantyne and Dawson 1997, 39). It is thought (above) that the shoreline at this time would have been at 12 m+ OD, and as the site is situated just above the 15 m contour (and on the basis of the collection's low number of rolled artefacts) the Mesolithic settlement of Freeland Farm was probably situated immediately above the shoreline when the Holocene sea level was at it highest.

The site's later prehistoric settlements would have been slightly further from the shore, but during those periods the river and the estuary would have had a different economical meaning, with the main economical focus having changed from hunting, gathering and fishing towards farming (the Neolithic period) and later also trade (the Roman period). During the Roman period, there were Roman forts to all sides of Freeland Farm, the closest being Braco near present-day Abernethy. It is possible that the shale workshop at the site should be seen in this light, representing the trade and communication associated with these forts, but at the present it is unknown whether this workshop is Roman or Romano-British.

Plate 4: Fieldwalking grid and view to Moncreiffe Hill © George Logan

The assemblage

General overview

From the excavation at Freeland Farm, 707 lithic artefacts were recovered. They are listed in Table 3. In total, 81% of this assemblage is debitage, whereas 9% is cores and 10% tools. Some post-medieval pottery and modern artefacts were also recovered, particularly from the site's eastern end, but they are not included in Table 3 or discussed further in this paper.

The definitions of the main lithic categories are as follows:

Chips: All flakes and indeterminate pieces the greatest dimension (GD) of which is ≤ 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.

Blades and microblades: Flakes where L ≥ 2W. In the case of blades W > 8 mm, in the case of microblades W ≤ 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).

Av. dim.: Average dimensions

GD: Greatest dimension.

Raw materials – types, sources and condition

As indicated in Tables 3-4, the lithic finds include a number of different raw materials which, for the sake of convenience, were grouped in the following manner: Raw materials belonging to the chalcedony family (Pellant 1992, 88), flint, fossiliferous chert, pitchstone, quartz/quartzite, shale, haematite, sandstone, igneous materials, and others. The vast majority of these sub-categories are either macro-crystalline quartz or crypto-crystalline quartz, all of which share the same basic chemical composition (SiO_2), defining them as silicon dioxide. The remainder of the raw materials are igneous, sedimentary or metamorphic types of rock.

	Nr	%
Jasper/carnelian	405	57.3
Chalcedony/agate	11	1.6
Flint	146	20.7
Fossiliferous chert	40	5.7
Pitchstone	1	0.1
Quartz/quartzite	62	8.8
Shale	7	1.0
Haematite	4	0.6
Sandstone	6	0.7
Igneous rock	18	2.5
Others	7	1.0
TOTAL	707	100.0

Table 4: Raw material composition of Freeland Farm.

In general terms, two main sets of definitions of flint/chert exist, namely 'American' and 'British' definitions, where American nomenclature perceives chert as more or less synonymous with the term 'crypto-crystalline quartz' and including flint (Luedtke 1992, 5), whereas British nomenclature defines flint and chert as two different forms of crypto-crystalline quartz, with flint having been formed in Cretaceous chalk formations and chert in all other formations. Chalcedony (and its various 'cousins') is commonly (American nomenclature) seen as forming part of the chert family (e.g. Luedtke 1992, 5), whereas others (British nomenclature) see it as neither a chert nor a flint but a separate type of crypto-crystalline quartz, a mineral (e.g. Pellant 1992, 88). The authors follow the British definition of chalcedony as a mineral most commonly formed in lavas and related rock formations by the solidification of hydrothermal fluids *not* of organic origin (where flints and most cherts are of organic origin). In Scotland, this choice of nomenclature is relevant to discussions of prehistoric procurement and exchange patterns, as it allows the various forms of crypto-crystalline quartzes to be grouped geographically and in relation to one or the other form of geological occurrence (e.g. bedrock and secondary pebble sources).

	Jasp./ carn.	Chalc/ agate	Flint	Foss. chert	Pitch-stone	Quartz	Shale	Haema-tite	Sand-stone	Igneous	Others	Total
Debitage												
Chips	80	2	58	5		7						152
Flakes	105	7	40	12		37	3	2	5	13	2	226
Blades	11		6			2	1					20
Microblades	47		3									50
Indeterminate pieces	77		11	21		5	2		1		2	119
Crested pieces	7		1									8
Total debitage	327	9	119	38		51	6	2	6	13	4	575
Cores												
Collected pebbles/ geodes	1		1					1				3
Split/flaked pebbles	2							1		1	1	5
Core rough-outs	1											1
Single-platform cores	8	1	1			2					1	13
Opposed platf. cores	4					1						5
Irregular cores	9		1	1		1						12
Discoidal cores	1											1
Bipolar cores	4		5	2		2						13
Core frags	6											6
Total cores	36	1	8	3		6		2		1	2	59
Tools												
Leaf-shaped arrowheads			1									1
Microlith preforms			1									1
Edge-blunted microliths	1											1
Truncated bladelets	1											1
Microburins	1											1
Short end-scrapers	4		5			1						10
Blade-scrapers	1											1
Side-scrapers			1									1
End-/side-scrapers			1			1						2
Atypical scrapers			1									1
Backed knives	1											1
Scale-flaked knives	1		1									2
Burins	4		2									6
Truncations	2				1							3
Pieces w edge-retouch	26		6							1	1	34
Hammerstones						2						2
Pounders						1						1
Polishers										3		3
Game pieces							1					1
Total tools	42		19		1	5	1			4	1	73
TOTAL	405	10	146	41	1	62	7	4	6	18	7	707
%	57.3	1.6	20.7	5.7	0.1	8.8	1.0	0.6	0.7	2.5	1.0	100.0

Table 3: General artefact list for Freeland Farm.

The lithic finds from Freeland Farm are notably dominated by raw materials of the chalcedony family (58.7%). The chalcedony family (which was one of most important raw material groups exploited by the early prehistoric settlers of the Fife/Angus/eastern Perthshire area; see for example Coles 1971) is defined by having a vitreous to waxy lustre, where for example flint and quartz both have a clearly vitreous lustre, and the different forms of chalcedony were generally formed in volcanic areas. This raw material family (Heddle 1901) may be subdivided into a number of different sub-categories on the basis of colour and patterning, such as chalcedony proper (grey or bluish-grey), agate (characterized by concentric banding), jasper (red, opaque), carnelian (brown, translucent), and bloodstone/plasma (green; only found on the Isle of Rhum; Wickham-Jones 1990).

Although the subdivision of chalcedony suggests that we are dealing with clearly definable categories, these types grade into each other and form a continuum. In Table 1, jasper and carnelian have been combined to form one group, as it may be difficult to distinguish between these red and brown forms (particularly when dealing with very small pieces), but it is thought that almost all of these pieces are carnelian. In the same manner, chalcedony proper and agate have been combined to form one group – although in this part of Scotland much agate is pink, there are also bluish-grey forms, which are almost indistinguishable from the common bluish-grey chalcedony, only defined as agate by its faint concentric banding.

Pebbles of the chalcedony family would probably have been available along the Tay, washed out of the lavas on either side of the estuary (Pellant 1992, 88; Heddle 1901). The higher ratio of chalcedony/agate north of the Tay (East Inchmichael Farm) and jasper/carnelian south of the Tay (Freeland Farm) suggests that chalcedony family pebbles may have been procured from a variety of outcrops. It is uncertain whether, in the Tay area, pebbles of the chalcedony family were quarried, but this raw material is probably more likely to have been procured mainly by ‘beach-combing’ along the shores of the Tay estuary. However, the presence of rough cortex on some of the site’s carnelian artefacts, as well as the recovery of one geode (CAT 501; hollow spheroidal nodule with the hollow covered by clusters of quartz crystals) which may represent stored raw material, suggests that a proportion of this material may derive from primary outcrops, prised from the local lavas.

The site’s chalcedonic materials – in particular the jasper/carnelian – is characterized by numerous parallel internal fault-planes, which seriously hampered the controlled reduction of this material, and many tool blanks are therefore tabular indeterminate pieces (Table 4).

Most likely, most of the flint was formed in Cretaceous chalk and limestone formations off the present east-coast of Scotland (Harker 2002), and probably washed in by wave action. The presence in the Tay estuary of minuscule natural flint pebbles (the smallest ones discarded by the authors) suggests that some flint may have been present along the banks of the Tay estuary, possibly washed in at a time when the estuary was more exposed to the weather and currents of the North Sea due to a higher water-level, such as during the various transgressions of early prehistory (see above). However, 11 blanks and tools are based on mottled grey or black Yorkshire flint, identifying these pieces has exotica imported into the region during the later Neolithic (Ballin 2011b).

	Chalcedony family		Flint	
	No	%	No	%
Primary	1	0.6	3	6.1
Secondary	11	6.5	13	26.5
Tertiary	158	92.9	33	67.4
TOTAL	170	100.0	49	100.0

Table 5: Reduction sequence of all unmodified flakes and blades; chalcedonic material and flint only.

The procurement of chalcedony (mainly carnelian) and flint from different sources is supported by Table 5. The former group of raw materials has a cortex ratio of 7.1% (primary and secondary pieces), whereas flint has a cortex ratio of 32.6%. These different cortex ratios may reflect the application of different reduction strategies (more or less extensive decortication), but it is more likely that the different cortex ratios simply reflect the different sizes of the collected nodules, with the chalcedony nodules (geodes) being considerably larger than the flint nodules.

As shown in Ballin (2016b), large nodules have more inner mass in relation to their outer surface, or cortex, than small ones, and large nodules therefore tend to have a considerably higher ratio of tertiary material than small ones. The largest chalcedony (carnelian) core has a length of 71 mm and the largest flint core a length of only 34 mm, which means that the largest chalcedony core would have had approximately nine times as much mass (using the equation V=(4/3)πr3) but only *c*. four times as much surface area (using the equation A=4π2) as the largest flint nodule.

The so-called 'fossiliferous chert' was probably locally available and formed in the few outliers of Carboniferous limestone present immediately east and south of Perth, for example at Errol on the north-side, between Perth and Dundee, and on the south-side near Bridge of Earn and Newburgh (Woodland 1979; Read et al. 2002, Fig. 9.2). Several pieces display numerous fossils, some of which are quite large, and these fossils include corals, brachiopods and crinoids (CAT 523). This raw material is very light in colour and brittle, and it appears to have poor flaking properties. Some pieces are also clearly affected by fire, either crazed, vitrified (CAT 467 and 353) or even slaggy (CAT 448 and 523). Although 13 pieces from Freeland Farm were defined as worked – that is, displaying flake scars and/or recognizable dorsal and ventral faces – none of these was identified as modified or as belonging to any form of formal tool types. One piece (CAT 392) resembles a bipolar core.

The apparently poor flaking properties of this material, the absence of formal tool forms, the heavily burnt nature of many pieces, as well as the presence of glaze and slag on several pieces, suggest that these objects may not be prehistoric artefacts, but products of more recent industrial processes, such as lime burning for fertilizer in post-medieval times. The presence of what seems to be flake scars may be a result of the industrial crushing of the limestone and its content of chert (the industrial crushing of flint and other types of stone for aggregate frequently produces pieces which appear to be bipolar flakes and cores, and such pseudo-artefacts may be found along railway lines and in drives). To investigate this angle, the authors contacted The Scottish Lime Centre Trust who kindly informed them that no lime kilns were known near the investigated archaeological sites, and the lime possibly spread across the fields in the Tay estuary may either have been imported and landed at Lime Shore in Perth Harbour; (pers. comm. Rosamond Artis, Scottish Lime Centre Trust), or it may have been distributed from small local kilns which have not yet been found, and these kilns may over time have disintegrated or been robbed of their stone. This question needs further investigation.

One truncated blade in pitchstone (CAT 408, Figure 4) is based on raw material procured from the Isle of Arran in the Firth of Clyde. Presently available evidence suggests that pitchstone was distributed across most of Scotland through a complex exchange network, and that most of this exchange took place during the early Neolithic period (Ballin 2015; 2017d). This piece is based on aphyric black pitchstone, probably deriving from outcrops in eastern Arran, just south of Brodick (Ballin and Faithfull 2009).

In total, six pieces of worked shale were recovered, one of which appears to be a game piece based on a recycled fragment of a polished bangle (CAT 352, Figure 4). As oil shale is present in various parts of the coal measures of central Scotland (Cameron and Stephenson 1985), this raw material could have been procured from a number of Scottish sources. CAT 352 may have been manufactured by the Romans or Romano-British people (pers. comm. Alison Sheridan).

Quartz was formed in all three main rock forms – igneous, sedimentary or metamorphic – and would have been locally available as erratics or beach pebbles. Four pieces of magnetic rock (they affect a compass needle) were recovered, and this raw material may be a form of haematite. Basaltic or granitic rock types were formed in the area's volcanoes; quartzite in the metamorphic areas covering much of the eastern and central Highland zone; and sandstone as part of the local outcrops of Old Red Sandstone. For more details on the Tay area's geology, see Woodland (1979); Cameron and Stephenson (1985); Stephenson and Gould (1995); and Trewin (2002).

Compared to the lithic artefacts recovered by the project from other parts of the Tay estuary (Ballin 2016a), the collection from the present site includes considerably fewer pieces (eight pieces) with superficial abrasion from having been submerged during postglacial transgressions in the area ('water-rolling'). Seventeen pieces display fire-crazing, six of which belong to the category of fossiliferous chert.

Figure 4: Tools – CAT 106 and 658 scrapers, CAT 108 and 168 burins, CAT 847 piece with straight truncation, CAT 208 and 592 microliths, CAT 183 knife, CAT 234 end/side scraper, CAT 134 short end scraper, CAT 324 piece with edge-retouch, CAT 352 shale gaming piece, CAT 408 piece with oblique truncation, CAT 588 scale-flaked knife, CAT 618 piece with edge retouch.

Debitage

In total, 575 pieces of debitage were recovered from the site (Tables 3 and 4). The debitage includes 152 chips, 226 flakes (Plate 5), 20 blades, 50 microblades, 119 indeterminate pieces, and eight preparation flakes (all crested pieces). Compared to other early prehistoric assemblages from Scotland, the chip ratio is relatively low (c. 26%), which is likely to reflect the fact that sieving was not carried out. As demonstrated in Ballin (1999b), the chip ratio of sieved Mesolithic assemblages usually varies between c. 30% and 55%.

Plate 5: Volunteer Allan finds Carnelian flake © George Logan

Table 6 shows the relative composition of the chalcedony family and flint debitage. There are notable differences, such as: 1) flint has a considerably higher ratio of chips (48.7% against 24.4%); 2) flint has a higher ratio of blades (5.1% against 3.3%); 3) the chalcedony family has a notably higher ratio of microblades (14.0% against 2.5%), and 4) the chalcedony family has a notably higher ratio of indeterminate pieces (22.9% against 9.3%). The higher chip ratio of flint may be due to the light-coloured flint being easier to spot by fieldwalkers than the brown-coloured jasper/carnelian, which might be difficult to identify against the brown-coloured plough-soil. The different blade and microblade ratios may indicate that flint and the chalcedony family were favoured at different times of prehistory, with most of the chalcedonic material probably dating to the later Mesolithic and the flint possibly to the Neolithic. The fact that the chalcedonic material includes higher numbers of indeterminate pieces may reflect the different flaking properties of the two raw material groups, not least the fact that particularly the jasper/carnelian is characterized by numerous internal fault-planes.

	Chalcedony family		Flint	
	No	%	No	%
Chips	82	24.4	58	48.7
Flakes	112	33.3	40	33.6
Blades	11	3.3	6	5.1
Microblades	47	14.0	3	2.5
Indeterminate pieces	77	22.9	11	9.3
Crested pieces	7	2.1	1	0.8
TOTAL	336	100.0	119	100.0

Table 6: The relative composition of the site's debitage; chalcedonic material and flint only.

Although large numbers of flakes were recovered from the site (226 pieces), the debitage includes substantial numbers of blades and microblades (70 pieces), and it is thought that the main aim of the lithic reduction at Freeland Farm was to produce small blades. It should be borne in mind that the site's microblades are minuscule (Plate 6), and fragments of microblades might easily have been missed in the field. If the site had been wet-sieved, the blade ratio would have been considerably higher.

Plate 6: Jasper/carnelian microblades.

Figure 5 shows the different dimensions of blades in chalcedonic material and flint. The former group consists almost exclusively of microblades, whereas the latter consists entirely of blades. This impression is further supported by Figure 6, which shows the width of all blades and blade fragments. According to this figure, the chalcedonic blades are mostly microblades (main peak at 6-7 mm), but with a small secondary peak at 9-10 mm. It is uncertain whether this secondary peak indicates post-Mesolithic use of jasper/carnelian (contemporary with the probably Neolithic flint blades), or whether these pieces may be slightly larger blades from the initial preparation of the cores.

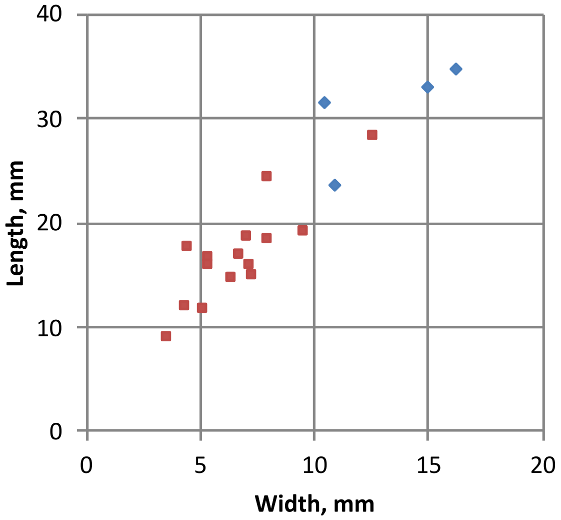

Figure 5: The dimensions of the intact blades in chalcedonic material (red) and flint (blue).

Table 7 shows the application of different percussion techniques across the site's flakes and blades. The blades were predominantly manufactured by soft percussion (c. 65%) and the flakes by hard percussion (c. 55%). The relatively high soft percussion ratio amongst the flakes (c. 17%) may indicate that some flakes may be failed blades which simply turned out shorter than intended. Compared to contemporary sites on the Scottish west coast (as indicated by the many bipolar cores recovered from sites on Jura but at the time erroneously referred to as 'chisels'; e.g. Mercer 1968, 1970, 1971 and 1974), bipolar technique was used sparingly (c. 8%). Interestingly, single-platform and opposed-platform cores are predominantly in jasper/carnelian, whereas there are more bipolar cores in flint than in jasper/carnelian (Table 1). This may indicate (as suggested in Ballin 2014e, Table 3) that a significant proportion of the bipolar cores are post-Mesolithic, and that in eastern Scotland (in contrast to in western Scotland), the bipolar technique is not used systematically until the later Neolithic period. One unmodified blade (CAT 240, Figure 7) and one tool blank (CAT 134) have finely faceted platform remnants identifying them as pieces struck off Levallois-like cores, and dating them to the later Neolithic (Ballin 2011a).

	Flakes		Blades	
	No	%	No	%
Soft percussion	19	17.0	26	65.0
Hard percussion	62	55.4	3	7.5
Indeterminate platform technique	11	9.8	6	15.0
Platform collapse	11	9.8	2	5.0
Bipolar technique	9	8.0	3	7.5
TOTAL	112	100.0	40	100.0

Table 7: Applied percussion techniques: definable unmodified flakes and blades.

The site's eight crested flakes and blades are mostly in jasper/carnelian, with one piece being in flint. These pieces are generally relatively large (av. dim.: 26 by 13 by 9 mm) and not very elegant, and they were manufactured by soft as well as hard percussion. These facts reveal that the crested pieces formed part of the initial shaping of the site's cores.

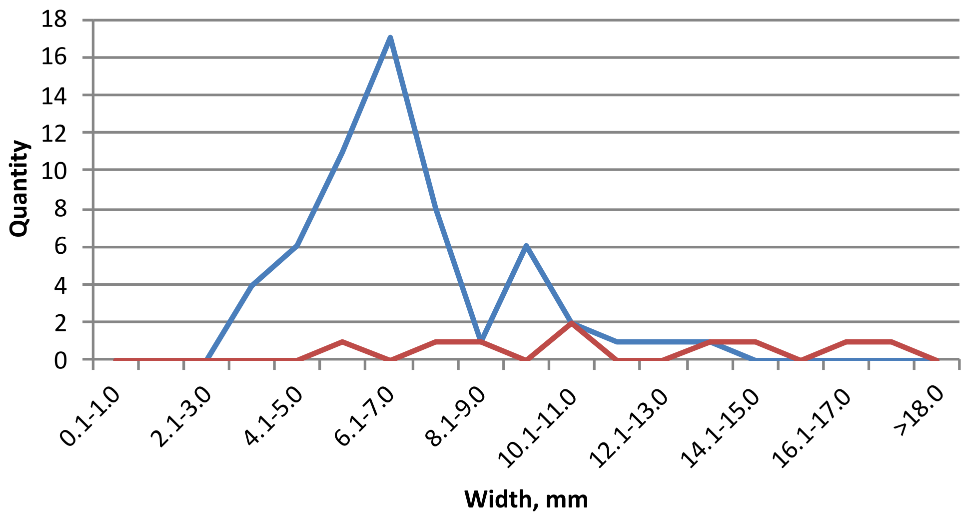

Figure 6: The width of all unmodified blades and microblades in chalcedonic material (blue) and flint (red).

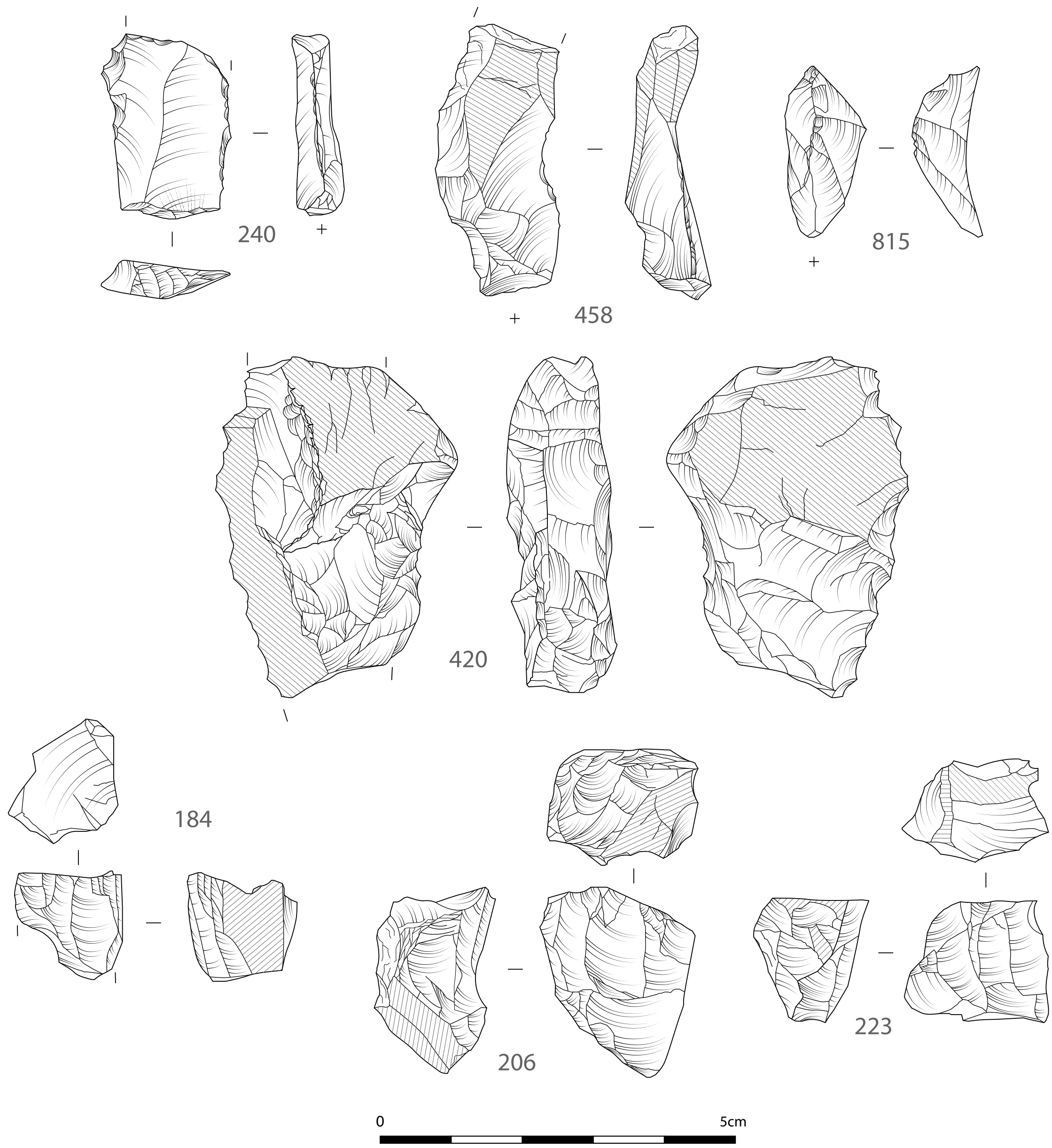

Figure 7: Lithic artefacts – CAT 240 unmodified blade, CAT 458 and 815 crested pieces, CAT 420 core roughout, CAT 184, 206 and 223 single platform cores.

Cores

In total, 59 cores were recovered during the excavation at the site. They include the following core types: Three collected pebbles or geodes, three split/flaked pebbles, three core rough-outs, 13 single-platform cores, five opposed-platform cores, 12 irregular cores, one discoidal core, 13 bipolar cores, and six core fragments. As shown in Table 3, the cores include a variety of raw materials, dominated by jasper/carnelian (36 pieces), flint (eight pieces), and quartz (six pieces).

The dimensions (L by W by 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/cortical '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 dimension. by second-largest dimension. by smallest dimension.

Various nodules: Three unworked nodules were kept, as they are expected to represent collected and stored raw material. They include one flint pebble (CAT 513; GD = 28 mm); one jasper/carnelian geode (CAT 501; GD = 57 mm); and one concretion of haematite (CAT 384; GD = 41 mm). The former two would have been kept as knapping material, but it can not be ruled out that the haematite concretion may have been intended for fire making with a flint strike-a-light (Pawlik 2004).

Split pebbles and core rough-outs: Three split pebbles were recovered, including one in chert (CAT 498), one in haematite (CAT 395), and one in igneous rock (CAT 314). They were all split on an anvil and vary considerably in size (GD = 16-64 mm). Three pieces in jasper/carnelian were classified as core rough-outs (CAT 420, Figure 7, 421 and 597). They are all tabular pieces with various forms of trimmed and rubbed edges. These edges are thought to be either prepared platform-edges or crests, although it can not be ruled out that CAT 597 may have been used as a burin. They vary in size between GD = 32-49 mm.

Figure 8 shows the size distribution of the main core types. The single-platform, opposed-platform, and bipolar cores are of roughly the same size, whereas the irregular cores tend to be considerably larger than the other core types. This is unusual, as the gradual reduction of cores following the formula pebble/quarried block ⇒ single-platform core ⇒ dual-platform core ⇒ irregular (multi-platform) core ⇒ bipolar core usually means that irregular cores have average dimensions smaller than the single- and dual-platform cores. In the present case, the large size of the irregular cores may reflect the fragmentation patterns of the local jasper/carnelian, which caused many geodes to disintegrate into useless irregular cores at an early stage (see technology section below). The fact that the bipolar cores are of roughly the same general size as the single- and dual-platform cores may reflect the chronology of the cores, where most of the platform-cores are in jasper/carnelian (Plate 7) and probably date to the late Mesolithic, whereas the bipolar cores include a larger proportion of flint cores, which may be later (see chronology section below).

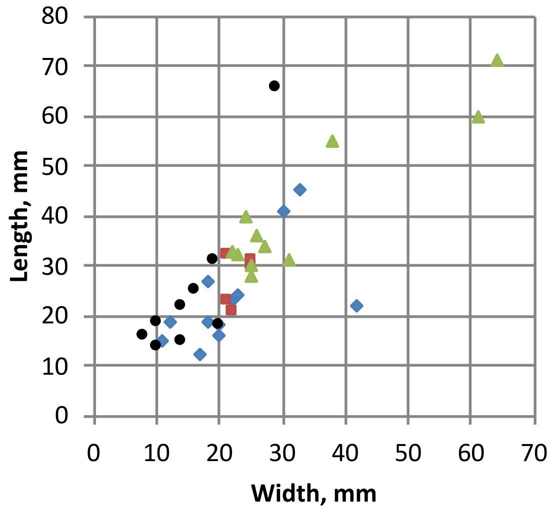

Figure 8: The dimensions of the main core types recovered at the site – single-platform cores (blue); opposed-platform cores (red); irregular cores (green), and bipolar cores (black).

Single-platform cores: The assemblage includes 13 single-platform cores, most of which are in jasper/carnelian, supplemented by small numbers of agate, flint and quartz cores. The two quartz cores (CAT 215 and 678) are considerably larger (GD = 42-45 mm) than the jasper/carnelian cores (av. dim.: 21 by 20 by 15 mm). The agate core (CAT 717) is of roughly the same size as the jasper/carnelian cores, whereas the fragmented solitary flint core (CAT 566) measures 27 by 18 by 12 mm. CAT 566 is in mottled-grey Yorkshire flint, suggesting that this piece may be of a later Neolithic date (Ballin 2011b).

Plate 7: Jasper/carnelian cores.

Some of the jasper/carnelian specimens are roughly conical (e.g. CAT 206, Figure 7, and 223), but most of the core shapes are affected by the presence of internal fault planes. The two quartz cores have cortical platforms, whereas most of the remainder have plain platforms. Approximately one-third of the platform-edges are untrimmed, with the remainder being neatly trimmed. The jasper/carnelian cores are generally microblade cores.

Opposed-platform cores: This category includes five pieces, one of which is quartz (CAT 329), with four being jasper/carnelian. Compared to other Scottish assemblages from the later Mesolithic, the assemblage from Freeland Farm includes relatively high numbers of opposed-platform cores (the single-platform : opposed-platform ratio of the site's jasper/carnelian cores is 2:1). This may be due to the fact that most of the location's small cores are based on tabular fragments of jasper/carnelian, in many cases offering two ready-made opposed platforms. The jasper/carnelian cores are generally microblade cores, and CAT 724 (Figure 9) is almost cylindrical. The quartz core CAT 329 is of roughly the same size as the jasper/carnelian cores, and the average dimensions of the opposed-platform cores are 27 by 23 by 14 mm. Most platforms are plain and trimmed.

Discoidal cores: Only one discoidal core was recovered (CAT 159, Figure 9); it is based on jasper/carnelian. It was reduced by strikes to

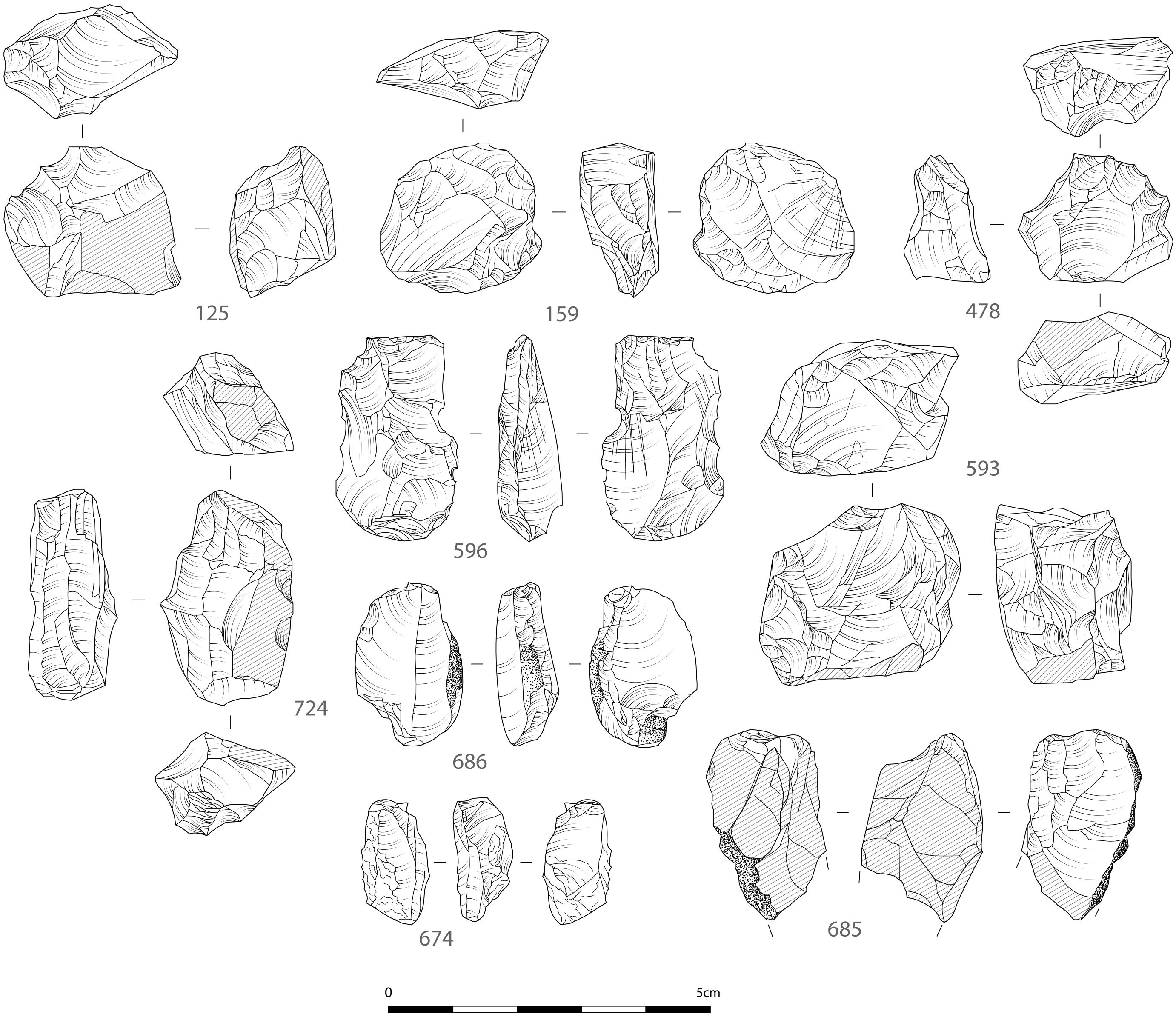

Figure 9: Cores – CAT 125 and 593 irregular cores, CAT 159 discoidal core, CAT 478 and 724 opposed platform cores, CAT 596, 674, 685 and 686 bipolar cores.

its circumference, and the two opposed faces were each worked from perpendicular directions (Figure 10). This core is formally related to the distinctive discoidal cores of Glen Luce type, which are common in many Scottish pitchstone assemblages. It measures 25 by 23 by 12 mm.

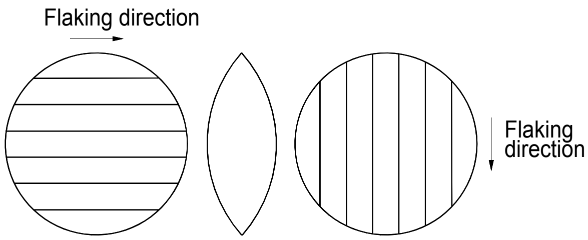

Figure 10: Schematic representation of a typical discoidal core of Glen Luce type (Ballin 2009).

Irregular cores: This category embraces 12 pieces, most of which are in jasper/chalcedony; one piece is flint (CAT 319), one is fossiliferous chert (CAT 119), one is quartz (CAT 102), and one is in a form of indeterminate silica (CAT 745). Although CAT 119 appears worked, it is thought that this piece may not be a prehistoric artefact. It has been exposed to fire, and this piece of chert may have been burnt in connection with the post medieval burning of limestone for fertilizer, and then crushed in an industrial stone crusher.

Like the single- and opposed-platform cores in jasper/carnelian, the irregular cores in this raw material are also clearly defined by parallel internal fault-planes, and thereby somewhat tabular. Two of the irregular cores in jasper/carnelian (CAT 308 and 531: GD = 61-71 mm) are considerably larger than the other irregular cores in this raw material (GD = 30-40 mm). The quartz core (CAT 102) and the flint core (CAT 319) have a GD = 28-34 mm.

Bipolar cores: Thirteen bipolar cores (Ballin 1999a) were recovered from the site. Five are flint and four jasper/carnelian, supplemented by two pieces in fossiliferous chert (CAT 311, and 392) and two in quartz (CAT 443 and 756). As in the case of the irregular core in fossiliferous chert (CAT 119), it is equally likely that the two bipolar cores in this material are also non-artefactual and that they were created when limestone was burnt and subsequently industrially crushed. The cores in flint may be post-Mesolithic, and for example CAT 686 (Figure 9) is in very dark Yorkshire flint, dating the piece to the later Neolithic period.

The two quartz cores include one very small piece and one very large (GD = 15-38 mm); the flint cores also vary considerably in size (GD = 14-31 mm); whereas the jasper/carnelian cores are all relatively small, measuring on average 22 by 16 by 10 mm. Most of the bipolar cores are bifacial cores (two opposed flaked faces) with one reduction axis (one set of opposed terminals). Only one is unifacial, and only three have two reduction axes.

Core fragments: Six core fragments are all in jasper/carnelian. Due to the degree of fragmentation, it was not possible to characterize these pieces more precisely. However, CAT 460 and CAT 506 both have one highly regular, convex, well-trimmed platform, suggesting that they may be fragments of either single- or opposed-platform microblade cores. The core fragments vary in size between GD = 20-31 mm.

Tools

The site's 73 tools (Table 3) include one leaf-shaped arrowhead (1.4%), four microliths and microlith-related implements (5.5%), 15 scrapers (20.5%), six knives and truncated pieces (8.2%), six burins (8.2%), 34 pieces with edge-retouch (46.6%), one shale game piece (1.4%), and six stone tools (8.2%). The tools are notably dominated by pieces in jasper/carnelian (57.5%) and flint (26.0%), with small numbers of tools based on pitchstone, quartz, shale and igneous materials.

Arrowheads: Only one arrowhead was recovered from Freeland Farm, namely a leaf-shaped point (CAT 757, Figure 11). The raw material is possibly (but not certainly) Yorkshire flint. This piece is kite-shaped, and it has a straight base. According to Green's (1980) terminology, CAT 757 is a leaf-shaped point of Type 3B. The piece is based on a flake, and where the dorsal face is fully modified by invasive retouch, the ventral face is only modified at the tip and base. It measures 29 by 17 by 3 mm.

Microliths and 'microlith-related implements': This category embraces a number of formal types, including one microlith preform (CAT 225), one edge-blunted microlith (CAT 208, Figure 4), one truncated bladelet (CAT 528), and two microburins (CAT 225 and 592). In the archaeological literature, the term microlith is defined in a number of different ways, adding some confusion to the discussion of the category and its dating. In the present report, 'microlith' is defined as in the analyst's previous reports on early prehistoric assemblages (e.g. Ballin et al. 2010):

> *Microliths are small lithic implements 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 (Clark 1934, 55) (Figure 12). This definition secures the microlith as a diagnostic (pre-Neolithic) type. Below, microliths* sensu stricto *(i.e. pieces which have had their usually proximal ends removed) and backed microblades (with surviving proximal ends) are treated as a group, as these types are thought to have had the same general function.*

Apart from CAT 225, which is in flint, all implements belonging to this category are in jasper/carnelian. CAT 208 is a very small edge-blunted microlith (10.6 by 3.1 by 0.9 mm). It has steep blunting along the left lateral side, and fine ancillary retouch along the right lateral side (Plate 8). It may possibly have the remains of a microburin facet at the proximal end. CAT 528 is the distal end of a microblade with a straight truncation (10.4 by 8.0 by 1.6 mm).

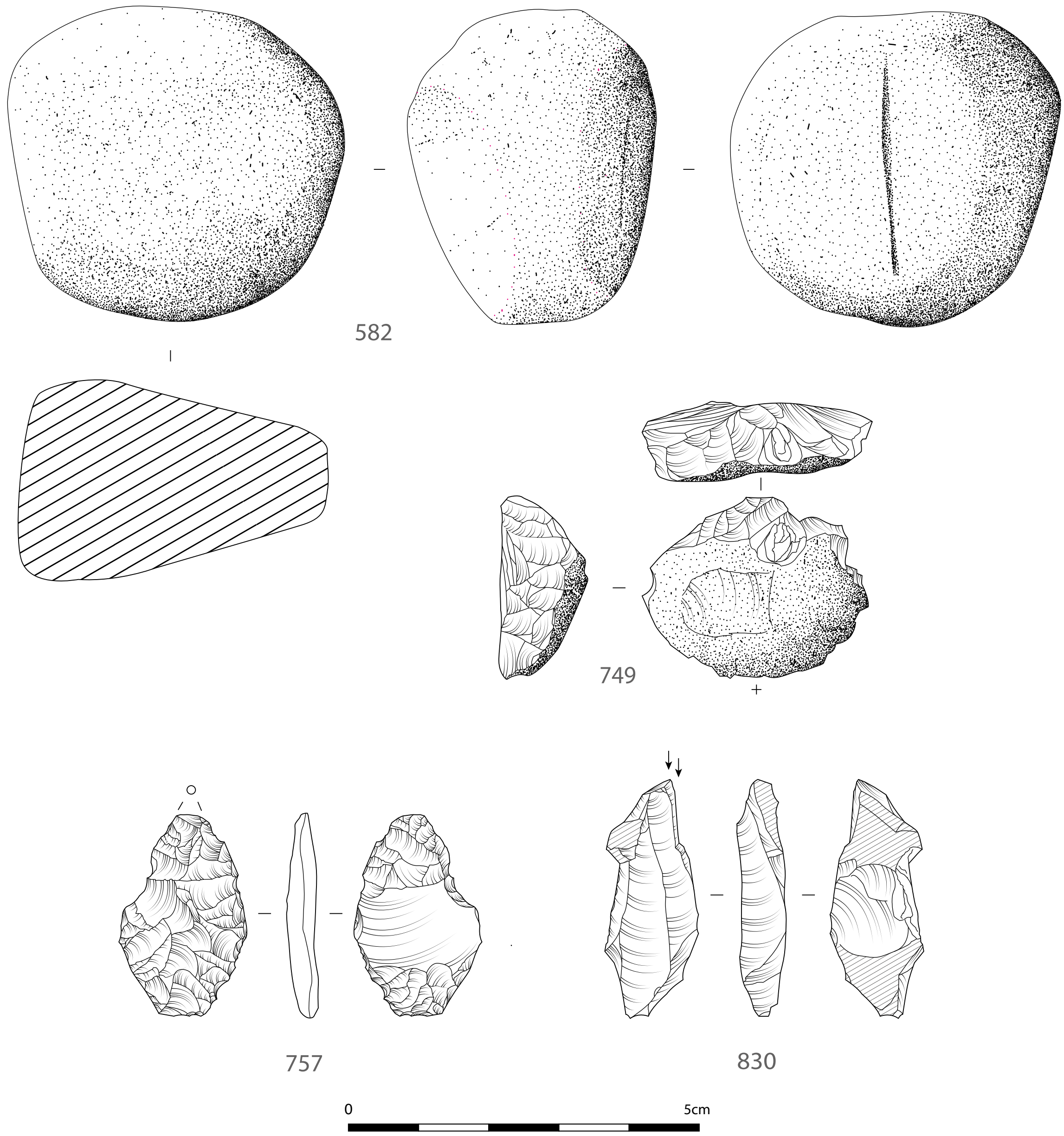

Figure 11: Tools – CAT 582 pounder, CAT 749 short end-scraper, CAT 757 leaf-shaped arrowhead, CAT 830 burin.

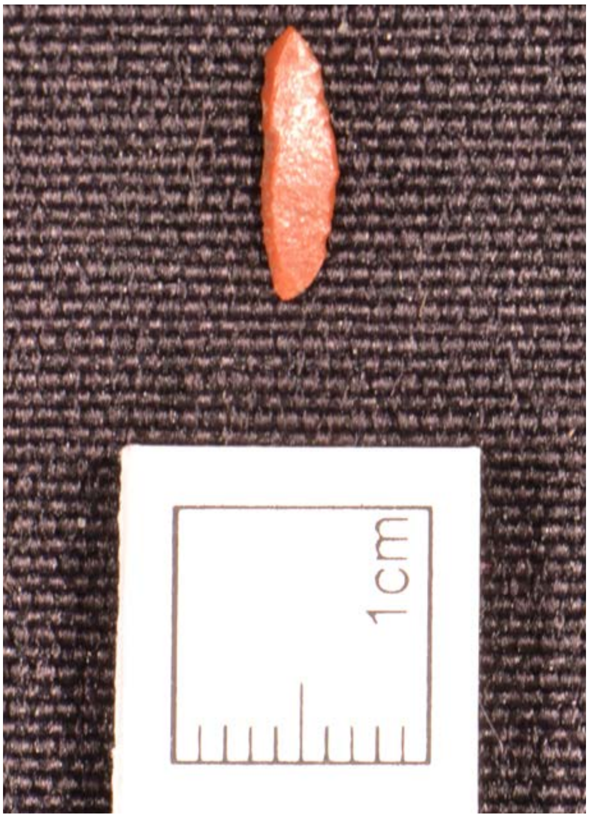

Plate 8: Jasper/carnelian microlith.

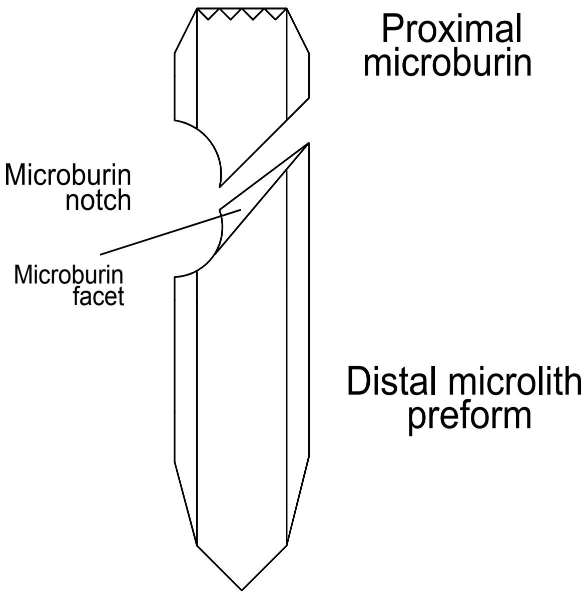

Figure 12: 'Standard' approach for the production of a microlith by microburin technique. A scalene triangle, for example, would be shaped by modifying the shortest lateral side of the distal part (in this case the left hand side) and parts of the oblique proximal facet.

CAT 225 is the proximal end of a microblade (11.7 by 8.4 by 2.0 mm), and it has a small retouched notch in the left lateral side near the platform remnant. Most likely, the purpose of this notch was to allow the original microblade to be broken by microburin technique (Figure 12), and to relieve the blank of its bulbar area. If successful, this process should create a sharp, oblique microburin facet, a so-called *piquant triédre*, '*… [with] a sharp extremity [which] cannot be obtained by simple retouch*' (de Wilde and de Bie 2011, 730) – that is, the piercing end of a microlith. Instead, the piece simply snapped straight across, immediately below the notch. CAT 592 (Figure 4) is also a microburin and, like CAT 225, it has a small retouched notch in the left lateral side near the platform remnant. This piece also snapped immediately below the notch, without forming a *piquant triédre.*

Plate 9: Jasper/carnelian end-scrapers.

Plate 10: End-scraper in Yorkshire flint.

Scrapers: The assemblage embraces 15 scrapers, including 10 short end-scrapers (CAT 47, 52, 106, 134, 152, 234, 344, 476, 658 and 749, Plate 9 and Figure 11), one blade-scraper (CAT 657), one side-scraper (CAT 509), two end-/side-scrapers (CAT 49 and 436), and one atypical scraper (CAT 667). Five scrapers are in jasper/carnelian, eight are in flint, and two are in quartz or quartzite. End-scraper CAT 134 is in dark Yorkshire flint (Ballin 2011b)(Plate 10), and the fact that the blanks is a Levallois-like flake suggests that it may date to the later Neolithic period (Ballin 2011a). The blanks of the flint scrapers are generally hard-hammer flakes, whereas the blanks of the jasper/carnelian scrapers include hard-hammer, soft-hammer, and bipolar flakes, as well as tabular indeterminate pieces. The quartz/quartzite scrapers are based on indeterminate flakes. Figure 13 shows the dimensions of the intact specimens, all of which are short end-scrapers. The intact short end-scrapers measure on average 23 by 24 by 9 mm, defining these pieces as squat.

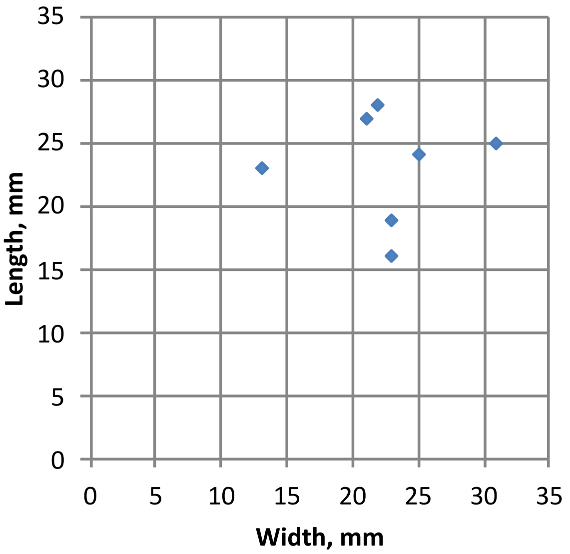

Figure 13: The dimensions of all intact short end-scrapers.

The working-edges of the jasper/carnelian scrapers are generally steep, approximately convex, and somewhat irregular, whereas the edges of the flint scrapers are equally robust, but somewhat more regular. The working-edge of flint scraper CAT 658 (Figure 4) has a nosed delineation; that of flint-scraper CAT 134 has inverse retouch; and the edge of jasper/carnelian scraper CAT 152 is best described as 'flimsy'. Several pieces have lost parts of their working-edges (e.g. CAT 152, 344, 476 and 657), and CAT 476 was definitely used for scraping after the damage had occurred. Several pieces also have overhangs along their working-edges, indicating extensive use (e.g. CAT 749). Some pieces may have lost their lateral sides due to the presence of fault planes (e.g. CAT 106, Figure 4; CAT 234). Some dorsal and ventral retouch on either face of flint-scraper CAT 436 is invasive, suggesting a post-Mesolithic date for this piece, and the regular working-edge of CAT 52 is neatly pressure-flaked, suggesting a similar date.

CAT 657 has been characterized as a fragmented blade-scraper in jasper/carnelian, as it would originally have been more than twice as long as it was wide; it is based on a tabular piece. The surviving fragment measures 33 by 18 by 7 mm. All side-scrapers and end-/side-scrapers are broken. CAT 667 is an atypical scraper in Yorkshire flint based on an indeterminate fragment (23 by 13 by 14 mm). It is probably the broken-off working-edge of a large later Neolithic scraper with a highly regular working-edge. Following the break, it had a new very narrow scraper-edge formed by modifying a pointed corner of the break facet.

Knives and truncated pieces: These pieces have been gathered within a joint category, as they are thought to have been used to perform the same task, namely cutting. The group includes one backed knife (CAT 183, Plate 11, Figure 4), two scale-flaked knives (CAT 58, 588, Figure 4), and three truncated pieces (CAT 408, 663 and 847). Most are in jasper/carnelian, but one is in Yorkshire flint (CAT 588, Figure 4), and one is in Arran pitchstone (CAT 408).

Plate 11: Backed knife in jasper/carnelian.

CAT 183 is a flake-based backed knife in jasper/carnelian (29 by 13 by 9 mm), and although its shape is crescentic, it is much too large and thick to be a microlith. One lateral side is fully retouched (crescent-shaped), probably representing the blunted back of the knife. The opposed side has retouch along half of its length (one end), possibly representing hafting retouch. CAT 58 is a flake-based scale-flaked knife in jasper/carnelian, and it measures 25 by 25 by 5 mm. The piece has a regular scale-flaked cutting-edge along its distal edge; apparent scale-flaking along the opposite edge is platform-edge trimming. CAT 588 is a flake-based scale-flaked knife in flint (21 by 16 by 5 mm), and it has semi-invasive flat retouch (cutting-edge) along its right lateral side (Figure 4). The three truncated pieces (CAT 408, 663 and 847) are based on narrow macro-blades, one being in pitchstone and the other two in jasper/carnelian. Two intact pieces (CAT 408 and 847) measure on average 20 by 9 by 5 mm.

Plate 12: Angle-burin in flint and dihedral burin in jasper/carnelian.

Burins: The site's six burins are mostly in jasper/carnelian (CAT 168, Figure 4; CAT 327, 387 and 830), with two being in flint (CAT 108, Figure 4; CAT 555). Five are angle-burins, with a burin spall having been detached along one lateral side, whereas one (CAT 168) is a dihedral burin with a central burin-edge formed at the crossing point between two perpendicular burin-facets (Plate 12). Four are based on hard-hammer flakes, whereas two blanks are tabular pieces (CAT 327 and 830). The blanks are all fairly robust, irregular pieces, with GDs of 16-36 mm and thicknesses of 6-11 mm. Flint burin CAT 555 has some additional retouch at the end opposite its burin-edge, and this modification may amount to an expedient scraper-edge. The blank of the other flint burin (CAT 108) may be a large core tablet (36 by 25 by 11 mm). Several of the burins (CAT 108, 387 and 555) display notable and typical wear of the burin-edge.

Pieces with edge-retouch: Thirty-four lithic artefacts display various forms of lateral modification. Twenty-six are in jasper/carnelian, six are in flint, one is in an igneous type of rock, and one is in an indeterminate raw material. Twenty are based on flakes, three are blades, one is a microblade, and nine are indeterminate mainly tabular pieces. These pieces differ considerably in shape and size (GD 10-40 mm), and it is thought that this tool group includes artefacts, or fragments of artefacts, with different functions (Plate 13).

Plate 13: Two edge-retouched pieces in jasper/carnelian and one in flint.

Gaming piece: CAT 352 (Figure 4) appears to be a gaming piece based on a recycled fragment of a polished bangle in shale (13 by 12 by 11 mm). It is a short tubular piece with polish around its circumference, and it has two flattened ends with criss-crossing striations from shaping the piece. The piece was identified by Alison Sheridan, National Museums Scotland (pers. comm.), as most likely a recycled fragment of a Roman or Romano-British bangle.

Stone tools: This category includes two hammerstones (CAT 107 and 492), one pounder (CAT 582, Figure 11), and three polishers (CAT 123, 370 and 500). The hammerstones are in quartz or quartzite, the pounder is in quartzite, and the polishers are all in igneous raw materials. Both hammerstones (GD = 43-51 mm) have lost one end, and the surviving ends have either light (CAT 107) or notable (CAT 492) crush-marks. The pounder (CAT 582) is a relatively small oval pebble (46 by 44 by 33 mm), and it has peck-marks around its entire circumference, forming notable facets against its flat main faces. The three polishers (CAT 123, 370 and 500) are all fragments of originally larger implements (GD = 32-72 mm), and they have one or several polished and striated faces.

Technological summary

In connection with the presentation of the lithic debitage, cores and tools, a number of categories were identified as diagnostic, and it is obvious that the assemblage includes material from several prehistoric periods (see dating section). They include 1) the late Mesolithic (microblades, microblade cores, microlithic material, burins); 2) the early Neolithic (one leaf-shaped point); 3) the later Neolithic (Levallois-like blanks and Yorkshire flint); and 4) the Roman period (shale game-piece). Most of the diagnostic late Mesolithic finds are based on jasper/carnelian, and the bulk of the assemblage is thought to date to this period. Most of the flint is probably post-Mesolithic (broad blades, a leaf-shaped arrowhead, a scale-flaked knife), although some flints are clearly Mesolithic (e.g. one microburin and two burins). The Yorkshire flint is likely to be later Neolithic (Ballin 2011b), and the shale may generally relate to a Roman period shale workshop.

Most of these artefact groups are too numerically small to allow the construction of coherent operational schemas, but the late Mesolithic jasper/carnelian assemblage is large enough (405 pieces) to make this possible. The aim of this section is therefore to construct an operational schema for the late Mesolithic component of the assemblage.

The Late Mesolithic operational schema

Procurement: The diagnostic late Mesolithic artefacts from Freeland Farm suggest that during this period the site's settlers focused on the procurement of jasper/carnelian (this raw material group is heavily dominated by carnelian), supplemented by some flint. The fact that it was possible to identify many flint objects as post-Mesolithic, suggests that during the late Mesolithic jasper/carnelian dominated the use of lithic raw materials more heavily than this paper's full artefact list indicates (Table 3).

The jasper/carnelian was probably procured from local igneous rock in the form of geodes. Examination of the cortex of this raw material suggests that most may have been collected from secondary deposits of nodules eroded out of the bedrock, whereas some geodes may have been prised out of primary sources. Most of the flint may have been collected from beaches along the North Sea and 'imported' into the estuary, but the recovery from some sites in the area of minuscule natural flint pebbles (too small to have been worthy of collection) suggests that some flint may have been present along the banks of the Tay estuary, possibly washed in at a time when the estuary was more exposed to the weather and currents of the North Sea due to a higher water-level.

Core preparation: Due to the flawed nature of the local jasper/carnelian, with most nodules being marred by the presence of numerous parallel internal fault planes, this raw material had a tendency to disintegrate into tabular pieces, which would then form blanks for the preparation of cores. Three tabular pieces were defined as core rough-outs, and they are all characterized by trimmed or rubbed edges. Some of these edges are clearly crests, whereas others may have been intended as platform-edges. The many jasper/carnelian cores are generally small microblade cores, and although most are single-platform specimens, the assemblage includes higher than expected numbers of opposed-platform cores. This is probably an effect of the use of tabular jasper/carnelian core blanks, which in many cases offered two ready-made opposed platforms.

Most platforms are plain, and most platform-edges neatly trimmed. The character of the crests suggests that guide-ridges were formed not only at the beginning of the operational schema (to shape the core), but also later in the reduction process (to adjust the core shape). The fact that most of the platforms are plain suggests that the detachment of core rejuvenation flakes was rarely carried out, as the occasional detachment of partial core tablets would have resulted in higher numbers of cores with faceted platforms. However, the blank of flint burin CAT 108 is clearly a large core tablet, indicating that if the original nodule was large enough, platform rejuvenation did occasionally take place.

Blank production: During the late Mesolithic visit(s) to the site, flakes were produced, probably mainly as part of the preparation of cores, and the main purpose of the small prepared cores was the production of delicate microblades (Figure 6). The microblades were intended to become inserts in composite tools, like slotted bone points, either as microliths, backed and truncated bladelets, or unmodified microblades. Due to the flawed nature of the jasper/carnelian, many (most?) microblades broke during production – of the collection's 58 unmodified narrow broadblades and microblades in this raw material, three-quarters are fragmented.

As shown in Figure 6, the flakes and the blades/microblades were manufactured by the application of very different percussion techniques. Most of the flakes are hard-hammer specimens, whereas most of the blades/microblades are soft-hammer specimens. This trend is even more notable amongst the jasper/carnelian blades/microblades, where only one of 29 technologically definable unmodified and modified blades/microblades is a hard-hammer specimen, with 28 pieces being soft-hammer specimens.

Although bipolar technique was used to some degree at Freeland Farm, it was used to a lesser extent than on the Scottish west-coast, where most late Mesolithic sites are characterized by the extensive application of this approach (e.g. Mercer 1968; 1970; 1971 and 1974). However, if it is taken into account that most of the flint recovered from the site may be post-Mesolithic, and that more bipolar cores from Freeland Farm are in flint than in jasper/carnelian, it is highly likely that bipolar technique was applied more as an expedient approach, than as an integral part of the site's late Mesolithic operational schema.

This supports the impression from other site's in eastern Scotland, that bipolar technique was in many cases not used at all during the Mesolithic and early Neolithic periods, and when applied it was only used sparingly. The assemblage from the late Mesolithic single-occupation site Standingstones, excavated in connection with the construction of the Aberdeen Ring Road, only yielded 2% bipolar flakes and not one bipolar core (Ballin 2019). The almost exclusively early Neolithic assemblage from Garthdee Road, Aberdeen (Ballin 2014b), yielded 8% bipolar flakes and one bipolar core, but the presence of several intrusive early Bronze Age style thumbnail-scrapers on bipolar blanks, indicates that the bipolar pieces may largely post-date the early Neolithic period. In eastern Scotland, bipolar technique appears to become an integral part of the lithic operational schema during the middle and late Neolithic periods, to become a dominant technological approach during the Bronze Age (Suddaby and Ballin 2010; Ballin 2008; Ballin et al. 2017).

Tool production: The production of tools was based on the selection of special blanks for special tool types. Robust hard percussion flakes from the preparation of the microblade cores were selected for the production of implements like scrapers and burins, whereas narrow broadblades and microblades were selected for cutting-tools and microliths. Microliths were generally produced by the application of microburin technique (Figure 6), and as shown by recent research, this is another area where approaches differed considerably between late Mesolithic sites on the Scottish west-coast and on the east-coast.

At Nethermills Farm on the Dee (Ballin 2017b), microburins outnumber microliths by a few percentage points (54:46% of 1,147 microlithic pieces), and the recently excavated late Mesolithic scatters along the Aberdeen Ring Road follow this pattern (Ballin 2019). In contrast, late Mesolithic sites from the west-coast usually offer considerably fewer microburins per microliths, probably due to 1) the extensive use of bipolar spalls as microlith blanks, rather than regular microblades, and 2) the application of other approaches for the removal of the microblades' bulbar ends, such as simple snapping without the help of a microburin notch. The flint and bloodstone assemblage from Shieldaig in Loch Torridon included approximately 25 microliths, but only one microburin (Ballin 2014d).

Technological approaches followed by post-Mesolithic settlers

Generally, early Neolithic lithic reduction was carried out following a schema more or less identical to that of the late Mesolithic that aimed to produce narrow macroblades or microblades from mostly conical single-platform cores. To do this, the knappers applied soft percussion, probably mostly pressure-flaking, and prepared their cores very much in the same manner as the late Mesolithic knappers. The evidence from Freeland Farm suggests that the early Neolithic and later knappers may have used flint to a greater extent than the site's late Mesolithic knappers, who clearly favoured jasper/carnelian.

By the early/middle Neolithic transition, the raw material focus changed again, this time by initiating importation of relatively large amounts of Yorkshire flint (Ballin 2011b). At the same time, the operational schema was redefined substantially – from the production of soft percussion narrow broadblades and microblades from mainly conical single-platform cores to the production of flakes and robust hard percussion blades from *inter alia* sophisticated Levallois-like cores (Ballin 2011a).

One of the reasons for this 'revolution' may have been the switch from one type of armature to the other, from tiny microliths which formed part of composite tools to large single-piece lithic arrowheads (chisel-shaped arrowheads and oblique points). It is thought that one of the benefits of the relatively large Levallois-like cores was that large flake-based arrowheads could be detached from their main flaking-fronts, and blade-based cutting-implements from their flanks (ibid.). The need for larger cores may then have necessitated importation of flint nodules larger than the relatively small local flint pebbles.

Distribution and on-site activities

General distribution patterns

The combined distribution maps (Figures 14-20) show a number of general distribution patterns: 1) All finds display a linear distribution of roughly 200 by 40 m, orientated roughly east-west; and 2) the western one-third of the linear scatter is considerably looser than the eastern two-thirds. As the field was also walked north and south of this scatter, its linear nature is a reality and not an artefact of, for example, fieldwalking methodology.

Most likely, the linear nature of the scatter is a result of the site's dominant late Mesolithic element representing coastal settlement, with the Mesolithic hunting, gathering and fishing settlers focusing on the position at the time of the southern shore of the estuary. It is well-known that a coastal location was favoured by many prehistoric (and also more modern) hunter-gatherers, as this gave them access to more than just one biotope, such as the water (fishing and fowling) and the coastal hinterland (hunting and gathering) (Fisher 1987). The topographic level of the site (just above the 15 m contour) suggests a date around the time of the Main Holocene Transgression, the shoreline of which probably reached 12 m+ OD (see above).

It is tempting to see the relatively tight clustering of the flint chips, crested pieces and cores (Figure 14) towards the site's eastern end as an expression of one visit to the site, but this cluster has a diameter of c. 30 m and it is more likely that this cluster represents repeated visits to the location, possibly by one group who favoured this particular corner of the site. The reason for this form of favouritism could be the specific micro-topography of this part of the site, or even the vegetation at the time (e.g. sheltering trees and bushes), and it is impossible today to determine what the specific location-selecting factors were. Research has shown that scatters left by individual family groups may be as small as a few metres across (Ballin 2013b), and even Mesolithic/early Neolithic house sites tend to be smaller than 10 m across (e.g. Waddington 2007; Gooder 2007; Robertson et al. 2013; Murray and Murray 2016). Most likely, the tight scatter of flint waste is a palimpsest, as is the site as a whole. In this respect the site shows similarities with for example the mainly late Mesolithic site at Nethermills Farm on the Dee (Ballin 2017b), which may be the result of repeated visits to a favoured location over millennia.

The looser nature of the main cluster's western one-third may be due to a number of possible factors, including some late prehistoric activity, as well as post-medieval activity, which could have disturbed the western periphery of the original early prehistoric scatter. The bulk of the probably Roman period worked shale was found at this end of the site, indicating that this may have been where a shale workshop was located (Figure 15). Most of the site's post-medieval pottery sherds were also found in this area, suggesting the position of a fairly recent farm midden and activity associated with this midden.

Jasper/carnelian

The distribution of this raw material (Figures 16-17) follows the general patterns described above, that is, with a relatively tight linear distribution towards the east, with a looser distribution towards the west. The distribution of the jasper/carnelian blades and microblades (Figure 17) is slightly tighter towards the centre of the linear

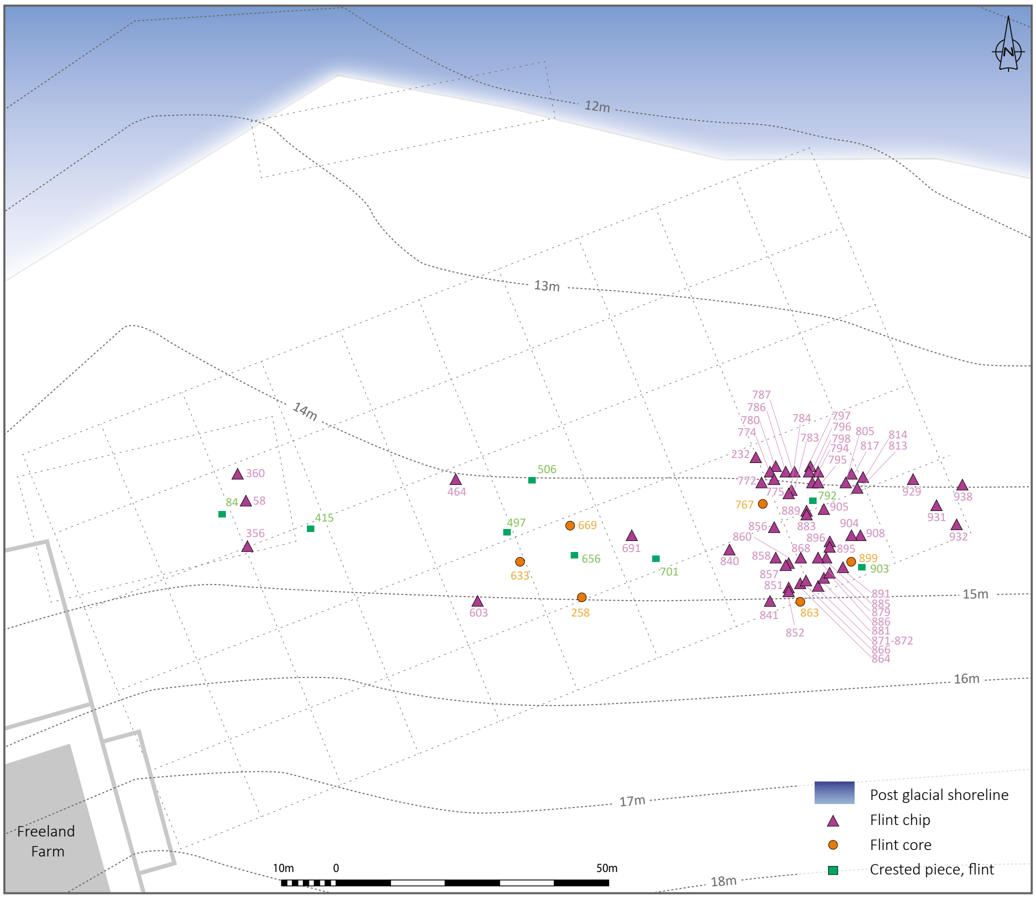

Figure 14: The distribution of flint chips, cores and crested pieces.

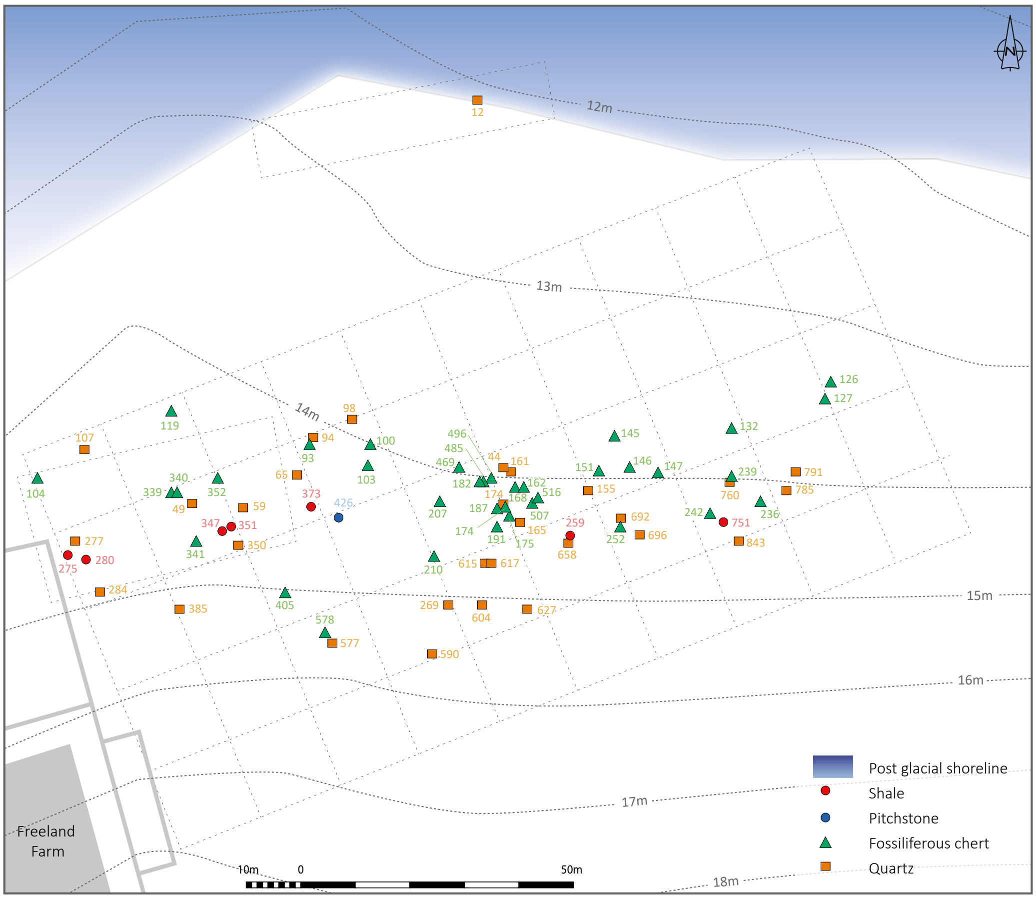

Figure 15: The distribution of shale, pitchstone, fossiliferous chert and quartz.

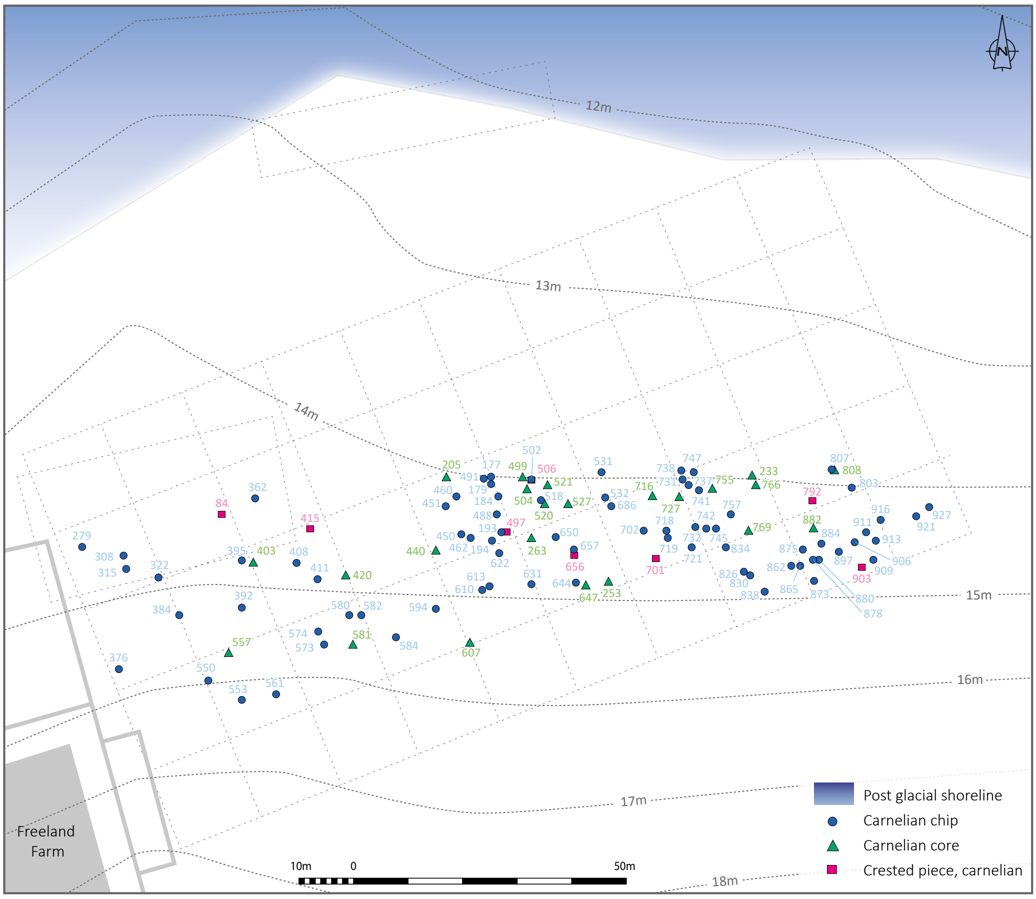

Figure 16: The distribution of carnelian chips, cores and crested pieces.

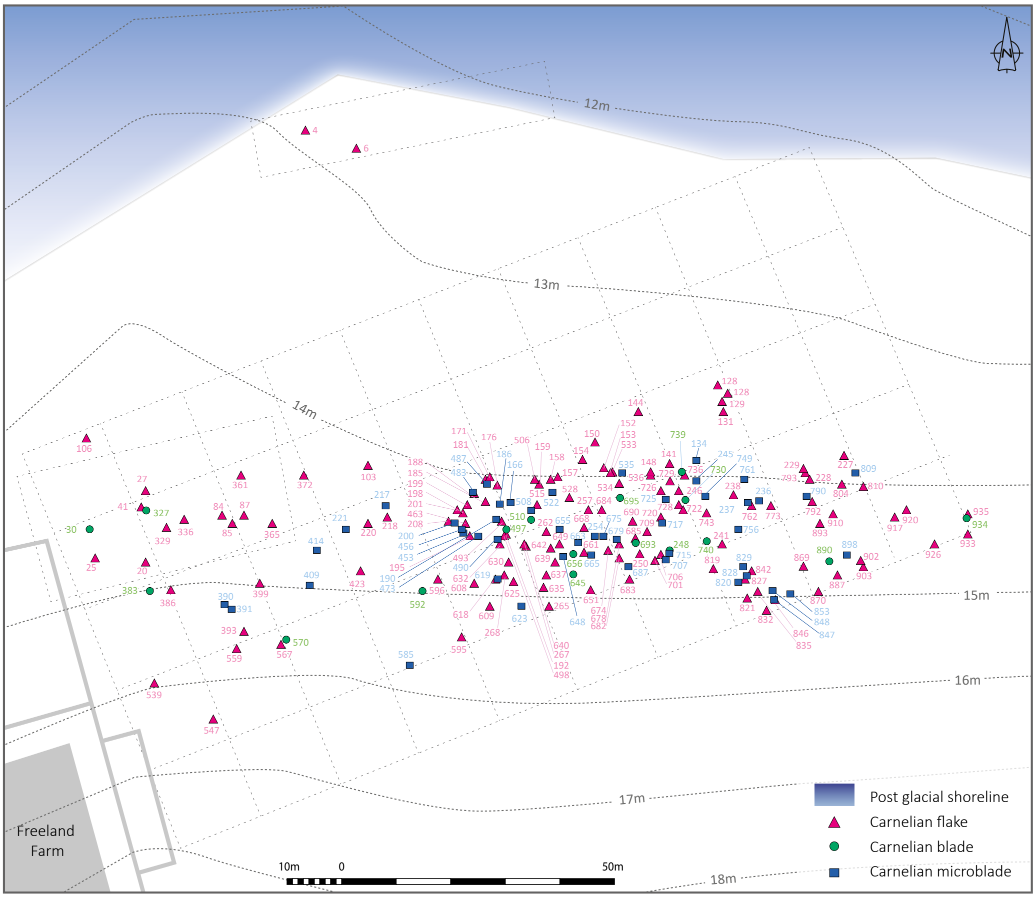

Figure 17: The distribution of carnelian flakes, blades and microblades.

scatter. It was hoped that the distribution of the site's chips and cores might have been helpful in terms of identifying individual knapping floors (based on Binford's drop-toss model; Binford 1983; Ballin 2013b), but due to the palimpsest nature of the site, this was not possible. A similar problem was experienced in connection with the discussion of the distribution of the lithic artefacts from Nethermills Farm (Ballin 2017b), where numerous individual knapping floors overlapped, with later activities disturbing and obscuring earlier ones (Ballin 2013b).

Flint

The distribution of the flint is generally looser than that of the jasper/carnelian (Figures 14, 18-19). As mentioned above, the distribution of the chips and cores is fairly dense, focusing on a location at the eastern end of the linear scatter (Figure 14). It is thought that this concentration may represent a number of overlapping knapping floors. The flint blades/microblades generally display few spatial trends (Figure 18), although they seem to be slightly more concentrated towards the east, with this relatively dense concentration of flint blades/microblades overlapping with the considerably denser concentration of flint chips and cores.

The Yorkshire flint (Figure 19) is partly associated with the northern half of the eastern dense scatter, but some pieces are also found as individual objects across the centre and in the western part of the site.

Other raw materials

The shale was mostly recovered from the site's western part (Figure 15), although a small number of pieces were found towards the east. The shale game piece (CAT 352) was found in the site's western half. The collection's solitary piece of worked pitchstone (CAT 408) was also found towards the west. The categories of fossiliferous chert and quartz do not show any particular spatial patterns. As mentioned above, the fossiliferous chert is probably non-artefactual, and it is thought that it was burnt and crushed with limestone, which was subsequently scattered across the fields as fertilizer.

Tools

Figure 20 shows the distribution of the lithic and stone tools. The distribution of this category confirms the impression of a mixed site. Although the typo-technological composition of the assemblage suggests that most of the finds are late Mesolithic, Mesolithic and Neolithic finds are found with each other throughout the location.

Although the Mesolithic microlithic pieces were found at the centre of the site, the Mesolithic burins were present from east to west. The early Neolithic leaf-shaped arrowhead (CAT 757) was recovered from the site's eastern half, whereas the probably early Neolithic truncated pitchstone blade (CAT 408) was recovered from the site's western end. The stone tools (the hammerstone, the pounder and the polishers), which are likely to be Neolithic or later, were all found in the site's western part. Most of the lithic tools were concentrated near the site's centre.

Dating

The lithic collection from Freeland Farm comes across as a fairly homogeneous assemblage, although examination of the finds clearly shows that it includes material from several prehistoric periods.

Raw material preferences: The combination at Freeland Farm of lithic raw materials and diagnostic types and technological approaches suggests that at this site jasper/carnelian (a group heavily dominated by carnelian) is mainly associated with the late Mesolithic settlement, and the flint with post-Mesolithic visits to the site, although not in an exclusive way (as indicated by burins in flint and a scale-flaked knife in jasper/carnelian).

In the Tay estuary, a preference for jasper/carnelian may be a diagnostic trait of the Mesolithic period, although it is not certain whether this feature only characterizes this site or this part of the estuary. The assemblage from the early and late Mesolithic site of Morton (Coles 1971, 291), just outside and south of the mouth of the estuary, is characterized by the extensive use of chalcedony proper, which is almost as common as flint. And on the northern side of the estuary (this project's first and second field season; Ballin 2016a; 2017a) chalcedony and agate appear to be considerably more common than at Freeland Farm (Table 2).

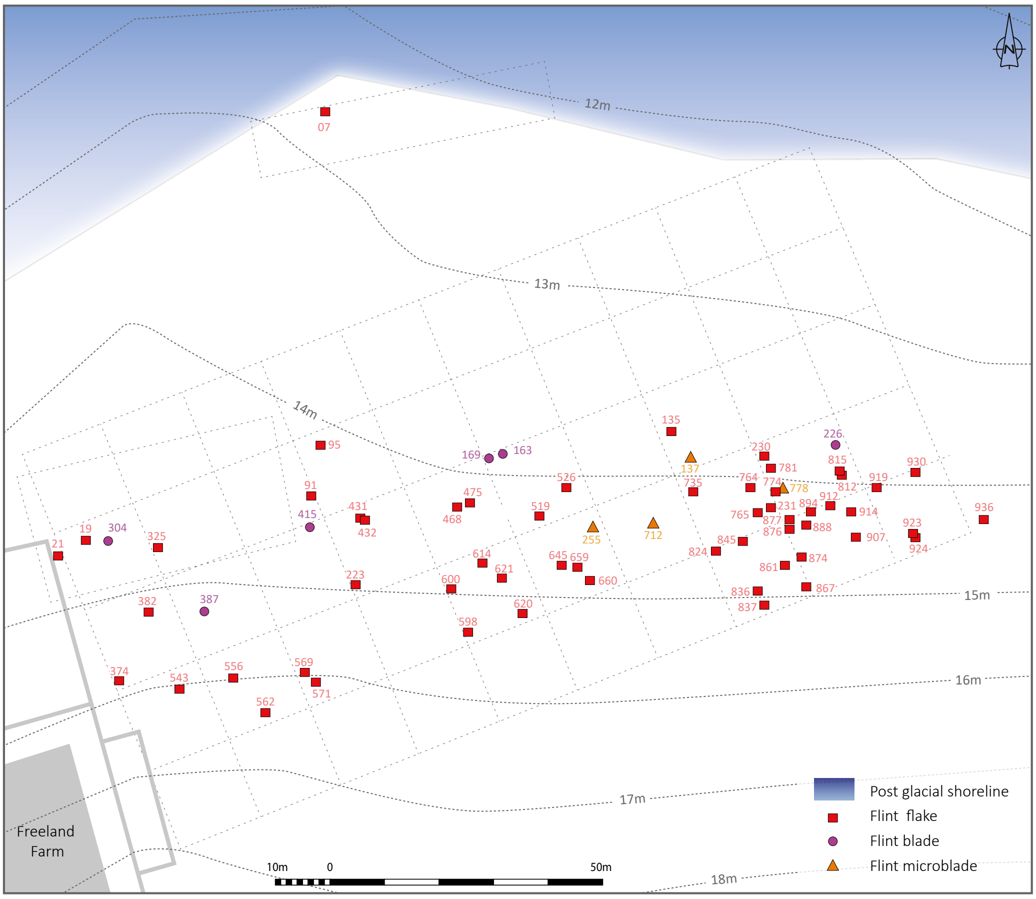

Figure 18: The distribution of flint flakes, blades and microblades.

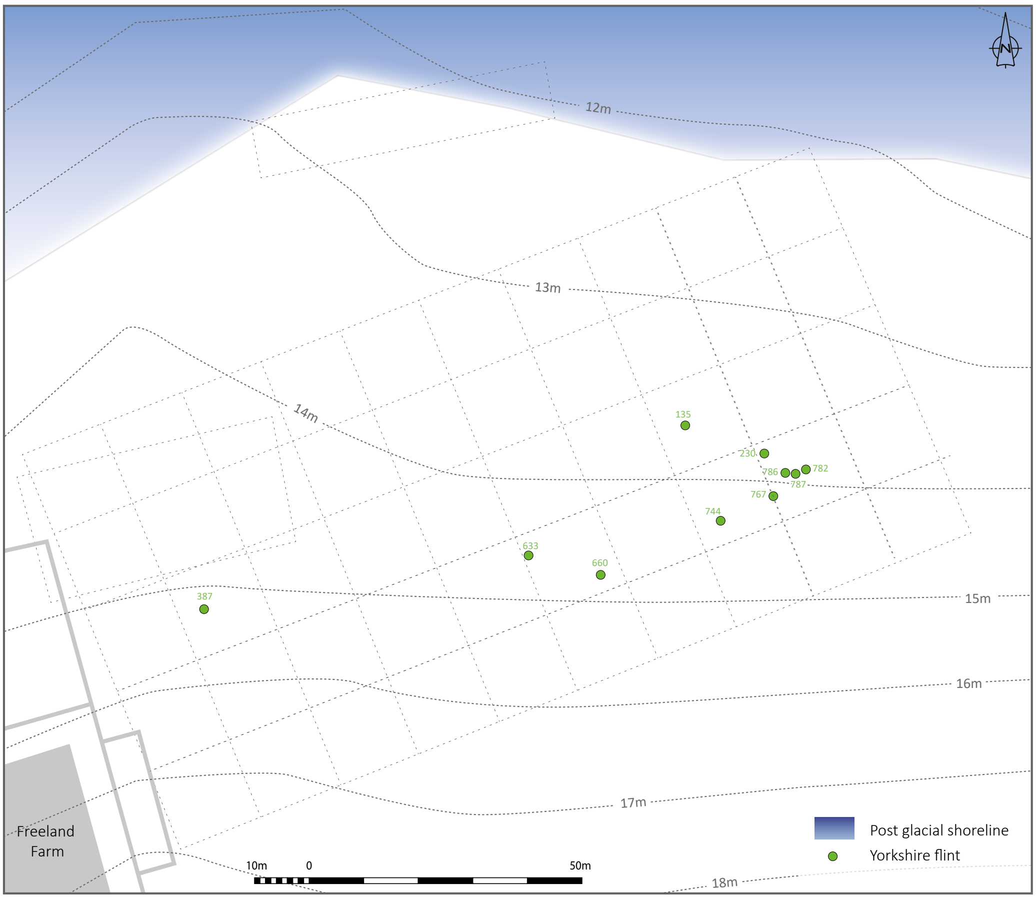

Figure 19: The distribution of Yorkshire flint.

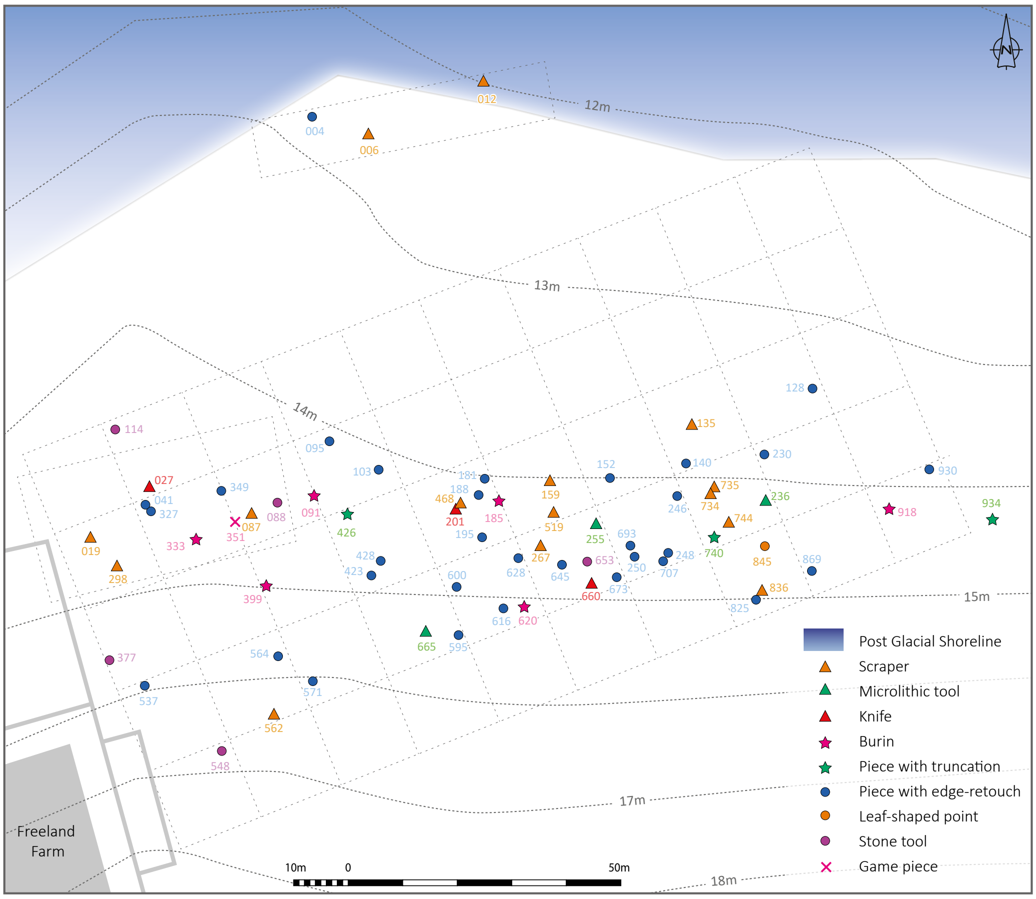

Figure 20: The distribution of all tools.

One piece of Arran pitchstone (CAT 408) is most likely of an early Neolithic date, as indicated by pitchstone found in radiocarbon dated pits (Ballin 2015). Examination and analysis of the lithic assemblages from sites near Overhowden Henge in the Scottish Borders suggests that in Scotland this raw material may largely date to the middle and late Neolithic periods (Ballin 2011b). However, recent analysis of the raw material of kite-shaped arrowheads from the area around Biggar, South Lanarkshire (Ballin 2019), suggests that the importation of Yorkshire flint into Scotland may have started towards the end of the early Neolithic period.

The site's shale may represent activities at the site during the Roman period. Although shale (and other raw materials of the jet family; Watts and Pollard 1998) was also used during the later Neolithic and early Bronze Age periods (Shepherd 1985, 204), the recovered game piece (CAT 352) was identified by Alison Sheridan, National Museums Scotland (pers. comm.) as a recycled fragment of a Roman or Romano-British shale bangle.

Typology: The assemblage includes a number of clearly diagnostic types which, in conjunction with raw material and technological evidence, suggest that the assemblage may largely be late Mesolithic, but with some later intrusive elements. One microlith (CAT 208) and two microburins (CAT 225 and 592) date to the late Mesolithic period, and six burins to the Mesolithic in general. A leaf-shaped point (CAT 757) belongs to the kite-shaped variety, which is generally perceived to date to the later part of the early Neolithic. Two small scale-flaked knives (CAT 58 and 588) are identified by the form of their modification as post-Mesolithic pieces, as invasive retouch was generally not used prior to the Neolithic period (Butler 2005). The small pounder (CAT 582) is also clearly a post-Mesolithic piece (e.g. Ballin 2017c; 2018). And the bangle on which game piece CAT 352 is based is clearly of Roman period type (Alison Sheridan pers. comm.).

Technology: Most of the assemblage is based on an operational schema focusing on the production of microblades and narrow broadblades by the application of soft percussion. This approach is characteristic of the Scottish late Mesolithic and early Neolithic periods (cf. Ballin 2014e). However, it appears that the larger blades are generally in flint (Figure 5), as is the site's solitary leaf-shaped arrowhead, and it is highly likely that the site's jasper/carnelian is predominantly late Mesolithic (as suggested by the microlithic material and the burins), whereas the flint may predominantly be Neolithic.

The site's single- and opposed-platform cores are almost exclusively in jasper/carnelian, whereas there are more bipolar cores in flint than in jasper/carnelian (Table 1). This indicates that, in eastern Scotland, bipolar technique may only have been an expedient technological element in the late Mesolithic operational schema, whereas – as suggested elsewhere (Suddaby and Ballin 2010; Ballin 2008) – bipolar technique became an integral part of the operational schema in later parts of prehistory, such as the later Neolithic and Bronze Age periods.

Scottish later Neolithic assemblages are characterized by a higher proportion of flint, and in eastern Scotland some of this flint was imported from north-east England (Ballin 2011b). These assemblages are also characterized by the use of Levallois-like technique and most blades were now produced by the application of hard percussion. The present assemblage includes 11 pieces in Yorkshire flint, as well as one Levallois-like flint blade (CAT 240, Figure 7) and one Yorkshire flint end-scraper on a Levallois-like flake (CAT 134, Figure 4).

Distribution: Unfortunately, the late Mesolithic mainly jasper/carnelian assemblage and the numerically smaller mainly flint Neolithic sub-assemblages are mixed, at least at plough-soil level, but some of the chronological elements appear to be concentrated in, or centred on, certain spatial zones. This may prove helpful in terms of planning any further work at the location, such as excavation of selected parts of the site.

Although objects dating to the various prehistoric periods may be found throughout the site, its late Mesolithic element (jasper/carnelian) appears to be focused on the eastern two-thirds; the Neolithic element (flint) probably its eastern one-third; the later Neolithic element (Yorkshire flint) the northern part of the latter concentration; and the Roman period element (shale) the western one-third.

Summary and discussion

In connection with the Tay Landscape Partnership project, a number of fields around the Tay estuary were investigated by volunteers through fieldwalking. They include Pitroddie and East Inchmichael Farm north of the estuary, Easter Clunie and Freeland Farm towards the south, and Scone Estate, north-east of Perth, approximately 2 km from the River Tay. Freeland Farm yielded the numerically largest lithic assemblage, namely 707 pieces. Combined, the other sites only yielded 135 lithic artefacts, namely 70 pieces from Pitroddie, 47 from East Inchmichael Farm, 12 from Scone Estate, and six from Easter Clunie.

An initial cursory assessment of the five collections suggested that the assemblage from Freeland Farm had the greatest research potential, as it is heavily dominated by late Mesolithic material (probably about 70% of the finds), supplemented by small sub-assemblages from the early Neolithic, later Neolithic and Roman periods. It was decided to make the assemblage from this location the focus of the present paper, and characterize its finds in detail, as this would allow light to be shed on the late Mesolithic of the Tay estuary. Before the initiation of the Tay Landscape Partnership project, the only excavated Mesolithic finds from the area was Morton (Coles 1971) just outside and south of the mouth of the estuary.

The other four assemblages are generally numerically small and include unquantifiable early and late elements (pre- and post-dating the Main Holocene Transgression), and they are only useful as general comparative material, offering chronological and topographical background information.

The finds from Freeland Farm include almost 60% jasper/carnelian (almost all of which is carnelian), and most of these artefacts are thought to be late Mesolithic (including microlithic material and burins), with a small proportion of this material being Neolithic (e.g. one scale-flaked knife). The flint (c. 20%) is probably predominantly early and later Neolithic (including a leaf-shaped point and Levallois-like blanks), with a proportion being Mesolithic (e.g. two burins). A small sub-assemblage of grey and black Yorkshire flint dates to the later Neolithic (Ballin 2011b). Seven pieces of worked shale are thought to date to the Roman period (including a recycled fragment of a Roman period bangle; Alison Sheridan pers. comm.). And a solitary truncated blade in Arran pitchstone is most likely to be of early Neolithic date (Ballin 2015). The assemblage from Freeland Farm also includes several other lithic and stone raw materials, which can not be attributed to any specific prehistoric periods. The following briefly summarises the site's late Mesolithic industry.

This industry is clearly based predominantly on the exploitation of local carnelian, but at the present time it is uncertain whether this is simply a matter of local availability or whether this choice is also a matter of non-functional reasoning. The fact that assemblages north of the estuary include higher proportions of other chalcedonic materials (chalcedony/agate rather than jasper/carnelian), and that later assemblages around the estuary in general seem to include higher proportions of flint, suggests that it may be a combination of the two.

It is difficult to say how the Mesolithic people of Freeland Farm perceived their carnelian, but it is likely that the brown colour had special meaning to them, for example as a means of identifying themselves as belonging to a specific social group. They may have seen themselves, and been seen by hunter-gatherer groups in neighbouring territories, as 'those with brown tool kits', just like people on Arran may have seen themselves as 'those with black tool kits' (Ballin 2009; Ballin and Faithfull 2009), and people on Rhum as 'those with green tool kits' (Wickham-Jones 1990). This may be an example of what the American anthropologist Polly Wiessner defined as 'emblematic style' (Wiessner 1983; 1984).

The debitage from Freeland Farm includes almost 20% narrow broadblades and microblades (width centred on 6-7 mm; Figures 5 and 6), and in conjunction with the presence of many small carnelian microblade cores, this defines the site's late Mesolithic assemblage as a microblade industry. The flakes, which were probably largely produced in connection with the preparation of the microblade cores (but subsequently used as blanks for tools like scrapers and burins), were generally manufactured by the application of hard percussion, whereas the blades and microblades (the 'target blanks') were produced by the application of soft percussion (and then used for microliths and cutting implements). The low number of carnelian bipolar blanks and cores at Freeland Farm suggests that, as seen elsewhere in eastern Scotland (e.g. Standingstones; Nethermills Farm; Ballin 2017b; 2019), bipolar technique may have been an expedient approach rather than an integral part of the period's operational schema (cf. Ballin 2017b; 2019), whereas on the Scottish west-coast bipolar technique may have been one of the main approaches for the production of flake and microblade blanks (cf. Mercer 1968; 1970; 1971; 1974).

The late Mesolithic tool spectrum of Freeland Farm includes diagnostic specimens like microlithic pieces (one edge-blunted microlith, one truncated bladelet and two microburins), and burins, as well as a relatively large number of squat and slightly elongated end-scrapers and pieces with edge-retouch (cf. Ballin 2017b). A scale-flaked knife in carnelian is clearly post-Mesolithic, and it is uncertain whether a backed knife and some truncated pieces in carnelian are Mesolithic or later.

Given the relatively large number of larger carnelian tools, it is almost certain that the low number of tiny microlithic pieces is an artefact of the applied recovery methods (i.e. fieldwalking rather than excavation with sieving), and that excavation at the site would result in the retrieval of many more such pieces. This view is supported by the relatively low number of small blades and microblades at the site. The tiny blade and microblade fragments would easily have been missed during the fieldwalking of Freeland Farm. *Meches de foret* (microlithic drill tips) are also commonly found at Scottish late Mesolithic sites (cf. Ballin 2017b), and the fact that none was found at the site may also reflect the applied recovery methods, rather than actual absence.

The lithic finds were distributed across the site in a manner which makes it difficult to interpret the spatial patterns at the present time, but the distribution is not entirely random. The most obvious trend is the linear nature of the assemblage, and as the shoreline at the time of the Main Holocene Transgression is thought to have been 12m+ OD, and as the site is situated around the 15 m contour, the site's late Mesolithic element is likely to represent coastal settlement around the time of this event. Due to the low number of rolled artefacts, the Mesolithic settlement is unlikely to have taken place before this transgression, as the site would then have been submerged, resulting in more rolled material. The fact that the site also attracted settlers after the Mesolithic period may simply be due to local factors, such as level ground, whereas in other parts of the estuary – such as at Pitroddie and East Inchmichael Farm – settlers returned to the Tay flood-plain after the lowering of the water level.

The western one-third of the main scatter is generally less dense than the eastern two-thirds. The reason for this is not yet entirely clear, but the presence in this area of much post-medieval pottery suggests that a historic-period midden may have been located here which may have affected the distribution of prehistoric finds. The distribution of the site's jasper/carnelian is fairly dense across the eastern two-thirds of the scatter, suggesting that this entire area may have been visited and re-visited over a long period, creating a dense palimpsest of a large number of individual small settlements and knapping floors. Research has shown that scatters left by individual family groups may be as small as a few metres across (Ballin 2013b), and even Mesolithic/early Neolithic house sites tend to be smaller than 10 m across (e.g. Waddington 2007; Gooder 2007; Robertson *et al.* 2013; Murray & Murray 2014).

The distribution of the (probably mostly Neolithic) flint overlaps the jasper/carnelian scatter, but with a notable concentration in the site's eastern one-third. This is also where most of the later Neolithic Yorkshire flint was found. And the Roman period shale workshop is thought to have been located in the site's western one-third.

Future perspectives

Although it is impressive how many tiny jasper/carnelian fragments the fieldwalkers were able to find (Plate 14), it is highly likely that this is only the tip of the iceberg. Most likely, sieving the plough soil, and excavating levels below the plough soil, will increase the number of finds multiple times. Where the finds in the plough soil may have been moved by the plough in a way that makes it impossible to distinguish individual knapping floors and short-term sites, finds below the plough soil, if excavated and recorded meticulously (for example in relation to 0.5 by 0.5 m grid squares), may allow the identification of these spatial patterns. The greater value of the distribution maps produced in connection with this paper is therefore as a tool which may allow decisions to be made as to which parts of the site should be excavated. This may allow the site to be interpreted in a more detailed manner, and hopefully making it possible to 'dissect' the site and identity at least some chronologically unmixed areas. Excavation of selected parts of the site may also allow late Mesolithic and later structures to be identified, and the recovery of

Plate 14: The finders - some keen eyed field-walking volunteers.

charcoal from these features would allow more precise dating of visits to the site.

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Early Settlers Volunteers		
Aileen Beattie	Donald McCrae	Kevin Woolard
Alan Livett	Dot Mechan	Leonie Poor
Alistair Leslie	Duncan Cameron	Lindsey Gibb
Allan Farmer	Elspeth Reid	Lynne Palmer
Andrew Hendry	Eva Bennett	Mark Brown
Anna Miller	Fraser Stewart	Mervyn Woodward
Anna Olaffson	George Logan	Michael Ballantine
Anne Campbell	Gordan Gerrie	Michael Cairns
Anne Gerono	Grant Muckart	Morgan Downie
Anne Gray	Greenbuds Group	Nicholas Meny
Anne Mitchell	Ian Bell	Nicola Carmichael
Anthea Deane	Ian Gerono	Various parent helpers
Barbara Hogarth	Ian Hood	Paul Booth
Brenda Peek	Irene Haggart	Rhona Roy
Carolyn Anstice	Jane Griffiths	Robert Bone
Cathie Booth	Jennifer Herd	Sally Rose
Chris McNeill	Jenny Simmonds	Steve Ponsonby
Daniel Cruickshank	Jim Butcher	Tom Sneddon
Dave Anderson	Jo Long	Tony Simpson
David Griffiths	John Bennett	William O'Driscoll
Deryck Deane	John Robb	Willie Rowan
Diana MacIntyre	Kaisha Murray	
Abernethy Primary School	Errol Primary School	Robert Douglas Memorial Primary School

Table 8: Volunteers and the schools that took part in the project.

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