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Culduthel

An Iron Age Craftworking Centre in North-East Scotland

Candy Hatherley and Ross Murray

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Culduthel

This volume is dedicated to the excavation team of Culduthel

Culduthel
An Iron Age Craftworking Centre in North-East Scotland

CANDY HATHERLEY and ROSS MURRAY

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HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

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SUMMARY

In 2005, Headland Archaeology excavated a site at Culduthel Farm on the southern outskirts of Inverness. What was initially a small-scale excavation of a palisaded enclosure turned into a major discovery when the works revealed a well-preserved craft production centre with large-scale roundhouses, multiple workshops containing iron smelting furnaces and glass and bronze-working hearths. The extensive artefactual assemblage contained a rich range of material including craftworking tools, working waste and finished items.

The site is highly significant for the study of the Scottish Iron Age and paints a detailed picture of the craft processes at play in the community, their contacts and networks for the procurement of raw materials and exchange of utilitarian and exotic objects. Archaeological analysis of the site informs wider research topics for the Iron Age in Scotland, illuminating the contact between Scotland and Rome in the early 1st Millennium AD and adding to our knowledge of how status was defined and displayed at this time.

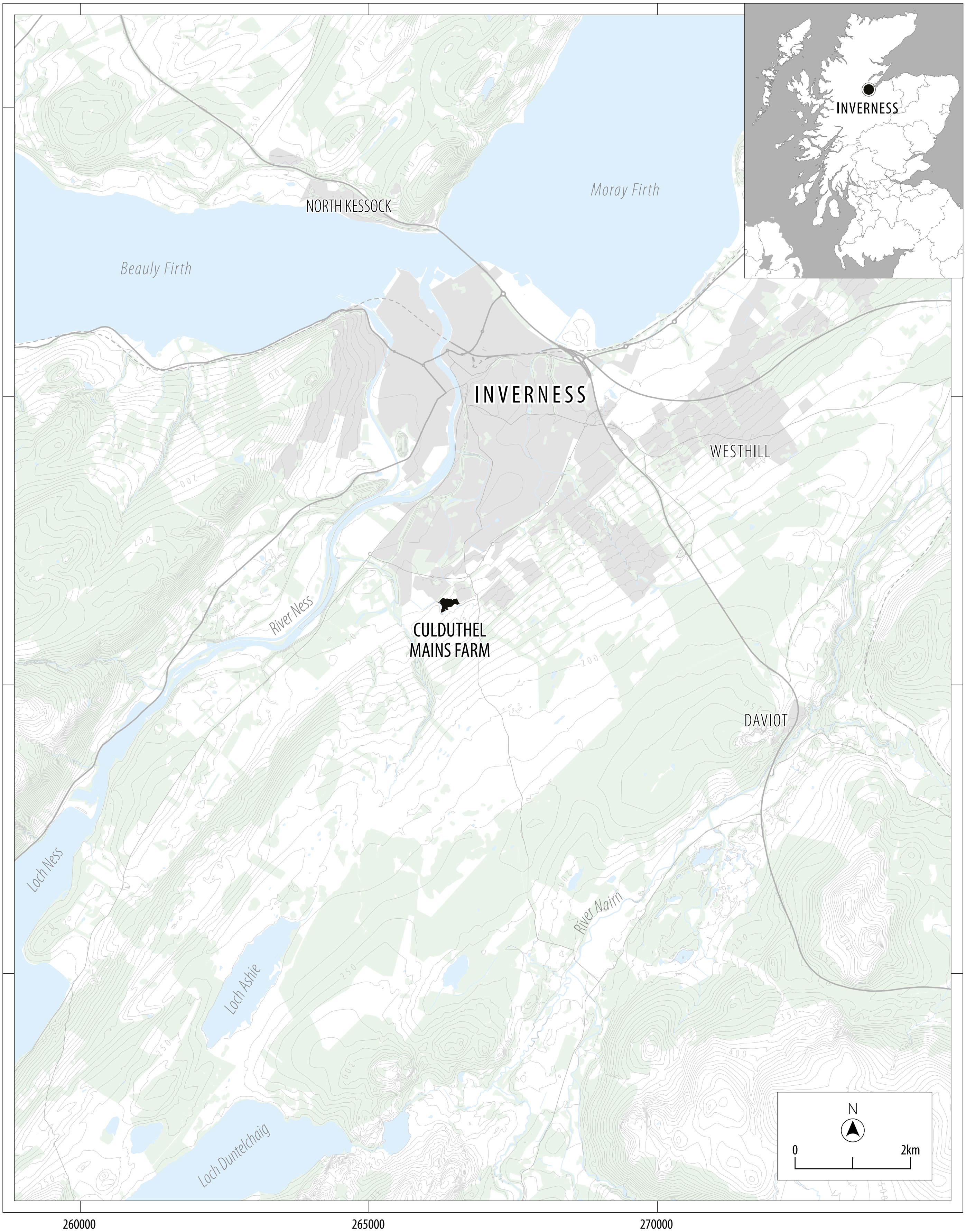

Illustration 1.1
Location of Culduthel Mains Farm. (© Headland Archaeology (UK) Ltd. Crown copyright and database right 2018)

Chapter 1

AN IRON AGE CRAFTWORKING CENTRE

Introduction

The Iron Age craftworking centre site known as Culduthel was identified in 2005 on the southern outskirts of Inverness prior to the development of the land for housing (Illus. 1.1). The excavation revealed a well-preserved settlement whose occupants had specialised in the production of iron, bronze and glass objects. Large-scale roundhouses, workshops, iron smelting furnaces and multi-purpose hearths were identified alongside a highly significant artefactual assemblage that included craftworkers tools, working waste and finished items (Illus. 1.2 and 1.3). A diverse assemblage of imported items shows that this proficient craftworking community was well-connected, participating in wide-ranging interactions with complex networks of exchange and trade, including contact with the Roman world.

The quality and quantity of the archaeological evidence recovered at Culduthel paints a vivid picture of an Iron Age community engaged in developed and sustained craft production at some point between the 2nd century BC and the early to mid-2nd century AD. The preservation of a suite of smelting furnaces, along with a substantial assemblage of iron objects and manufacturing waste, demonstrate that the site must have been a centre for significant iron production in the region with manufacture undertaken by skilled ironworkers. The wealth of evidence for this production has elucidated the entire ironworking cycle carried out on site, from the smelting of the ore to the manufacture of individual finished objects, while the range of iron artefacts recovered (including specialist craft tools, agricultural and architectural implements, weaponry and chariot parts) provides exceptional insights into the spectrum of activities in play in Iron Age northern Scotland.

The evidence for non-ferrous metal- and glassworking represents a smaller-scale industry than the iron production, underway prior to any significant contact with the Roman world at some point between the 2nd century BC and early 1st century AD. Assemblages of crucible and mould fragments, casting waste and finished and unfinished copper alloy objects demonstrate that bronzeworkers were making high-quality decorative pieces. The analysis of the glassworking debris, mostly offcuts from imported glass rods and a range of molten waste, show that coloured beads and enamels for decorating prestigious metal objects were the main products. The distribution of the non-ferrous and glassworking debris confirms that glass and bronze objects were manufactured in tandem, probably within a single specialist workshop.

Culduthel is one of the most significant Iron Age sites excavated in mainland Scotland in the last 20 years, a purpose-built manufacturing hub for iron, glass and bronze objects run by an influential and prestigious community. The site has produced secure evidence for glassworking which demonstrates that it was one of several centres of bead production in North-east Scotland in this period. It has also produced the largest later prehistoric iron and copper alloy working assemblage so far identified in Scotland, the study of which has significantly altered our

Illustration 1.2
Excavating the iron smelting furnaces

Illustration 1.3
Team on the completion of House 4. The author (Candy Hatherley) is on the furthest right

perceptions of Iron Age craft skills, technologies, innovation and manufacture.

Discovery of the site

Between 2004 and 2012 a phased plan for a large-scale housing development by Tulloch Homes Ltd on the southern outskirts of Inverness triggered a series of archaeological investigations by Headland Archaeology (UK) Ltd. Evaluations in the area prior to the discovery of the Iron Age settlement had identified little archaeology (Dutton 2004; Halliday 2000; Hastie 2004) but a single large field (*c*.5ha) was deemed to have higher archaeological potential as it contained the cropmark of a palisaded enclosure Old Town of Leys (NH64SE 241) (Illus. 1.4). An evaluation in May 2005 focused on locating the palisade, determining its level of survival and identifying if there was any associated settlement within its interior or immediate environs. Targeted trial trenches located the palisaded enclosure and showed it was well preserved along most of its circumference with features in the interior. Trenches across the remainder of the field identified two further concentrations of archaeology (in the south-west and north-east corners). An area along the northern edge of the field was excluded from the evaluation due to the presence of badger setts.

An excavation followed the evaluation in June 2005, with the objective of stripping and excavating the three concentrations of archaeological features previously identified (the palisaded

Illustration 1.4
Cropmark of palisaded enclosure.
(© Crown Copyright: Historic Environment Scotland)

enclosure, the south-west and north-east corners of the field). During the stripping of these areas, it quickly became clear that the archaeological activity continued beyond these areas and that the palisaded enclosure was not the main focus of the settlement. Discussions between Highland Council Archaeology Services, Headland Archaeology and Tulloch Homes Ltd concluded that the whole development area should be stripped of topsoil and the full extent of the archaeology within the land parcel be revealed. This topsoil strip, which included the area of the (now vacated) badger setts along the northern edge of the field, was archaeologically monitored by Alba Archaeology Ltd. Once stripping began in earnest it became clear that part of a spectacular prehistoric settlement had been discovered, located mainly to the north-west of the palisaded enclosure and previously not visible on aerial photographs (Illus. 1.5). Initial investigations indicated that this was a well-preserved, and multi-phase, Iron Age settlement with at least 17 roundhouses, alongside multiple features associated with ferrous metalworking (Illus. 1.6). These remains appeared to be extant on a scale previously unseen in mainland Scotland and included multiple stone-based iron smelting furnaces and intact stratified working surfaces overlain with vast spreads of waste debris.

Illustration 1.5
Aerial photograph of site during excavation.
(© Fraser Hunter/National Museums Scotland)

Illustration 1.6
Plan of all archaeological features at Culduthel

Once stripping was completed, Headland Archaeology was approached to produce a methodology for the excavation of the site. This work, and the subsequent excavation, is detailed in the *Preservation of the site and excavation methodology* section below.

Topography, landscape and settlement

Landscape setting

The location of Culduthel is significant. It is situated on the southern edge of the Moray Firthlands, the east coast of northern Scotland running from Orkney to Moray. The site is located on the southern shores of the Beauly Firth, a sheltered inlet of the Moray Firth that must have provided a major routeway for waterborne trade and communication along the coast and the greater Moray Firth to the north. The entire southern coast of the Moray Firth is a low-lying coastal plain that forms a discrete topographic zone bounded to the south by the Grampian mountain range, which acts as a natural boundary for a narrow strip of rich arable land with a highly accessible coastline facing the Moray Firth from Inverness to Peterhead. This fertile plain has a wealth of resources and has been noted as an attractive region for settlement from early prehistory (Jones et al 1993). It is intersected by four major rivers: the River Ness at Inverness and Findhorn, the Spey and the Deveron along the coast, and the Moray and Beauly Firths to the north.

The wider Moray Firthlands were clearly an important and busy maritime routeway through history for the exchange of goods and ideas and the movement of people. That this coastline was a key route for communication and cultural exchange in prehistory is well-illustrated by the spread of Neolithic Orkney/Cromarty tombs across Orkney and down the east coast to Inverness (Bradley 2000, Illus. 3). The meeting point of the greater and Inner Moray Firth appears key to this distribution and has been considered a frontier where a range of different cultural traditions may have intersected throughout prehistory (Bradley 2000, 229; Carver 2008, 193; Henshall and Ritchie 2001, 31). This 'boundary' is seen again in the distribution of large stone-built Iron Age roundhouses termed 'Atlantic roundhouses', whose concentrations down the east coast of Caithness and Sutherland notably peter out at the southern shores of the Beauly Firth (Illus. 7.1; Cunliffe 2005, figure 14.12).

Local topography

The site itself lies inland from the coast, *c*.4.5km to the south of the city of Inverness (NGR NH 6640140) (Illus. 1.1). It is situated on a spur of land near the base of a broad sand and gravel moraine terrace, a continuation of the southern bank of Loch Ness and the edge of the Great Glen Fault, which forms a dominant landscape feature in the area. The site's elevated position on this spur allows for clear views over the broad valley to the north and west, across the mouth of Ness valley and the Beauly and Moray Firths to the Black Isle.

Locally the site is positioned between the 60 and 65m contours at the base of a steep slope that runs downhill from moorland in the south. Adjacent to the site is a tributary of the River Ness (the Big Burn). Via this waterway, access could have been gained in wooden vessels to the River Ness and downstream to the Beauly Firth. South along the River Ness gains access to Loch Ness and the Great Glen, opening a route to the west coast and the Atlantic.

This area was part of the rural hinterland of Inverness until the end of the 20th century but is now located on the southern edge of the modern city. The field had formed part of Culduthel Mains Farm, with 19th and 20th century Ordnance Survey maps showing it as the southern part of a parcel of agricultural land (Ordnance Survey 1874).

This area enjoys fertile soils and a microclimate that belies its northerly latitude, as the mountains to the south and west shield it from the worst of the prevailing weather and provide some shelter (Richards 1999, 9–10). Roy's Military Survey of the late 18th century shows small clusters of houses strung out along the terrace, from Torbreck in the south-west to Castlehill in the north-east, marking the boundary between the cultivated land to the north and the rough grazing and moorland to the south. Modern agricultural improvements have extended the boundary between cultivated land and rough grazing a little further up the hills to the south, but 2km south of the site forestry marks the beginnings of the uplands proper.

The natural topography of the gently sloping pasture field was revealed once stripping of the topsoil and subsoil was complete. The underlying ground was undulating, with two prominent areas of higher ground separated by a large depression. The north-east part of the site sloped downwards from east to west to an area of flat ground at the base of this slope while the western edge of the site sloped sharply down towards a small stream. Between these areas of higher ground was a depression where hillwash had accumulated over the centuries, sealing and preserving the archaeological features in this area from the plough.

Archaeological background

Prior to its intensive development in the 21st century, the area was known to be rich in prehistoric sites, included some significant monuments and finds particularly from the later Neolithic and Bronze Age periods. The National Record of the Historic Environment and the Highland Historic Environment Record show numerous sites and finds spots in the immediate vicinity of the site recorded since the 18th century (Table 1.1). Many of these sites were located on the gentle north-west slope of the terrace and had been identified during the cultivation of this fertile area (Illus. 1.7). There is a stone circle at Torbreck to the west of the site (NH64SW 1), and a ring-cairn of the Clava type (NH64SE 26 – Site 1 on Illus. 1.7) on a rise to the north-west of the site, with a second Clava-type cairn a little further away to the north-east at Druidtemple (NH64SE 23). A Bronze Age gold torc (NH64SE 24), now lost, was ploughed up close to this latter cairn, where there were also reports of cists and urns being found in the vicinity. A number of Bronze Age short cists were discovered to the north and north-east of the site, including one found in 1975 which contained a Beaker, an archer's wrist guard in green-grey stone with gold rivet caps and a very fine set of barbed and tanged arrowheads (NH64SE 36 – Site 5 on Illus. 1.7). A second contained a jet necklace and bronze awl (NH64SE 30 – Site 4 on Illus. 1.7).

Table 1.1
Sites, findspots and cropmarks in the immediate vicinity of Culduthel

Site No.	NRHE No.	Site name	Description
1	NH64SE 26	Culduthel	Clava-type cairn
2	NH64SE 49	Culduthel	Two re-touched pieces of flint and a blue glass bead, found in a ploughed field
3	NH64SE 33	Culduthel Mains, Knocknagael	Bronze Age short cist
4	NH63SE 30	Culduthel	Bronze Age short cist – a crouched female skeleton, a necklace or girdle of jet, including a V-perforated toggle, a small flake of obsidian a fragment of a bronze awl, and pieces of charcoal
5	NH64SE 36	Culduthel	Bronze Age short cist, containing a skeleton, beaker, eight flint arrowheads, bone toggle, amber bead, and a rare stone arm-bracer (used by archers to protect their arms from the bowstring) mounted with four large gold caps measuring about a quarter of an inch across their heads
6	NH64SE 25	Knocknageal Boar Stone	Class I Pictish Symbol Stone bearing a boar surmounted by a mirror-case
7	NH64SE 241	Old Town of Leys	Cropmark – Enclosure; palisaded
8	NH64SE 71	Culduthel	Cropmark – Barrow (possible)
9	NH64SE 48	Inverness, Royal Academy	A riveted piece of bronze and several flints, including a microlith, found during work on Academy

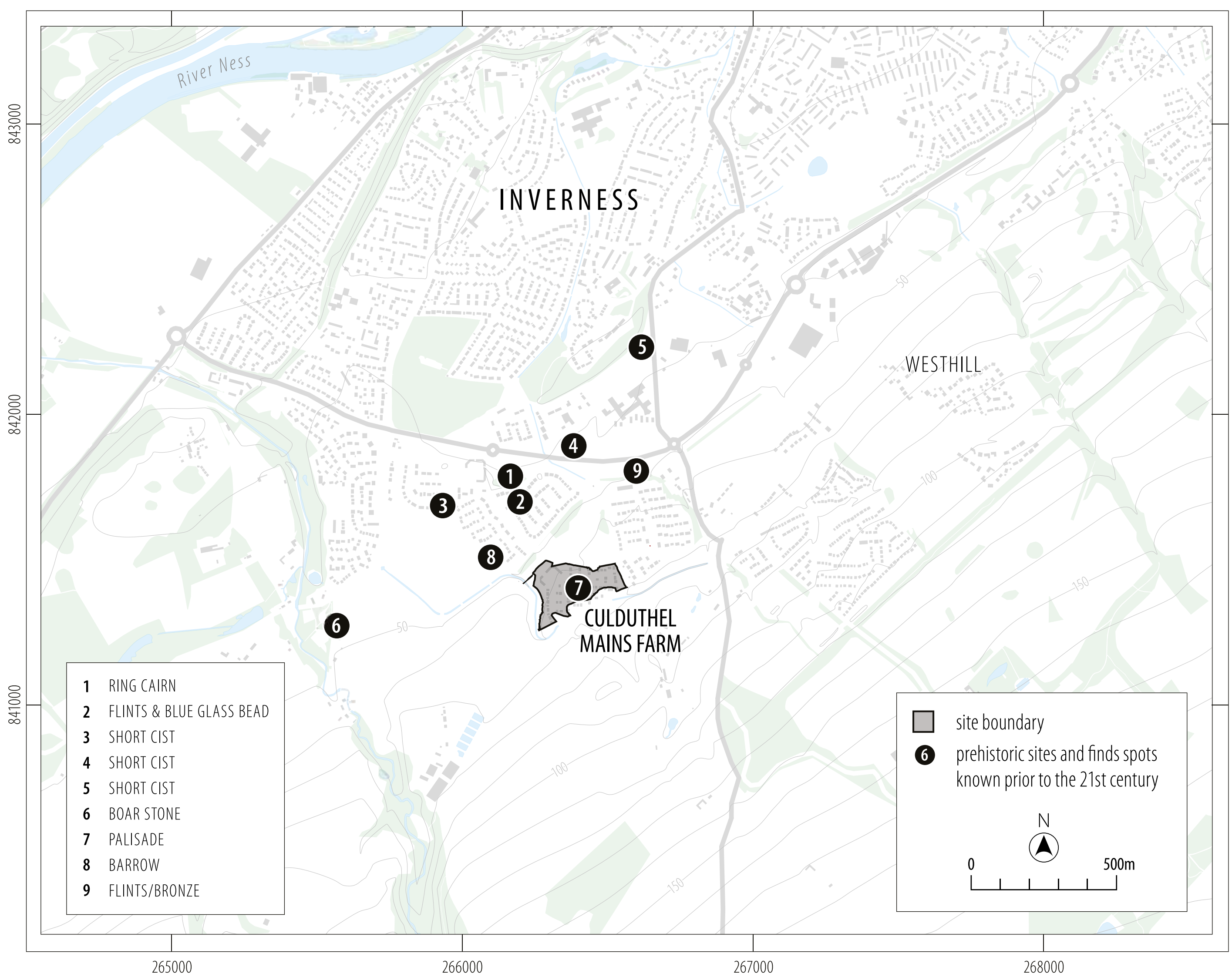

Illustration 1.7
Prehistoric sites and finds spots known prior to the 21st century. (© Headland Archaeology (UK) Ltd. Crown copyright and database right 2018)

The Knocknagael Boar Stone (NH64SE 25 – Site 6 on Illus. 1.7) is a Class I Pictish symbol stone formerly located to the west of the site. The stone is now in the foyer of the Highland Council Offices in Inverness.

Cropmarks visible on aerial photographs have expanded this picture of prehistoric ritual and funerary activity along the terrace to include a possible barrow (NH64SE 71 – Site 8 on Illus. 1.7). Settlements have also been identified on aerial photographs around Torbreck (NH64SE 70), Lower Slackbuie (NH64SE 37) to the west, and the Iron Age settlement and palisade at Balloan Park to the north-east (NH64SE 42 (Wordsworth 1999)).

Modern archaeological investigations

This area has seen major development in the late 20th and early 21st centuries with the expansion of the city's housing, infrastructure and shopping centres. As the terrace and its environs is known to be rich in prehistory, archaeological investigations prior to construction in the area of Culduthel have been frequent and this is now one of the most thoroughly investigated landscapes in north-east Scotland (Illus. 1.8).

Most fields in the immediate vicinity of the site have undergone investigation (Illus. 1.8 – Headland Archaeology Investigations Phases 1 to 9). Unfortunately, the fields to the north and north-west of the site, into which the Iron Age activity seen on the site may have originally extended, were heavily plough truncated and almost void of archaeological features (Headland Phases 1 and 4 (Hastie 2004); Headland Phase 6 (McCondichie 2006)). Archaeological investigations in the wider area have identified Neolithic, Bronze and Iron Age activity, which is detailed below. Where available, radiocarbon dates gained for this activity have been recalibrated using OxCal v 4.2 (Bronk Ramsey 2009), which utilises the most recent calibration curve available at the time of writing (Reimer et al 2013).

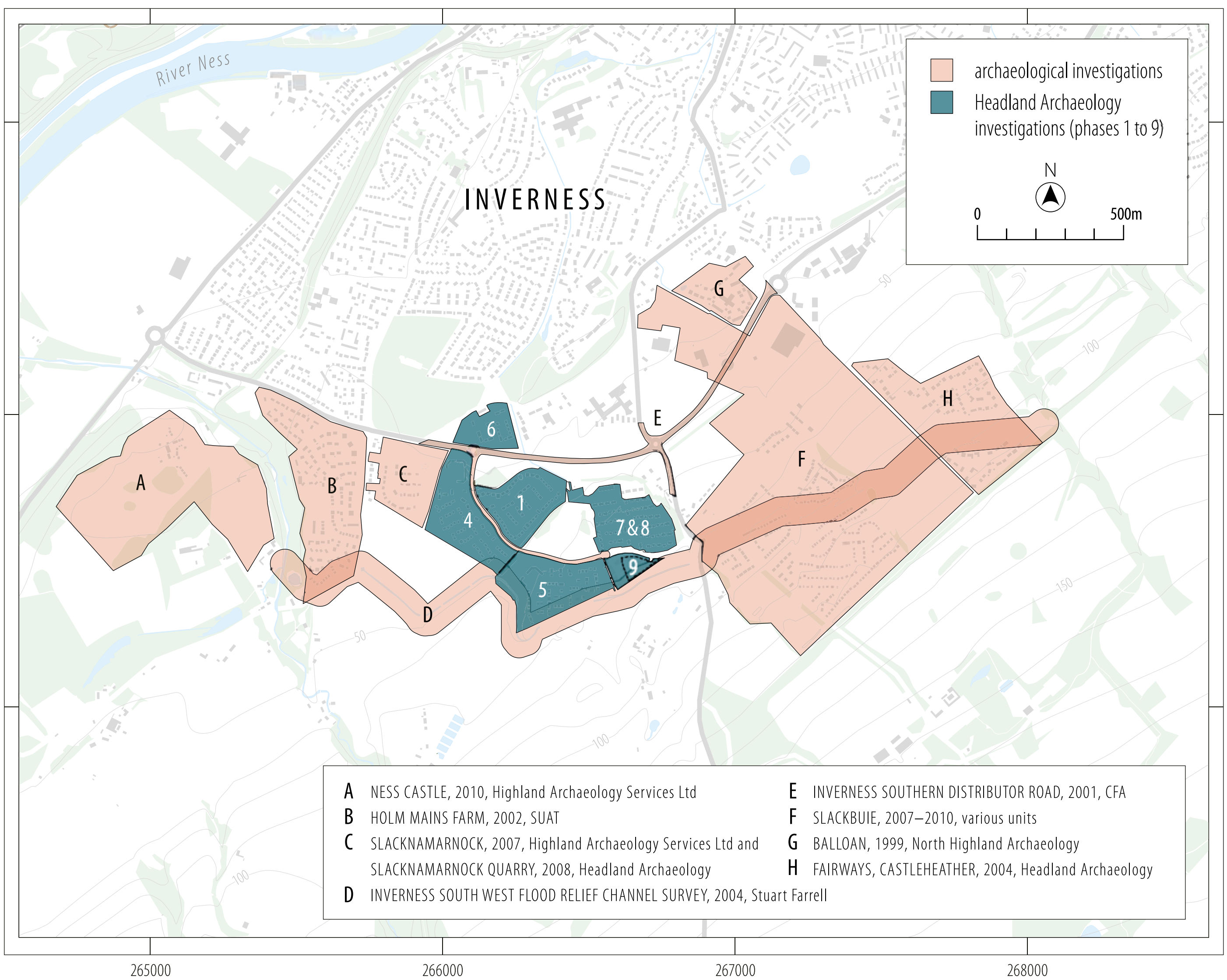

Illustration 1.8
Archaeological investigations around Culduthel 2000–2011. (© Headland Archaeology (UK) Ltd. Crown copyright and database right 2018)

Early prehistoric activity

Corroborating the evidence from the national and regional monuments records that the terrace was a hub for earlier prehistoric activity, investigations along the Southern Distributor Road to the north of the site identified numerous pits, mostly thought to be Neolithic in date (Site E on Illus. 1.8; Suddaby 2001). Work on the same linear scheme also identified prehistoric settlement evidence including pits, post-holes and Bronze Age pottery (Kilpatrick 2009; 2010). At Holm Mains Farm to the west of the site, two early Bronze Age cists with Beaker pots were uncovered in 2003 (Site B on Illus. 1.8; Brown 2003). One of the cists contained an individual male placed in a crouched position, accompanied by a collection of lithics including two barbed-and-tanged arrowheads.

Excavation at Slacknamarnock Quarry (Site C on Illus. 1.8) also identified a cist burial containing a crouched inhumation and a pit with a double cremation (Murray 2009). These were located close to a cist burial discovered in 1970 during quarrying (NH64SE 33). None of the burials have been dated but they may broadly be assigned a Bronze Age date.

Headland's Phase 7, 8 and 9 investigations identified substantial earlier prehistoric activity including a possible Neolithic mortuary enclosure alongside clusters of pits with Early, Middle and Late Neolithic pottery (Headland Phase 9 (van Wessel 2012)) and a multi-phase landscape with evidence of Neolithic, Bronze Age and Early Historic activity (Headland Phase 7 and 8 (Murray 2008)). Both these sites are further explored in Chapter 3.

Later prehistoric activity

Later Bronze Age and Iron Age unenclosed settlements have been identified in the land around the site. At Balloan Park an evaluation across the line of a cropmark palisade enclosure (NH64SE 42) identified hints of an extensive unenclosed settlement surrounding the small oval enclosure (Site G on Illus. 1.8; Carter and Russell-White 1993; Wordsworth 1999). The narrow stone-filled palisade ditch was unfortunately not dated, and nor was its interior investigated. The two radiocarbon dates gained for the site, for features outside of the enclosure, returned an Early Iron Age date (770–390 cal BC – GU3174) and a Middle Iron Age date (60 cal BC–cal AD 250 – GU3175) (Wordsworth 1999).

An evaluation of another unenclosed settlement at Balloan Park (Site G on Illus. 1.8 – Balloan Cottages NH64SE 37) identified post-holes and pits, two of which were dated to the Middle Iron Age (350–50 cal BC – SUERC-32353; 200–50 cal BC – SUERC-32354) (Farrell 2010). Further south at Slackbuie, one of the numerous investigations of this area identified a complex of pits and post-holes, which appeared to represent the remains of several roundhouses and storage pits (Site F on Illus. 1.8; Fyles 2007; Dutton 2007). Mid- to late Bronze Age pottery recovered was complemented by radiocarbon dates, indicating Bronze Age activity on the site. The clearest visible structure was a roundhouse with a central hearth dated to the Middle Iron Age (350–40 cal BC – SUERC-15207).

The only confirmed early medieval activity in the area was a metalworking site excavated in Headland's Phase 7 and 8 excavations, a rare site for mainland Scotland as most evidence for metalworking in this period comes from the Northern Isles (e.g. Birsay, Orkney (McDonnell 1986); Scatness, Shetland (McDonnell 1998a)). A cobbled surface preserved below an area of hillwash containing 11 iron objects including a small knife blade, a hook, a decorated copper alloy pin and a fragment of lead plate. Metalworking debris overlying the cobbles included furnace bottoms, smelting and smithing slag, suggested that small-scale metalworking was taking place (Murray 2008; Hatherley and Scholma-Mason [forthcoming]). Charcoal overlying the cobbles was dated to cal AD 570–650 (SUERC-20239), an early medieval date that was supported by proxy dating of the metal objects. To the east of the cobbled surface was a bowl furnace for smelting and to the west were numerous pits, including one that contained nearly 16 kg of iron slag, including several furnace bases. Charcoal from this pit returned a radiocarbon date of cal AD 770–990 (SUERC-20227).

Preservation of the site and excavation methodology

Deposition and taphonomy

The intensive agricultural regimes practiced in lowland Scotland has led to the removal of upstanding prehistoric structures and heavily truncated sub-surface archaeology. Many of the archaeological features identified at Culduthel were in the condition expected from a field that had been cultivated for several centuries, heavily truncated with only the lower portions of features surviving. Dense patches of stratified archaeological deposits and upstanding stone structures did, however, survive in the north-west area of the site. This level of preservation was surprising as, prior to stripping, the shallow regular slope of the field suggested that the underlying subsoil was uniform in depth and the area had been heavily ploughed. On stripping, it became clear that the underlying glacial sands and gravels gave rise to a hummocky, undulating terrain. An area of ground (approximately 8000m^2), located at the base of a slope separating two areas of higher ground, had been capped by colluvium, which had sealed and protected an area of archaeological features (approximately 1300m^2).

This hillwash must have come from bare soil upslope, possibly from a combination of open, trodden ground within settlement areas nearby and/or from tilled arable fields. The bulk of the deposits preserved under this hillwash were located within a slight hollow at the base of the slope to the east and south-east of a large ring-groove roundhouse (House 10). Another major factor in the excellent preservation of this area, and the roundhouse beside it, was thick layers of waste debris (an artefact-rich stony matrix that contained charcoal, slags, moulds, crucibles, discarded tools and unfinished items), which had sealed the archaeology after the site was abandoned. These layers had presumably formed from the gradual spreading of the industry's spoil heaps through natural processes such as wind and rain. The accumulation of hillwash above these spreads of waste had, in turn, helped to minimise the dispersal of artefacts contained with them.

The undulating topography of the site, areas of upstanding archaeology and the thick homogeneous spreads of waste material made the stripping of the site very difficult. Areas of the site do appear to have been over-machined; in particular, a baulk along the north-west limits of the excavation showed a deep layer of waste debris that had been removed over a wider area.

Excavation methodology

As the importance of Culduthel was quickly realised during the topsoil strip, the first task for Headland Archaeology was to produce a pre-excavation plan of the site once the strip was complete. This plan was first shown to the Highland Council curator Kirsty Cameron and the Edinburgh-based specialists to assist in the production of a methodology for the excavation of the site, including advice on how to excavate the huge mass of industrial waste material encountered and the upstanding stone-lined iron smelting furnaces. As some parts of the site appeared to be more akin to an urban settlement it was decided to modify excavation techniques accordingly, to consider the well-stratified, archaeologically rich deposits present. A single context recording system was therefore adopted site-wide and used in combination with hand-drawn plans and sections, and digital survey equipment. The director, Ross Murray, was a keen photographer and the site was frequently shot from the top of a four-storey photographic tower to carefully record progress (Illus. 1.9). Finds were located three-dimensionally, photographed and planned, and this data has been invaluable in creating distribution maps of artefacts, waste debris and working waste, during the post-excavation process.

Specialist advice was ongoing during the excavation, with staff from National Museums Scotland (notably Fraser Hunter, Andy Heald, Dawn McLaren and Trevor Cowie), the team from the Highland Archaeology Service (notably Kirsty Cameron), environmental, soil and finds specialists from Headland (Scott Timpany, Stephen Carter and Julie Franklin) all visiting to help with excavation and sampling methodology, on-site finds advice and spot dating.

As the site had been identified early on as the focus of ferrous and non-ferrous metalworking, metal-detectors were used throughout the excavation to screen all deposits prior to and during excavation. The detecting gave the excavators advance warning that they might be about to encounter significant artefacts and allowed them to maximise the recovery of metal artefacts. Given the abundance of metal finds across the site, careful progress was made through the deposits, which also helped in the detection of non-metallic artefacts. Extra care was taken to avoid the unnecessary fragmentation of objects, and to prepare appropriate conservation-standard storage containers for large

Illustration 1.9
The photographic tower in use

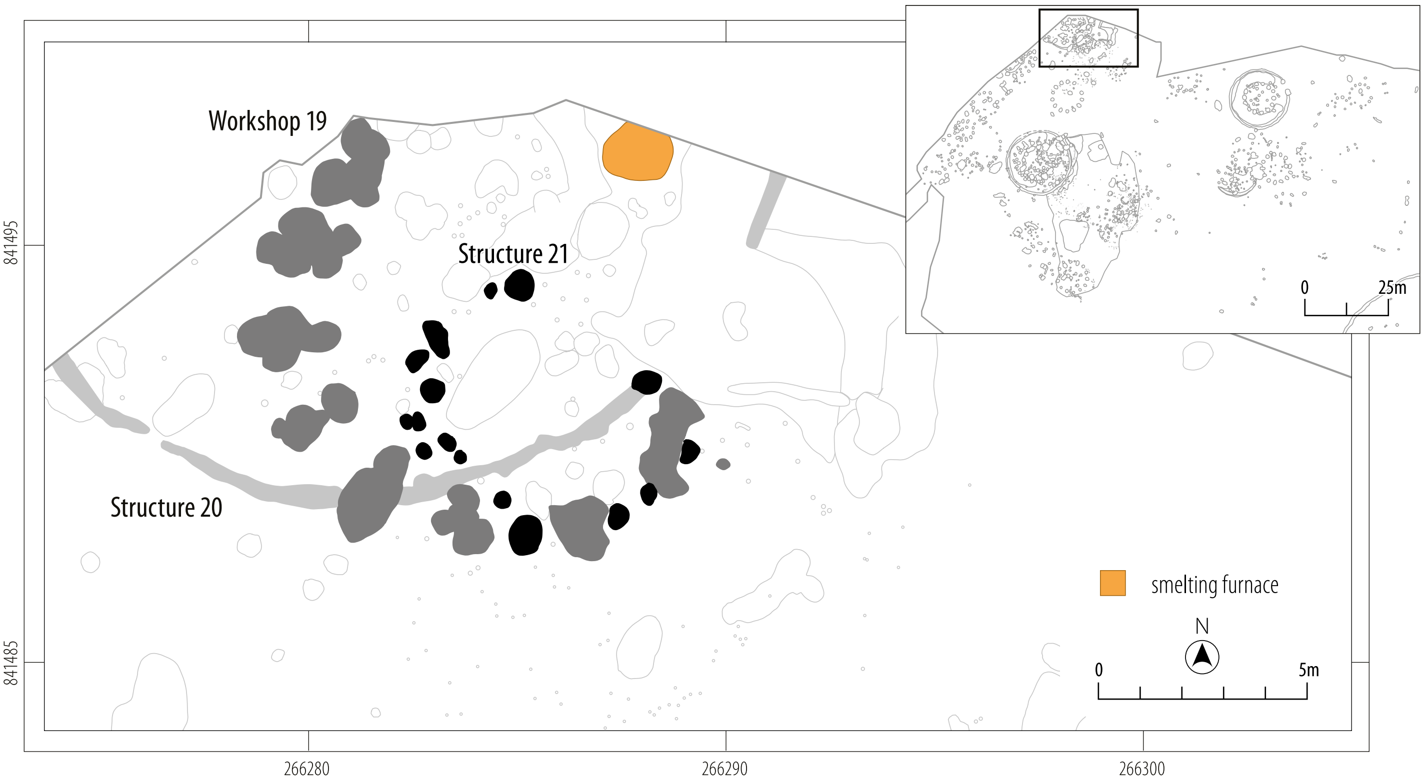

Illustration 1.10
Plan of the archaeological features in the unexcavated area of the site

and fragile artefacts such as the daggers and spearhead. Additional metal-detecting across the site was undertaken by volunteers Len Pentecost-Ingram and Eric Soane from the Highland Historical Search Society.

Sampling also played a key role in the excavation methodology. Bulk samples were taken from all deposits with the intention of using these to recover (in addition to ecofacts) small artefacts and microscopic items of industrial waste that would otherwise have gone largely undetected. This sampling strategy certainly helped to identify that an area of the site had been used for glass manufacture as the tiny fragments of glass and copper alloy waste material (miniscule flakes, droplets or fragments of rods, crucibles and moulds) would have been missed by the naked eye and were only been identified by careful sieving on site or back at the lab. The routine sampling of such materials also assisted in addressing any potential bias that could be introduced from the hand-selection of artefacts and types of industrial waste and has led to greater confidence in compiling and interpreting distribution patterns for material across the site.

Due to the time constraints and pressure to complete the work, some areas of the site were not as thoroughly investigated as they should have been. This is notable in the methodology used to excavate the thick layers of waste debris. Due to the sheer scale of the debris, stripping by hand was considered too time-consuming and the bulk of the material was removed by mini-digger, with only a few test pits and slots dug by hand. One area in the northern corner of the site was deemed suitable for preservation in situ, as it was to be open ground in the proposed development. The area contained a series of overlapping structures (19, 20 and 21) alongside a dense area of pits, gullies, post-holes and a furnace (Illus. 1.10) These features were surveyed, and a selection were excavated. The majority were unexcavated, and the area was wrapped in Teram to protect the archaeology, and backfilled.

Post-excavation analysis

The assessment of the bulk of the finds and the subsequent programme of post-excavation and analysis were undertaken by a team of specialists from National Museums Scotland led by Dawn McLaren (now at AOC Archaeology Group) and Fraser Hunter. On their advice the entire iron assemblage was X-rayed, and a large proportion conserved. This not only ensured the long-term survival of this important assemblage but allowed for fine tools and other finds to be identified at an early stage, rather than being classed as probable nails. It also allowed the identification of substantial amounts of bloom, which would have been impossible without X-rays.

Aside from the iron, detailed analysis was also undertaken on the copper alloy finds, including XRF scientific analysis; the Roman coins; glass finds and glassworking debris; lead including isotope analysis; ceramics (crucibles, moulds, tuyères and fired clay) including petrographic and technical analysis; prehistoric and Roman pottery; and chipped and coarse stone. The methodology for individual specialist analysis of this assemblage is detailed within each separate report in Chapter 6.

The environmental analysis for the site was unfortunately very limited. Of the 1,676 bulk samples taken from site and processed, only 48 samples were selected for analysis. This selection was based on features that contained the most abundant grain, together with those that contained significant quantities of charred nutshell fragments. To compound this limited analysis, the preservation of the small amount of animal bone was poor and the entire assemblage of small fragments deemed too degraded to identify. Additionally, the charcoal analysis to investigate the wood fuels used for the furnaces was started (notes of this work survive in the site archive) but was never completed, and the material could not be found at the time this publication was being written.

As the site was densely occupied over a considerable period, there is a question of the security of the environmental material and the likelihood that the majority of this material was intrusive and unrelated to the features it was retrieved from. Due to this conclusion, and the minimal analysis undertaken, the information that the environmental analysis of the site can add to the overall narrative of the site is considered to be limited, and therefore the environmental evidence is presented here as short summaries within each period chapter. The full environmental report is located within the site archive.

A total of 34 radiocarbon dates were obtained from a range of features, each a single date from a single feature. This dating programme and the radiocarbon dates are discussed in detail in Chapter 2. Due to this limited radiocarbon dating programme, and the general lack of datable artefactual material recovered across the site, a substantial number of discrete features (pits and post-holes) excavated across the site could not be placed within a phase of activity. All undated features that formed no coherent structures, relationships or clusters and contained no diagnostic artefacts have therefore not been included within any of the periods outlined in the following chapters. They are only illustrated on the master-plan of all archaeological features (Illus. 1.6).

The site is archived with the NRHE as CDF05 (acronym for Culduthel Farm 2005).

Illustration 1.11
House 10 under excavation

This publication

The excavation was undertaken by a commercial archaeology unit, Headland Archaeology (UK) Ltd, between May 2005 and February 2006 by a team of up to 30 field archaeologists ranging from recent graduates to long-serving professionals. It was directed in the field by Ross Murray (now of AOC Archaeology Group), who wrote the post-excavation assessment report (Murray 2007), and managed by Mark Roberts (now of CFA Archaeology). The main author of this monograph (Candy Hatherley) was part of the excavation team from October to December 2005. The excavation was funded by the developer Tulloch Homes Ltd and undertaken, as are all commercial archaeological projects, within a pressurised environment to have the on-site work completed as quickly as possible. The bulk of the post-excavation programme, which ran from 2006 to 2008, was co-ordinated by Ross Murray at Headland Archaeology and Dawn McLaren and Fraser Hunter at National Museums Scotland. This post-excavation programme was funded by the developer with a grant from Historic Environment Scotland assisting with the final publication of this monograph.

As is often the way within commercial archaeology units, Ross Murray moved on to pastures new before the post-excavation process was complete but much of this publication can be credited to his hard work and understanding of the site. The programme to publication has been completed at Headland Archaeology between 2016 and 2020 with ongoing support from National Museums Scotland (NMS). This publication has been co-ordinated and written by Candy Hatherley. The contributions from independent and NMS specialists were written between 2008 and 2011 and, as such, their references, and specific archaeological data, may reflect this lag in publication. It has been illustrated by Headland's in-house graphics team lead by Julia Bastek-Michalska.

The structure of this monograph

Following this introduction to the archaeology of Culduthel and its landscape, Chapter 2 gives an overview of the archaeological sequence and the phasing of the site with an analysis of the chronology of the site gained through Accelerator Mass Spectrometry (AMS) dates and the finds. Chapter 3 outlines the earlier prehistoric activity (Period 1) and the Early Iron Age occupation of the site (Period 2). Chapters 4 and 5 focus on the most intense period of occupation at Culduthel when the site was a craftworking centre engaged in the production of iron, bronze and glass (Period 3; Illus. 1.11). Chapter 6 contains the series of specialists reports for the finds assemblages, which have been spilt into four parts by material (Part A – Pottery and fired clay Part B – Stone; Part C – Metal; and Part D – Glass).

The final chapter, Chapter 7, reviews what we have learned from the excavation of this unique Iron Age craftworking centre. It looks at the community that worked and lived at Culduthel and tries to define the role that architecture and industry played in the settlement. Explorations into the scale of production and possible networks of exchange, trade and resources, help to demonstrate that Culduthel was a major production centre in north-east Scotland in the later prehistoric period and potentially part of a network of production sites across the southern coast of the Moray Firth. We then turn to view their neighbours along the Moray Firth coastal plain, primarily to help to place Culduthel in a regional context in north-east Scotland, but also to explore its potential for wider social and cultural networks. This concluding chapter is set against the backdrop of some reccurring themes in Iron Age studies, including identity, place, status and ritual practices, to aid the discussion on how the new evidence from Culduthel impacts on Iron Age studies in Scotland and beyond.

Chapter 2

CHRONOLOGY AND THE RADIOCARBON DATES

Introduction

The phasing of the site is summarised here alongside the approach taken in the radiocarbon dating programme carried out in 2010. The site phasing is heavily reliant on the suite of 34 radiocarbon dates along with some stratigraphic and artefactual evidence, a data set that unfortunately restricts discussions on the evolution and longevity of the site. Due to the number of radiocarbon dates and the strategy for this programme, Bayesian modelling was not deemed suitable as an interpretative tool. Subsequent discussions with Derek Hamilton of SUERC indicate that analysis could have been done to refine the overall start and end dates for the ferrous metalworking activity identified on site and that this work could be undertaken by future researchers (pers. comm. Derek Hamilton).

Artefactual evidence has aided the identification of the earliest prehistoric features on site. A small number of early prehistoric pottery sherds have dated Early and Late Neolithic pits (Period 1). The datable later prehistoric finds such as Roman coins and the decorative metalwork have helped refine elements of the later occupation of the site (Period 3) and support some of the radiocarbon dates gained for this period of activity.

In brief, the early prehistoric evidence indicates that the site at Culduthel was certainly visited in the Neolithic and could, at times, have been intensively settled. The site is next occupied, potentially periodically, in the Early Iron Age, at points between the 8th and 5th centuries BC. After this occupation ceases there is no further evidence of activity on the land until the intense period of craft-focused settlement of large-scale roundhouses and smaller 'workshop' roundhouses. Radiocarbon dates for this phase cover the period from the early 4th century BC to the mid-4th century AD, but evidence suggests that the main phase of craft-working was between the 2nd century BC and the 2nd century AD. The radiocarbon dates indicate no activity on site after *c.*AD 340.

Chronology

This publication uses the following chronological period breakdown:

Neolithic (4100–2450 BC)
Chalcolithic (2450–2150 BC)
Bronze Age (2150–800 BC)
Early Iron Age (800–400 BC)
Middle Iron Age (400 BC–AD 300)
Late Iron Age (AD 300–400)
Early Historic/Early Medieval Period (after AD 400)

Radiocarbon dates

Sample selection, objectives and issues

The radiocarbon dating programme for Culduthel had several key objectives. Firstly, it was designed to gain dates for most of the buildings, furnaces and other significant structures and features, to aid the construction of a chronological framework for the site and its subsequent interpretation. Secondly these dates were intended to clarify whether certain features (e.g. the roundhouses workshops and their internal furnaces) were contemporary activities. Finally, dates were sought for features containing deliberately deposited artefacts, to ascertain their date of deposition and, by extension, an approximate date for the artefact itself.

As most features on site produced charcoal or material suitable for radiocarbon dating, the sample choice appeared, on the surface, to be almost endless. Ideally, all the 34 samples chosen for radiocarbon dating would have come from features that contained carbonised material that was in situ (such as charcoal within the primary fill of a furnace or burnt posts within a post-hole) and from short-lived species or 'freshly' deposited articulated animal bone. These types of material have the highest chance of being primary deposits and could therefore be attributed with some confidence to a structure or feature. In reality the bone preservation across the site was very poor and the primary deposition of material was rare, aside from the final firings within the bases of the furnaces and hearths. Material was selected for dating with the issues outlined above in mind, and samples were taken from basal contexts that, although potentially not primary in nature, were the least likely to have intrusive material unrelated to the original function. Selection also focused on short-lived tree species, cereal grains, hazelnut shell and in one case a charred fruit stone. Where possible the charcoal came from small branch wood in order to refine the date range further. In only a couple of cases there was no option other than dating oak charcoal, never ideal given its long-lived nature and the potential for the 'old wood' effect.

Table 2.1
Radiocarbon dates from Culduthel

Period 2				Period 3		
Lab ID	**Feature**	**Context**	**Material Type**	**Radio-carbon Age (bp)**	**δ13C (0/00)**	**Calibrated date (95% confidence)**
SUERC-30366	House 5	(792) Fill of post-hole [791]	Charred pip *Malus sylvestris* (Crab Apple)	4885 ± 35	-26.4 ‰	3760–3630 cal BC
SUERC-30399	House 10/1	(3869) Fill of post-hole [3868]	Charcoal *Corylus avellana* (Hazel)	4220 ± 35	-26.1 ‰	2910–2680 cal BC
SUERC-30360	Palisade	(468) Fill of palisade ditch [469]	Charred grain *Hordeum Vulgare* (Hulled Barley)	3895 ± 35	-24.6 ‰	2470–2240 cal BC
SUERC-30367	House 3	(1613) Fill of ring-groove [724]	Charcoal *Corylus avellana* (Hazel)	2565 ± 35	-27.8 ‰	810–550 cal BC
SUERC-30405	Clearance cairn [4234]	(4234) Fill within cairn	Charcoal *Prunus avium* (Wild Cherry)	2505 ± 40	-26.9 ‰	800–490 cal BC
SUERC-30375	House 9	(2108) Post-pipe of post-hole [2106]	Charcoal *Corylus avellana* (Hazel)	2175 ± 35	-25.5 ‰	360–120 cal BC
SUERC-30369	House 7	(1936) Post-pipe of post-hole [1830]	Charcoal *Quercus sp.* (Oak)	2140 ± 35	-26.9 ‰	360–50 cal BC
SUERC-30376	Hearth [2166]	[2166] Fill of Glass/Copper Alloy Furnace	Charcoal *Alnus glutinosa* (Alder)	2125 ± 35	-27.5 ‰	350–50 cal BC
SUERC-30370	Workshop 8	(1992) Fill of post-hole [1991]	Charcoal *Corylus avellana* (Hazel)	2120 ± 35	-24.8 ‰	350–50 cal BC
SUERC-30379	House 17	(2347) Fill of eroded hollow [2403]	Charcoal *Corylus avellana* (Hazel)	2115 ± 35	-25.5 ‰	350–50 cal BC
SUERC-30407	Hearth [4273]	(4279) Fill of black-smithing hearth	Charcoal *Corylus avellana* (Hazel)	2110 ± 35	-25.2 ‰	350–40 cal BC
SUERC-30377	Furnace [2246] Workshop 16	(2288) Fill of iron-smelting furnace within Workshop 16 (PRIMARY)	Charcoal *Corylus avellana* (Hazel)	2080 ± 35	-25.6 ‰	200 cal BC–cal AD 1
SUERC-30388	Pit [2777]	(2778) Fill of Pit	Charcoal *Salix sp.* (Willow)	2080 ± 35	-25.6 ‰	200 cal BC–cal AD 1
SUERC-30368	Workshop 6	(1619) Fill of post-hole [1618]	Charcoal *Pomoideae sp.* (Apple/Pear/Hawthorn)	2080 ± 35	-25.7 ‰	200 cal BC–cal AD 1
SUERC-30400	Furnace [4147] Workshop 15	(4141) Fill of iron-smelting furnace in Workshop 15 (PRIMARY)	Charcoal *Quercus sp.* (Oak)	2060 ± 35	-25.8 ‰	170 cal BC–cal AD 20
SUERC-30378	Workshop 16	(2304) Post-pipe of post-hole [2303]	Charred grain *Hordeum Vulgare* (Hulled Barley)	2055 ± 35	-25.1 ‰	170 cal BC–cal AD 20
SUERC-30386	Hearth [2434]	(2677) Fill of Glass/Copper Alloy Furnace (PRIMARY)	Charcoal *Alnus glutinosa* (Alder)	2055 ± 35	-27.3 ‰	170 cal BC–cal AD 20
SUERC-30390	Furnace [3050] Workshop 13	(3204) Fill of iron-smelting furnace [3050] within Workshop 13 (PRIMARY)	Charcoal *Prunus avium* (Wild Cherry)	2035 ± 35	-26.2 ‰	160 cal BC–cal AD 50

Table 2.1
(continued)

Period 3						
Lab ID	**Feature**	**Context**	**Material Type**	**Radio-carbon Age (bp)**	**δ13C (0/00)**	**Calibrated date (95% confidence)**
SUERC-30398	Pit [3811]	(3812) Fill of metalworking waste pit [3811]	Charcoal *Corylus avellana* (Hazel)	2030 ± 35	-24.8 ‰	160 cal BC–cal AD 60
SUERC-30381	Posthole [2416]	(2419) Fill of post-hole [2416] containing iron dagger blade (SF 479)	Charred grain *Hordeum Vulgare* (Hulled Barley)	2025 ± 35	-24.6 ‰	160 cal BC–cal AD 60
SUERC-30387	House 10/2	(2738) Fill of post-hole [2670]	Charcoal *Pomoideae sp.* (Apple/Pear/Hawthrorn)	2025 ± 35	-25.0 ‰	160 cal BC–cal AD 60
SUERC-30385	Workshop 12	(2461) post-pipe in post-hole [2459]	Charcoal *Alnus glutinosa* (Alder)	2015 ± 35	-27.6 ‰	110 cal BC–cal AD 70
SUERC-30401	Furnace [4355] Workshop 15	(4148) Fill of iron-smelting Furnace [4355] within Workshop 15 (PRIMARY)	Charcoal *Alnus glutinosa* (Alder)	2010 ± 35	-25.0 ‰	110 cal BC–cal AD 70
SUERC-30391	Furnace [3790] Workshop 13	(3467) Ash fill of iron-smelting furnace [3790] within Workshop 13 (PRIMARY)	Charred fruit stone *Prunus avium* (Wild Cherry)	2000 ± 35	-25.7 ‰	90 cal BC–cal AD 80
SUERC-30371	Workshop 11	(2100) Abandonment phase of Workshop 11	Charcoal *Prunus spinosa* (Blackthorn)	1985 ± 35	-25.7 ‰	90 cal BC–cal AD 90
SUERC-30361	Workshop 2	(595) Fill of post-hole [597]	Charred grain *Hordeum Vulgare* (Hulled Barley)	1975 ± 35	-23.2 ‰	50 cal BC–cal AD 120
SUERC-30406	Furnace [4262] Workshop 15	(4257) Fill of iron-smelting furnace [4262] within Workshop 15 (PRIMARY)	Charcoal *Corylus avellana* (Hazel)	1975 ± 35	-25.4 ‰	50 cal BC–cal AD 120
SUERC-30395	Workshop 15	(3495) Fill of post-hole [3494]	Charred grain *Hordeum Vulgare* (Hulled Barley)	1965 ± 35	-23.1 ‰	40 cal BC–cal AD 120
SUERC-30365	Furnace [681] Workshop 2	(676) Fill of iron-smelting furnace [681] in Workshop 2 (PRIMARY)	Charcoal *Quercus sp.* (Oak)	1960 ± 35	-25.7 ‰	40 cal BC–cal AD 120
SUERC-30389	Workshop 13	(2920) Fill of post-hole [2919]	Charred grain *Hordeum Vulgare* (Hulled Barley)	1935 ± 35	-23.1 ‰	40 cal BC–cal AD 130
SUERC-30397	House 10/3	(3799) Fill of post-hole [3746]	Charcoal *Alnus glutinosa* (Alder)	1890 ± 35	-27.3 ‰	cal AD 30–230
SUERC-30396	Workshop 18	(3600) Fill of pit [3599]	Charcoal *Corylus avellana* (Hazel)	1870 ± 35	-26.3 ‰	cal AD 70–230
SUERC-30380	House 4	(2351) Fill of post-hole [2352]	Charred grain *Hordeum Vulgare* (Hulled Barley)	1860 ± 35	-23.7 ‰	cal AD 80–240
SUERC-30359	Cobbled surface [227]	(225) Dark deposit overlying cobbles	Charcoal *Alnus glutinosa* (Alder)	1785 ± 35	-27.9 ‰	cal AD 130–340

As there is high potential for cross-contamination on a site rich in charcoal and industrial debris, the radiocarbon dates presented here are more likely to have come from material influenced by redeposition than, say, a comparable group of samples retrieved from purely domestic Iron Age settlements. It is also clear that, even with the careful selection outlined above, the majority of the radiocarbon dates obtained are derived from material retrieved from secondary or tertiary contexts. These two issues are further compounded by the single-date strategy employed during the selection process (see Results section below). As only one date was obtained from each building or feature there are no supporting radiocarbon dates available to corroborate any of the 34 dates obtained.

Where the radiocarbon dates are considered to be 'secure' (i.e. retrieved from primary deposits) they have been used to assist in the development of the chronological framework. The most obviously secure dates were from deposits assumed to be primary: the fuel of the final firing of a smelting furnace or hearth. These are eight of the 34 radiocarbon dates, seven from the iron-smelting furnaces and one from a glass/copper alloy working hearth. These dates are noted as 'primary' on the radiocarbon date table (Table 2.1).

The dates made for the final firing of three of the furnaces do appear to corroborate those obtained for the roundhouse 'workshops' that housed them. As the origins of the charred material used to make the radiocarbon dates for the buildings is unknown (for each date the sampled material was obtained from backfill of the buildings' post-holes), it can only be postulated that the workshops and furnace were contemporaneously constructed.

Results

A total of 34 samples from 34 separate deposits were sent for radiocarbon dating to the Scottish Universities Environmental Research Centre (SUERC). Each AMS radiocarbon age measurement was made on a single entity. Samples were taken from:

- Each roundhouse
- The palisade
- A clearance cairn
- All excavated iron smelting furnaces
- Hearths associated with copper alloy/glassworking
- A layer overlying Workshop 11, a building associated with copper/glassworking
- A layer overlying cobbled yard (227), associated with ironworking
- A post-hole [2416] containing a deliberately deposited iron dagger
- Pits with ferrous, non-ferrous or glassworking waste.

The results of the radiocarbon dates are presented in chronological order in Table 2.1 and as a multiple curve illustration (multi-plot) (Illus. 2.1). Calibrated date ranges were calculated using the calibration curve of Reimer et al (2013) and OxCal v 4.2 (Bronk Ramsey 2009). They are presented as 95% probability ranges throughout the text, unless otherwise noted.

The sequence of radiocarbon dates runs from *ca.* 3760 BC to AD 340. This is not a continuous sequence of dates, with three clear periods of activity (Period 1, 2 and 3) and two hiatuses

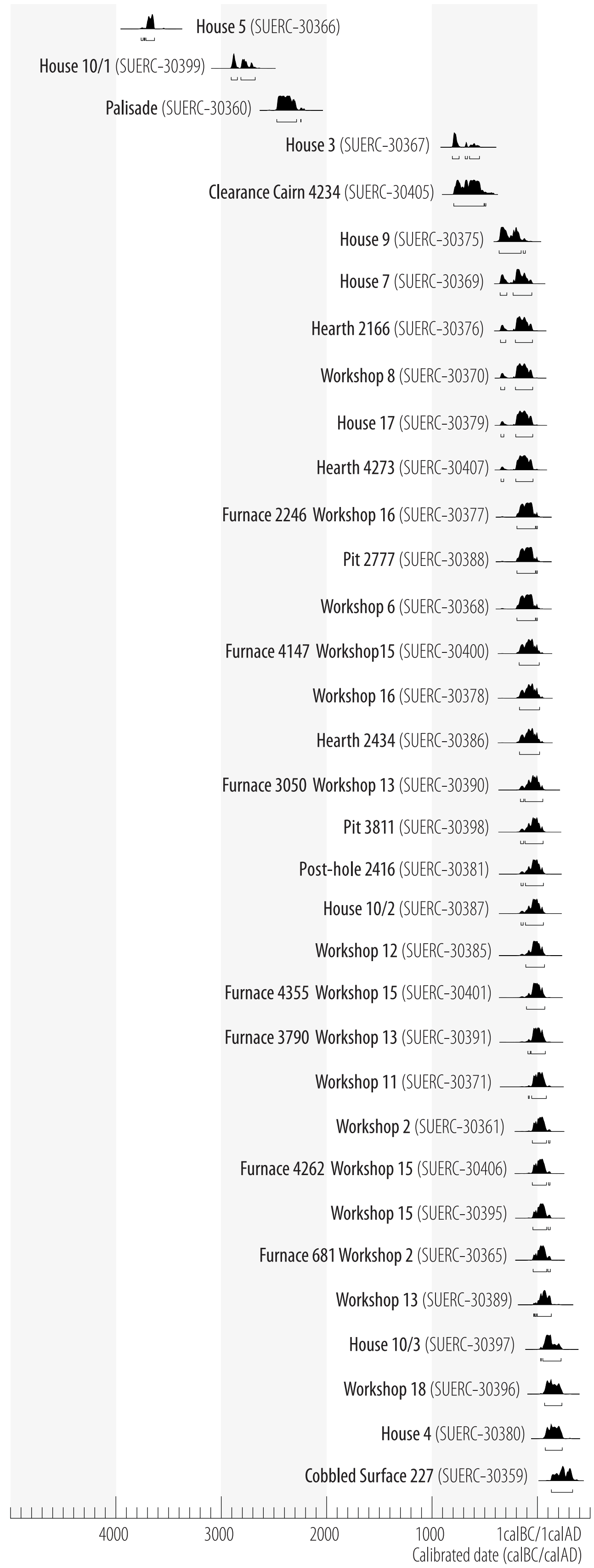

Illustration 2.1
Calibrated radiocarbon dates for Culduthel

recognised (Table 2.1). Period 1 falls into the Neolithic/ Chalcolithic (between 3760 and 2240 BC) and is followed by the longest gap in the sequence, potentially lasting up to 1470 years, between 2240 BC and 810 BC. Period 2 spans the Early Iron Age between 810 and 490 BC and is followed by another break between 490 BC and 360 BC. The remaining Iron Age sequence (Period 3) is seemingly unbroken single continuous distribution which spans a potential 700-year period from 360 BC to AD 340, with 29 of the 34 dates falling within this sequence.

Period 1 – Earlier prehistoric activity

The pre-Iron Age activity at Culduthel was represented by a small number of pits scattered across the excavation area, which contained sherds of Early/Middle Neolithic carinated bowls, Beaker pottery of the Late Neolithic/Early Bronze Age and lithics. Numerous undated pits scattered across the site may also have related to this early prehistoric activity.

Three AMS dates, all from charred material, also came back with Neolithic or Chalcolithic dates. In each case they seem to represent residual material within later, Iron Age, features, which suggests that earlier prehistoric features were disturbed by the Iron Age occupations. A single AMS date from the Early Neolithic (3760–3630 cal BC, SUERC-30366) was retrieved from a crab apple pip within a post-hole of the post-ring of House 5. The design of the roundhouse, and its relationship to other features on site, suggests that it was Early Iron Age in date, and it has been placed within Period 2.

A second Early Neolithic date was obtained from the fill of a post-hole of the primary phase of House 10 (2910–2680 cal BC, SUERC-30399). This building is clearly Iron Age in date as it is succeeded on the same footprint by two houses (House 10/2 and 10/3) that are dated to Middle Iron Age (Period 3) by material culture. House 10/1 has been placed within Period 3.

The Chalcolithic AMS date (2470–2240 cal BC, SUERC-30360) is more problematic as it is the only radiocarbon date obtained from the palisade enclosure. As this AMS date was from a charred hulled barley grain present in the main fill of the ditch, it is impossible to ascertain whether the charred grain is a reliable indicator of the date of the enclosure or residual material from the early prehistoric activity in the immediate vicinity.

Similar palisade enclosures have been identified at Dryburn Bridge and Broxmouth hillfort in East Lothian; the construction of both heralded the start of the occupation of these sites in the Early Iron Age (*c*.800–400 BC) (Dunwell 2007; Armit and McKenzie 2013). While the construction of these palisades appears to signal the establishment of new settlements in this period in East Lothian and across to south-east Scotland (Armit and McKenzie 2013, 40), evidence for this tradition taking place in the north-east in the Early Iron Age is currently scant.

Closer to Culduthel, the palisade identified in Headland Phases 7 and 8 to the north of the site also returned a Neolithic date of 3340–3010 cal BC (SUERC-20230). The excavator was keen to emphasise, however, that this backfill was redeposited as it also contained plastic and modern glass (Murray 2008). To the north-east of the site the palisade at Balloan Park remains undated but is likely to relate to the Early and Middle Iron Age settlement clustered around its perimeter (Wordsworth 1999). The date of the Culduthel palisade remains unclear but as it contained no material relating to the industry seen in the Middle Iron Age (Period 3) it appears unrelated to this phase of occupation. As a stand-alone fenced enclosure set apart from any other occupation of the land it may have been a stock enclosure for the Early Iron Age farming activity identified on the site (Period 2). It has been placed within this period of activity.

Period 2 – Early Iron Age occupation

Two AMS dates came back with Early Iron Age dates, one from a ring-groove roundhouse (House 3 – 810–550 cal BC, SUERC-30367) and one from a clearance cairn (Cairn 4234 – 800–490 cal BC, SUERC-30405).

As House 3 overlies another roundhouse (House 5) and was cut by an iron smelting workshop from Period 3 (Workshop 2), both houses have been interpreted as Early Iron Age in date. The clearance cairn, alongside another similar cairn and a cobbled surface, was located beneath a thick layer of hillwash that predated the Middle Iron Age settlement (Period 3). Another similar cairn to the east and the palisade enclosure may also be part of this activity.

Period 3 – The Middle Iron Age craftworking centre

Radiocarbon dates indicate that the most intense period of occupation at Culduthel occurred between the 2nd century BC and the 2nd century AD. The majority of the structural remains, the artefact assemblage and the wealth of evidence for the on-site production of iron, glass and copper can be placed in this period. Ten remarkably similar workshop roundhouses were constructed in this period, nine of which contained iron smelting furnaces or evidence of activities associated with ironworking within their interiors. Several of these workshops contained multiple furnaces with each additional furnace built to replace derelict structures, evidence that suggests iron production was at times intense and may have been ongoing for a considerable period.

Glass and copper alloy items were manufactured on site within a group of hearths located beside a U-shaped turf-walled workshop. Items produced include opaque red glass for metalwork inlay, glass beads and a copper alloy harness strap mount. A radiocarbon date from the basal fill of one of the hearths indicates that this hearth was fired at some point between the 2nd century BC and the early 1st century AD.

Domestic evidence in this period is limited but four post-ring roundhouses, located to the north-west side of the site, could have been for housing. In the final phase of occupation (defined as Period 3b) two large ring-groove houses were constructed, one overlying an existing roundhouse. A wealth of artefacts was recovered from the backfilling of these large houses, including leather-, bronze- and woodworking tools, a chariot linchpin, Roman coins and decorated copper alloy items and sheetwork.

The abandonment of the settlement is recognised in the archaeological record as thick layers of waste debris that covered structures and cobbled surfaces over a large area in the north-west of the site.

Chapter 3

EARLIER PREHISTORIC ACTIVITY AND EARLY IRON AGE OCCUPATION

Period 1 – Earlier prehistoric Culduthel

Culduthel was certainly inhabited in the early prehistoric period, with both Early and Late Neolithic activity represented by pits containing identifiable and datable pottery and a scattering of unstratified pottery across the site. The true extent of the pre-Iron Age activity is unknown, as the intensive Iron Age occupation of the land seen in Period 3 could have eradicated many earlier features. The lithic assemblage suggests people lived on or near Culduthel for several millennia, from the Late Mesolithic to the later Bronze Age (Bjarke Ballin, Chapter 6). Previous archaeological investigations have also shown that the terrace was a focus for both Neolithic and Bronze Age communities.

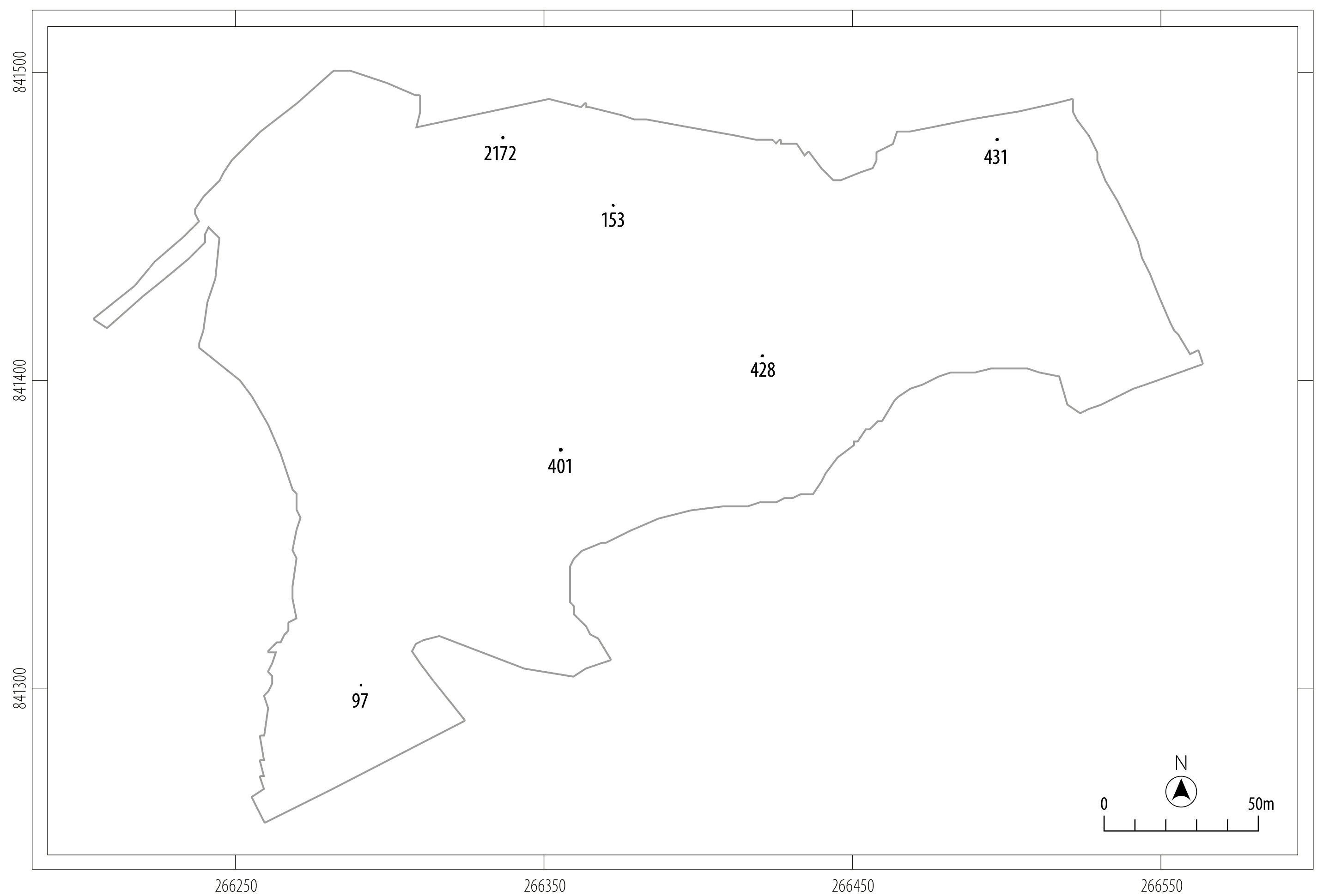

Illustration 3.1
Period 1 – Earlier prehistoric activity

Early Neolithic pits

There were numerous small pits present across the excavated area, mostly in the higher eastern half of the site, with the majority containing no evidence of their date or function. However, sherds of Early Neolithic carinated bowls were present in three shallow pits (097, 153 and 2172 – Illus. 3.1). Two sherds (Vessel 8) were present in Pit [097], which was located among a fairly isolated cluster of features in the south-west corner of site. The pit was pretty unremarkable being 0.4m in diameter and 0.08m deep with a single fill. Pit [153] contained the sherds of three Early Neolithic carinated bowls (Vessels 1, 14 and 15 – Vessel 1 Illus. 6.1). It measured 0.4m by 0.3m and was 0.22m deep. The third pit [2172] was located near the northern limit of the site. The pit measured 1m by 0.8m and was 0.08m deep. It contained five sherds from a single carinated bowl (Vessel 3 – Illus. 6.1).

One carinated vessel (Vessel 2 – Illus. 6.1) was recovered during the topsoil strip.

Late Neolithic pits

Two features contained sherds of Beaker pottery (Illus. 3.1). A stone-lined pit or post-hole [401] had a diameter of 0.9m and a depth of 0.4m and was lined with cobbles across the base, and angular stones around the lip of the cut. Nine sherds of Beaker pottery from the same vessel were found within the fill (Vessel 21). Pit [428] also contained Beaker pottery. It measured 0.7m by 0.5m and was 0.27m deep.

Discussion

There is certainly evidence on the site of Neolithic activity in the form of scattered pits, some characterised by deposits of carinated bowl or Beaker pottery, lithics and charred material. The excavation and curation of pits throughout the Neolithic was a common act, likely done for a wide variety of reasons such as waste disposal and crop processing, or less prosaic reasons such as commemorating an event or marking a location (Brophy and Noble 2011). Pits are often the only evidence for Neolithic settlement and Culduthel could have been significantly settled or frequently visited by more mobile societies in earlier prehistory. The carinated bowl (CB) tradition is a well-documented feature of eastern Scotland at this time, and Culduthel fits well into the map of CB activity in the north-east (Sheridan 2016).

Archaeological investigations in the immediate area in the last 20 years (Illus. 1.8) indicate that this activity generally fits well into a wider picture of fairly intensive use of the landscape in this period, focused along the ridge of the terrace, likely a prominent local place in earlier prehistory. Neolithic activity has been identified on the terrace through archaeological investigations to the north-east (Headland Phases 7 and 8 (Murray 2008)) and east of the site (Headland Phase 9 (van Wessel 2012); Flood Relief Channel (Peteranna 2011)). Dense clusters of pits and hearth pits identified in Headland Phases 7 and 8 contained Early to Middle Neolithic carinated bowl, one of which was AMS dated to 3650–3510 cal BC (SUERC-20229) (Headland Phases 7 and 8 (Murray 2008)). Late Neolithic activity was also identified on the site with one pit containing 195 pieces of flint, representing an entire knapping sequence, dated to the Late Neolithic (2870–2570 cal BC, SUERC-20247), while another containing concentrations of burnt bone alongside Late Neolithic pottery AMS dated to 2910–2670 cal BC (SUERC-20308) (ibid). Other pits showed structured deposition of food preparation equipment including one with a carefully placed saddle quern, rubbing stone and heat-fractured stone alongside Early to Middle Neolithic pottery, dated to 2880–2610 cal BC (SUERC-20240) (ibid).

Monitoring prior to the construction of a flood relief channel in 2011 opened up areas immediately adjacent to the eastern limit of Headland Phases 7 and 8. The activity seen in Headland Phases 7 and 8 continued within this area, with pits containing both sherds of carinated bowl of the Middle Neolithic and Late Neolithic Grooved Ware dated to 3030–2890 cal BC (SUERC-34575) and 3090–2900 cal BC (SUERC-34576) (Peteranna 2011).

Further work to the east was undertaken during Headland Phase 9. Alongside numerous clusters of pits with Early, Middle and Late Neolithic pottery and lithics was an enclosure of possible Neolithic date (Illus. 3.2) (van Wessel 2012). The enclosure ditch had a rounded western end and an entrance on the southern side marked by shallow pits. It enclosed a centrally located large pit with a row of post-holes cut into its base. Further pits and post-holes were located within the interior, both continuing the line of the post-holes in the base of the large pit and curving around it. Although the enclosure remains undated at the time of writing, typological parallels suggest that this elongated rectilinear enclosure may have been a ceremonial monument associated with mortuary activity during the Neolithic (Barclay and Maxwell 1991). It closely resembles the Early Neolithic rectilinear mound identified at Kintore in Aberdeenshire constructed between 4250 and 3950 cal BC (Cook and Dunbar 2008, 35–42) and an undated double enclosure at Whelphill in South Lanarkshire (Masser 2009). The Kintore feature has been described as 'a large, complex communal monument' (Cook and Dunbar 2008, 49), perhaps functioning as a ceremonial or ritual focus for social gatherings and the wider community for hundreds of years. In a similar linear monument tradition are the Early-Middle Neolithic long mortuary enclosure at Inchtuthill in Perthshire (Barclay and Maxwell 1991), the long barrow at Dalladies (Piggott 1972) and several pit-defined enclosures such as Douglasmuir and Cowie Road, Bannockburn (Kendrick 1995; Rideout 1997; Brophy 1999). The linear arrangement of post-holes within the interior of the enclosure bears some similarity to the possible mortuary platforms that predated the oval barrows at Pitnacree in Perthshire (Scott 1992, 107–17) or the division of space seen within the interior of enclosure at Kintore (Cook and Dunbar 2008, 51). Whatever the function of the rectilinear enclosure at Culduthel its construction would have been a highly significant event that would have required substantial planning and labour to build.

Period 2 – Early Iron Age occupation

Charcoal retrieved from two structures, a roundhouse (House 3) and a clearance cairn [4234], returned Early Iron Age radiocarbon dates. House 3 was a ring-groove roundhouse that contained a

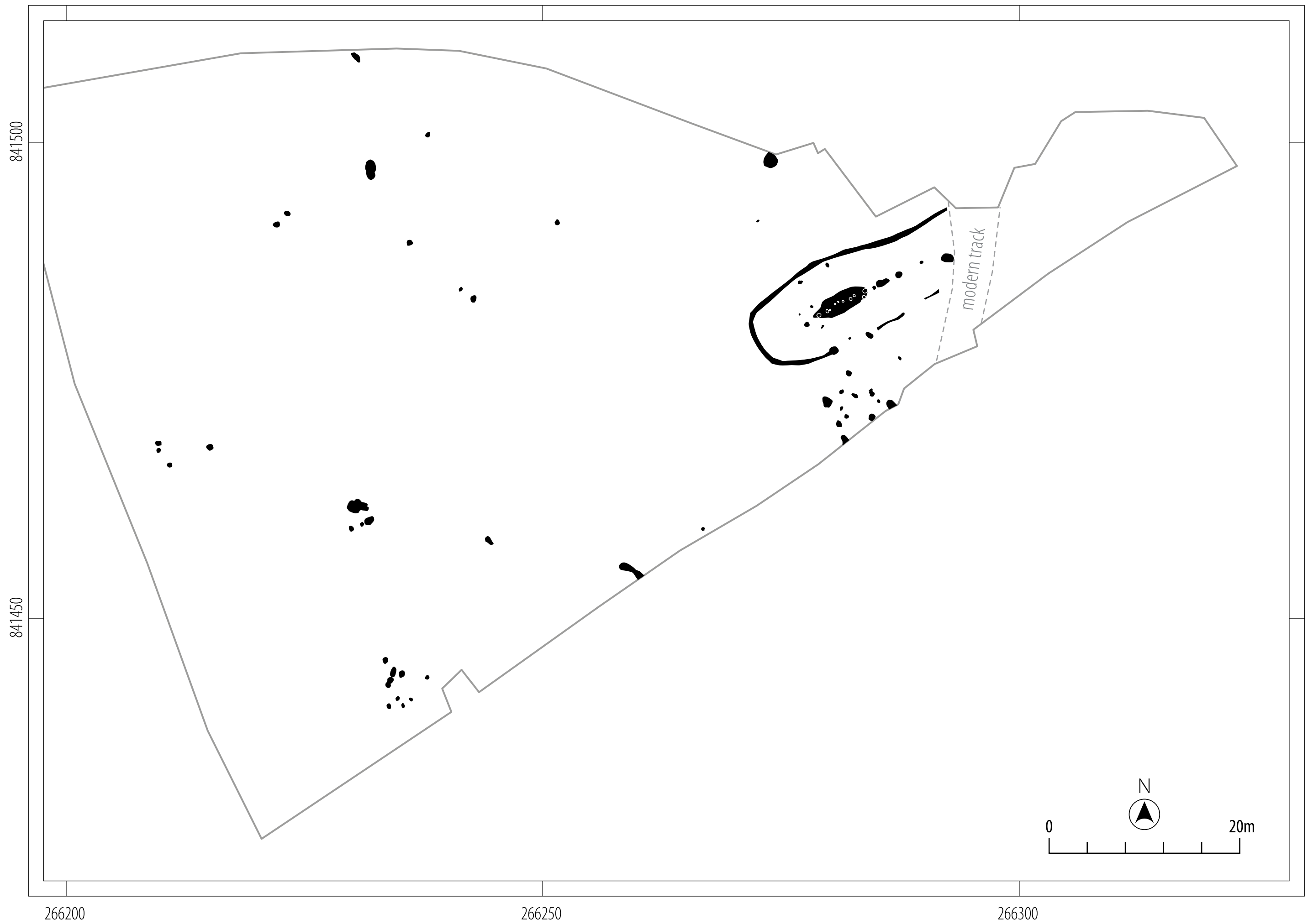

Illustration 3.2
Phase 9 excavations at Culduthel by Headland Archaeology

sizeable assemblage of saddle querns incorporated into the structure of the building, both in the walls and the post-holes. The house was constructed over a post-built roundhouse (House 5) and was later cut by an iron-smelting workshop (Workshop 2). Both House 3 and 5 are considered to represent Early Iron Age occupations of the site. The clearance cairn was one of a series of cairns, some of which were situated beneath a thick layer of hillwash that predated the Middle Iron Age settlement (Period 3). These cairns may represent Early Iron Age clearance of the land. As discussed in Chapter 2, the palisade enclosure has also been placed within the Early Iron Age occupation of the site.

All of these Early Iron Age features (Illus. 3.3) were protected from plough truncation or obliteration by the later occupation, by a thick layer of hillwash (the cairns), by their location in a natural dip (the houses) or by being elevated (the palisade). The density of the Early Iron Age occupations of Culduthel therefore could have been considerably higher.

Chronology

The two dates within this period come from charcoal from the ring-groove of House 3 (810–550 cal BC – SUERC-30367) and from within Cairn 4234 (800–490 cal BC – SUERC-30405). These are very broad dates as they fall onto a plateau within the calibration curve between 800 and 400 cal BC (Reimer et al 2013). As discussed within Chapter 2, these dates are likely to have been obtained from charred material from secondary or tertiary deposits.

The only material culture that could assist with the dating of these features was the saddle querns identified within House 3. While saddle querns have a long currency in prehistoric Scotland, their location within a ring-groove house (a fairly common structural form in this period in north-east Scotland) which contained no rotary querns, may corroborate the Early Iron Age radiocarbon date made for the structure. Stratigraphically, Cairn 4234, another similar cairn (Cairn 2671) and a cobbled surface were all located beneath hillwash that predated the Middle Iron Age occupation of the site (Period 3) and are here considered broadly contemporary features.

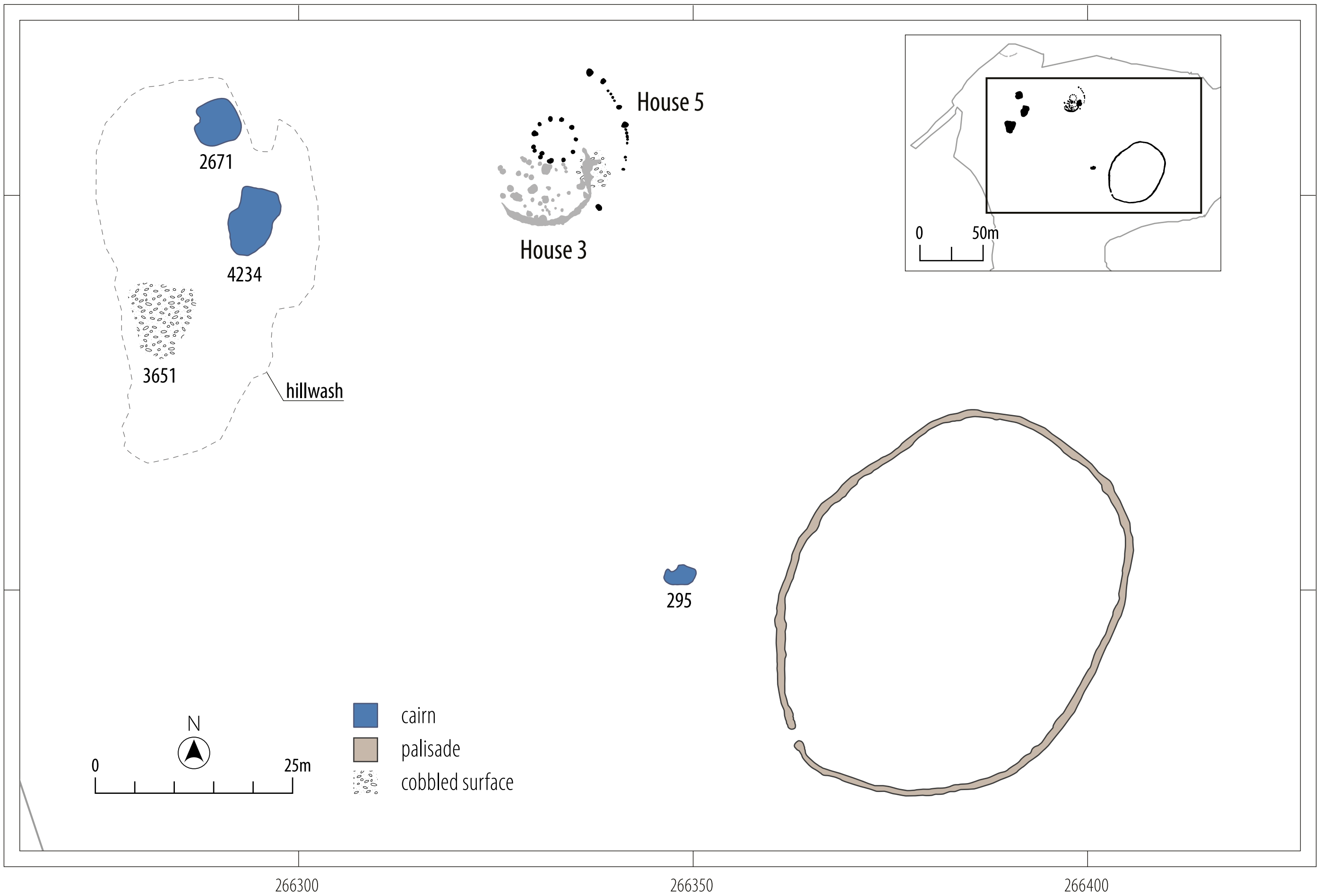

Illustration 3.3
Period 2 – Early Iron Age occupation

The houses

House 5

House 5 survived as a 5.3m diameter post-ring of 14 post-holes (Illus. 3.4). It was truncated by House 3 to the south and House 4 to the north. Three of the post-ring post-holes had been recut and two contained packing stones. The outer wall was represented by an arc of stake and small post-holes located 6m from the post-ring. Larger post-holes were identified at intervals along the line of the outer wall and a north-east facing entrance (*c*.1.8m wide). The outer wall formed a *c*.18m diameter circular structure.

House 3

House 3 was defined by an arc of heavily truncated ring-groove, which formed the south and east arc of a wall-slot with an east-facing entranceway (Illus. 3.5–3.7). The building would have been *c*.12m diameter. It was located within a dense concentration of roundhouses, partially overlying an earlier roundhouse (House 5) to the north and cut by a Middle Iron Age building (Workshop 2) to the east (Illus. 1.6).

Stage 1

The house was defined in plan by the southern arc of a stony ring-groove and a cobbled entranceway (Illus. 3.6). The ring-groove was a wall-slot [724], a steeply cut gully up to 1m in width and 0.25m in depth, widening and shallowing into a flat-based gully at the entrance into the house on the east. This transformation of the ring-groove from a narrow steep sloping slot into the shallow sloping flat-bottomed wide cut suggests that the wall-slot section closest to the entrance may have been the foundation cut for a low wall or timber forming a threshold step. Substantial packing stones along this stretch suggest that upright timber posts may also have been located here, forming a possible door frame. Running north of the entrance the shallow gully tapered, to end in a clear terminal. The ring-groove was not present along the north side of the house.

Packing stones located along the entire length of the interior of the ring-groove must have supported contiguous split-timber wall, wattle panels or upright planks rather than individual posts or stakes. A single AMS date from charcoal within the backfill of the ring-groove yielded a date of 810–550 cal BC (SUERC-30367). There was no evidence on the ground that the ring-groove formed a more complete circle, but a number of factors suggest

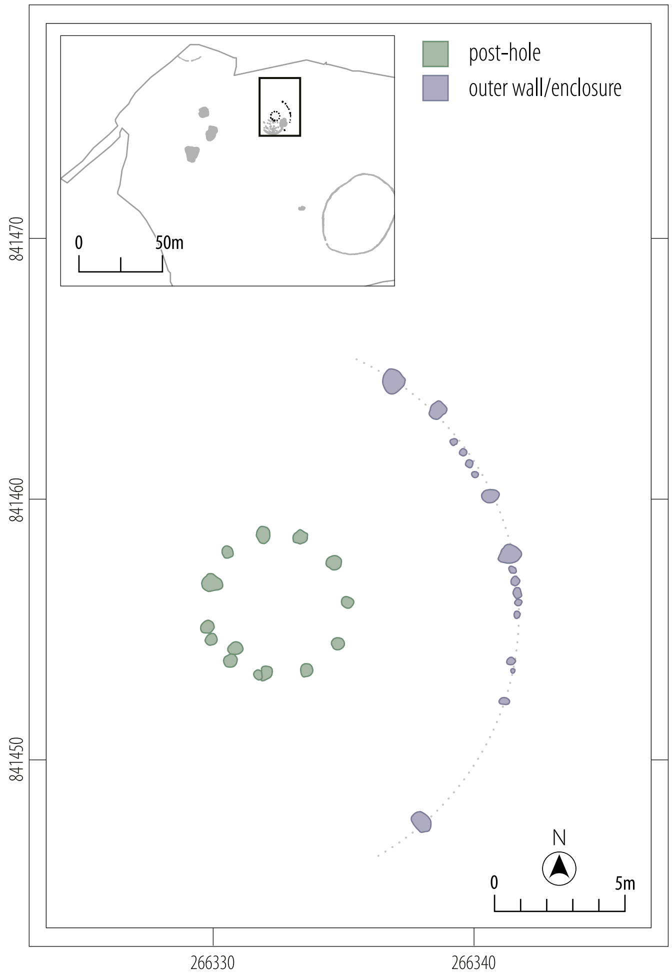

Illustration 3.4
Plan of House 5

this was the case. The surviving ring-groove was slightly revetted into a natural dip located along the southern and eastern sides of the house and the wall-slot was substantially cut into the slopes here. The missing northern half of the house would have been located on more level ground and may have been shallower cut and removed by the plough.

Pits and post-holes were located within the interior of the house, but no coherent internal post-ring or hearth was identified. It was not clear if any of these internal features were associated with the construction or occupation of the house, but a number of pits and post-holes were slightly cut into the inner edge of the ring-groove indicating that they may have been cut up against an existing wall. Linear or curvilinear patterns could be distinguished from this group (Illus. 3.5), perhaps representing elements of internal partitions or furniture.

Saddle querns and rubbing stones were incorporated into the ring-groove and the post-holes as packing or post-pads (SF0233, SF0234, SF0235 and SF0428). All the querns bar one (SF0428) were fragments, either broken during use or deliberately shattered prior to deposition. Other internal pits and post-holes also contained coarse stone tools – a whetstone (SF0244), a cobble tool (SF0223 – Illus. 6.15) and a grinding surface (SF0238).

Stage 2

Overlying the upper fill of the ring-groove was a deliberately placed stony spread (793 – Illus. 3.6). This rough cobbled surface was confined to the narrower part of the ring-groove and was absent from the entrance area, and may have been an intentional backfill of the ring-groove or the base of a stone/turf wall. Two fragments of a large rubbing stone (SF0204 and SF0205) and one complete one (SF0206) were recovered from the spread.

Another cobbled surface was constructed to level the well-worn entrance of the roundhouse. This surface was overlain by a spread of large sub-angular stones (796), which formed an uneven surface with two roughly circular arrangements of stones, possible settings for posts. A large, and almost complete, saddle/trough quern (SF0147 – visible in Illus. 3.6 and illustrated on Illus. 6.15), a hammerstone (SF0207), a fragment of a saddle quern (SF0222) and a grinder (SF0209) were recovered from the spread. The saddle/trough quern (SF0147) may have been deliberately set into the surface with the grinding face upwards. Two post-holes of Workshop 2 truncated this surface.

The stones across the entrance and the top of the ring-groove may represent deliberate infilling of the building to level and reuse the land.

Clearance cairns

Three cairns were identified on site (295, 2671 and 4234). These amorphous spreads of stones are likely to have been created during the clearance of ground for ploughing and planting. Each had been disturbed in antiquity, most likely by the occupants of the Middle Iron Age settlement (Period 3).

The best-preserved cairn (4234) (Illus. 3.8 and 3.9) was sealed beneath a layer of hillwash (3720) that predated the Middle Iron Age settlement (Period 3). A single AMS date of 800–490 cal BC (SUERC-30405) was obtained from charcoal recovered from within the cairn. The core of the cairn was a roughly circular arrangement of densely packed stones that measured 3.7m in diameter and 0.35m in height. Spreading out from this was an amorphous thin spread of stone; the disturbed or truncated base of the cairn. A sub-circular pit cut was through the centre of the cairn, interpreted as a robber trench cut in antiquity (Illus. 3.9). A fragmented cobbled surface was sealed beneath the cairn.

Cairn 2671 was also sealed beneath a layer of hillwash (3720) that predated the Middle Iron Age settlement (Period 3). It was less well preserved, and its remnants had been incorporated into a later cobbled yard (1945) associated with House 10/3 (Period 3). The cairn was sub-circular in plan and *c.*7m in diameter and a similar construction to Cairn 4234. A similar pit had been cut through the cairn material, presumably to remove and reuse the stone.

The third cairn (295) consisted of an amorphous spread, measuring *c.*7 × 5m, of small sub-angular stones in a loose sandy-silt matrix, which overlay a core of more substantial, deliberately placed stone. This was interpreted as the remnants of a small cairn that had been robbed or plough truncated. The cairn sealed a preserved ground surface (447), which contained a rich quantity

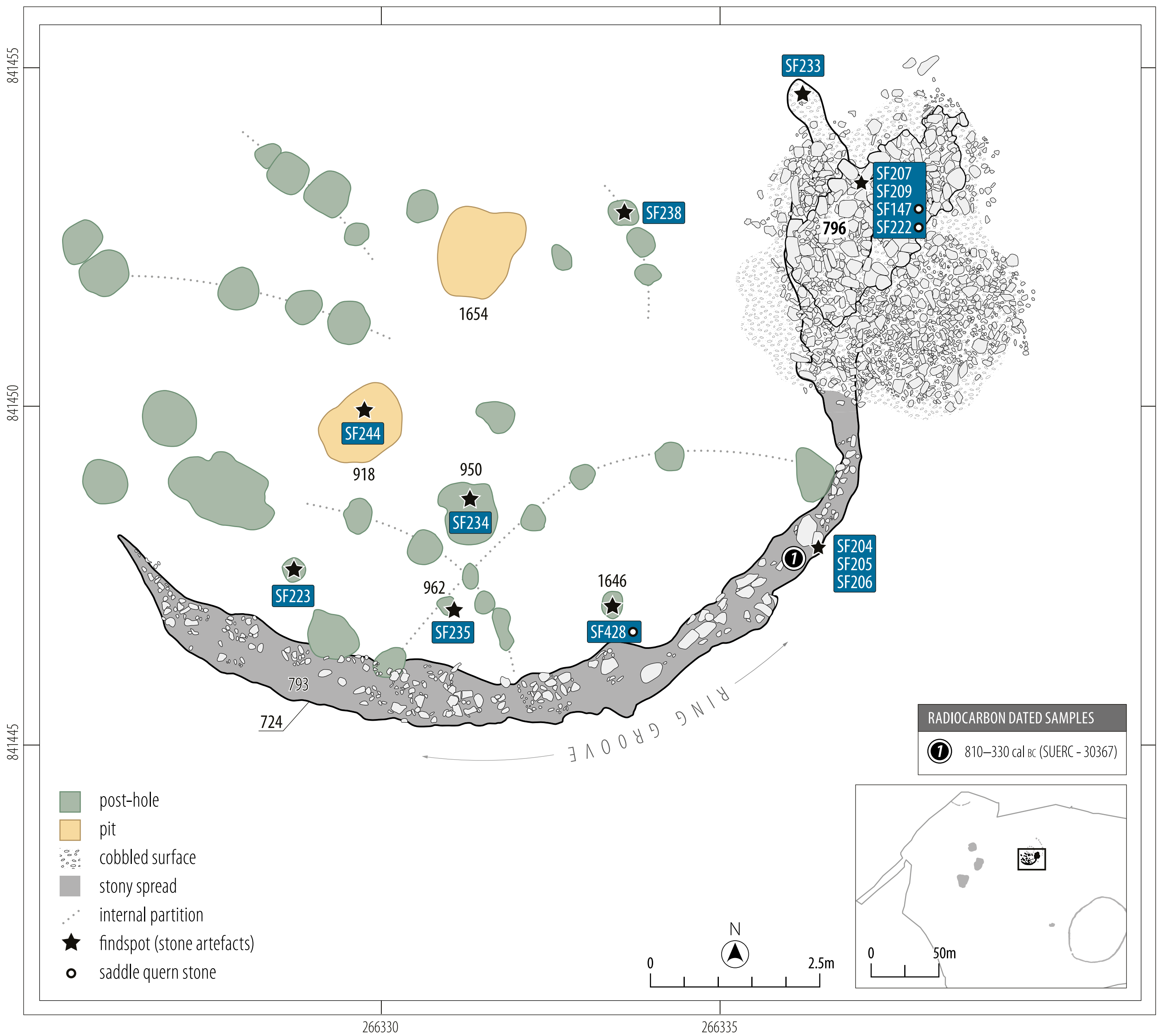

Illustration 3.5
Plan of House 3

Illustration 3.6
Pre-excavation photo of House 3 showing the location of SF0147

Illustration 3.7
House 3 after excavation

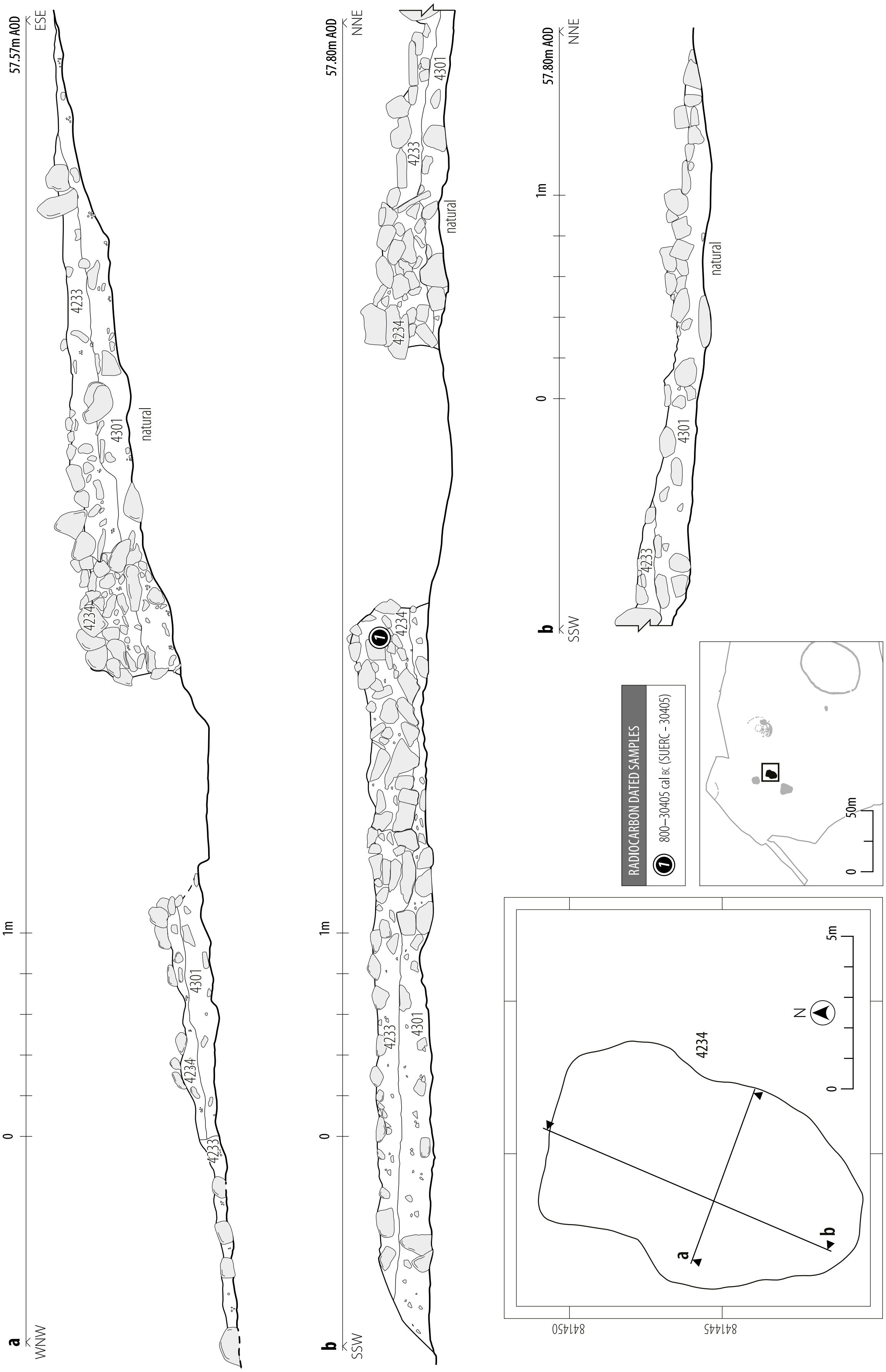

Illustration 3.8
Plan and section through Cairn 4234

Illustration 3.9
Cairn 4234 after the excavation of the central pit

of hazel nutshell, charcoal and burnt bone (detailed in the environmental section below). It is not clear if this activity related to the Early Iron Age occupations of the site or the earlier prehistoric activity identified.

Cobbled surface 3651

Situated to the south-west of Cairn 4234 was an amorphous area of rough cobbling also sealed by the hillwash. This cobbled surface or platform (*c*.9.5 × 8.4m) was formed from small rounded and sub-angular cobbles supported by loosely compacted dark-brown silty sand matrix that contained charcoal, burnt bone and 28 sherds of later prehistoric flat-rimmed domestic pottery, much from the same vessel (Vessel 4 – Illus. 6.2). One possible flint tool (SF0840) was also recovered. Slightly larger stones had been placed around the periphery of the surface to form a possible revetment.

The palisade

The large single-phase enclosure was located on a plateau of raised ground. It was an oval palisade ditch measuring 52m long (NE/SW) by 41m wide (NW/SE) with a 1.75m wide entrance on the south-west side (Illus. 3.10 and 3.11). The ditch was up to 0.8m wide and 0.7m deep with near vertical sides breaking sharply to a broad flat base. Where the ditch was situated on a slight down slope to the south-west it had been more affected by plough truncation and here the ditch was 0.3m wide and survived to a depth of 0.3m. Its sides here were shallow, and the base was narrow and concave.

Along the edges of the cut, large stones had been used as packing for posts (Illus. 3.12). The location of the posts was visible in section and, although it was not possible to discern individual post-settings in plan, it was clear that the timbers would have been closely set or potentially even contiguous. The fill of the ditch contained frequent large stones, presumably used as packing material for each post. At the entrance, the ditch widened to 1.15m and a post-hole was located at each terminal ([480] and [539]) (Illus. 3.10 inset), presumed to be settings for a gate. These cuts were lined with two tiers of flat, edge-set packing stones. The south terminal had one stone placed across the base to form a distinct footing or pad for the main entrance post. No artefacts were recovered within the slots excavated through the ditch or entrance post-holes.

As stated in Chapter 2 the single radiocarbon date obtained from a hulled barley grain sampled from within the main fill of the palisade ditch yielded a date of 2470–2240 cal BC (SUERC-30360). As hulled barley is identified as a crop from the Neolithic (Bishop et al 2009) the charred grain cannot be used as an indication of any period of activity and is thought to be residual.

Thirty features were located within the palisade, most clustered in the western half and all heavily plough truncated (these are shown on Illus. 1.6). Twenty-three were interpreted as post-holes, with the only clear structure being a ‘four-post’ structure. The four post-holes were arranged in a square, forming a structure with sides measuring *c*.2.8m, and all were *c*.0.4m in diameter and 0.2m deep. The remaining features were pits, none of which contained artefacts. Some had higher concentrations of charcoal and were interpreted as possible simple hearths or cooking pits. It is unknown if any of these features were contemporary with the palisade.

While the date and the use of the palisade at Culduthel is unknown the lack of material culture (especially any metalworking debris) recovered from the enclosure or its interior, does suggest that its construction and use predated the Middle Iron Age craftworking settlement in Period 3.

Hillwash

A large area of hillwash (3720) had formed within a natural dip in the topography of the site (Illus. 3.3). It sealed many of the Early Iron Age features described above and provided a clear horizon between the earlier occupation of the site and the Middle Iron Age settlement in a discrete area of the site. In addition to the cairns and the cobbled surface, several alignments of stake-holes were identified below the hillwash that formed possible curvilinear and linear fence lines. A group of thin ephemeral linear features interpreted as ardmarks were also located here. These were mainly oriented south-west to north-east and measured a maximum of 3m in length, with shorter ardmarks crossing at right angles. The date of the stake-holes and ardmarks is unknown.

Environmental summary for Period 2

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A sample (196) was taken from an old ground surface (447) located beneath Cairn (295). The layer was found to contain an abundance of hazel nutshell (135 fragments) together with charcoal and burnt bone fragments (Timpany 2007). No dating evidence was retrieved from this layer and it may significantly pre-date the clearance cairn. The spread provides some potential evidence for foraging activity, which together with the charcoal and burnt bone, may represent the discard of domestic waste.

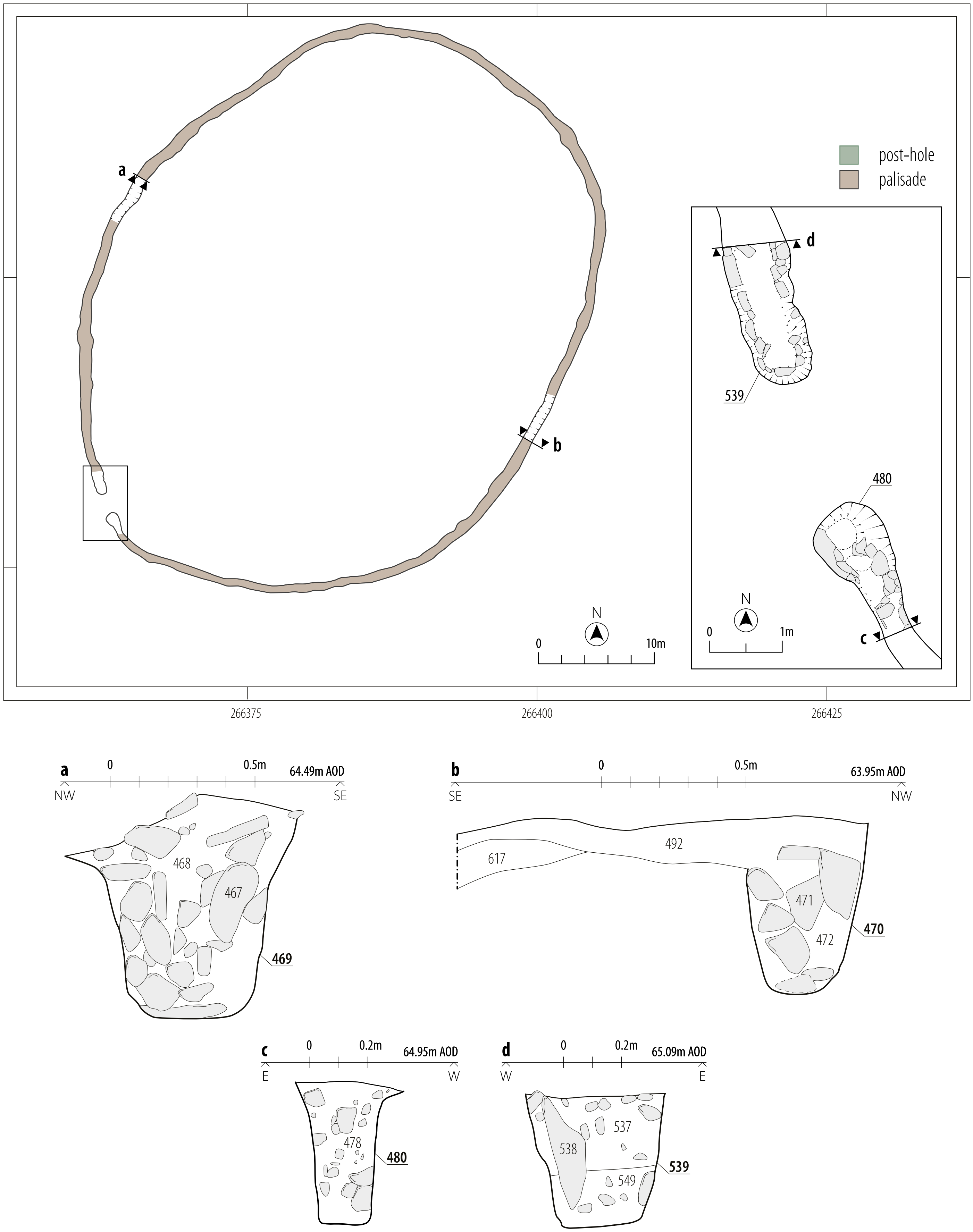


Illustration 3.10
Plan of the palisade

Illustration 3.11
The palisade (facing north-west)

Illustration 3.12
South-east terminal of the palisade

The Early Iron Age settlement

Evidence for Early Iron Age occupation at Culduthel comprises two overlapping roundhouses, a substantial palisade, three clearance cairns and a cobbled surface. Aside from the successive roundhouses, it is unclear if any of these features were in contemporary use. From the plan of these features it is tempting to characterise this occupation as the southern edge of an unenclosed settlement where houses gave way to fields with a fenced enclosure perched on the small hill beyond.

The most distinct feature placed within this phase, the palisade, is also the most difficult to date. Palisading is a simple technique to physically define a parcel of land or rejuvenate denuded earthworks and is often employed to create a defined area for internal domestic occupation. Palisade enclosures have a long currency in Scotland, from the Neolithic to the later medieval period. Their functions vary immensely, from the initial phase of a developing enclosure scheme, such as the Early Iron Age oval palisade identified at Broxmouth Hillfort in East Lothian (Armit and McKenzie 2013, 27-28), to an enclosure for a homestead such as at Ravelrig Quarry (Rennie 2013) or large settlement such as at Dryburn Bridge (Dunwell 2007). Palisade enclosures of a much smaller scale have been identified as cropmarks throughout lowland Scotland. These are likely to have been ancillary structures used for stock control or, at the smallest scale, ring-grooves of large roundhouse.

While these structures form part of the archaeological record for multiple periods, palisaded enclosures associated with settlements in south and south-east Scotland have been demonstrated to be an Early Iron Age tradition (Harding 2006 67–8; Armit and McKenzie 2013, 40). In contrast, the north-east of Scotland, which contains some of the most striking and seemingly well-preserved palisade enclosures in the archaeological record, has little in the way of a chronology for these structures. Their distribution in Inverness-shire and along the Moray coast correlates well to the low-lying land suitable for cropmark identification across this area (Illus. 7.1). These palisades are varied in size and form and appear to enclose both single roundhouses and small settlements. Most are circular or oval and fairly modest in size, ranging from 20m to 60m in internal diameter. This group includes both palisades located within the inner lip of ditched enclosures such as those seen at the two sites at Creich Mains in Sutherland (NH68NW 17) and the stand-alone post-built fences like the one at Culduthel. Features within their interiors are rarely revealed by aerial photography but in some cases, such as Aldourie Farm near Inverness (Harden and Bone 1990, 23), a 22m diameter palisade encloses a concentrically constructed central post-ring roundhouse. Other similar sized palisaded enclosure cropmark sites in Inverness-shire, such as Blackhill (NH74NW 122) and Ballindoun (RCAHMS 1979, 21), also contain single roundhouses while the considerably larger oval double palisaded enclosure at Balblair in Nairnshire (NH85NE 46) may have contained a small settlement.

As this site type has not been the focus of research, their true forms and chronology are not well understood (Feachem 1966; Ralston and Halliday 2009). Their considerable cropmark record and limited excavation evidence does however hint that palisade enclosures were common across the region and many may be Iron Age in date.

Excavation of the palisade at Balloan Park in Inverness identified a narrow stone-filled gully, a similar construction to Culduthel. The interior of the enclosure was not exposed, and it remains undated. Its size (*c*.30m diameter) and the radiocarbon dated peripheral settlement activity suggests that it may have been an enclosed homestead of Early/Middle Iron Age date (see Chapter 1; Carter and Russell-White 1993; Wordsworth 1999).

The palisade at Culduthel would certainly have been a major building project for a community and must have been a conspicuous display of the community's wealth, identity and place. The similar oval palisade at Broxmouth Hillfort was calculated to have at least 500 timber posts around its 200m circumference, each at least 2m in height (Armit and McKenzie 2013, 27–8).

Due to the heavy truncation within the interior, its function remains unclear. If it was not settled its uses are likely to have been multiple and seasonally adapted, at times serving an important central place for the community to gather in private, and at others as secure storage for livestock and food. Its prominent elevated location on a low hill suggests that it would have been an imposing monument, a dominating feature within any contemporary settlement and identifiable across the wider landscape. Whatever its original function the enclosure perhaps only lasted a generation or two as it was not repaired or rebuilt and was left to rot in situ.

The evidence for domestic occupation in this period is the two dwellings of strikingly different design. Only the internal post-ring of the earliest roundhouse (House 5) survived intact with a curved line of posts and small post-/stake-holes defining the outer wall. The outer wall may have been constructed from turf, with the line of stakes and larger posts forming a timber revetting, encasing the outer edge of the wall. Turf-and-earth-walled roundhouses (also known as ring-bank roundhouses) are seen from the early part of the 2nd millennium cal BC (Pope 2015). These structures are mainly recognised in upland and coastal sites in northern England and north and west Scotland, a distribution that must reflect the survival of these fragile buildings in areas of less intense modern agricultural rather than a lack of decent timber (contra Reid 1989, 17; Reid 1993; O'Sullivan 1998, 109; Pope 2015). Excavation of Bronze Age turf houses in Scotland have recognised wattle and post revetting on both the inner and outer faces of the outer walls (e.g. Green Knowe in the Borders (Feachem 1963, 83); Lairg in Sutherland (O'Sullivan 1998); and on Arran (Barber 1997)) and in the Early Iron Age at Douglasmuir in Angus (Kendrick 1995, 62).

Iron Age turf buildings are less frequently seen in the archaeological record. Where they have been excavated in Scotland, they are often very large buildings e.g. Culhawk Hill in Angus with a *c*.20m in internal diameter (Rees 1998) and the Phase 4 roundhouse at Bellfield, North Kessock with a *c*.19m in internal diameter (Jones 2009, 15). House 5 is a large building, (*c*.18m in diameter) in the current corpus of structures identified for Early Iron Age Scotland. Substantial roundhouses of this size are seen widely throughout the British Isles from the Early Iron Age (*c*.800–400 cal BC) and are commonly regarded as the timber element of the wider phenomenon of domestic monumentality that developed from the early part of the 1st millennium BC (Halliday 1985, 246; Hingley 1992, 39). There are examples of Early Iron Age post-ring roundhouses of comparable size, such as House 1 at Bannockburn (Rideout 1996) and the double post-ring roundhouse at Ironshill East in Angus (McGill 2003), but substantial roundhouses on the whole appear to be more commonly ring-groove constructions in this period (e.g. Houses A and B, Phase 1 at Broxmouth (Armit and McKenzie 2013, 37) and at Dryburn Bridge (Dunwell 2007)).

The construction of such a large house in the Early Iron Age at Culduthel potentially shows an affluent extended family group lived here, with a wide range of resources at hand, from skilled labour to prime managed woodland.

Overlying the southern side of House 5 was a ring-groove roundhouse (House 3). The outer wall of the house may have been constructed from planks or closely set posts. The ring-groove clearly terminated to the north of the entrance and there was no sign of a northern wall of the building. This missing section of outer wall may well have been a shallower cut in level ground but equally could have been an above ground structure, with the wall set into a sleeper beam or sections of moveable wattle panels. This latter configuration was mooted for the Bronze Age ring-groove roundhouses at West Acres, Newton Mearns (Toolis et al 2005, 489), where the excavators postulated that moveable wattle screens may have formed the wall along missing segments of the ring-groove.

Internally, an array of undated post-holes may have been phases of curved partition walls or fences to separate the space into different functional areas such as sleeping and cooking or stalls for livestock. Partitioning is a commonly seen feature in later prehistoric roundhouses. Linear radial partitions and elongated bays survive particularly well in stone-built structures (e.g. at Bu and Toft's Ness in Orkney (Hedges 1987, 140) but are also seen in timber houses (e.g. Douglasmuir in Angus (Kendrick 1995, 63)). Similar curvilinear divisions were identified at West Acres in Newton Mearns (Toolis et al 2005, 489). A *c*.2m wide 'corridor' is noticeably clear of post-holes running from the entrance to the centre of the building.

The in situ finds related to the construction of House 3 were fragments of saddle querns and their associated rubbing stones deliberately placed in post-holes and within the ring-groove as packing stones or post-pads. This practice of intentionally depositing querns within roundhouses, especially within post-holes and at thresholds, is a widespread later prehistoric practice (Hingley 1992, 32; McLaren and Hunter 2008; Waddington 2014) and the incorporation of querns into the foundations of Iron Age houses is commonly seen in Scotland (i.e. Dryburn Bridge, East Lothian (Cool 2007, 76), Broxmouth hill fort, East Lothian (Büster & Armit 2013, 143–7) and at Kintore, Aberdeenshire (Engl 2008, 223–6)). Querns would have been both potent symbols of agricultural life and esteemed tools within the household, and must have held pervasive symbolic meaning to the community long after their original function had passed (Hingley 1992, 32; Williams 2003, 237; Heslop 2008, 73–80). That these items were often deliberately broken and carefully placed suggests that they were part of a defined ritual practice (cf. Goldberg 2015, 216–17), potentially to connect the present community with their predecessors.

Once the timber superstructure of the house was gone, the ring-groove was backfilled and the entrance was levelled with cobbles and larger stones. Querns and rubbing stones were incorporated into the cobbling and rough paving laid at the entrance. The placement of querns and other utilitarian household items at the end of the life of houses is commonly seen in the Iron Age (Waddington 2014), and their deposition during the decommissioning of the house suggests continuity of the tradition seen during construction.

Ring-groove roundhouses can be identified from the Neolithic in Britain (e.g. at Kintore (Cook and Dunbar 2008, 81–3)), and were common in the Early Bronze Age in Scotland, developing from polygonal to circular buildings by the 1st millennium BC (Pope 2015, 180). By the Early Iron Age in southern Scotland, they were becoming grander in scale (i.e. at the hillfort of Broxmouth (Armit and McKenzie 2013, 37) and at Dryburn Bridge (Dunwell 2007, 46–7) in East Lothian).

Due to the poor survival of House 3 and 5, their structural biographies are difficult to determined. It is unclear whether House 3 was a direct replacement of House 5, or an unrelated later event. The replacement of buildings and the reuse of house stances are both commonly seen through the Iron Age, perhaps demonstrating that the long-term tenure of the land by individuals or family groups was important. The deliberate closing of House 3, with the backfilling of the ring-groove and the levelling of the entrance, may be a deliberate act to bury the house at the end of its life or to level the land to reuse the plot.

Chapter 4

PERIOD 3 – THE IRON AGE CRAFTWORKING CENTRE

Introduction

After a hiatus in occupation of at least 100 years, a major period of settlement begins on site at some point after the mid-4th century BC. This settlement is dominated by 10 similar 'workshop' roundhouses, which are constructed across the terrace. Many of these buildings contained upstanding iron-smelting furnaces constructed in stone, most with their final firings in situ (Illus. 4.1). The quantity and uniform design of the workshops and furnaces suggests that the site was a craft-focused settlement, primarily engaged in the manufacture of iron objects.

A wealth of information has been revealed about the iron manufacturing practices taking place on site from the excavation of the smelting furnaces alone. This data has been further enhanced by the analysis of the ferrous metalworking waste (including over a third of a tonne of slag and other working vitrified debris), and one of the largest assemblages of iron objects ever identified from an Iron Age site in Scotland. More than 150 objects were recovered, including a range of tools and weaponry, both produced on site and imported. Brought together, this data set shows that all stages of ironworking were undertaken at Culduthel, from the reduction of iron ore to fine smithing.

Concurrent with the manufacture of iron was evidence of a thriving and sustained glass and copper alloy industry producing a wide range of goods – glass beads, enamels and decorative metalwork – on stone-lined hearths and within a turf-walled workshop. While the output of these highly specialised crafts appears to be at a much smaller scale than the iron, the assemblage of objects and waste indicates that Culduthel was a substantial producer of glass and bronze objects in the region.

In contrast with the wealth of craftworking evidence, indications of domestic occupation in this period is limited. Four post-ring roundhouses located on the north-west side of the site (Houses 7, 9, 10 and 17) may have been dwellings but could equally have functioned as 'clean' workshops for the final finishing of ferrous, non-ferrous and glass objects or for the production of organic crafts. More compelling evidence comes from a range of well-worn rotary querns reused in the fabric of the furnaces and hearths and in the construction of buildings as packing material for posts, an assemblage that suggests that the craftworking community wished to maintain a tangible link with a contemporary or abandoned domestic settlement close by.

Preservation

The extraordinary preservation of pockets of archaeology on the site resulted in some of the best surviving lowland archaeological features encountered in Scotland, and it is a salutary lesson in what can survive in ploughed landscapes given the right conditions. The highly unusual circumstances that allowed for the blanket protection of archaeological features in some areas of the site had three main contributing factors: the topographic situation of discreet areas of the site; the development of hillwash; and the sealing of parts of the site with waste debris from the industrial activity. The area to the east and south-east of House 10 was particularly well preserved. Here the house and three workshops were constructed within a slight hollow at the base of a slope, built directly over the hillwash that sealed the cairns and cobbles seen in Period 2. Paved and cobbled surfaces, post-holes, stone-built hearths and the stone bases of turf walls had all survived the plough in this area, sealed in turn by a series of hillwashes and capped by thick layers of waste debris.

During the excavation, this area was considered to be the manufacturing hub of the site and was labelled 'the industrial area'. This interpretation was given due to the intact nature of the surviving archaeology (especially the smelting furnaces) and the quantity of waste material and artefacts recovered here associated with ferrous and non-ferrous working. While this area can be recognised as the best preserved on site, it was not necessarily the core of production. Evidence from plough truncated areas of the site, such as the fragment of cobbled yard identified on the eastern edge of the site (detailed in Chapter 5), shows that iron production was certainly taking place in other parts of the site and considerable activity may have been lost by the plough.

Chronology

Twenty-nine radiocarbon dates have been placed in Period 3. These all fall between 360 BC and AD 340 (Table 2.1) and form a seemingly single continuous distribution spanning a potential 700-year period. While seven centuries are certainly not the duration of the Iron Age industry identified on site, without Bayesian analysis, a start and end date for this activity is currently not possible.

As 21 of these radiocarbon dates were obtained from charred material from secondary or tertiary deposits (these samples mainly coming from the backfills of post-holes and pits), they cannot be

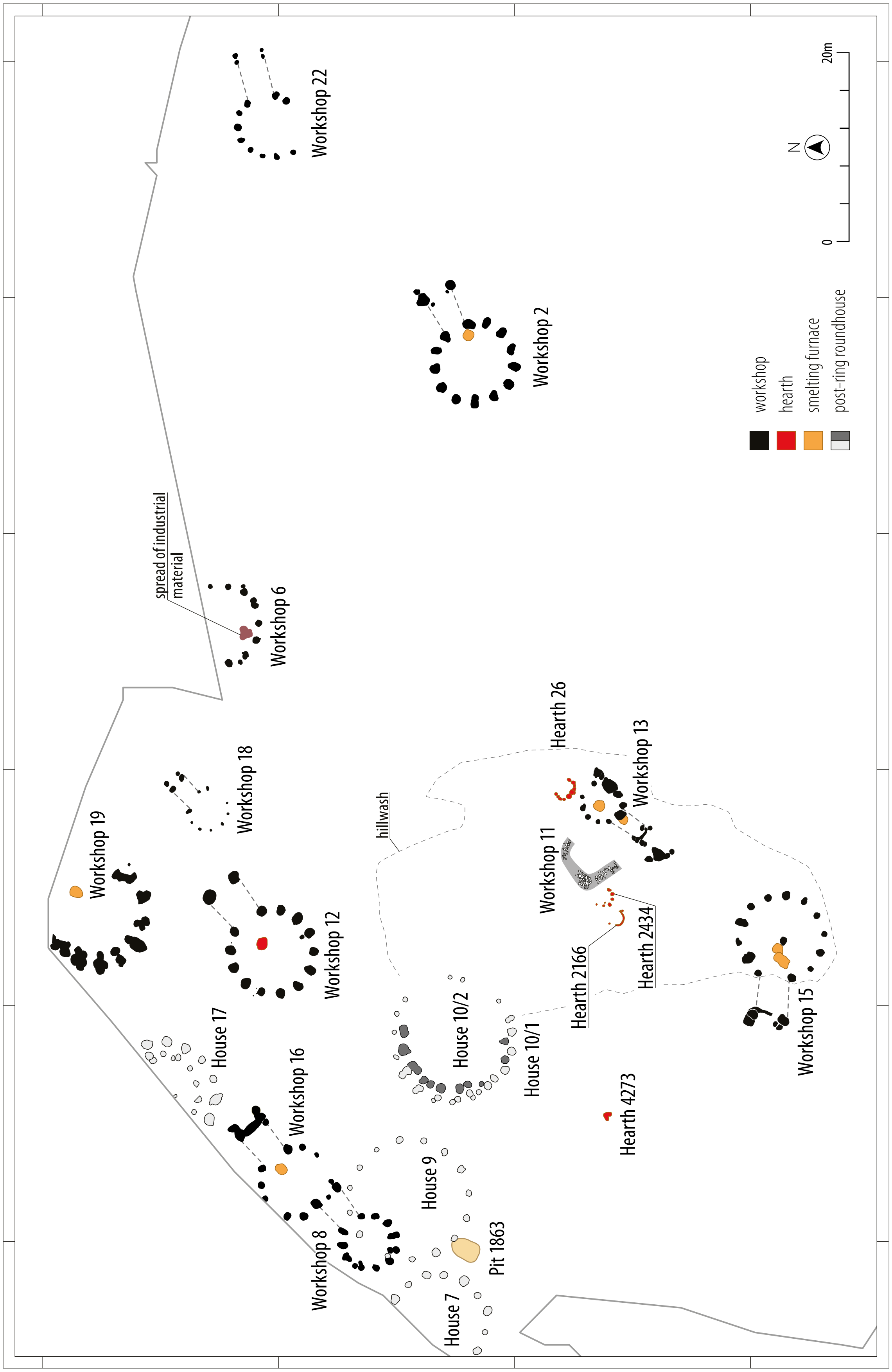


Illustration 4.1
Period 3a – The Iron Age craftworking centre

used with confidence to date these features. This group includes the dates obtained from the backfill of one of the glass/copper alloy hearths [2166] and associated workshop (Workshop 11).

Single radiocarbon dates (SUERC-30377, SUERC-30390 and SUERC-30406) were obtained from the basal charcoal deposits interpreted as the final firings of three iron-smelting furnaces (Furnaces 2246, 3050 and 4262). These radiocarbon dates from primary deposits indicate that the final use of these furnaces was between 200 BC and AD 120. Material retrieved from the ashy or charcoal rich fills immediately overlying the basal fills of four further iron-smelting furnaces (Furnaces 4147, 4355, 3790 and 681) are also considered to be by-products of their final firings. The radiocarbon dates made for these (SUERC-30400, SUERC-30401, SUERC-30391 and SUERC-30365) were also between the 2nd century BC and the early 2nd century AD. Radiocarbon dates obtained from charred material within the backfill of post-holes of three iron-smelting workshops (Workshops 13, 15 and 16) also appear to substantiate this date range for the iron-smelting activity on site (SUERC-30389, SUERC-30395 and SUERC-30378). As the origins of this material are less certain, these radiocarbon dates have not been used to date these buildings.

Illustration 4.2
House 7 and Workshop 8 (looking west)

A radiocarbon date retrieved from a compacted layer of charcoal-rich black sandy silt (SUERC-30386) overlying the flagstone base of the glass and copper alloy hearth [2434] has also been interpreted as a date for its final firing. This radiocarbon date indicates that this event took place between 170 cal BC and cal AD 20. This date is tentatively supported by the evidence that the bulk of the copper alloys from site were a pre-Roman Iron Age leaded bronze recipe and that a 2nd–1st century BC copper alloy sword hilt, presumably brought onto site for recycling, was found in the adjacent cobbled yard.

As a distinctive later phase of development can be identified during the lifetime of the settlement with the construction of two large ring-groove roundhouses, Period 3 has been separated into the primary phases of settlement (Period 3a – this chapter) and these later additions (Period 3b – Chapter 5). Although the Period 3b structures were obviously built into a well-established site, the lack of a chronological framework for the development or longevity of the other buildings in this period means that any or all of the structures placed into Period 3a could equally have been constructed or still been in use in Period 3b.

Period 3a

Post-ring roundhouses

Four post-ring roundhouses were located on the north-west side of the site (Houses 7, 9, 10 and 17). As the material culture recovered from each house was clearly residual it is not clear if these buildings were primarily dwellings or workshops. The proximity of Houses 7 and 9 and the truncation of House 9 by a later workshop (Workshop 8) indicates that multiple phases of construction had occurred in this part of the site (Illus. 4.2).

House 7

Only the southern half of the post-ring of House 7 was revealed within the excavation area. Nine post-holes (which varied from 0.30 to 1.1m in diameter and 0.25 to 0.60m in depth) would have formed a *c.*9.7m diameter structure (Illus. 4.3). No entrance was apparent within the excavation area. Most of the post-holes contained small quantities of iron slag identified as smithing waste. Post-hole [1834] contained a fragment of an iron strap with a nail in situ (SF0330) and a small, translucent mid-blue annular bead (SF1260) was found in post-hole 1778 (Illus. 6.61). A single AMS date from charcoal from a post-pipe of post-hole 1830 yielded a date of 360–50 cal BC (SUERC-30369).

Several shallow post-holes were present in the interior and four formed a clear linear pattern, potentially an internal wattle wall projecting from the southern side of the house. A short dagger (SF0363), which had been damaged on one side and had been resharpened, was recovered from one of these post-holes [1898] (Illus. 6.46). Extensive brown corrosion identified on one side of the blade is probably from leather, suggesting that the dagger was sheathed when it was deposited. It is not clear when the dagger was placed in the post-hole and it could theoretically have been deposited at any time between the construction of the hole to after the post went out of use.

House 9

House 9 was a single post ring of 15 post-holes placed at between 1.40 and 1.80m intervals, creating an internal diameter of *c.*11.80m

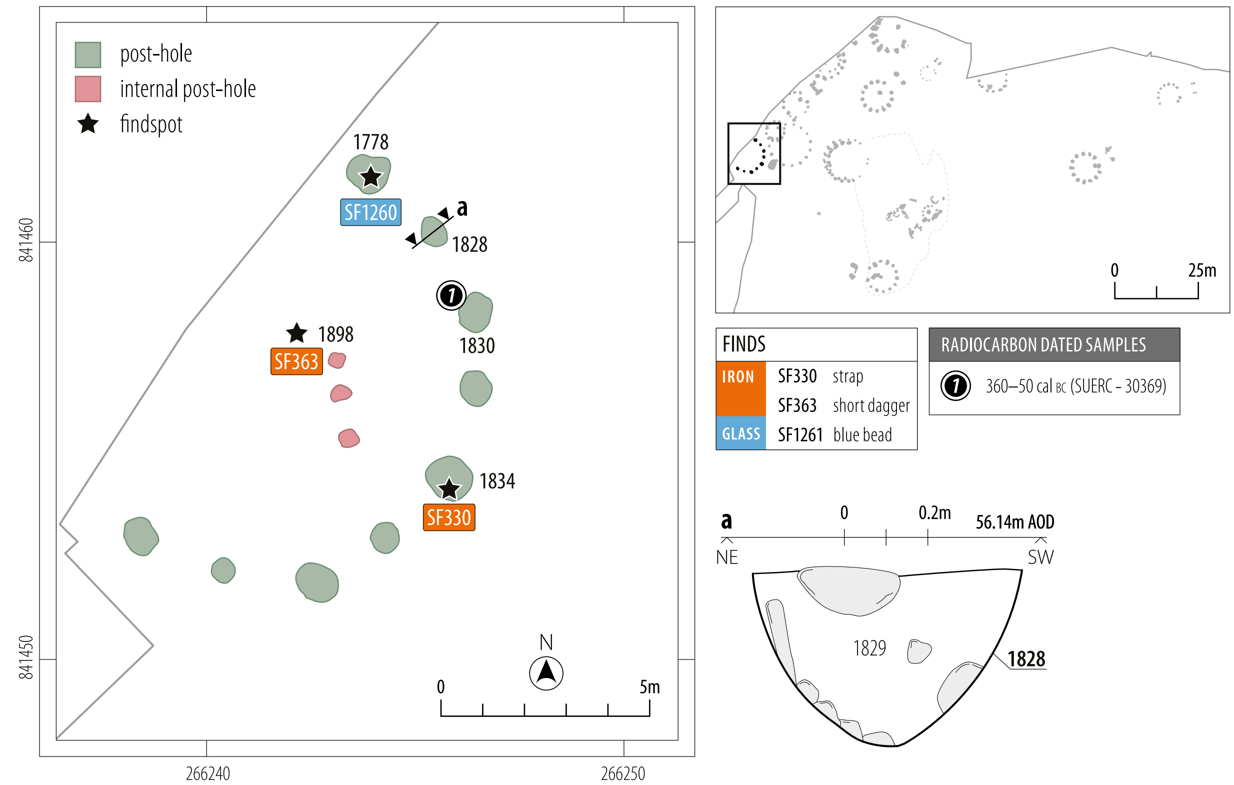


Illustration 4.3
Plan of House 7

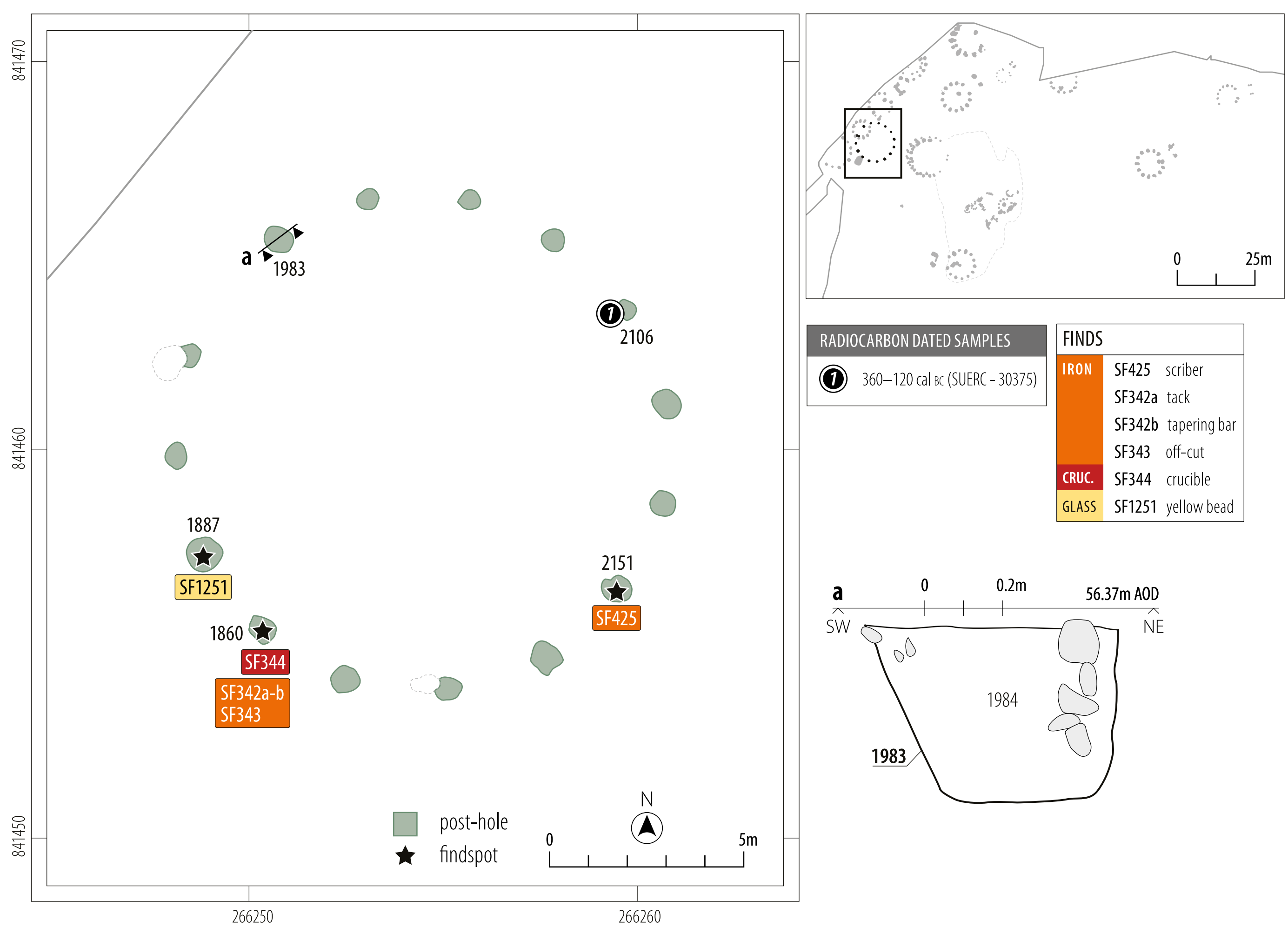


Illustration 4.4
Plan of House 9

(Illus. 4.4). The posts varied from *c*.0.40m to 0.80m in diameter and from 0.20 to 0.50m in depth. There was no obvious entrance into the house.

The majority of the backfill of the post-holes contained small amounts of iron slag and several contained artefacts. A small, fine iron tool, perhaps a point or scriber used for leatherwork or fine metalwork (SF0425), was recovered from post-hole [2151]; an iron offcut that had been thinned at both ends (SF0343), a small square-headed tack (SF0342a), the broken end of a tapering bar with rounded tip (SF0342b) and a possible crucible sherd (SF0344) were all recovered from post-hole [1860]; and a small yellow glass bead (SF1251) was recovered from post-hole [1887]. A single AMS date from charcoal from a post-pipe of post-hole [2106] yielded a date of 360–120 cal BC (SUERC-30375).

A large oval pit [1863] measuring 2.8 by 2.4m was situated on the south-east edge of the roundhouse, cutting the post-ring. The pit was clay-lined with a large amount of charcoal, lumps of burnt clay and a lesser amount of burnt bone. A hammer/rubbing stone (SF0323) was recovered.

House 10

Located on a flat terrace at the base of a slope was a house plot with a long and complex history (Illus. 4.5 and 4.6). The initial post-built roundhouse (House 10/1) was replaced on almost the same footprint by a new post-built house (House 10/2). Both of these houses are detailed here. House 10/2 was subsequently replaced by a very large ring-groove building (House 10/3) (Chapter 5).

Few artefacts were recovered from either house, and there was a notable absence of iron slag, which was recovered in high quantities across the rest of the site in this period. This absence of material culture may be due to ground clearance across their footprints for the construction of House 10/3 but it is possible that these buildings were separated from the dirty hot processes

Illustration 4.5
House 10 under excavation

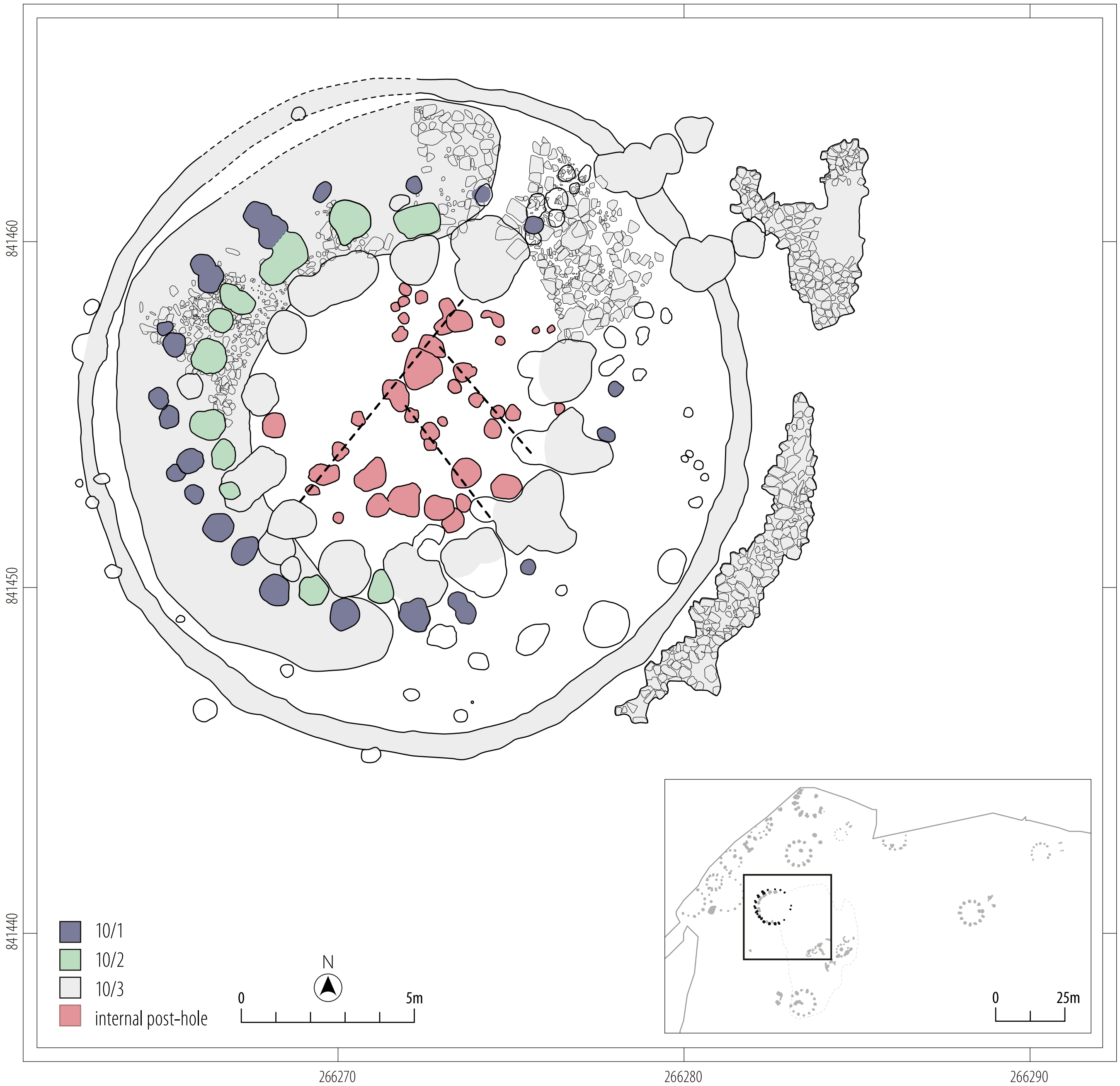


Illustration 4.6
House 10 all phases

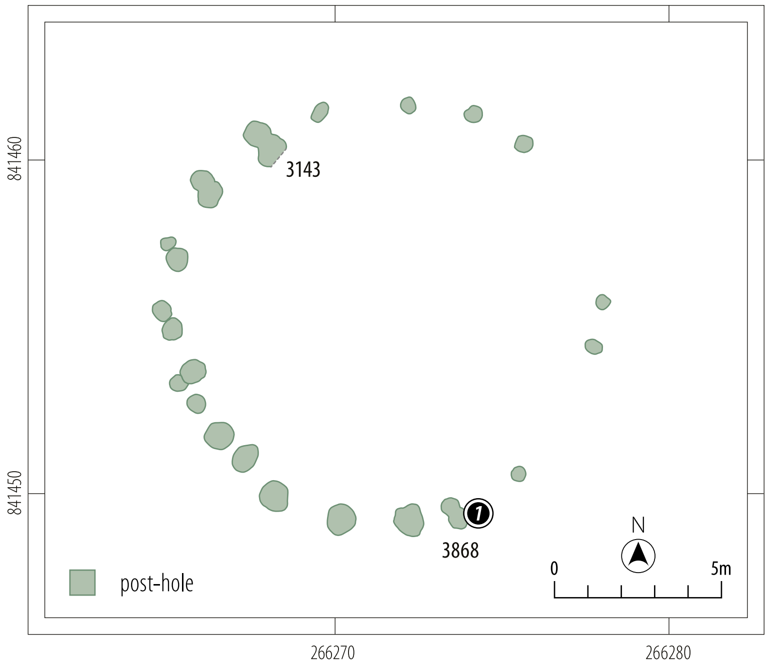
that surrounded them and regularly cleaned (as observed in many domestic dwellings of this period, cf. Armit and McKenzie 2013, 184).

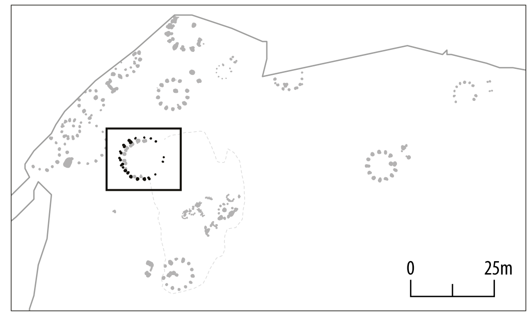
House 10/1

The earliest roundhouse survived as a 20 post-ring structure of *c*.12.50m internal diameter (Illus. 4.7). The south-east of the house had been truncated by later constructions and no entrance was identified. Aside from obvious truncated elements of the post-ring, many of the post-holes were placed at intervals of less than 1m and many were very closely set.

The post-holes were circular or slightly sub-circular in plan with diameters varying between 0.3m and 0.9m and depths between 0.08m and 0.6m; the larger diameter and deeper post-holes were in the south and west. Six post-holes in the south-west had been recut, indicating that posts had been replaced over time.

Artefactual evidence recovered from the post-hole fills consisted of small quantities of iron slag, burnt clay and flint flakes. A single AMS date of 2910–2680 cal BC (SUREC-30399) was obtained from charcoal within post-hole [3868].

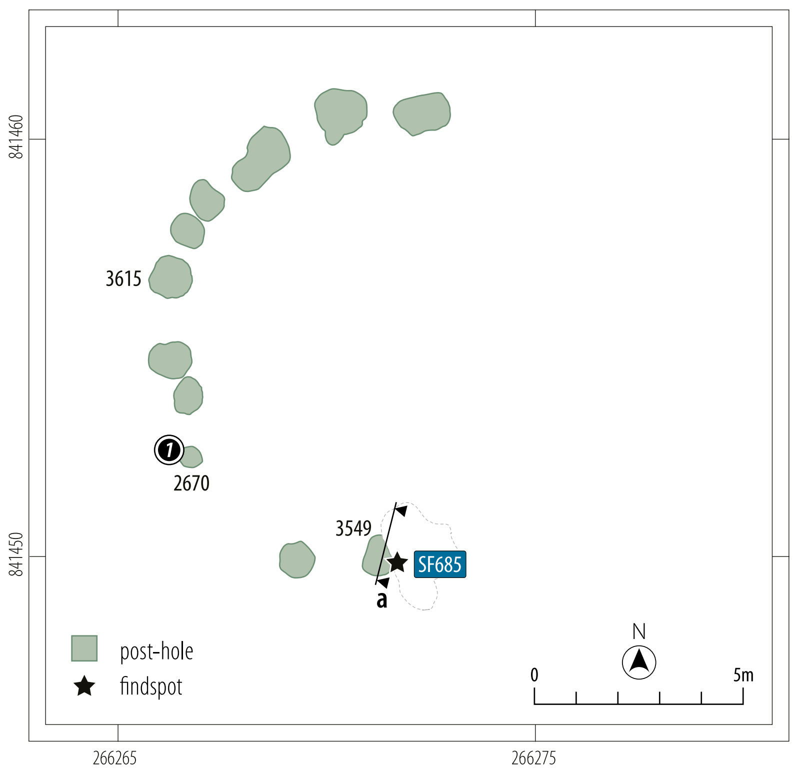


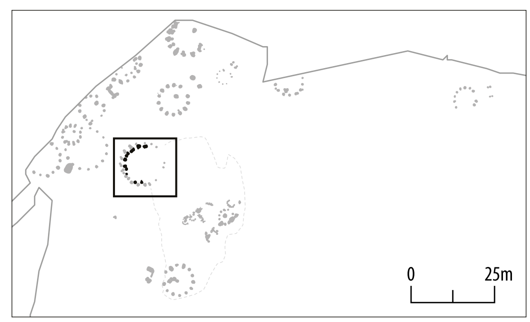


RADIOCARBON DATED SAMPLES

1 2910 – 2680 cal BC (SUERC - 30399)

Illustration 4.7
House 10/1





RADIOCARBON DATED SAMPLES

1 160 cal BC – cal AD 60 (SUERC - 30387)

FINDS

STONE SF685 rotary quern

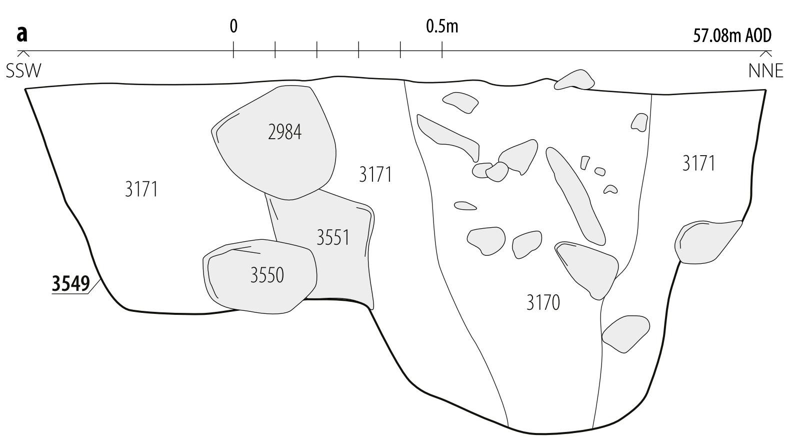


Illustration 4.8
House 10/2

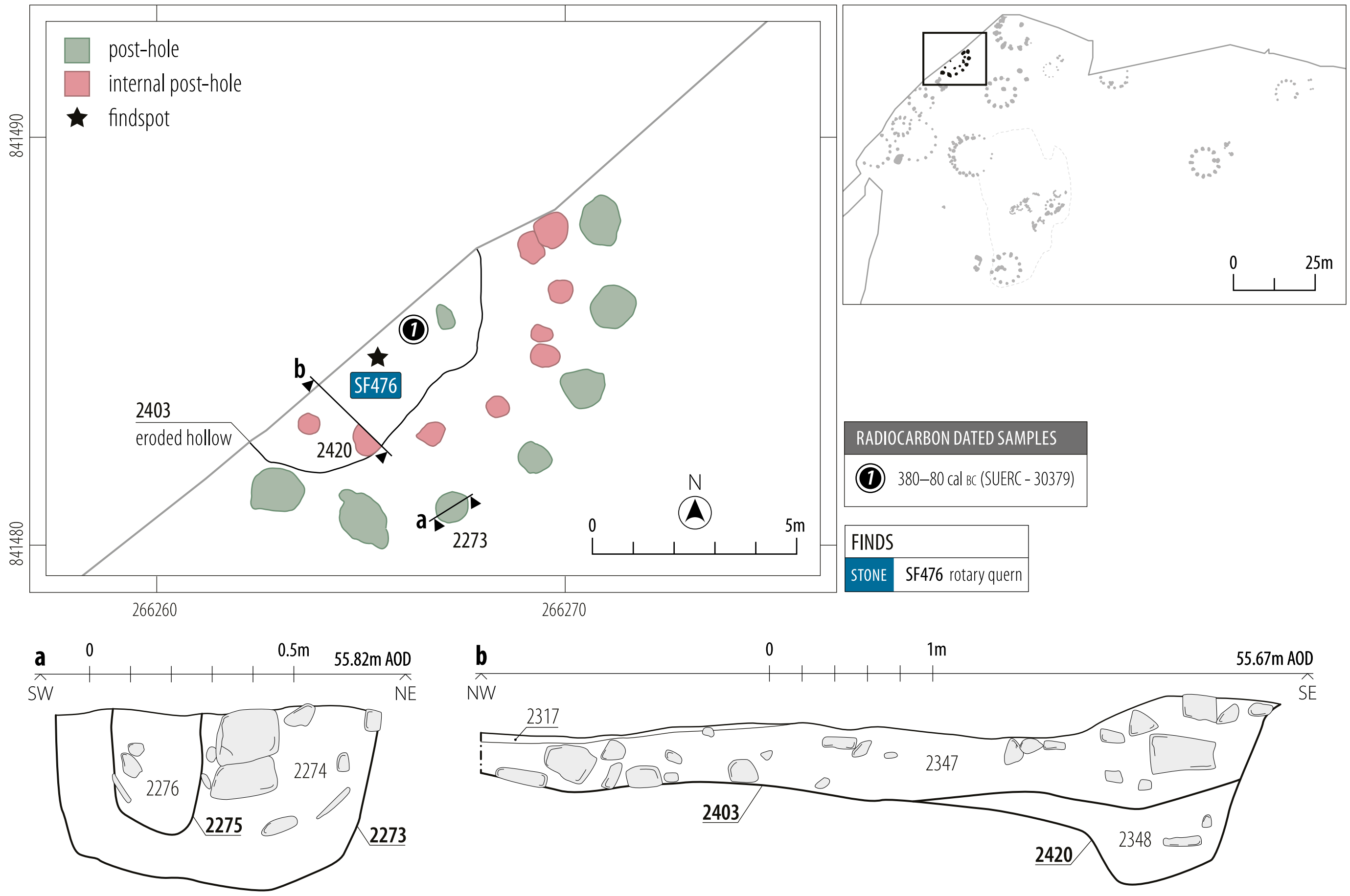


Illustration 4.9
Plan of House 17

House 10/2

In a second phase, House 10/1 was replaced by a slightly smaller post-ring roundhouse, House 10/2 (Illus. 4.8). A concentric post-ring was constructed along the inner edge of the original post-ring, creating a building with an internal diameter of *c*.10.5m. Only 11 post-holes survive, with the east side and entrance of the house truncated away. The post-holes diameters ranged from 0.35m to 1.2m and depths between 0.2 and 0.5m, and some had been recut.

Artefactual evidence from the post-holes, like the primary phase of the house, was almost exclusively confined to small pieces of iron slag and daub, as well as small quantities of magnetic residue. However, in one post-hole [3549] a fragment of bun-shaped rotary quern (SF0685) had been incorporated into the packing material close to the base of the cut. A single AMS date from post-hole 2670 gave a date of 160 cal BC–cal AD 60 (SUERC-30387).

House 17

Only the southern half of House 17 was located within the excavation. The roundhouse was formed by a post-ring of seven post-holes *c*.1m apart, which would have formed a *c*.14m internal diameter (Illus. 4.9). Some contained packing stones and one had clear evidence of a post-pipe.

Within the interior of the house was an arc of another post-ring. This post-ring contained seven circular post-holes placed at *c*.1m intervals. Three post-holes contained packing stones and two had been recut. A shallow undulating scooped feature [2403], a probable hollow eroded by wear, was *c*.0.2m deep and truncated two of the internal post-holes. A spread of stones and a bun-shaped upper rotary quern stone (SF0476) had been placed within the base of the hollow, presumably to level it and prevent further erosion. A single AMS date from charcoal recovered from the fill of the hollow gave a date of 350–50 cal BC (SUERC-30379).

Workshops, furnaces and industrial waste

Five remarkably similar roundhouses (Workshops 2, 13, 15, 16 and 19) were identified across the site in this period. Each was constructed with a single post-ring and four had a porch extending some way out from the main structure. Each contained the surviving stone bases of furnaces used to smelt iron ore, some of which had been repeatedly replaced over time. Most of these furnaces were located at the entrances of the buildings and appeared to be integral to the design and function of the workshop. Another two very similar buildings (Workshops 6 and 12) were also probably iron smelting workshops. Workshop 12 contained a hearth associated with metalworking (potentially a disturbed

Table 4.1
Summary of principal features of the workshops

Workshop	Diameter	Porch width	Porch length	Porch orientation	RC Date	Furnace	Furnace RC date
2	7.3	1.2	4	NE	50 cal BC–cal AD 120	681	40 cal BC–cal AD 120
6	7.8	n/a	n/a	–	200 cal BC–cal AD 1	–	n/a
8	4.7	1.8	3	NE	350–50 cal BC	–	n/a
12	7.8	1.10	4	NE	110 cal BC–cal AD 70	Hearth pit/disturbed furnace 2226	n/a
13 Stage 1	3.7	1	n/a	NE	40 cal BC–cal AD 130	3050	160 cal BC–cal AD 50
13 Stage 2	3.7	1	2	SW	–	3050	90 cal BC–cal AD 80
15	8	2	4	NW	40 cal BC–cal AD 120	4355 4262 4147	4355 110 cal BC–cal AD 70 4262 50 cal BC–cal AD 120 4147 170 cal BC–cal AD 20
16	6.90	1.3	4.10	NE	170 cal BC–cal AD 20	2246	200 cal BC–cal AD 1
18	4.3	0.5	3	NE	n/a	–	n/a
19	9	n/a	n/a	–	n/a	3127	n/a
22	6	2.5	5	NE	n/a	–	n/a

furnace) and Workshop 6 contained a thick spread of material identified as rake-out from an (unseen) nearby iron smelting furnace. A further three roundhouses had an identical 'porch and ring' design but contained no furnaces or ironworking material within their interiors (Workshops 8, 18 and 22). Given the similarities in design, these buildings are likely also to have functioned as some type of workshop space. Table 4.1 summarises the principal features of the workshops.

Strikingly different in design was a turf-and-stone structure (Workshop 11). This U-shaped arrangement of stones may have been the foundation for a turf/stone-walled structure. Within its boundaries were deposits containing glassworking and copper-alloy-working residues, and close by were two stone-lined glass/copper alloy hearths (Hearths 2166 and 2434). The workshop and hearths appear to have been primarily engaged in the manufacture of both glass and copper alloy objects.

Workshops containing iron-smelting furnaces

Workshop 2

Workshop 2 was a single post-ring of 13 post-holes with an internal diameter of 7.3m (Illus. 4.10). Two posts formed a north-east facing porch, which was *c*.1.2m in width. The porch was located at *c*.3.2m from the internal post-ring. Two small posts positioned just inside the main porch post-holes ([145] and [398]) may be the door jambs. The posts within the post-ring were placed at approximately 1m intervals with many containing packing stones.

Several artefacts were recovered from these post-hole fills. Most were likely related to metalworking activity including charcoal, heat-fractured stones, burnt clay and slag.

A pink glass bead (SF0156 – Illus. 6.61) was recovered from the upper fill of post-hole [597]. The bead is problematic, however, as, despite coming from a seemingly secure context, it does not have an ancient glass composition and is a colour otherwise unattested in the Iron Age. It also appears remarkably fresh and may well be a modern intrusion, a reminder that objects can significantly move between the top and subsoils. A small fragment of runned slag (SF1006) was recovered from the basal fill of post-hole [637]. A single AMS date from charcoal recovered from post-hole [597] gave a date of between 50 cal BC and cal AD 120 (SUERC-30361).

A well-preserved base of an iron-smelting furnace [681] was situated just inside the post-ring of the building (Illus. 4.11). It was constructed of four large edge-set stones in a 'horseshoe' shaped arrangement placed in a sub-rounded cut. Two stones had been used to form the back of the structure with one located either side. The stones were angled inwards at approximately 40°

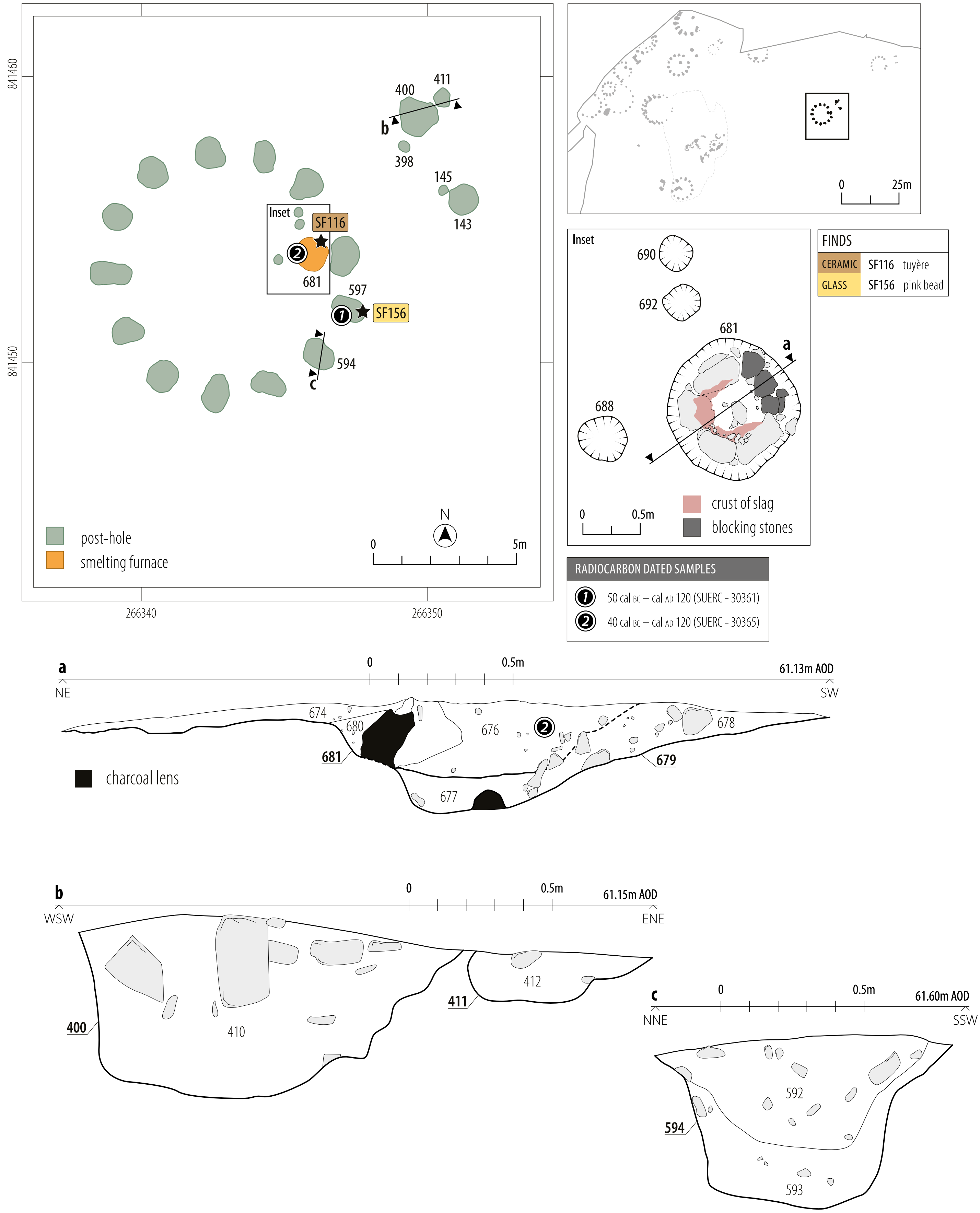


Illustration 4.10
Workshop 2 and smelting furnace; Section through smelting furnace

and rose to a height of 0.4m from the base of the cut. These heat-fractured stones were fused together at the upper internal edge by a crust of slag up to 0.10m thick. Smaller angular stones had been used to block the opening.

The furnace contained three fills, each of which related to its final firing or immediate post-use. The basal fill (677) was moderately compact black silty sand that covered the base. Small pieces of dripped slag and lumps of charcoal were abundant; the charcoal increased in size towards the base. Above this, a sandy clay (675) had been placed up against the inside of the stone structure as lining. This deposit contained few stone inclusions and had very fine flecks of charcoal and charcoal dust. A fragment of a conical tuyère (a clay nozzle through which air was forced into the furnace – SF0116) was identified in this deposit. Two large pieces of slag (SF0131 and SF0132) were slightly pressed into this clay lining towards the back of the furnace. This slag was an amalgam of smaller droplets and had a large amount of mineralised charcoal attached to it. Sealing this was another black deposit (676) that contained less charcoal and more slag than the basal deposit. Frequent fragments of burnt clay were recovered, which are likely to have originated from the clay superstructure of the furnace. A single AMS date from charcoal recovered from within this deposit gave a date of between 40 cal BC and cal AD 120 (SUERC-30365).

The space between the stone structure and the edge of the pit cut was filled with a moderately compact dark-brown sandy silt containing charcoal, slag and burnt clay. A fragment of a thick cylindrical tuyère (a bellows shield) with the partial remains of a circular bellows hole (SF0133) was recovered here. A sub-oval, shallow cut [679] present at the open end of the furnace was perhaps for the removal of waste or to control of air. An amorphous spread (674) surrounding the furnace was thought to be the remains of a contemporary ground surface. Three small post-holes ([690], [692] and [688]) were situated close to the furnace and may have been related to its use.

Illustration 4.11
Smelting Furnace 681 within Workshop 2

Workshop 13

Stage 1

Workshop 13 was originally built as a single post-ring roundhouse of nine post-holes with an internal diameter of *c.*3.7m (Illus. 4.12). The initial entrance was located on the north-east side of the building, defined by two post-holes ([2917] and [2919]) *c.*1m apart. A single AMS date from charcoal retrieved from [2919] returned a date of between 40 cal BC and cal AD 130 (SUERC-30389). The post-holes were mostly sub-circular with diameters ranging between 0.4 and 0.6m. Two had been cut by later pits [3792] and [4179]. Post-hole [2912] had a plano-convex ovoid rubbing stone (SF0598) incorporated into the packing and [2900] contained a sandstone worked surface (SF0599). The post-hole fills all contained varying amounts of iron slag, up to 1kg, and small quantities of burnt clay.

Located within the centre of this post-ring was the stone base of an iron-smelting furnace [3050] (Illus. 4.13). The rectangular stone setting was set into a steep sided sub-oval pit (*c.*1.2 × 0.97m), forming a box 0.30m in height. The two side slabs of sandstone were set on edge and angled inwards at *c.*60–70°. Both had been heavily heat-affected and had fractured into several pieces. The short sides of the furnace were formed by two or more stones, with the three stones on the north-east forming a removable blocking.

The furnace interior contained three fills, all relating to its final use or immediate post-use. The basal fill (3204) was fine black silt that was very rich in charcoal and iron slag (approximately 2.7kg). Small pieces of burnt clay and flecks of burnt bone were also present. A clear interface existed with the deposit overlying this layer (3147), a mottled brown sandy silt with large concentrations of charcoal and iron slag (approximately 5kg). A single AMS date retrieved from charcoal within (3204) returned a date of between 160 cal BC and cal AD 50 (SUERC-30390).

The upper fill (3064) was softly compacted, dark grey sandy silt with occasional fire-cracked stones (whereas the lower fills were largely stone-free) and 'ashy' patches that suggest a mixed deposit of furnace debris and backfill. A large quantity of iron slag (approximately 9kg) and burnt clay, most likely from the furnace superstructure, was recovered from this deposit. The space between the furnace stones and the edge of the cut was also filled with dark grey sandy silt (3458) that contained small quantities of iron slag, charcoal, prill and a small annular yellow glass bead (SF1255).

Stage 2

The second phase of Workshop 13 saw major alterations both to the building and to its interior. A south-west facing porch was constructed *c.*2m south-west of the post-ring, formed by two roughly parallel lines of post-holes, *c.*1m apart, joined by a narrow gully [3866]. The post-holes on the north side of the porch were more substantial than those to the south, with the largest [3807] measuring 0.6 × 0.46m and 0.42m deep with a recognisable

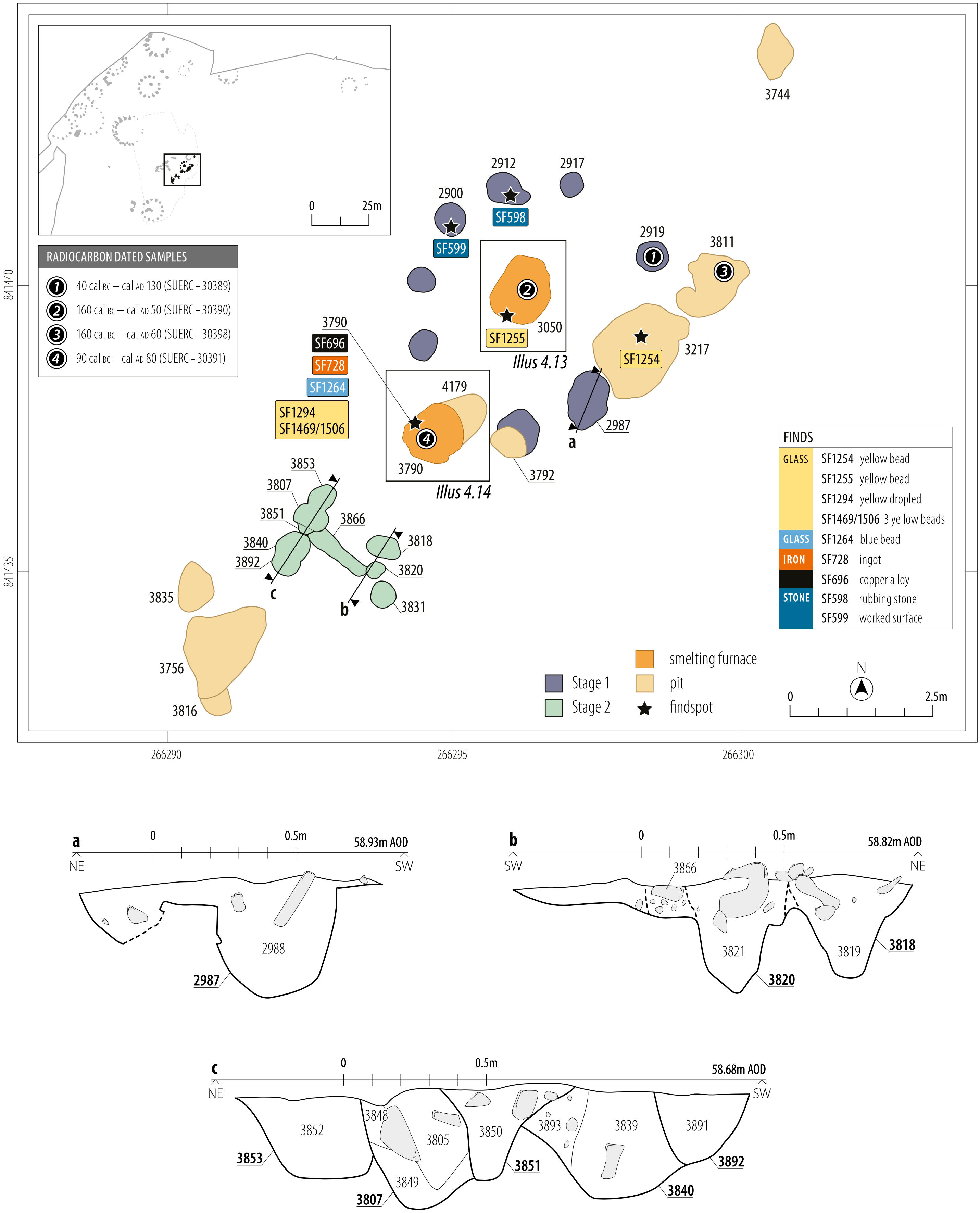


Illustration 4.12
Workshop 13 Stages 1 and 2; Sections through Workshop 13 post-holes

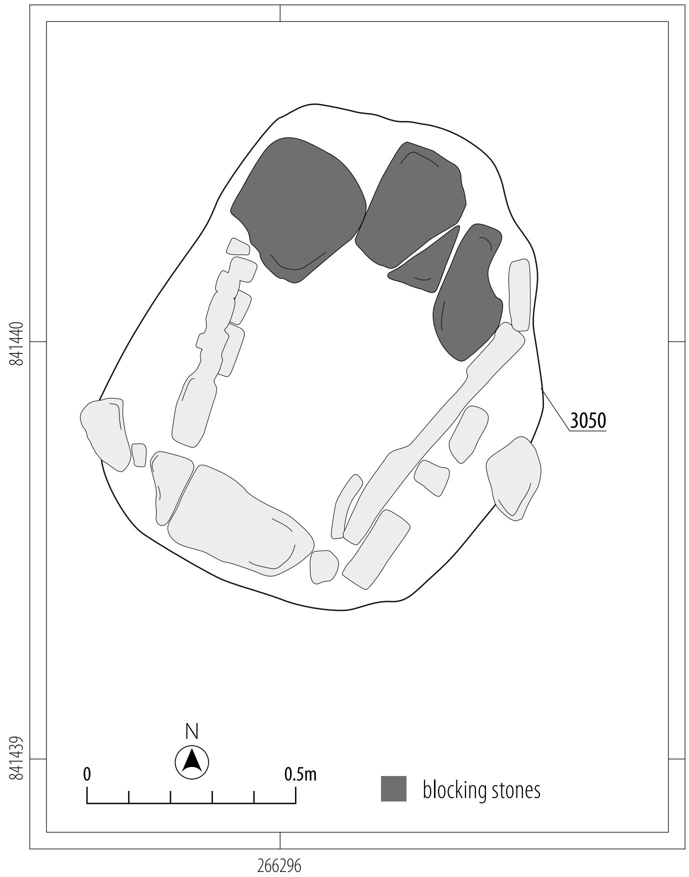


Illustration 4.13
Plan and photo of Furnace 3050

post-pipe and packing. The gully, which likely formed a wooden threshold to the building, contained a small amount of iron slag.

Located slightly on the outside the post-ring at the 'building end' of the porch was the stone base of an iron-smelting furnace [3790] (Illus. 4.14). This was a sub-rectangular stone setting, very similar to the furnace located within the building. Seven stones of varying size were set in a U-shaped structure into an oval pit (*c*.0.96 × 0.94 m). The stones were massively heat-affected and fused together by a crust of iron slag up to 0.18m thick. They had been set tilting inward at an angle of approximately 60°, 0.3m in height. The 'open' north-east end of the stone setting had been blocked by a line of removable stones and clay.

The concave base of the furnace had been lined with a thin layer of clay over which a deposit of unspent fuel (charcoal) and iron slag (6.46kg) had formed (4182). The deposit above (3467) differed from this basal fill as it contained larger pieces of iron slag and abundant lumps of burnt clay. These deposits appeared to represent the final firing of the furnace and its immediate post-use.

A total of 25.7kg of iron slag, 1.2kg magnetic residue, 0.031kg of prill, 6kg of burnt clay and a fragment of an iron ingot (SF0728) was recovered from (3467). Other artefacts recovered were not associated with ironworking. A small amorphous fragment of copper alloy (SF0696), three small yellow glass beads (Guido class 8: SF1469, SF1506 – Illus. 6.61), a very dark blue opaque annular glass bead (SF1264) and a small droplet of yellow glass (SF1294 – Illus. 6.76), possibly waste from bead manufacture, were also recovered. A single AMS date retrieved from charcoal within (3467) returned a date of 90 cal BC–cal AD 80 (SUERC-30391).

Furnace [3790] superseded an earlier furnace formed by an oval pit [4179]. This pit contained an arrangement of sub-angular stones and burnt clay towards its north-east end, similar to the blocked end of the later furnace, and high concentrations of iron slag, burnt clay and significant quantities of micro-debris diagnostic of smithing. This furnace appears to have been dismantled and backfilled to accommodate the construction of furnace [3790].

Metalworking pits

Clustered around the entrance to the porch of Workshop 13 were several pits and post-holes. Two pits were of note as they contained an abundance of metalworking debris that may have originated from the building's furnaces. Pits [3756] and [3835] both contained heat-fractured cobbles, charcoal and iron slag, burnt clay and magnetic residue. Pit [3756] cut an earlier, smaller pit [3816] which containing burnt clay and iron slag as well as small amounts of hammerscale.

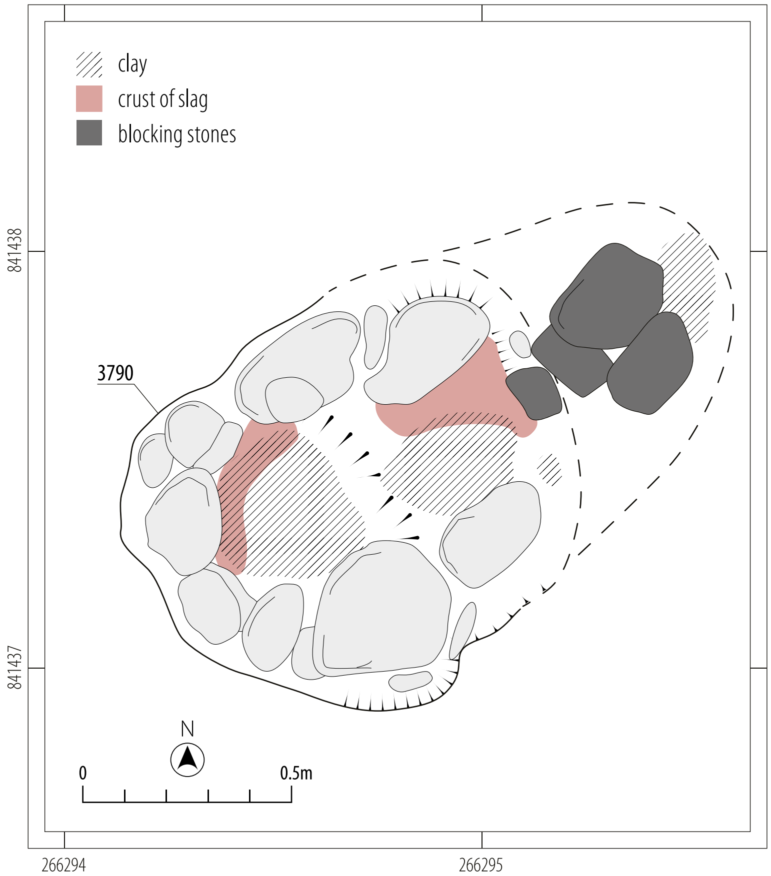


Illustration 4.14
Plan and photo of Furnace 3790

Illustration 4.15
Workshop 15 under excavation

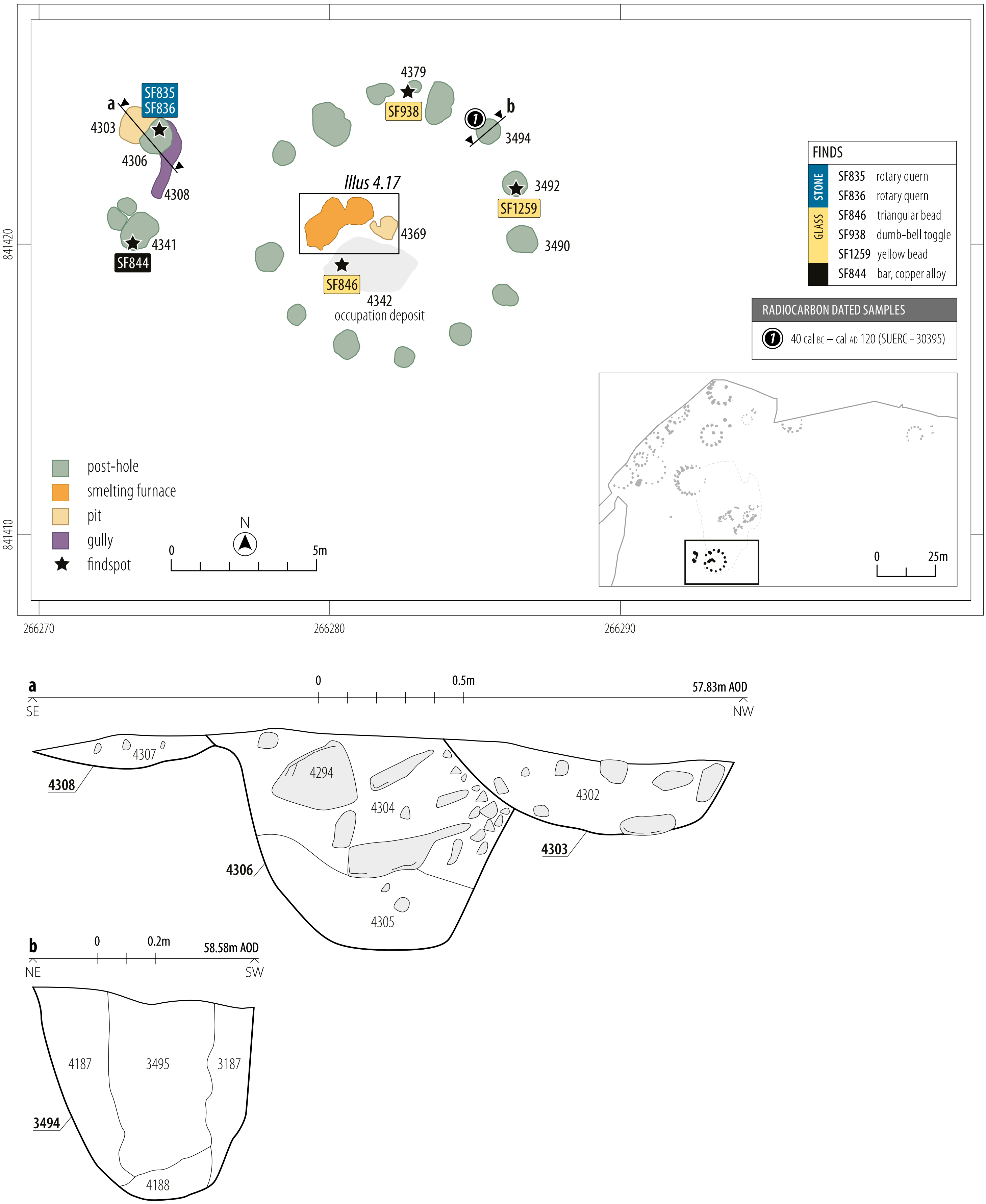


Illustration 4.16
Workshop 15 and smelting furnaces; Section through Workshop 15 post-holes

Adjacent to furnace [3790] was a small pit [3792] that truncated a post-hole of Workshop 13. This pit was oval in plan, measured 0.8 × 0.6m and was 0.25m deep, and its top edge of cut had been lined on one side by five large stones. These stones appear to have formed a setting for a large square boulder that was accidently removed from the pit during the topsoil strip (pers. comm. Ross Murray) and was not recorded in situ. The setting of this large square boulder next to an iron-smelting furnace may indicate that it was an anvil.

To the east and north-east of the workshop were further clusters of pits and post-holes, which contained metalworking debris in varying quantities. Of note were several pits to the north-east of the building. Pit [3217] contained 2kg of iron slag and a small opaque, amber-yellow glass bead (SF1254). Immediately to its north was Pit [3811]. This stone-lined pit was backfilled with material rich in industrial debris (3812) and sealed with two heat-affected flat stones, and may have been the remains of a decommissioned furnace. A single AMS date retrieved from charcoal within (3812) returned a date of 160 cal BC–cal AD 60 (SUERC-30398).

Pit [3744] situated to the north-east of the building contained abundant iron slag (1.9kg), fired clay (315.2g) and magnetic residue as well as a small quantity of prill. Much of the fired clay had wattle impressions indicating that wet clay had been applied to a wattle surface. Close by was post-hole ([2835] – not illustrated), which contained both ferrous and non-ferrous metalworking debris in the form of iron slag, prill and a small piece of copper alloy slag.

Workshop 15

Situated to the south-west of Workshop 13 was a single post-ring roundhouse with a north-west facing porch (Illus. 4.15 and 4.16). The post-ring consisted of 13 post-holes placed at *c.*1m intervals with an internal diameter of *c.*8m. Metalworking debris was present in many of these post-holes. Two glass beads were recovered: a yellow Guido class 8 glass bead (SF1259) from the upper fill of post-hole [3492]; and half a triangular bead (SF0846 – Illus. 6.61), of complex design and high quality, which was recovered from an occupation deposit (4342) located within the interior of the building. One post-hole located between two post-holes in the post-ring [4379] contained a dumb-bell toggle made from two conjoined spheres in very dark greenish blue glass with yellow stripes and patches (SF0938 – Illus. 6.61). Samples were analysed from two post-holes (3490 and 3494), both of which contained low levels of charred cereal grains. A single AMS date from charcoal retrieved from post-hole [3494] returned a date of 40 cal BC–cal AD 120 (SUERC-30395).

The *c.*2m-wide porch extended *c.*3.30m to the north-west of the post-ring and comprised two large post-holes ([4341] and [4306]) with a narrow gully [4308] between, representing a setting for a wooden threshold. A square sectioned copper alloy bar (SF0844) and a large quantity of dense iron slag (SF0845)

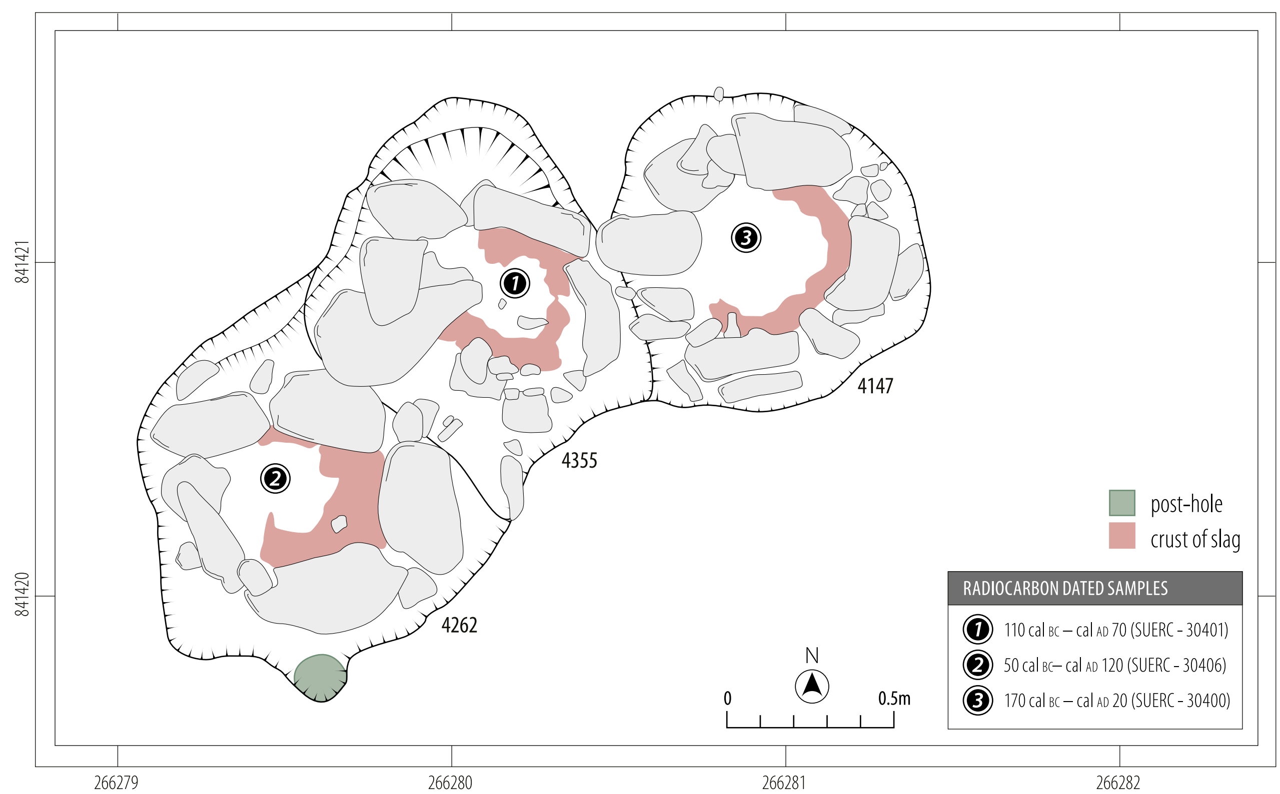


Illustration 4.17
Smelting furnaces 4355 (centre), 4262 (left) and 4147 (right)

were recovered from the southern post-hole [4341]. The northern post-hole [4306] contained large packing stones with two rotary quern fragments (SF0835 and SF0836) incorporated.

The bases of three identical iron-smelting furnaces were located just inside the entrance of the post-ring (Illus. 4.17 and 4.18). The earliest furnace [4355] was a horseshoe shaped stone setting within an oval pit (*c.*1m in diameter). It was cut to the east by furnace [4147] and to the west by furnace [4262]. To the south-east of the complex of furnaces was a 0.15m thick occupation deposit (4342), which contained heat-fractured stones, lumps of charcoal and fired clay, probable rake-out waste from the furnaces.

Furnace 4355

The stones that formed the main structure of furnace [4355] were fused together by a ring of iron slag, and two blocking stones had been placed at the open south-west end (Illus. 4.18 and 4.20). The stones on the south and east side were very fragile due to heat exposure and had been damaged by the construction of the two adjacent later furnaces. A thin deposit of pinkish brown sandy clay (4217) lined the interior of the stones. The basal fill (4218) was rich in charcoal and pieces of 'dripped' slag, and overlaid a thick deposit (4148) containing burnt clay and iron slag as well as large quantities of charcoal; this was found in higher concentrations towards the open end of the furnace. A single AMS date retrieved from charcoal within (4148) returned a date of 110 cal BC–cal AD 70 (SUERC-30401). The upper fill (4121) appeared to be a deliberate backfill of both this furnace and furnace [4147] and contained abundant burnt clay and iron slag.

Illustration 4.18
Smelting furnaces 4147 (top), 4355 (middle) and 4262 (bottom)

Furnace 4262

Furnace [4262] was also formed by horseshoe-shaped stones set on edge at an angle of approximately 60°. It was located to the west of furnace [4355] and cut through its back end. The stones were fused together by two tiers of iron slag with the remains of the furnace superstructure still adhering to the stones' upper surface as patches of burnt clay and small decayed stones (Illus. 4.19 and 4.20). A thick basal deposit of charcoal and slag (4257 – 0.26m deep) was present and likely represented the final firing of the furnace. A single AMS date retrieved from charcoal within (4257) returned a date of 50 cal BC–cal AD 120 (SUERC-30406). Deposits immediately overlying (4257) contained burnt clay fragments with finger and hand impressions, likely the remnants of the clay superstructure.

Furnace 4147

Furnace [4147] was located immediately to the east of furnace [4355] and cut its front end. Furnace [4147] was also horseshoe-shaped and formed by large stones set on edge at an angle of approximately 60° set into an oval pit (*c.*0.80 × 0.60 m). A thick crust of iron slag had fused most of the stones together. Loose stones had blocked the opening and were still in situ (Illus. 4.21). The remains of the furnace superstructure were present as a ring of burnt clay with fragments of quartz and stones located on the top of the stones, spreading down over their external faces. On the outer face of the stones the clay had noticeably fewer inclusions and in several places wattle and finger impressions were noted.

The basal fill of the furnace was a 0.04m thick layer of charcoal and 'dripped' slag. A deposit (4141) containing abundant iron slag, burnt clay and charcoal, sealed this basal fill. As with furnace [4355] the charcoal within this layer was more concentrated towards the open end of the structure. A single AMS date retrieved from charcoal within (4141) returned a date of 170 cal BC–cal AD 20 (SUERC-30400). The upper fill (4121) was a spread of material, likely deliberate backfill, across both furnace 4147 and 4355.

A pit [4369] was situated within the interior of the workshop and immediately to the east of the furnaces. It appeared to be related to the metalworking process. The top edge of the 1m diameter pit was lined by well-fired clay and it was backfilled with large quantities of burnt clay, clay fused to slag and iron slag.

Workshop 16

The roundhouse comprised a single post-ring of 10 posts with an internal diameter of 6.90m (Illus. 4.22). The post-holes were between 0.7 to 1m in diameter and 0.3 and 0.7m deep. The porch was defined by two (heavily recut) posts (1.30m apart) located 2.65m to the north-east of the post-ring. These post-holes were

Illustration 4.19
Smelting furnace 4262 with elements of the furnace superstructure intact

Illustration 4.20
Smelting furnaces 4355 (foreground) and 4262

joined by a linear gully which formed a threshold into the porch entrance.

Post-holes within the post-ring yielded a number of finds including a fragment of a bun-shaped rotary quern (SF465/471) reused as a packing stone (2253), a possible working surface (SF0464 in [2306]), a small yellow glass bead (SF1252 in [2284]) and a possible sharpening stone (SF0456), which had been reused as a packing stone of one of the porch post-holes. Iron slag and prill was present in a total of six post-holes. A single AMS date retrieved from charcoal within post-hole [2303] returned a date of 170 cal BC–cal AD 20 (SUERC-30378).

The truncated base of a smelting furnace [2246] was located within the interior, placed just inside the post-ring in line with the entrance. The sides of the rectangular cut (1.3m long, 1m wide and 0.23m deep) were partially lined with a mixture of rounded and flat stones. Two stones, one on the west edge (SF0457) and the other on the south (SF0458), were fragments of a rotary quern. These were set on edge with the central perforation located at the top of the cut and were heat damaged, heavily vitrified and fragile. These rotary quern fragments had been incorporated into the furnace structure with their central perforations potentially reused to support ceramic tuyères.

The basal fill (2288) was the in situ remains of its last firing. The deposit was a black, compact amalgam of gravel, burnt clay, iron slag and charcoal, approximately 0.15m deep. A single AMS date retrieved from charcoal recovered from (2288) gave a date of 200 cal BC–cal AD 1 (SUERC-30377). The upper fill of the furnace was lighter in colour with small fragments of burnt clay, iron slag and charcoal, and probably derived from post-use silting. Within the interior of the workshop was a shallow circular pit [2238] located 1m to the south-west of the furnace. Half a bun-shaped rotary quern (SF0465) had been placed with the central hole facing upwards against the cut of the pit, echoing the position of the quern fragments reused within the furnace.

Illustration 4.21
Smelting furnace 4147 showing blocking stones

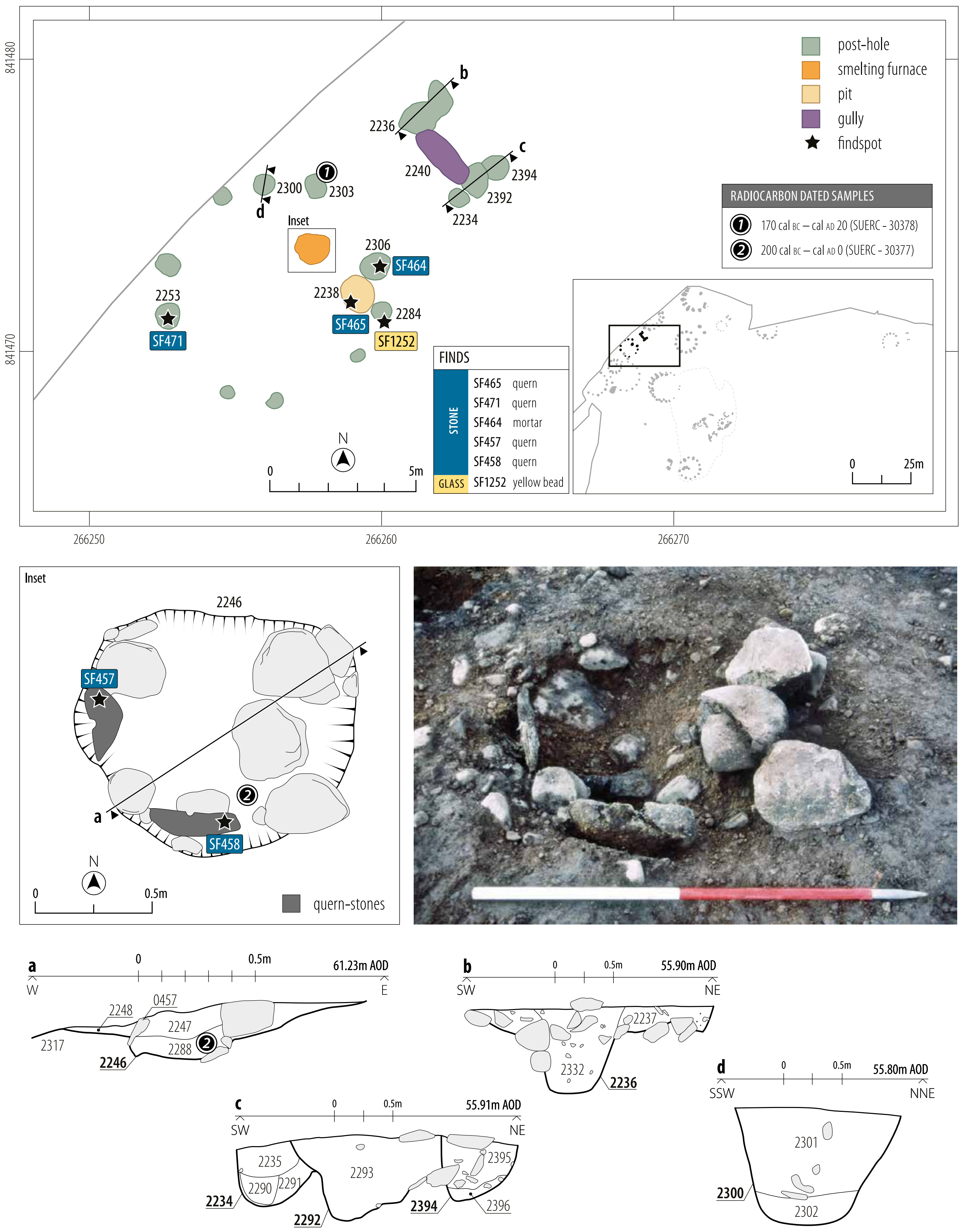


Illustration 4.22
Plan of Workshop 16 and smelting furnace 2246; Sections through Workshop 16 post-holes; Smelting furnace 2246 showing reused rotary quern in situ

Another part of this bun-shaped quern was identified within one of the workshop's post-holes [2253].

Workshop 19

The post-ring of a *c*.9m diameter roundhouse was only partially exposed within the excavation area and only two post-holes were excavated (Illus. 4.23). Nine post-holes were visible, all of which appeared to be heavily recut. Post-hole [2713] was sub-oval, measuring 1.2 × 1.1m, and was 0.94m deep. The section revealed a 0.7m wide deposit of redeposited natural packing material abutting a clear 0.4m post-pipe that tapered slightly towards the base. This post-hole truncated the ring-groove of Structure 20 (Illus. 1.10). The largest post-hole [2535] measured 1m in diameter and was 0.72m deep. Packing stones had been placed along its southern edge; these and the post-pipe suggested a post width of *c*.0.4m. This post-hole was truncated by a small pit [2457], which contained an iron hooked mount (SF0504–Illus. 6.46).

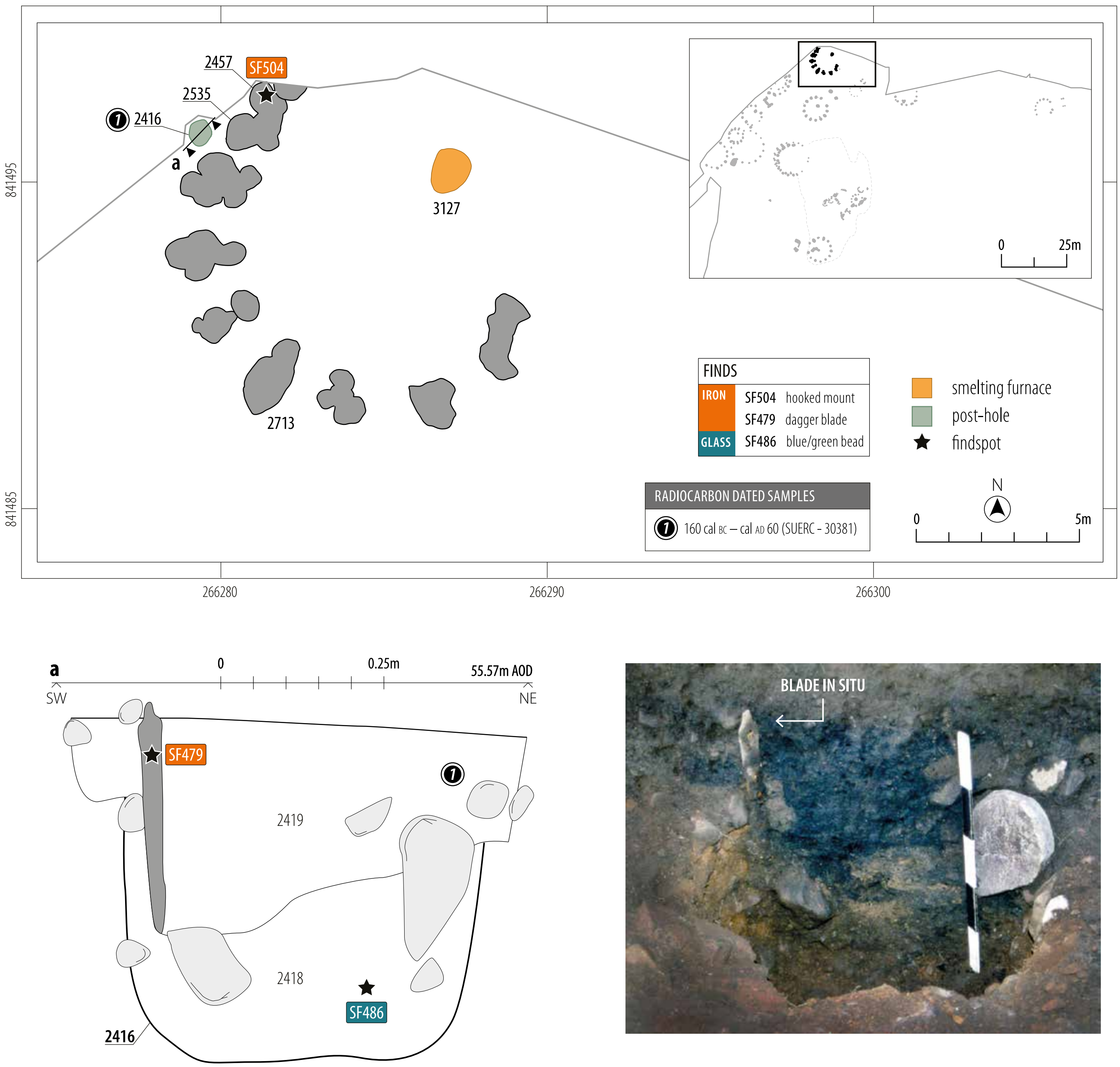


Illustration 4.23
Workshop 19; Section through post-hole 2416; Photo of dagger blade in situ

A stone-lined feature [3127], located in the interior of the workshop, was identified as an iron-smelting furnace in plan. It was not excavated and was preserved in situ.

Post-hole 2416

This circular post-hole was situated to the north-west of Workshop 19. It was 0.65m in diameter, 0.35m in depth and contained packing stones, some of which were heat-fractured, surrounding a post-pipe. Incorporated into the packing material up against the post-pipe was an iron dagger blade (SF0479 – Illus. 6.46). The dagger had been placed vertically with its point down alongside the post when it had been originally set. The dagger was 0.28m in length and had a maximum width of 0.037m. The lentoid-sectioned blade had a stump of a tang measuring 0.02m and, while it had been deposited whole, it had fractured into three fragments in antiquity. A small mid-blue-green glass bead (SF0486 – Illus. 6.61) and a fragment of crucible were also recovered from the fill. A single AMS date retrieved from charcoal from the upper backfill of the post-hole [2419] returned a date of 160 cal BC–cal AD 60 (SUERC-30381).

Numerous other pits and post-holes, a circular post-built building (Structure 21) and a ring-groove building (Structure 20) were also identified in this corner of the site. Aside from the two post-holes of Workshop 19 and post-hole [2416] these features were not excavated and were preserved in situ (Illus. 1.10)

OTHER WORKSHOPS

Workshop 6

Only the southern half of a *c.*8m diameter roundhouse was identified within the excavation area, with eight post-holes of a single post-ring exposed (Illus. 4.24). These were spaced around 1.8m apart, and were between 0.08 to 0.44m in diameter and 0.16 to 0.61m in depth. No entrance was identified.

A large piece of burnt clay adhered to slag (SF0208) was found in post-hole [889], and the head of an iron spear (SF1026), probably a light throwing spear, was found within the packing material of post-hole [1607]. A single AMS date retrieved from charcoal from post-hole [1618] returned a date of 200 cal BC–cal AD 1 (SUERC-30368).

No hearth or furnace was identified within the interior of the building but a thick spread of material rich in metalworking debris (1632) was present. This deposit was a dump of material or rake-out from a firing of an iron-smelting furnace. As this material is unlikely to have travelled far from its source, Workshop 6 could have contained an iron-smelting furnace within its interior located beyond the excavation area.

Workshop 12

Workshop 12 was a circular building formed by a single post-ring of 13 post-holes with an internal diameter of *c.*7.8m. A porch extended 4m to the north-east (Illus. 4.25). Most of the posts were located *c.*1m apart, with the porch post-holes *c.*1.10m apart. The upper fills of the post-holes contained many heat-fractured stones, lumps of iron slag and burnt clay. Metalworking debris was common in their basal fills and slag had been reused as packing material. A single AMS date was retrieved from charcoal within post-hole [2459] and returned a date of 110 cal BC–cal AD 70 (SUERC-30385).

A shallow circular hearth pit [2226] was located adjacent to the entrance in line with the porch and contained charcoal, heat-fractured stones, quantities of iron slag and magnetic residue. Its backfill and similar location to many of the furnaces seen on site suggests that this pit was the remains of an iron-smelting

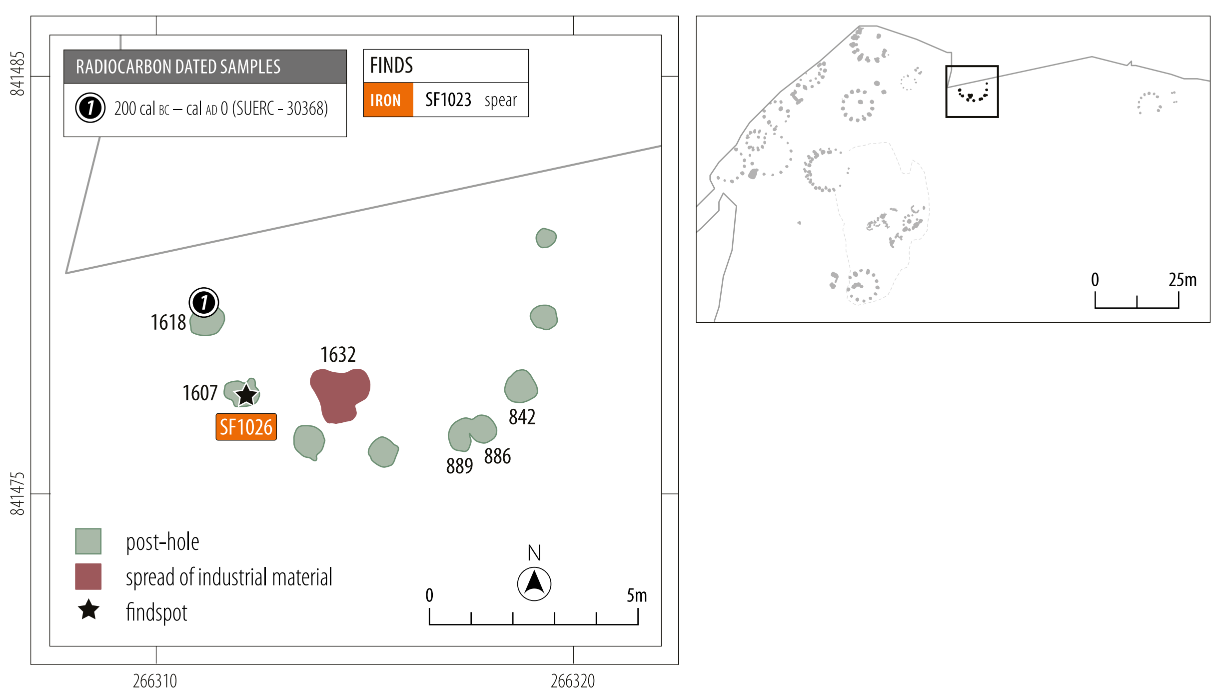


Illustration 4.24
Workshop 6

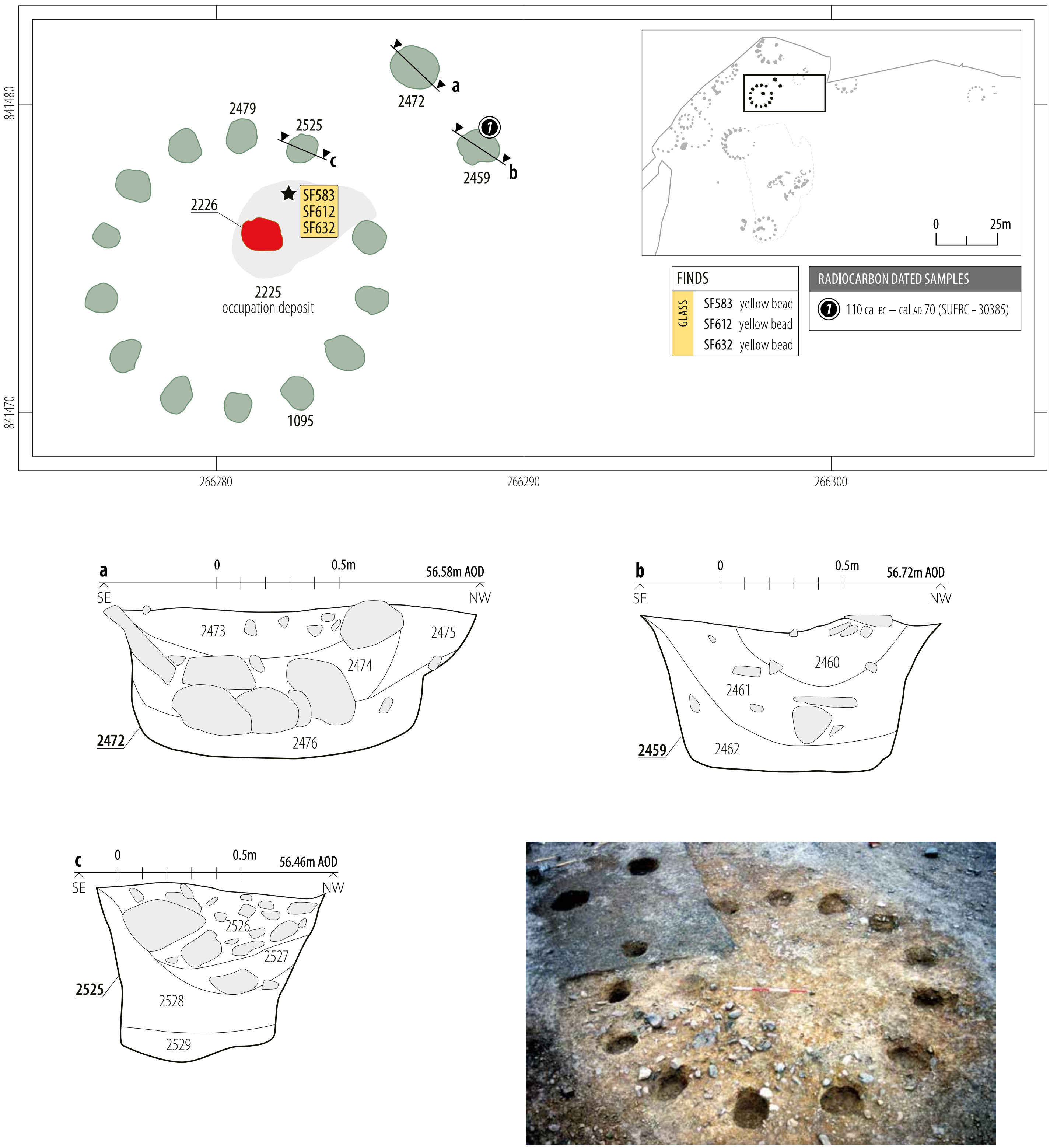


Illustration 4.25
Workshop 12; Sections through Workshop 12 post-holes; Workshop 12 (looking east)

furnace that had been removed. The pit cut an occupation deposit (2225), which contained three yellow beads (SF0583, SF0612 and SF0632 – Illus. 6.61).

Workshop 8

This roundhouse comprised a single post-ring of 11 posts with an internal diameter of 4.7m. It had truncated a post-ring roundhouse House 9 (Illus. 4.26). A porch was located 3m to the north-east of the post-ring of the building, with an entrance *c*.1.8m wide. No internal features were identified. A single AMS date retrieved from charcoal recovered from this feature gave a date of 350–50 cal BC (SUERC-30370). The similarity of the layout of Workshop 8 to the iron-smelting workshops suggests that this building also functioned as a type of workshop.

Workshop 18

Workshop 18 was a single post-ring of nine post-holes with an internal diameter of 4.3m (Illus. 4.27). The post-ring and the interior of the building were heavily truncated, with no internal features surviving and only slight traces of many of the post-holes. The porch area appeared to be least affected and four post-holes formed a north-east-facing porch *c*.1.2m in width. Most of the post-holes contained small quantities of iron slag.

Workshop 22

Workshop 22 was a single post-ring of 12 post-holes with an internal diameter of 6m (Illus. 4.1). It was excavated during the top-soil stripping of the site by Alba Archaeology and only minimal records survive. Four post-holes formed a north-east facing porch *c*.2.5m in width and were located *c*.5m from the main structure. No furnace or hearth pit was identified within the building's interior. A small fragment of fired clay spindle whorl (SF0584 – Illus. 6.18) was recovered from one of the post-holes of the structure. Pits to the north and east of the workshop (Pits [1076] and [1077]) contained glass working debris.

A SMITHING HEARTH

A shallow oval pit [4273] was located to the south of House 10. It was lined with clay on three sides of the cut, forming a 0.10m

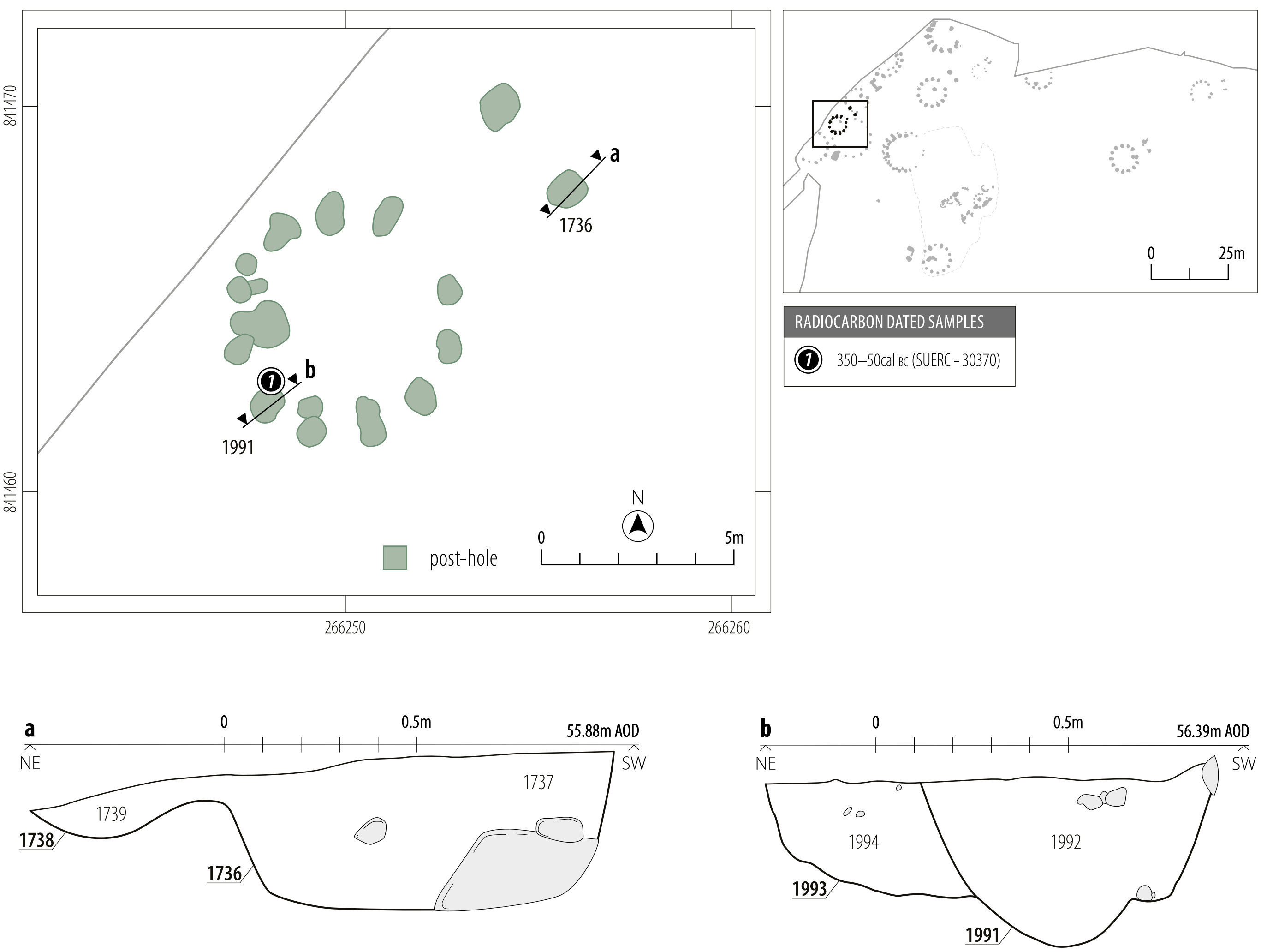


Illustration 4.26
Workshop 8; Sections through Workshop 8 post-holes

thick dark-grey horseshoe-shaped band. Beneath the clay was a deposit of light pink clay and charcoal-flecked dark-brown silty sand, which sealed the basal deposit of the hearth, a brown silty sand (4279). Over 1kg of vitrified ceramics and iron slag was recovered from the hearth alongside 0.2kg of magnetic residue, identified as smithing waste. A single AMS date retrieved from charcoal within (4279) returned a date of 350–40 cal BC (SUERC-30407).

Glass and copper alloy production

Two paved hearths (Hearths [2434] and [2166]) and a turf-and-stone workshop (Workshop 11) formed a tightly placed group of features located to the north-west of Workshop 13 associated with the manufacture of glass and copper alloy objects (Illus. 4.28 and 4.29). Deposits within and surrounding each of the hearths and the workshop contained abundant evidence of copper alloy casting alongside finished glass and copper alloy objects including glass beads and a bronze rivet. Hearth 26 located to the north-east of this group may also have been associated with copper alloy casting. Iron slag, hammerscale and other smithing waste around the workshop and the hearths indicated that ironworking and smithing was also taking place in this area.

Glassworking waste was limited to Hearth [2434] and its internal deposits, a distribution that suggests that Hearth [2434] was used as a glass furnace.

The distribution of copper alloy objects, crucibles and moulds in this area is shown in Illus. 4.34. The distribution of glass beads across the site is shown in Illus. 4.36.

Illustration 4.27
Workshop 18

THE HEARTHS

Hearth 2434

This hearth survived as five closely spaced edge-set stones set in a C-shape with a flagstone base (Illus. 4.30 and 4.31). Overlying the flags was a compacted layer of charcoal-rich black sandy silt (3035)/(2677)/(3022), interpreted as the remains of the final firing of the hearth. A single AMS date from charcoal retrieved from (2677) returned a date of 170 cal BC–cal AD 20 (SUERC-30386).

Abundant iron, copper alloy and glass waste debris was recovered from these internal deposits, including 1.6kg of iron slag, two small pieces of copper alloy casting waste (SF0433 and SF0445), a fragment of stock metal (SF1246), crucible rim sherds (SF0447 and SF0481; the latter had an adhering copper alloy fragment – Illus. 6.5), body and base sherds, mould fragments including two fragments of a ring mould (SF1125 – Illus. 6.7) and three fragments of red glassworking waste (SF1281, SF1282 and SF1283). Nine iron objects were also recovered. These were: a small V-shaped object (an unsuccessful decorative terminal?) and a possible peg or bolt (SF0434a&b); a U-shaped shaft, possibly part of a chain link, staple or bent nail (SF0435); a small round ball (SF0438); a probable nail (SF0487); a tool blade with toothed tip-blunt teeth (SF1002 – Illus. 6.46); a strip of iron, possibly an offcut (SF1018); and part of a blade (SF1019). Burnt clay was abundant and included one finger-impressed piece (SF0558).

An arc of four post-holes ([2541/2549/2547/2543]) was located on the south side, curving around the flagstones. The post-holes were sub-circular, between 0.25m and 0.45m in diameter and 0.1 to 0.2m deep. Their backfills were remarkably rich in artefactual evidence. They contained crucible sherds (SF1111-5), fragments of a ceramic mould (SF1110), fragments of glass/enamel-working debris (red, blue/yellow, blue and clear), a lump of copper alloy casting waste (SF0535), an iron file (SF0534 – Illus. 6.45), a cast fine rivet (SF1240) and fragments of a flat cast object (SF1241), iron slag and magnetic residue (Illus. 4.34 and 4.36).

To the north and north-west of the hearth was a cobbled surface (1945), which respected the hearth and may have been contemporary with its use. A spread of dark-brown sandy silt (2435) covered the hearth and must have accumulated or been dumped after it went out of use. A pair of fine iron scissor-shears for delicate metalworking (SF0540 – Illus. 6.46), two sherds of a crucible (SF0539) and a piece of copper-alloy waste (SF0490) were recovered from this layer.

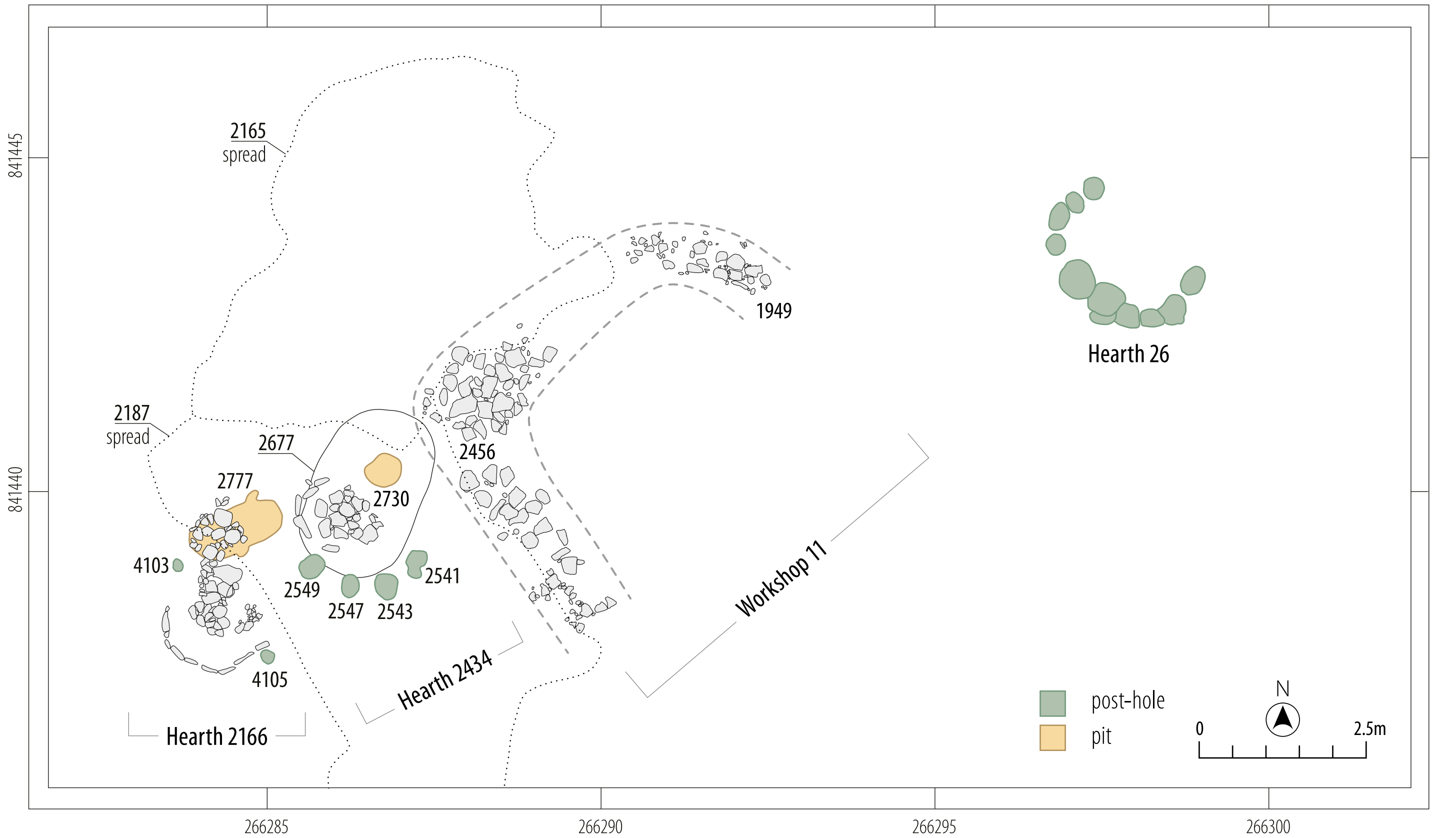


Illustration 4.28
Workshop 11 and Hearths 26, 2434 and 2166

Illustration 4.29
The glass and copper alloy hearths under excavation

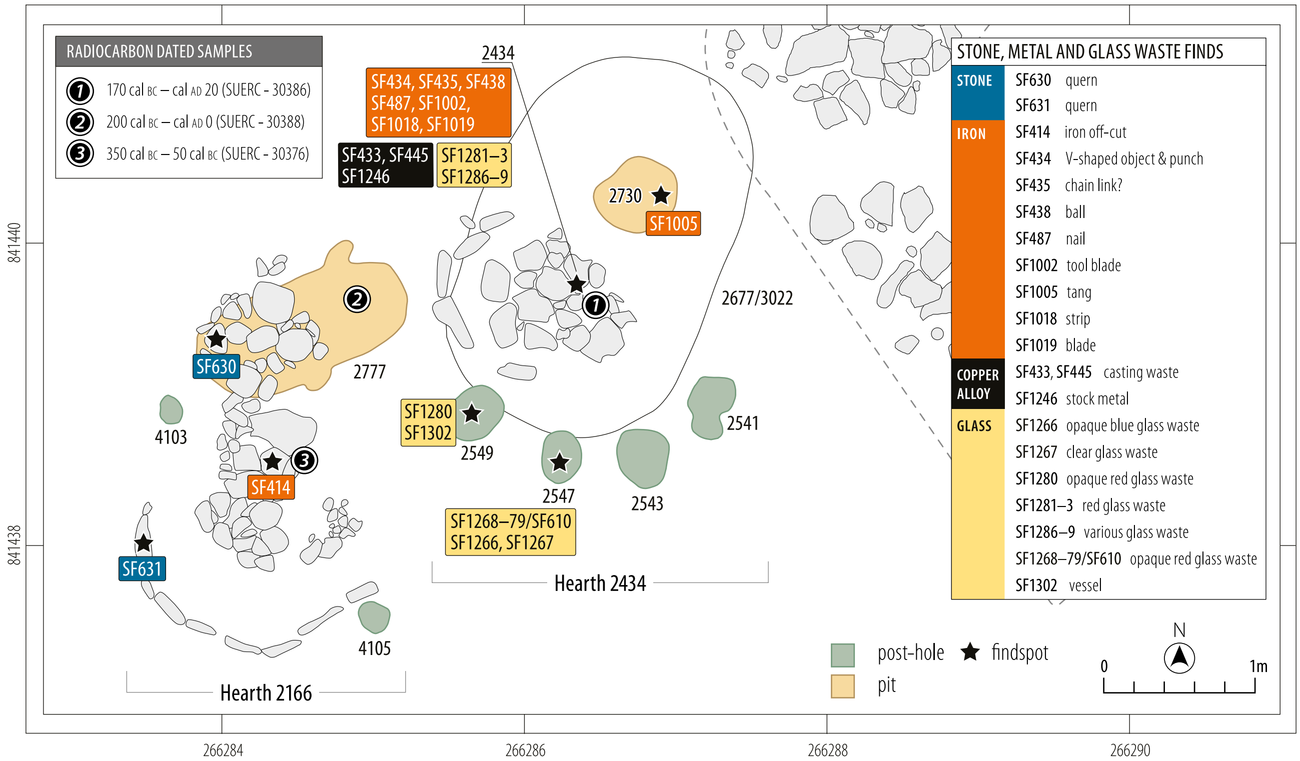


Illustration 4.30
Plan of Hearths 2434 and 2166

Illustration 4.31
Hearth 2434

An oval pit [2730] adjacent to the hearth contained a black charcoal rich sandy fill with frequent fire-cracked stones and an iron tang (SF1005). Small quantities of iron slag and magnetic residue were also present.

Hearth 2166

Situated immediately to the west of hearth [2434] was a similar hearth [2166] (Illus. 4.32). Its edge was defined by eight closely spaced edge-set stones in a C-shape. One of these stones was a fragment of a bun-shaped upper rotary quern stone with a decorated collar (SF0631). As the quern fragment was not heat damaged and had no adhered slag, it probably functioned as an edging stone rather than as a support for a tuyère or bellows as seen in several of the iron-smelting furnaces. The interior of the hearth was covered in heat-fractured flagstones surrounded by cobbling. Finds recovered from its interior include an iron offcut (SF0414), a crucible rim and body sherd (SF0415) and another fragment of a bun-shaped upper rotary quern (SF0630). Two adjacent post-holes (4103 and 4105) may have been associated with the superstructure of the hearth, and a cobbled surface (1945) located along its northern side respected the flagstone.

A single AMS date retrieved from charcoal overlying the flagstones returned a date of 350–50 cal BC (SUERC-30376). It is clear from the excavator's records that this material was not considered to be the final firing of the hearth. A single AMS date retrieved from charcoal within an oval pit [2777] partially underlying the hearth yielded a date of 200 cal BC–cal AD 1 (SUERC-30388), providing a *terminus post quem* for the construction of the hearth. The pit contained sherds from crucibles (SF1127–9).

Hearth 26

This structure consisted of 10 closely spaced post-holes forming a U-shaped structure *c.*2m wide (Illus. 4.28). Most of the post-hole fills contained metalworking debris in the form of iron slag and burnt clay. One contained a crucible sherd (SF0656) and a fine iron nail (SF0629); another contained a small piece of copper alloy slag. These post-holes may have been the settings for stones like C-shaped constructions seen in hearths [2166] and [2434].

A circular pit [3564] 1.5m to the north-west may be related to the hearth. The pit had a diameter of *c.*0.7m, was vertical sided and was 0.57m deep. Both the upper and lower fills of this feature contained approximately 1kg of iron slag. A spread of dark-brown charcoal-rich silt (2102) to the north of the pit contained multiple crucible fragments and iron objects, including the tip of a fine knife blade (SF0340), and may again represent a dump of material from the firing of the hearth or furnaces close by.

WORKSHOP 11

Situated to the east of hearths [2166] and [2434] was the fragmented stone base of an irregular U-shaped structure (Illus. 4.28 and 4.33). Two curvilinear arrangements of flat stones formed the remaining foundations for a probable turf wall. A 2m long and 0.6m wide structure (1949) formed the north-east corner of the structure. This wall base had three large pieces (up to 4kg) of iron slag/furnace base incorporated into the stones. To the south-west a curving length of flat stones (2456) formed part of the north and west walls of the structure. The flat stones here formed a base up to 1.48m wide. Two joining pieces of a stone basin (SF0505 and SF0506 – Illus. 6.15) and two fragments of upper rotary querns (SF0507 and SF0508) had been incorporated into this surface and an iron tool (SF0509 – Illus. 6.45) was recovered from within the stones. A thick layer of compacted light-yellow sandy silt (2477) overlying the stones here was interpreted as collapsed turves. Several post-holes were identified within the interior of the structure, one [3829] containing a fragment of mould (SF0712).

Illustration 4.32
Hearth 2166

The walls had been built onto a compacted sandy layer (2471) that contained charcoal, burnt clay and slag, a blue barrel shaped bead (SF1261 – Illus. 4.36 & 6.67) and moulds fragments (SF1108-9 – Illus. 6.7). Several layers contained within the interior space formed by the wall bases were interpreted as deposits associated with the use of the structure. These included a spread of compacted black silt (1952), which contained large quantities of burnt clay, iron slag (over 10kg), a crucible rim sherd (SF1101-2) and a rotary quern that had been reused as an ingot mould (SF0339) for copper alloy metalworking (Illus. 4.34, 4.35 and 6.17). The mould was two-sided, with a dish and bar mould on one side and a vase-shaped mould carved around the central feeder pipe on the smoother 'grinding' face. In the north corner of the interior, another very similar deposit (2191) also appeared to be waste debris and contained frequent fire-cracked stones and iron slag.

To the north-west of the building was a cobbled surface (1945), which respected the outer edge of the north wall of the structure. A deposit rich in charcoal and industrial debris (2100) overlaid this cobbling and Workshop 11. This spread measured 6.2m × 2.3m and varied in depth from 0.1m to 0.2m. The remains of three industrial processes were present here: 18 crucible fragments indicative of non-ferrous metalworking/glassworking; a small piece of red glassy material (SF0355), which was waste from enamelling or glass making; and large lumps of iron slag (totalling 6.5kg) from ferrous metalworking. Eight iron objects were also recovered from (2100) including a possible graver (SF0372 – Illus. 6.44), a toothed leather decorating tool (SF0371 – Illus. 6.44), a fragment of a fine bent bar (SF0379), a fragment of a U-shaped square-sectioned bar (SF0409) and an iron nail (SF0407). A single AMS date from charcoal

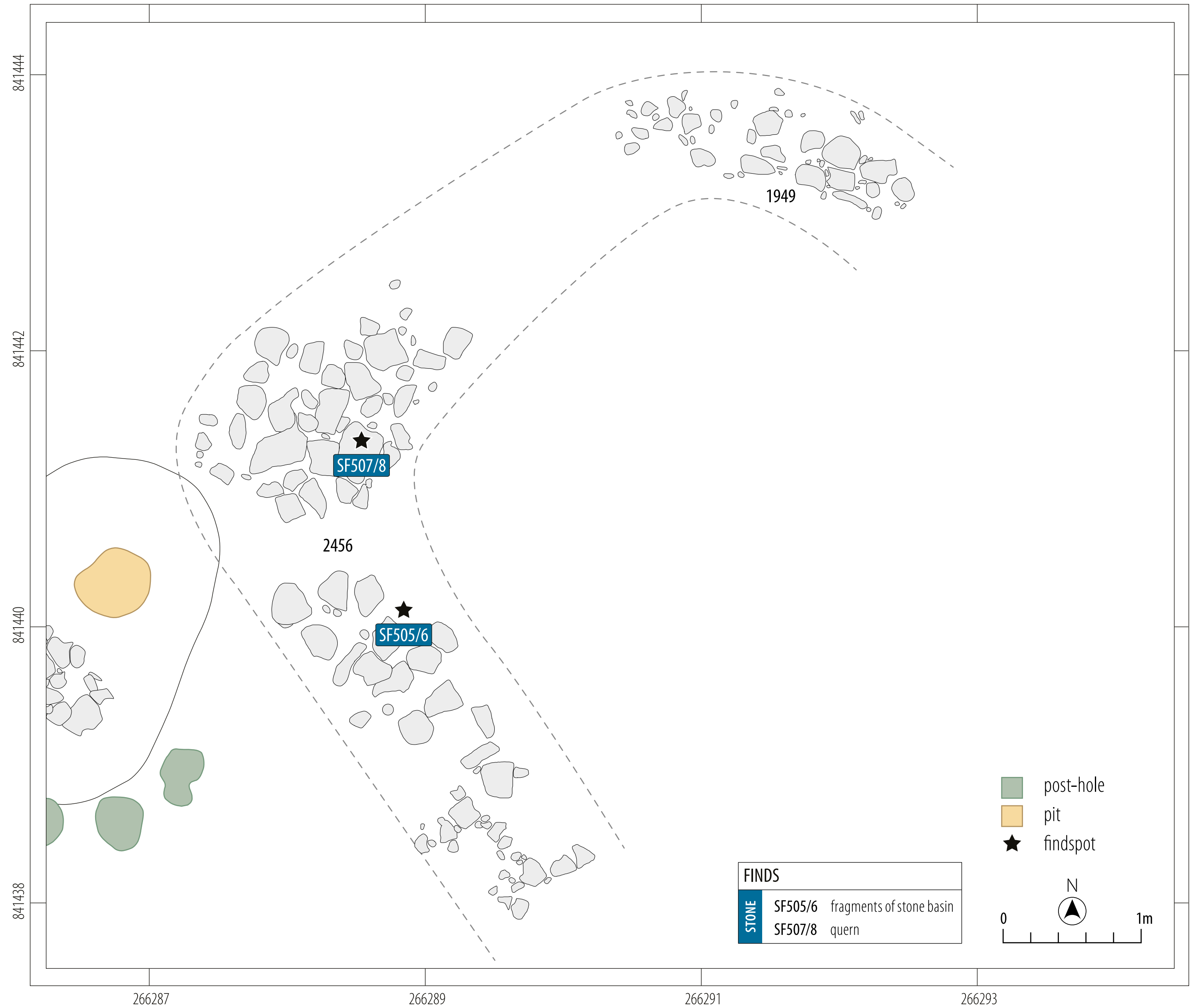


Illustration 4.33
Plan of Workshop 11 showing the location of stone basin and rotary quern

retrieved from (2100) returned a date of 90 cal BC–cal AD 90 (SUERC-30371).

Overlying Workshop 11, the three hearths [2166], [2434] and [26], the cobbled surface (1945) and layer (2100) was a series of spreads of dark-brown silts, which contained frequent slag, fire-cracked stones, burnt bone, teeth and burnt clay inclusions (1896, 2165, 2187 and 2186) (Illus. 4.34 and 4.36). Fragments of crucibles, moulds, fire-cracked stones, and smelting and smithing slag, including a smithing hearth bottom, were also recovered from these spreads, which may represent dumps of material from the firings of the hearths and furnaces in the vicinity.

A further dump of material that included iron slag (including a furnace bottom, smelting and smithing slag) was identified in an oval pit [2143] located to the south of the hearths. The pit was lined with heat-fractured pebbles and may have originally been a forge or furnace.

Environmental summary for Period 3a

Scott Timpany, Sarah-Jane Haston and Abby Mynett

Pit 1863

Four samples were analysed from pit [1863], located overlying the post-ring of House 9. Three samples (593, 594, 601) came from backfills of the pit (1862, 1864, 1865) and one sample (607)

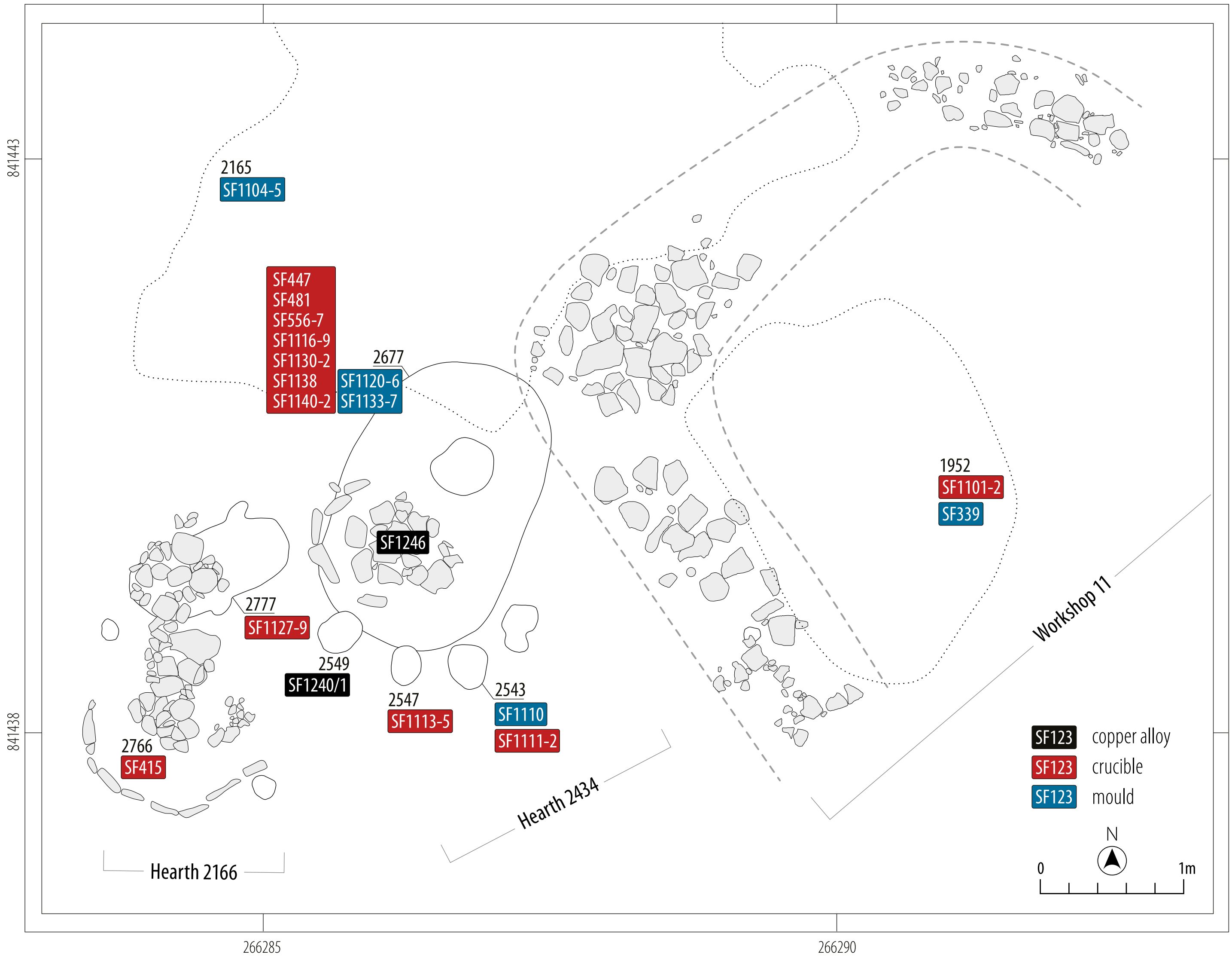


Illustration 4.34
Distribution of CU objects, crucibles and moulds

Illustration 4.35
Ingot mould SF0339 in situ

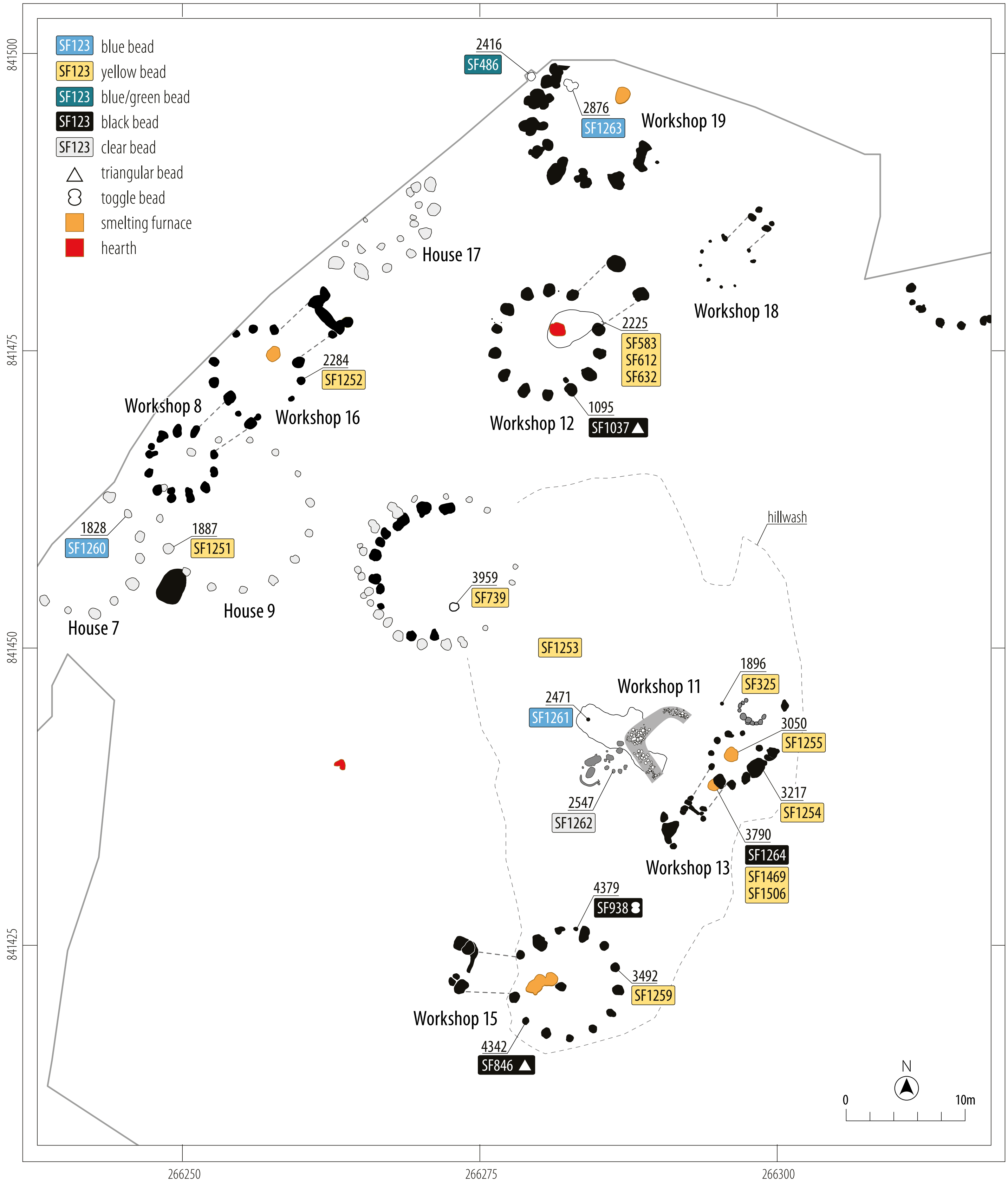


Illustration 4.36
Distribution of glass beads

from the burnt clay lining (1884). The clay lining of the pit contained a mixed charred grain assemblage, mostly consisting of hulled barley, thought to represent 6-row hulled barley, together with oat, with poor preservation meaning most of the oat grains can only be identified as probable oat (cf. *Avena* sp.). A small number of wheat grains with wheat sp. (*Triticum* sp.), probable spelt wheat (cf. *Triticum spelta*) and probable club/bread wheat were also represented. The wild taxa assemblage contained mainly arable and grassland plant such as grasses, goosefoots, corn spurry, sheep's sorrel (*Rumex acetosella*) and hemp nettles (*Galeopsis* sp.).

The backfills (1862 and 1864) of pit [1863] contained moderate quantities of cereal grain primarily consisting of hulled barley grains, and again it is suggested that this represents the cultivation of a hulled 6-row barley. Single grains of probable naked barley and emmer wheat were also present, which may represent a relict crop from the Neolithic now present as an arable weed, as too might the single grain of probable club/bread wheat in fill (1862). Small numbers of oat and probable oat were present, while there is a rare presence of probable rye (cf. *Secale Cereale*) within fill (1864). The wild taxa assemblage consisted mainly of arable and grassland taxa, including goosefoots, ribwort plantain (*Plantago lanceolata*), common hemp-nettle (*Galeopsis tetrahit*), grasses and buttercups (*Ranunculus* sp.).

Backfill (1865) contained an abundant and diverse grain assemblage, particularly in relation to the other pit fills, with 108 grains recovered per litre compared to 10–29 grains per litre in the other pit fills. Similar to the other contexts, the majority of grain present was hulled barley and it is again suggested that this represents the cultivation of a 6-row hulled barley variety. Within this sample were a number of broken barley embryo fragments, which suggests that a proportion of grain had sprouted. Growth of embryos is also associated with the malting of grain as part of the brewing process and may provide some tentative evidence for this activity at Culduthel.

A significant number of oat grains (175) were present in this assemblage, with palaea/lemma fragments recovered, together with a single glume base of common oat (*Avena sativa*), indicating this was the type of oat that was being cultivated. Significant numbers of wheat grains were also recovered from this fill, including grains of wheat sp., bread/club wheat, emmer wheat and spelt wheat (*Triticum spelta*). The numbers of wheat grain recovered are suggestive of some, perhaps limited, cultivation of different wheat types. Rye grain was also recovered from this fill and marks this as the only feature analysed at Culduthel to contain this cultivar. Large numbers of wild taxa were also present within this assemblage and, similar to the other fills, consisted largely of arable and grassland taxa, in particular grasses, goosefoots, docks (*Rumex* sp.), sheep sorrel, corn spurry and bristly oxtongue (*Helminthotheca echiodes*). A small number of damp/wet ground taxa were also recorded, such as sedges (*Carex* sp.), probable butterbur (cf. *Petasites hybridus*) and probable floating sweet-grass (cf. *Glyceria fluitans*). There is also some tentative evidence for the collection and consumption of wild foodstuffs, with the presence of a single probable crab apple pip (cf. *Malus sylvestris*) and a single probable wild strawberry fruit (cf. *Fragaria vesca*).

House 10/1

Charred grain from one of the post-holes (the postpipe (3144) in post-hole [3143]) produced a characteristic Iron Age grain assemblage of hulled barley grains. The number of 6-row hulled barley grains outnumbered the number of 2-row hulled barley grains at a ratio of approximately 3:1, indicating that it was the 6-row variety that was being cultivated. A significant number of indeterminate grains were present. The wild taxa assemblage was three goosefoot seeds, which, due to poor preservation, could not be identified to species level and are suggested to represent arable weeds.

House 10/2

Charred cereal grain from the fill (3616) of post-hole [3615] contained a small and varied grain assemblage. Hulled barley was the main cultivar present with both 2-row and 6-row grains identified, suggesting that 6-row barley was the main cultivated barley type. Along with the hulled barley there is evidence for the cultivation of oats, with both oat and possible oat recovered, and potentially spelt wheat, with spelt and probable spelt wheat both recovered. Together with the grain, a variety of wild taxa were identified, largely of arable weeds such as redshank, probable creeping buttercup (cf. *Ranunculus repens*), goosefoots, corn spurry and sheep's sorrel, together with grasses. Damp ground indicators such as sedges and pale persicaria suggest drainage may have been an issue in fields with areas prone to pooling of water. The presence of a small quantity of charred hazel nutshell fragments also suggests the continued collection of wild foodstuffs to supplement the diet.

Workshop 13

Samples were analysed from two pits ([3217] and [3811]) and a possible furnace [4179]. A small number of hulled barley grains were recovered from pit [3811], representing the cultivation of a 6-row variety. A limited assemblage of arable weeds of buttercup sp., grasses and fat hen were also recovered. Hazel charcoal from the fill of pit (3811) produced a radiocarbon date of 170 cal BC–cal AD 60 (SUERC-30398).

Pit [3217] contained a greater variety of grain. The majority was hulled barley, and probably reflects the cultivation of a 6-row variety. A small number of naked barley grains were also recovered, identifiable as 2-row naked barley, which may represent a relict crop now present as an arable weed. The recovery of grains of oat and probable oat suggest oats were being cultivated as a possible second crop to barley. Wheat was also represented by a small amount of emmer wheat grains, which again may also be part of a relict crop, together with a small amount of spelt wheat grain. The wild taxa assemblage was similar to pit [3811] and consisted mainly of arable and grassland taxa including goosefoot sp., hedge bedstraw (*Galium album*), black bindweed (*Fallopia Convolvulus*), redshank, docks and common chickweed (*Stellaria media*). There is also evidence for foraging and consumption of wild foodstuffs with the recovery of a significant amount (>100) of charred hazel nutshell fragments.

Five samples (1469, 1539, 1544, 1661 and 1666) from the fill (3467) of a possible former furnace [4179] were analysed. As this furnace was heavily cut into by the overlying furnace [3790] these samples may have been contaminated by this feature The samples contained hazel nutshell fragments (in particular from samples (1469) and (1539), which both contained >100 nutshell fragments), a blackthorn fruit stone and a small assemblage of charred cereals consisting of hulled barley, likely 6-row hulled barley and oats, together with a single emmer wheat grain. Small numbers of arable weeds and wayside plants were also present such as fat hen, grasses, nipplewort (*Lapsana communis*) and common chickweed.

Workshop 15

Sparse amounts of charred cereal grain consisting of hulled barley, including one grain of 6-row hulled barley and grains of oat and probable oat, were recovered. Both samples contained a higher percentage of wild taxa to cultivated grain at 82–84% wild taxa. Goosefoot sp. seeds were present in the largest numbers, together with corn spurry and common chickweed. Other wild taxa present included possible woodland margin plant, nipplewort and damp ground plants in possible club-rush (cf. *Eleocharis* sp.). Hulled barley from the fill of [3494] returned a date of 50 cal BC–cal AD 130 (SUERC-30395)

Material was also analysed from the fill (4121) of Furnace [4147]. Sample (1609) contained slightly more cultivated plant remains (56%) to wild taxa (44%). Barley was again the main cultivar with hulled barley recovered in the largest volume (although small number), with a single 2-row hulled barley grain and two 6-row hulled barley grains also retrieved. Naked barley was also represented in the assemblage from the furnaces, with probable naked barley and 2-row naked barley grains recorded. A single barley type grain (*Hordeum* sp.) was also present. The only other cultivar recorded in this assemblage was a single oat grain. A small number of wild taxa were present in the assemblage, which largely consisted of arable weeds such as mustards, redshank, goosefoot sp. & common chickweed. Possible wild foodstuff remnants of hazel nutshell fragments and crab apple pips were also present, similar to that seen in Workshop 13.

Discussion

Candy Hatherley with David Dungworth, Fraser Hunter, Dawn McLaren and Gillian Paget

A craftworking centre

The Period 3a settlement comprised a group of 10 'workshop' roundhouses, many with distinctive porched entrances, and four post-ring roundhouses. The majority of the workshops were for the smelting of iron and other processes associated with the manufacture of iron objects. Five contained stone smelting furnaces (Workshops 2, 13, 15, 16 and 19), each of which was in use at some point between the 2nd century BC and the early 2nd century AD. A further two workshops (Workshops 6 and 12) had evidence that smelting or other iron manufacturing processes were taking place within their interiors. Three workshops had no direct evidence of ironworking (Workshops 8, 18 and 22). Two (Workshops 8 and 18) were small buildings in the corpus of workshops identified on site and may have functioned as storerooms or shelter for other processes associated with the ironworking. Alternatively, these buildings may have been dedicated to the production of other 'clean' crafts, such as leather, wood or textiles. The four post-ring roundhouses (Houses 7, 9, 10 and 17) identified on site could equally have been workshops for organic crafts or non-combustible elements of ironworking. It is also possible that at least a few of these were domestic dwellings that predated the establishment of the craftworking settlement.

To the south of the main cluster of buildings, two stone-lined hearths and a turf-walled workshop were engaged in the production of glass and copper alloy objects. Only one of the hearths appears to have been used as a glass furnace and the date of the final firing of the hearth indicates it was undertaken at some point between the 2nd century BC and the early 1st century AD. Both hearths and the workshop were also engaged in ferrous and non-ferrous metalworking, and glass, bronze and iron objects may well have been made in tandem in this area.

The layout of the settlement suggests a closely packed but well organised group of workshops evenly spaced out across the terrace in a broad north-east/south-west orientation. Clear routeways between the workshops and open areas around each entrance can be recognised, presumably to assist the movement and stockpile of raw materials for iron-smelting (the charcoal and iron ore) to the workshop doors.

It is not clear if the workshops were constructed contemporaneously or if the craftworking site developed over time. Only on the north-west side of site, crowded with roundhouses and workshops, can the progressive development of the buildings be recognised. The archaeological record does indicate, however, that both the buildings and furnaces had complex histories. The multiple rebuilds of several of the furnaces show that these structures required a high level of maintenance and could have undergone periods of intense iron production. Similarly, the workshops were maintained over time and one was extensively remodelled. The rebuilding of House 10 may signify something distinct, perhaps that this was an important building or location in the settlement for the community and its continued presence was required.

Iron production at Culduthel

The exceptional preservation of seven iron smelting furnaces along with the large assemblages of iron objects and waste materials recovered from site demonstrate that the craftworking settlement at Culduthel was a highly organised enterprise that specialised in producing iron and high-quality natural steel. This evidence has illuminated many aspects of the cycle of iron manufacture undertaken on site, from the initial smelting of the ore to the finishing of objects. The iron objects show the activities the community was undertaking, the tools indicate that a wide range of crafts was practised, building materials were being manufactured and weapons were being made and repaired. Some finds, such as the chariot linchpin, daggers and spearhead, are rare finds for Iron Age Scotland and suggest that the community was of some status.

Resources

Iron ore and charcoal are the main resources required for the manufacture of iron. Although the evidence for the smelting of ore to extract metallic iron dominates the archaeological record at Culduthel, no ore was recovered from the tens of kilos of waste material collected across the site. Analysis of the waste and the objects recovered from the site has shown that the majority of the ore came from local sources and only a small percentage was imported.

Bog ore was widely available throughout the wetlands of Europe in the Iron Age (Tylecote 1986, 125; Pleiner 2000, 88) and was almost certainly used at Culduthel. Peat moorland is a familiar feature throughout the highlands of Scotland, and Drummossie Muir (an area of now drained blanket bog previously located a few miles to the south-east of Culduthel) is a good candidate for the main source of ore for the settlement (Ordnance Survey 1874, Sheet XII). As early medieval iron manufacture has also been identified close by (at Headland Phases 7 and 8) this may have been a continued source of good quality accessible ore.

A considerable amount of charcoal would have been required to fuel the furnaces and hearths. Pleiner (2000, 118) calculates that 8–10 units by weight of charcoal would be the minimum required to produce 1 unit by weight of iron, and this may have increased to 15 units for natural steel. The charcoal was most likely produced in managed or semi-managed woodland surrounding the site (Wheeler 2007). The initial identification of the wood species from the final firings of the furnaces indicated a mixed resource, with alder, hazel, oak and wild cherry were all used.

Production

The primary process to prepare iron ore for smelting is to roast it in a fire to remove unwanted material and break it into manageable lumps (Historic England 2011). This process was absent from the archaeological record at Culduthel but, practically, must have taken place reasonably close to the site. The lack of ore across the site and the lack of any evidence of its primary processing suggests that this work was separate, and production was highly organised on site with dedicated areas for specific tasks and a clear flow of processes through the site.

The main iron production processes identified at Culduthel were smelting and smithing. Each of the iron-smelting furnaces was remarkably consistent in form and appears to have been built following an established design. Each was built into a sub-circular or sub-rectangular pit with the edges of the pit lined with a horseshoe arrangement of water-worn boulders or slabs bonded with clay. Built onto this stone base would have been a thick clay-walled superstructure. This clay chimney would have been constructed by moulding wet clay around a roundwood withy frame and the stone base. Evidence for the clay superstructure, in the form of furnace walls and rims, were identified as fired clay fragments found within the interior of the furnace and adhering to the upper side of the stones with preserved wattle impressions. The rim fragments are a significant find, unparalleled within a Scottish Iron Age context, and confirm the use of cylindrical shaft-furnaces at Culduthel; an element of Iron Age ironworking technology that has always been assumed in Scotland but never demonstrated. Due to the fragmentary nature of the fired clay it was not possible to determine the diameter of the shaft top or its height, but it is not unreasonable to suggest that may have been up to 1m in height (Pleiner 2000, 175). A possible reconstruction of one of the shaft-furnaces is shown in Illus. 4.37.

The smelting furnaces were all free-standing non-tapped furnaces that produced bloomery iron, an identification made through the types and quantities of slag recovered. To produce iron within a non-tapped smelting furnace, a fire is first started in the base of the furnace (the slag pit) with the ore and charcoal placed into the shaft above. The ore and charcoal would be heated together, and slag would gradually form in the pit. To reach the temperature required for smelting (*c.*1200ºC), bellows would be used to blow air into the furnace, with the colour of the flame indicating when conditions suitable for reduction were reached, a process that would have taken hours (Historic England 2011, 3–4 and fig. 4; Pleiner 2000).

The ceramic tubes (tuyères) used to protect the bellows or to direct air into the interior of the furnaces were found in abundance on site. Three types of tuyère were identified, each presumably designed to be used in slightly differently structures. Some were very thick and heavily vitrified, suggesting that they were built into the clay shaft of the furnace. One furnace within Workshop 16 had a fragment of rotary quern where the central perforation had been reused as a support for a tuyère. The iron, leather and wood tools needed to construct a set of bellows are all present within the artefact assemblage.

Once cooled, the spongy metallic iron slag (the bloom) could be removed from the base of the furnace. The temporary wall seen in the stone lining of many of the furnaces at Culduthel was to allow access to remove the bloom. Within the furnaces was the last firing, which contained up to 10 kg of slag. The analysis of these bloom fragments show that the smelting process produced carbon steel in a single process, as opposed to producing plain iron, which would have been subject to further processing to produce steel or steeled edges; this direct steel is often known as natural steel. One significant discovery of the analysis of the waste

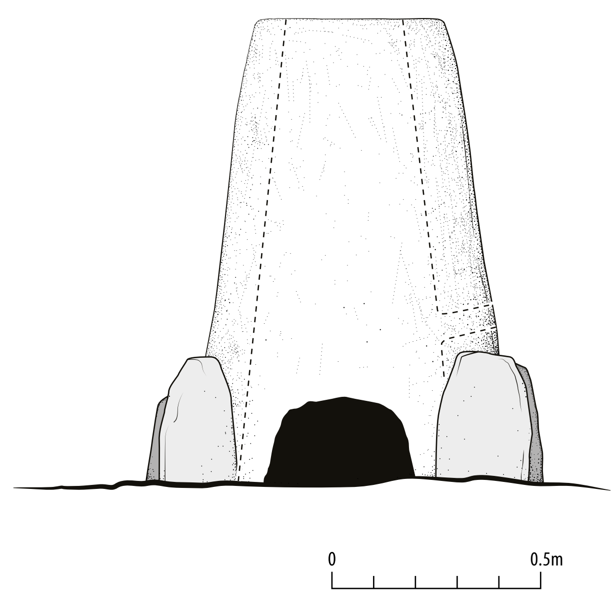


Illustration 4.37
Reconstruction of iron smelting furnace

material was that flakes and globules, first thought to be a type of hammerscale, had formed during smelting by flakes of metal forming between layers of fuel and ore, and by the globules of iron burning in the furnace.

Once completed, the iron bloom would first require further consolidation through primary smithing to remove impurities prior to the final process of shaping the iron to form bars, billets or objects. Evidence for smithing on pre-industrial sites is often found alongside the smelting furnaces due to this need to forge the bloom prior to any further working. From the waste material and iron objects recovered on site, both the initial forging of the bloom and the shaping of the iron were taking place. This waste material included pieces of 'smithing pan', processed bloom and plano-convex cakes of slag that form in the bottom of the hearth. Compacted fragments of floor surface, presumably close by the smithing hearths, contained hammerscale, charcoal and tiny slag fragments.

The iron objects produced on site demonstrate some of the processes used in the hot working of iron. The iron tools included sets that would have been used to cut up pieces of bloom and worked billets of iron. Bloom would be worked into a series of bars or billets of iron, which could then be further worked to make a product. The waste generated by these processes would include offcuts from the bloom and billets, hammerscale and hearth residues. Out of a total of over 470g of iron offcuts, the bulk came from the ends of various forms of bars.

Iron objects were also being recycled on site and several reused items are recognisable: fragments cut from a joiner's dog, a knife, and a bolt. Some pieces graphically illustrate the practicalities of recycling, with the ends heated up and twisted with the tongs to give them a good grip while the iron was cut. There was also ornamental ironworking being made, with a fine decorative branched terminal recovered that had been broken and abandoned during manufacture.

As well as recycling it appears that some objects were on site to be repaired or overhauled by the blacksmiths; Hunter (Chapter 6, Iron Artefacts) suggests that the copper alloy hilt guard was part of a sword that had been dismantled for repair, work that could be undertaken by a worker of metal. Other items showed signs of on-site repair, including a pair of iron snips and a bolt head.

Smithing hearths or forges are not easy to identify on archaeological sites as they do not require specifically built structures and can be simple pits which, during excavation, look like domestic hearths (Hodges 1989, 84). The evidence presented on site suggests that the main bank of smithies may have been located at some distance from the smelting of iron and outside of the excavation area. The only smithing hearth identified on site was a simple clay-lined bowl-shaped pit to the south of House 10. The hearth was a shallow oval pit that was bounded along its upper lip by a 'wall' of clay, presumably placed to support the bellows and protect the smith from the intense heat. This clay lip (or a series of lips) had fallen into the pit, sealing the final firing of the hearth. Concentrations of smithing waste was also identified around the area of the glass and copper alloy hearths and workshop (Workshop 11) and to the south in Workshops 13 and 15. Workshop 13 is a good candidate for the location of a smithy. Here a possible anvil stone set into a stone-lined pit was machined out during the topsoil strip and two blacksmith's sets (SF0352 and SF1001 – chisels with shafts or handles used to cut hot and cold metals) were recovered, one from the waste layer overlying the building and one close by. Alongside these tools were a collection of offcuts and unfinished items, which give a vivid picture of the blacksmithing processes potentially underway in this area.

The scale and duration of production

As the radiocarbon dating programme has only been able to identify a broad period of iron production between the 2nd century BC and the early 2nd century AD it is difficult to gain a better understanding of the potential scale of iron production at Culduthel without knowing whether this was a short-lived or long-term enterprise and when it started and finished. Iron artefacts do little to help to refine this chronology but the iron dagger (SF0479) of pre-Roman style and the lack of nails potentially hints that the majority of manufacture could predate Roman contact in Scotland from the later 1st century AD (Hunter, Chapter 6, Iron Artefacts).

Evidence for the scale of production is limited. The dumps of iron waste material are likely to represent only a small percentage of the later periods of production and cannot be used to accurately calculate the scale of production. Pleiner (2000, 172) states that, if maintained, a thick-walled free-standing shaft furnace could have been used intensely for years. The stone bases of the smelting furnaces do show repeated and intensive use and the thin skims of moulded clay recovered from their interiors would have been used to reline and repair the clay superstructures where necessary between smelts. Devitrified (heavily burnt) slag was also identified that could only have developed through multiple firings of the furnaces.

Workshop morphology

The workshops were each defined by a single post-ring that formed the load-bearing post-ring for the building. The roof of each workshop would have extended beyond the post-ring and an outer wall would have been located under the eaves, forming a circle round the house and adjoining the inner or outer ends of the porch. Giving the function of these buildings it is possible that an outer wall was extant or was in the form of moveable wattle screens to aid ventilation and control light when required.

The size of the workshops' post-rings varied considerably, from the smallest, which was only 3.7m in diameter (Workshop 13) up to the largest, at 9m in diameter (Workshop 19) (Table 4.1). This variation in size may have been the individual builder's choice but could reflect the multifunctional nature of the building. If the smelting of iron was a seasonal or periodic industry, these buildings may have been used at times for other craftworking or domestic habitation.

The eight workshops completely exposed in plan all contained porches. These entrances were predominantly located on the north-east side of each building, with only two on different orientations (Workshop 13 Stage 2 and Workshop 15). The porches were all narrow, with most a metre or under in width and one (Workshop 18) less than 0.5m wide. Their posts were consistently more substantial than those of the post-ring and many had multiple posts located at the outer ends, suggesting that doors were in place across the entrance or that posts for the outer wall were attached here. The length of the porches varied from *c.*2

to 5m from the inner post-ring, all considerably longer than the average prehistoric roundhouse porch of *c.*1.6m (Pope 2003, 196).

The north-east orientation of the entrances may have been linked to the time of year, and even the time of day, that iron smelting was underway. As the spring and summer sunrise is to the north-east (from April to September) this orientation would have harnessed the early morning sun, potentially to coincide with setting up for the day of work. Equally, this orientation would have ensured that the sun was not directly coming in during the winter months, being restricted to the SE–SW path during this season. The north-east opening would also have minimised the effects of the prevailing south-westerly wind (the predominant wind direction in northern Scotland). Only one entrance (Workshop 15) was orientated north-west, with one other (Workshop 13) shifting orientation from the north-east to the south-west. As both buildings were clearly engaged in the smelting of iron it is unclear why the entrance orientation was reversed for these buildings. Perhaps these workshops were designed to maximise the afternoon spring/summer sunlight or the winter light. It is also possible that certain other tasks (such as smithing) undertaken within these buildings required different ventilation conditions and the prevailing wind was of use.

Although it is not unequivocal that these buildings were constructed for the sole purpose of metalworking, their recurring design and similar internal layouts suggests they were. The repeated positioning of the furnaces just inside the entrance indicates that they were purposefully placed close to the doorway, presumably to maximise and control the light and ventilation into the interior of the building during smelting (McDonnell 1998b, 160). Being able to control the light is especially important here as the colour of the flames and the bloom were the sole indicators of temperature (a blue flame would show that carbon monoxide was present in excess and the conditions suitable for reduction – Hodges 1989, 88). As the furnaces in use would have been an astonishing sight for the community, especially glimpsed through the long narrow tunnel created by the porch, their placement would also have enhanced the spectacle and enigma of iron production.

Iron products and their distribution

The presence of well-stratified deposits at Culduthel had major implications for the recovery of finds during the excavation and has enhanced the understanding of their deposition. Hunter (Chapter 6 – Iron Artefacts) identifies that 77% of the ironwork came from occupation layers (i.e dumps of waste material or the backfill of ring-ditches), with the remaining 23% coming from features such as furnaces, pits or post-holes. So even on this rich site, barely half of the roundhouses produced iron objects, and only the well-preserved House 10/3 in Period 3b produced more than three finds. With this taphonomy in mind, if Culduthel had consisted only of negative features, less than a quarter of the iron objects would have been recovered. Even in deeper negative features that might have survived plough-truncation (such as the ring-ditch of House 10/3 in Period 3b), the more interesting patterns of deposition were usually identified in the upper fills. Without the protection of the hillwash or the spreads of waste material, these upper fills would have been lost or severely disturbed by the plough.

The working waste debris in Period 3a was mostly found within spreads of material identified across the site, either located within buildings or close by in adjacent open areas. These spreads probably represent the tramping of material during the occupation of the building or working area, or material accumulated immediately after. The spreads contained many artefacts that appeared to have been misplaced or discarded in the course of their use: fixings and fastenings, and small tools.

There are also examples of structured deposition in Period 3a, with several iron weapons deliberately incorporated into post-holes. A short dagger (SF0363 – Illus. 6.46) had been deposited in a post-hole located within the interior of House 7, a feature not definitively associated with the building. The dagger had clearly been well-used and maintained and had been resharpened prior to deposal. A second iron dagger (SF0479 – Illus. 6.46) was found in a post-hole immediately outside of the post-ring of Workshop 19. This dagger had been placed vertically point down into a matrix of stones and sandy silt that had been packed around the post. For the dagger to have survived intact it must have been carefully placed during the construction of the post-hole and the packing material built up, a difficult task to do without damaging the blade. The final weapon deliberately deposited was the head of a small throwing spear (SF1026) that had been placed within a post-hole of the post-ring of Workshop 6. The spearhead was also located within the stone packing, suggesting either deposition during the construction of the post-hole or very careful deposition when the post-hole was in use.

The deposition of high-status objects was also observed within the larger, and more elaborate buildings, in Period 3b (House 4 and House 10/3), which suggests that this was a relatively long-lived cultural tradition for the occupants of the site. These rites are discussed in greater detail in Chapter 7.

Glass and copper alloy production

Glass and copper alloy working debris (including droplets, rods and flakes of glass and crucibles, clay moulds, castings and casting debris) and finished or partially finished objects such as glass beads and decorative metalwork were recovered from a concentrated area to the south-east of House 10 (Illus. 4.34 and 4.36). Their distribution showed that the manufacturing hub for glass and copper alloy objects on site was three hearths ([2166], [2434] and [26]) and a turf-walled U-shaped structure (Workshop 11). The chronology of these industries is not well understood but a single radiocarbon date for the final firing of one of the hearths [2434] shows that this event took place at some point between the 2nd century BC and the early 1st century AD. This date is tentatively supported by the bulk of the copper alloys identified on site, which were a pre-Roman Iron Age leaded bronze recipe and a 2nd–1st century BC copper alloy sword hilt discarded in the nearby cobbled yard, presumably brought to the site for recycling.

Glassworking material (small flakes, droplets or fragments of rods or bars) was restricted to Hearth [2434] and its internal deposits, a distribution which suggest that only Hearth [2434] was used for glassworking. All three hearths contained non-ferrous casting debris including one large failed casting (SF0333 – Illus. 6.57), small fragments of casting waste (mostly droplets or nodules spilled from moulds) and crucibles and moulds, an assemblage that suggests that they were each used for casting bronze. The distribution of glass beads and copper alloy waste and objects (Illus 4.12, 4.16, 4.34 and 4.36) also suggests that Workshops 13 and 15 (or the areas where they stood) may have been utilised during the manufacture of glass and bronze objects.

The concentrations of glass and copper alloy casting debris across this area proves that the production of glass beads, enamelling and bronze-casting were undertaken in tandem, over the same hearths and within one specialist workshop. As these simple hearths could have been easily adapted to work either material, and enamelling was used to decorate bronze objects, these shared spaces seem both practical and functional. It also seems logical that these specialist workers, their toolkits and the precious raw materials required were kept together in one area of the settlement.

Alongside the glassworking material and the copper alloy casting debris were impressive assemblages of bronze items and glass beads, including an unfinished harness strap mount seemingly awaiting enamel. This evidence for Iron Age working of glass is very rare in Scotland and is exceptional for the UK. The recovered material indicates that the craftspeople had two main products: opaque red glass for inlay for metalwork (enamel) and yellow, blue and clear glass for jewellery, mainly beads. This production appears to be the reworking of imported glass ingots and objects, some at least coming from the Roman world. Glass could have been made at Culduthel and some level of primary production is implied by the assemblage of red glass fragments recovered. Non-ferrous casting has been identified on other Iron Age sites in Scotland (cf. Heald 2005). The Culduthel assemblage is an extraordinary find, however, and one of the largest ever discovered. It represents production of some scale, carried out within a dedicated workshop.

These assemblages and the evidence for glass and bronze-working on site show that Culduthel was a major production centre in the region for high status prestige items including glass jewellery and inlayed bronze objects.

Manufacture and resources

The hearths and workshops

The two stone hearths ([2434] and [2166]) were of similar design, comprising a paved area of flat stones edged on the south and west by a C-shaped area defined by edge-set stones and post-holes. The edge-set stones would have provided support for bellows and the post-holes may have supported timber fencing to protect from the weather. A third hearth (Hearth [26]) also had a close-set group of post-holes creating the C-shaped 'wind-break' along the south-west edge but no paving or pit was extant. All three hearths appear to have been used for bronze casting while only Hearth [2434] was used as a glass furnace.

To fire enamel and glass the temperature of these open fires would have had to reach *c.*800°C, an achievable temperature in a sheltered location with the aid of bellows (Bateson 1981, 87). Although there is no evidence that these hearths were located within a formal structure, it is assumed that they were protected from the elements by windbreaks of some form during firings. It is unclear if the U-shaped turf-walled workshop was roofed but even as an open structure it could have provided a level of shelter from the elements for various tasks associated with manufacture, such as the shaping and working of the glass, the inlaying of the metalwork and pouring molten bronze into moulds.

Glass

Glass arrived on site as recycled objects or imported ingots or bars. The glassworkers melted these items and shaped the molten glass into various forms. The paved hearths would have been ideal for this task. Most of the beads recovered from the site (the Guido 8 and 13 and the blue beads) were made at Culduthel and presumably within Hearth [2434]. Some single beads (the blue, black and green beads and the blue and white spiral bead) are characteristically Roman in composition and style and were imported.

There is no evidence that glass was coloured on site but imported rods or canes of different colours could easily have been combined here and cables or trails added using fine strands created from the primary canes. One high-quality opaque blue and white cable or trail intended for inlay in beads was probably Roman, identifying that specialist pre-formed components from the Roman world were also imported.

To create a glass bead, the glass ingots or objects would first have been melted over a fire within a crucible and poured to create short rods or canes. The rods would then be heated to 'plastic' over a flame on an iron rod (a mandrel), which also formed the central perforation. Once the glass was plastic it was shaped into beads through various methods (i.e. cut to shape, wound around the iron rod, twisted with other canes). Evidence of this manufacturing technique was seen on the beads, several of which had the fragile iron scale still in place from being worked on a mandrel. An unidentified iron tool recovered from Workshop 11 (SF0509 – Illus. 6.45) could have been used to roll heated glass beads.

For enamelling, the ingots of ready-made imported opaque red glass would first have been ground into a powder or paste with a mortar or rubbing stones before being placed into individual cells, like those seen on the unfinished strap mount from the site (SF0318). This careful work would have been done with a spatula or knife before the object was placed into the fire with tongs to melt the glass into place (Bateson 1981, 87). The item would then have been finished off by lightly grinding the surface of the glass-filled cells before polishing.

Copper alloy

The early stages of copper alloy production (the preparation of the ore, smelting and refining) are not evident at Culduthel. Analysis showed that the copper alloys on site were not, as has often been assumed for this period, made of mainly reused Roman material. The bulk were an Iron Age leaded bronze recipe, which indicates that the main period of production was prior to major contact between the settlement and the Roman world. The copper source cannot be pinpointed but analysis of lead coils found on site (presumably imported to make the leaded bronze) indicates a source in the Wanlockhead/Leadhills area in south-west Scotland. Zinc-containing alloys are evident in small quantities, showing that an amount of recycled Roman material was available at times.

The melting of copper alloy to cast could have been undertaken in a crucible over a sheltered fire intensified with bellows. Once the metal is heated within a crucible, and any impurities skimmed off, it can be poured into a mould of stone, clay or metal. The pouring and subsequent cooling would be done within a roofed building to keep the mould dry and clean as it was often prepared with a dressing of soot, ash, flour or animal fat to ensure a good surface for casting (Hodges 1989, 70).

The crucibles were made from local clays and would have been made on site (Chapter 6 – Sahlén). Many have signs of sustained use and evidence for curation, relining and repair. These objects show that the copper alloy workers at Culduthel were highly competent, with considerable technological knowledge. They clearly understood which alloys worked best for casting and which were good for sheetwork. Several very large crucibles suggest that substantial objects were being cast, while unusual forms of crucible indicate a willingness to experiment and try unorthodox forms.

Evidence for what they were manufacturing on site is unfortunately slim as many of the moulds are too fragmentary to identify what objects were cast. Elements of the bronzesmiths' toolkit, used to finish both objects and sheetworking, suggest that fine decorative objects were being made. These include fine snips for trimming pieces (SF0540), files (SF0512 and SF0534 – Illus. 6.45) for removing irregularities, a graver (SF0372) for engraving, a tracer (SF0357) for chasing them, scribers (SF0425 – Illus. 6.45 and SF1013) and punches (SF0366a – Illus. 6.44) for laying out designs.

A fine bar ingot (SF0844), the reused quern mould (a mould for bar ingot SF0339 – Illus. 6.17) and the concentrations of sheetworking debris show that casting to create roughouts for sheetworking was undertaken. The unfinished harness strap junction, and several other items (a toggle and a projected ring-headed pin), along with a failed casting of a possible ring, suggest that the site was creating exceptionally decorative pieces. Their style indicates that they were made by craftsmen with extensive knowledge of different regional and national artistic styles that were influenced from both Britain and the Roman world.

Illustration 5.1
Period 3b – The later craftworking centre

Chapter 5

PERIOD 3B – THE LATER CRAFTWORKING CENTRE

Introduction

The construction of two large and distinct ring-groove roundhouses of similar design herald the final phases of occupation of the craftworking settlement at Culduthel (House 10/3 and 4) (Illus. 5.1). Both houses were rich in artefacts, the majority seemingly deposited during or after their abandonment. Most were tools or debris associated with the craftworking activities of the settlement but some were high-status imported objects which imply a 1st to 3rd century AD bracket for occupation. For House 10/3 this deposition was a series of deliberate and carefully curated acts with an assemblage of exceptional items including Roman coins, a Roman brooch and an unfinished strap mount. A tight grouping of copper alloy sheetworking fragments recovered from House 4 may also have been a deliberate cache.

Immediately to the east of House 10/3 was a cobbled yard that had been repeatedly repaired during the occupation of the house. The southern edge of this yard respected the glass and copper alloy hearths and workshop and indicates that these industries were active when the cobbles was laid. The fragment of another cobbled yard was located to the south-east of House 4.

This activity is the last period of settlement at Culduthel and the subsequent abandonment of the site is identified by spreads of waste material that covered House 10/3 and its yard, and the workshops and hearths to the south. These spreads were likely derived from the collapse and natural spreading of multiple spoil heaps generated from the surrounding iron, glass and copper alloy industries.

Chronology

The Period 3b activity has been defined by stratigraphic relationships, roundhouse morphology and datable artefacts. Two artefacts recovered from House 10/3, a sestertius (AD 112–114) (SF0405) minted during the reign of Trajan (AD 98–117), and sherds of a later 1st to 3rd century AD Roman glass vessel from a pit within its interior indicate that House 10/3 was likely to have been in use at some point between the 1st and 3rd centuries AD and certainly up until the early part of the 2nd century AD. These artefacts help to support the 1st to 3rd century AD radiocarbon date recovered from material within one of the porch post-holes of the house (SUERC-30397). As the design of House 10/3 is strikingly similar to House 4, they are considered here as contemporary or near contemporary constructions. A single radiocarbon date from charred grain from one of the post-ring post-holes of House 4 also returned a date of between the 1st and 3rd century AD (SUERC-30380).

In terms of spatial relationships, the cobbled yard located to the south-east of House 10/3 clearly respected the ring-groove for its outer wall and is likely to have been broadly contemporary with the building. The cobbled surface to the south-east of House 4 had iron objects and waste incorporated into its matrix. It was overlain by a layer that was radiocarbon dated to the 2nd to 4th centuries AD (SUERC-30359), a date that is partially

Illustration 5.2
House 10/3 during excavation

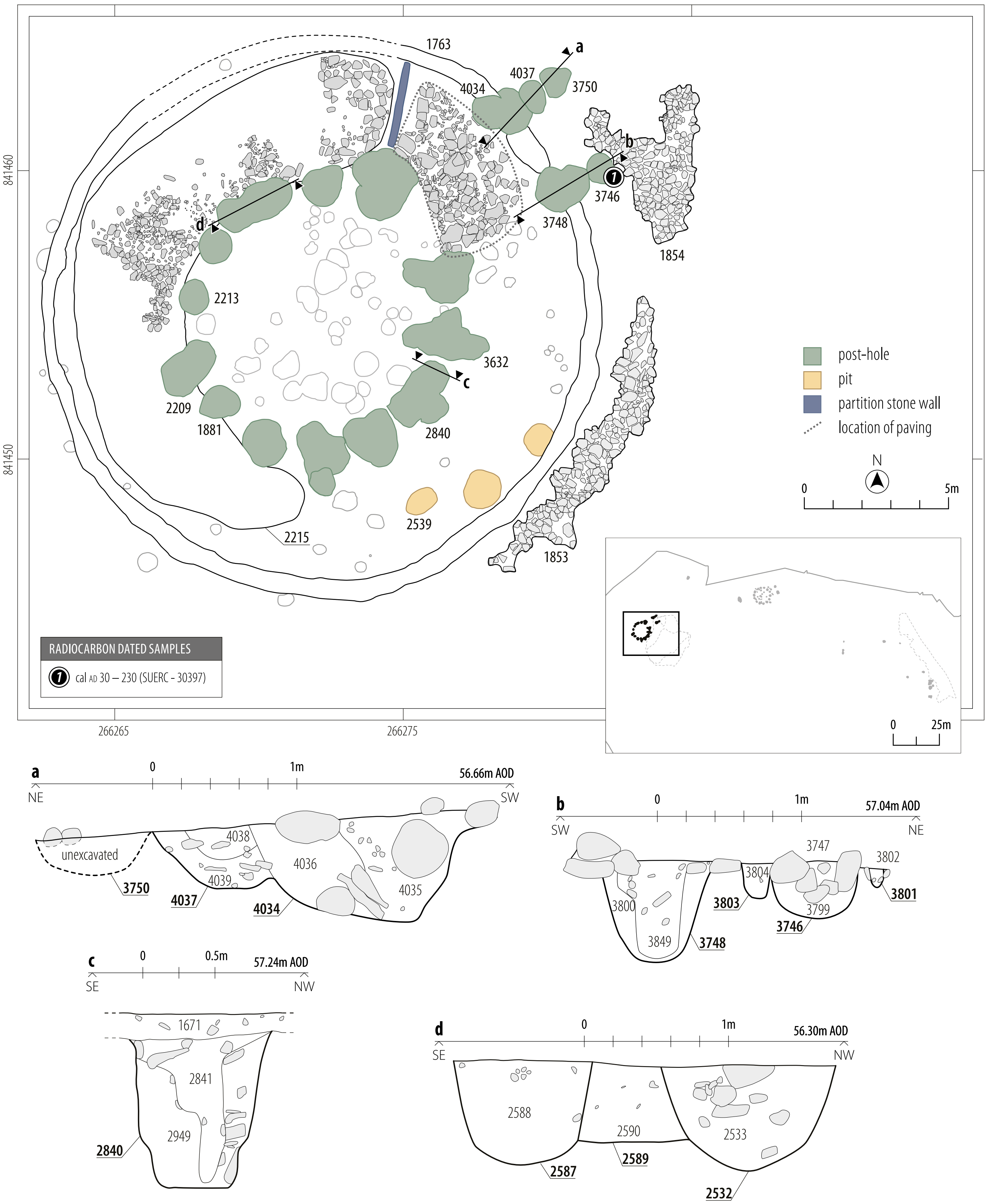


Illustration 5.3
Plan of House 10/3: Sections through post-holes

supported by a sherd of 1st/2nd century AD Roman pottery recovered from this matrix.

As stated in the previous chapter, any of the structures placed into Period 3a and described in Chapter 4 could have been constructed and/or in use in this period. Period 3b is probably best characterised as a series of modifications, upgrades or enhancements to a fully operational craftworking centre.

Period 3b

House 10/3

In its final phase House 10 was completely transformed into a large ring-groove roundhouse, complete with paving, an external 'apron' wall of turf and stone and an elaborate porch (Illus. 5.2 and 5.3). This house was a multi-phase building that had been modified and enhanced over time and could in theory have been upstanding for generations. In its primary form (Stage 1) the external wall was defined by the narrow ring-groove with the roof supported by an inner post-ring comprising large posts, many over 1m in diameter. At a later stage (Stage 2) the north-east facing porch was paved and an external stone-and-turf wall built to encompass the house.

Stage 1 – A grand building

The ring-groove

The ring-groove or outer wall-slot [1763] survived as a circular ditch up to 0.65m wide and up to 0.6m deep, with a projected internal diameter of *c.*18m (Illus. 5.4). The cut had near vertical sides that broke sharply to a slightly concave base. Packing stones and a dark band of material located on the inside edge of the cut indicated that the wall had been created with closely set posts (*c.*0.2m in diameter) held in place with stones. The ring-groove terminated either side of the porch's post-holes. It had been truncated on a section on the north. Stake-holes located around the outer edge of the circuit of the ring-groove indicate that wattle fencing may have been located abutting the wall (Illus. 5.5).

The porch projected *c.*3m out from the ring-groove and formed a *c.*2.3m wide entrance into the roundhouse. It was formed from four pairs of heavily recut post-holes, suggesting that the porch had been renovated over time. A single radiocarbon date of cal AD 30–230 (SUERC-30397) was recovered from porch post-hole [3746] located on the south wall.

A sill-beam trench (0.9m wide and 0.3m deep) with a U-shape profile was located within the porch in line with the ring-groove. This trench would have originally held a wooden sill-beam which was subsequently replaced by a stone

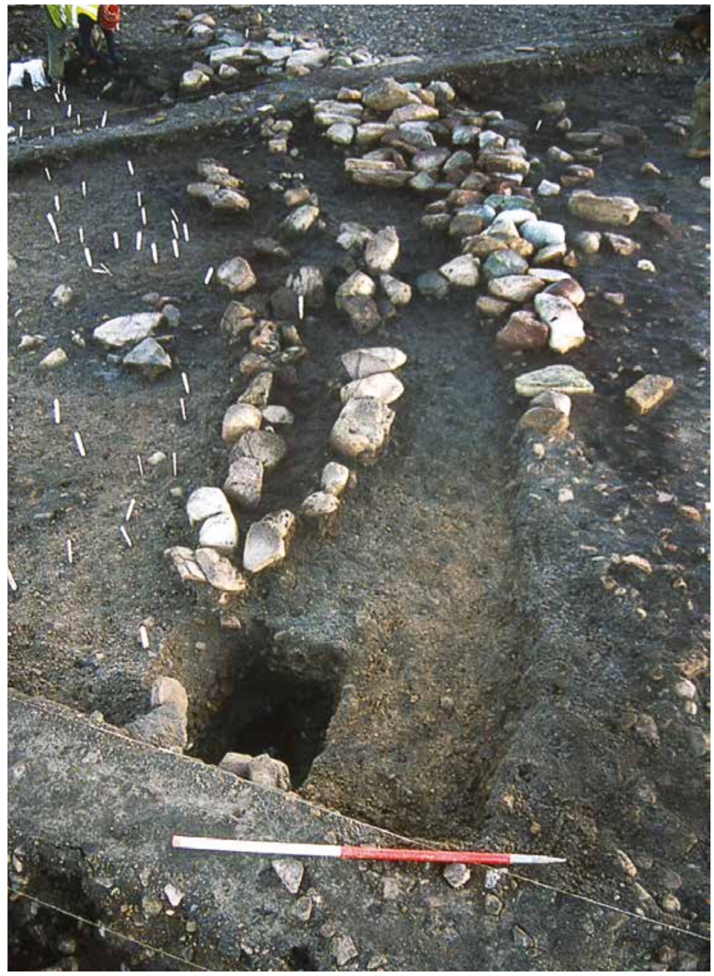


Illustration 5.4
House 10/3 – The ring-groove

Illustration 5.5
Excavating stake-holes beside the outer edge of ring-groove of House 10/3

threshold (3.8m long and 0.6m wide). Within the trench cut for the sill-beam was a small post-hole *c.*0.2m in diameter, which contained the in situ remains of a post that had been braced with a small wooden wedge. Fragmented remains of planking, presumably the vestiges of the sill-beam, were also identified within the cut.

Finds recovered from the entrance area of the house included several iron objects, *c.*3.5kg of iron slag and a smoother/polisher stone (SF0529) from upper fill of the ring-groove [1763]. Concentrations of burnt clay fragments from the interior of the porch and its post-holes indicate that the porch walls were likely constructed from lengths of wattle and daub.

Internal post-ring

The internal post-ring had a diameter of *c.*9m and contained 14 post-holes placed at regular intervals less than 1m apart. The post-holes were mostly sub-circular in plan with diameters ranging between 0.95m and 1.6m; the others had an amorphous shape in plan due to recutting to replace posts. Depths varied from 0.23m to 1.2m.

Most of the post-holes contained post-pipes. These were charcoal rich and remarkably consistent in their size between 0.4m and 0.55m wide, each tapering at the base. The depths at which the posts had been set were also consistent, between 0.6m and 0.8m deep. The majority contained large packing stones with smaller stones wedged into gaps.

Several significant artefacts were recovered from the various post-hole fills, including rotary quern stones and an iron linchpin. The upper part of a rotary quern (SF0324 – Illus. 6.16) had been placed grinding face down beside post-hole [1881] while the adjacent post-hole [2209] had three conjoining pieces of an upper rotary quern (SF0654) incorporated into the packing material. The other half was recovered in two pieces (SF0328 and SF0365 – Illus. 6.16) from the ring-ditch next to the post-hole. These quern stones may have been deliberately incorporated into the foundations of the house, a tradition first seen at Culduthel in the Early Iron Age roundhouse House 3 (Period 2). The iron linchpin with decorative fan-shaped head (SF0683) was recovered from the post-pipe of post-hole [3632] located near the entrance to the house. The pin is an unusual form, with a decorative fan-shaped head which may be a particular north-eastern type. It would have formed a part of a wheeled vehicle, presumably a chariot. This prestigious and rare item may have also been deliberately buried as a foundation offering for the house.

Iron slag was present in varying quantities in almost all the post-holes and most contained small quantities of burnt clay. Several pieces of flint including two scrapers (SF0655 and SF0662), a fragment of stone palette (SF0747 – Illus. 6.17), a roughed-out stone spindle whorl (SF0584) and a cylindrical fragment of lead (SF1624) were also recovered from the post-ring post-holes.

Ring-ditch

Located within the inner edge of the ring-groove was a ring-ditch [2215] located curving along the western side of the roundhouse. It was a shallow cut feature with a maximum depth of 0.4m and was between 3.6 and 4.2m wide with a broad, flat base partially lined with a rough cobbled surface. Through erosion its inner lip had encroached onto the cuts of several post-holes of the post-ring. At the northern terminal of the ring-ditch a low drystone wall was built onto a cobbled surface. Within the centre of the ring-ditch were six pieces of burnt planked timber overlying the cobbled surface. These planks were consistently 0.07m wide and 0.03m thick with lengths varying between 0.13 and 0.3m and may represent the remnants of a wooden floor.

The ring-ditch was backfilled (perhaps intentionally) with compacted black silty sand sealed by dark grey silty sand (2155/2179) up to 0.4m deep. This backfill had an abundance of charcoal and pockets of burnt bone throughout, as well as occasional patches of yellow/orange ash, and was incredibly rich in artefacts (Illus. 5.8). The most notable of these were an iron sickle (SF0510 – Illus. 6.45) and three copper alloy Roman coins; a *sestertius* (AD 112–14) (SF0405) minted during the reign of Trajan (AD 98–117), an almost blank sub-circular disc (SF0401 – Illus. 6.55) that could be another *sestertius* based on its size and an unidentifiable coin (SF0503 – Illus. 6.56) possibly an *As* with the bust of Domitian (AD 81–96) on the obverse. The other metal finds were a probable shank of a copper alloy ring-headed pin (SF0368), a possible iron nail (SF0497), an iron blade tip (SF0367) and three iron objects (SF0366), two of which may be pin shanks, the other a small iron bar. Two quern fragments (SF0328 – Illus. 6.15 and SF0365), a rubbing/hammer stone (SF0477) and quantities of slag were also recovered.

Stage 2 – The remodelling of the house

The stone wall base

Along the east side of the house was a line of rubble (1853 and 1854), constructed from a single course of stones that curved to follow the line of the ring-groove. This has been interpreted as the base for a turf-and-stone wall that would have encircled the house parallel to the outer timber wall (Illus. 5.6). It was built directly onto the cobbled surface (1945), suggesting that the wall was not part of the original design of the house but a later remodelling of the façade of the building.

The wall base was heavily truncated and collapsed elements of it were identified (1682) but towards the entrance of the house the wall widened and originally may have encompassed the porch and flared out beyond it. A semi-circular 'cell' was located at the terminal of the wall at the porch (seen in the foreground of Illus. 5.6). It created a recessed area 2.2m wide and 2m deep. A flat stone with sharpening grooves (SF0519) was recovered from within the 'cell' and a single yellow bead [SF 1253] was recovered from rubble (1853).

Paving

The space between the porch and the internal post-ring had been paved with flat stone slabs (1979) with the gaps between the flagging filled with smaller angular stones (Illus. 5.7). This paved entrance measured 5.4 × 4.7m and was roughly rectangular in plan. A possible pivot stone (SF0725) had been incorporated into this surface and may have been in situ. The paving sealed a line of small post-holes that formed a timber wall or panel, which would have covered access to the right-hand side of the roundhouse from the entrance. Beyond this line of post-holes was a parallel line of stones set within a narrow gully. As this feature was located immediately in front of the north terminal of the ring-ditch it may have been a threshold at its entrance.

Illustration 5.6
House 10/3 – Stone wall base

Illustration 5.7
House 10/3 – Paved entrance

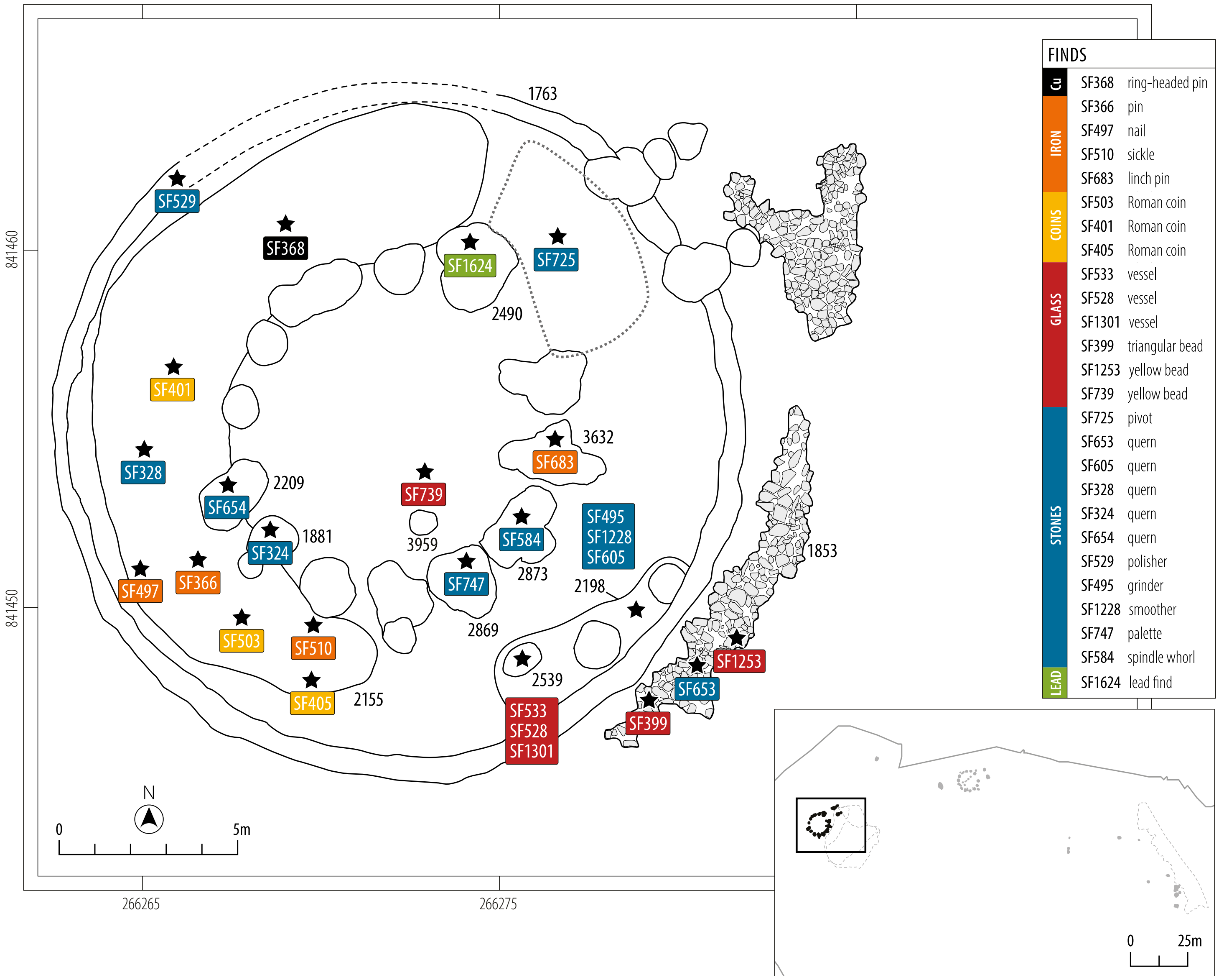


Illustration 5.8
House 10/3 – Distribution of finds

Internal pits, post-holes and occupation deposits

Lines of post-holes formed partition walls or fixed furniture within the interior of the house (Illus. 5.3). Their layout suggests linear sub-division within the interior of the building following the alignment of the entrance and at right angles to it. A patch of possible occupation deposit (2470), located in the area between the post-ring and the ring-groove, contained a probable Iron Age rim sherd decorated with incised motifs (V19) and one pit within the interior Post-hole [3959] contained a single yellow bead [SF0739] (Illus. 5.8).

On the southern side of the house, between the post-ring and the ring-groove, were three pits (Illus. 5.3 and 5.8). One pit [2539] contained pale-blue/green fragments of Roman vessel glass (SF0533 and SF1301). Additional fragments of the same vessel (SF0528) were found within a layer overlying the pits (2198), alongside a smoother (SF1228), a grinder (SF0495) and a fragment of rotary quern (SF0605).

Stage 3 – Abandonment

A layer of black sandy silt (1671) was located across the interior of the house, respecting the boundary of the outer wall but covering the cut of the ring ditch and most of the cuts of the post-ring. This deposit must have developed (or been dumped) once the house was abandoned and the post-ring and roof removed. It contained several high-status and unusual artefacts, many of which were located close to the entrance of the former building (Illus. 5.9). A copper alloy Romano-British enamelled plate and fantail brooch decorated with inlaid rings of blue, red and yellow enamel (SF0278 – Illus. 6.50), and a copper alloy cruciform harness strap mount (SF0318 – Illus. 6.50) were both near the entrance and a copper alloy ring fitting (SF0313) overlaid the ring-ditch on the north. A miniature iron axe (SF0338 – Illus. 6.44), possibly for fine woodworking, and eight lead objects

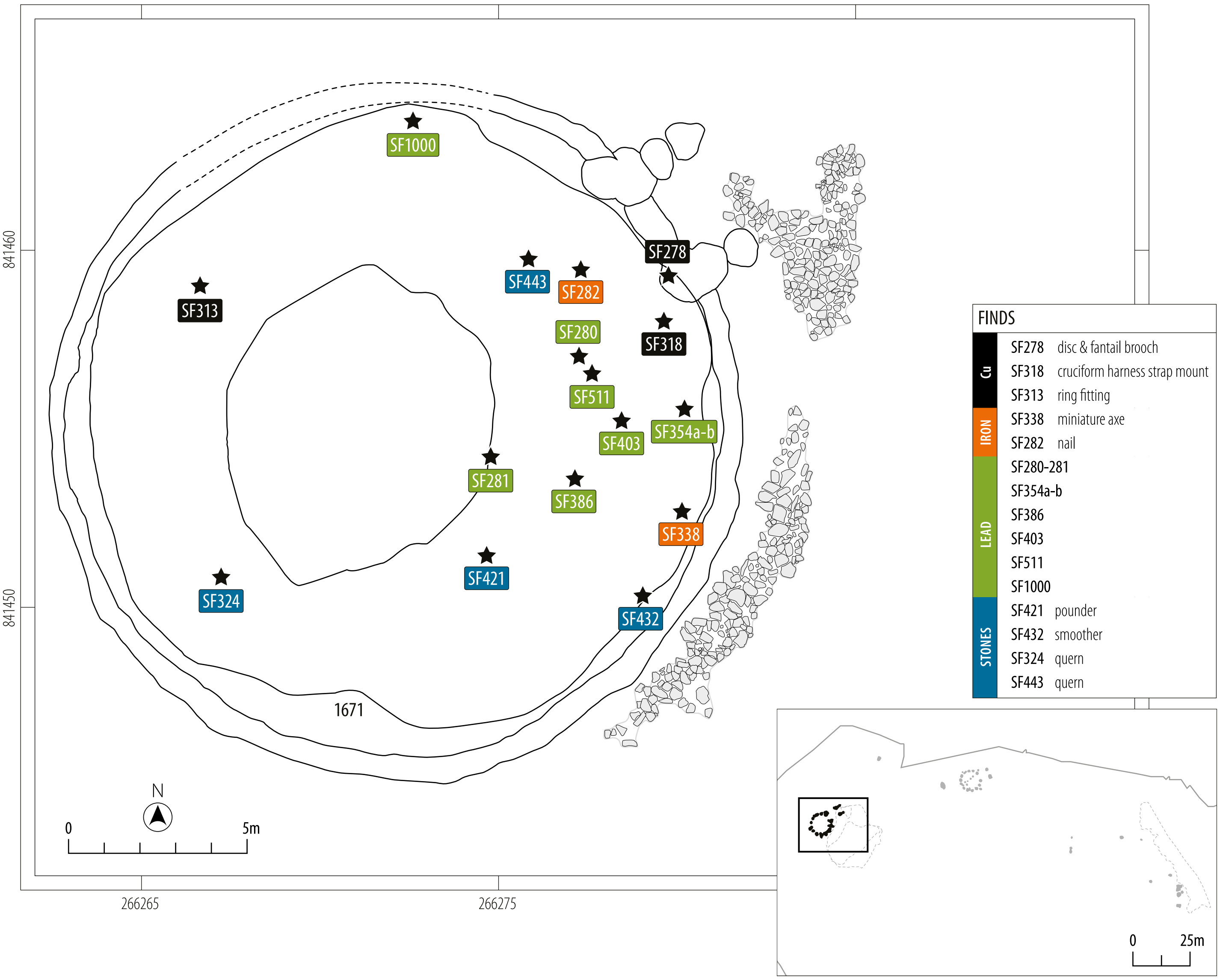


Illustration 5.9
House 10/3 – Plan of abandonment layer 1671 showing finds

(seven tightly coiled strips – SF0280, SF0281, SF0354a, SF0354b, SF0386, SF0403 and SF0511) and a folded and hammered D-shaped sheet (SF1000) were also recovered.

House 4

Situated *c.*50m to the north-east of House 10/3 was another substantial ring-groove roundhouse of similar design and size (Illus. 5.10 and 5.11). The house was defined by a narrow ring-groove, *c.*17m in internal diameter, which enclosed a ring-ditch and internal post-ring.

The ring-groove

The ring-groove or wall-slot survived as a continuous circular ditch with a steep sloping cut *c.*0.9m wide and 0.4m deep. It had been recut intermittently along its inner and outer edges, suggesting that repairs to the wall were staggered. On the north-east side of the house, two substantial post-holes ([1635] and [1661] – measuring 1.25m in diameter and 0.42m in depth and 1.7 × 1.45 × 0.7m respectively) formed a *c.*2m wide entrance into the house. An offcut of an iron sheet (SF0245) was recovered from the packing material of post-hole [1635].

The post-ring

The internal post-ring of 13 post-holes measured *c.*8m in internal diameter with the posts placed at less than 1m intervals; the two posts forming the entrance into the interior (1709 and 1814) were 2.5m apart. Two post-holes ([765] and [2244]) contained packing material in the form of large sub-angular stones; the gaps had been filled with smaller, more fractured stone. A single

Illustration 5.10
House 4 during excavation

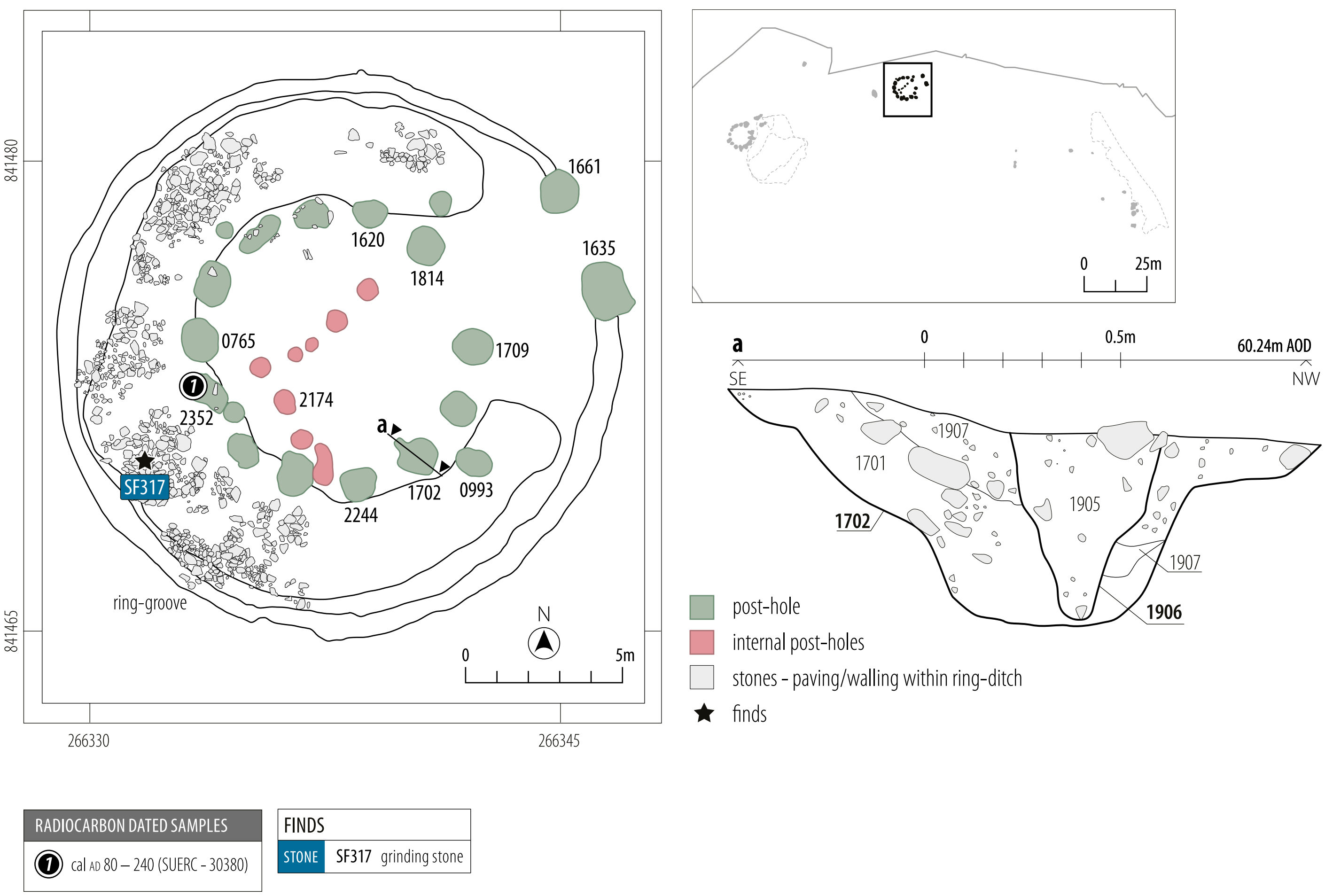


Illustration 5.11
Plan of House 4: Sections through post-hole; Sections through ring-ditch and ring-groove

Illustration 5.12
House 4 – Stone paving and walling within ring-ditch

radiocarbon date from charred grain from one of the internal post-ring post-holes [2352] yielded a date of cal AD 80–240 (SUERC-30380).

Post-holes within the interior of the post-ring formed an L-shaped structure and may represent internal partitions within the house. A large collection of fired clay was collected from the interior, suggesting that wattle and daub panels may have been extant.

Ring-ditch

A ring-ditch was located within the western side of the house. It was a deliberately cut feature, curvilinear in plan with a shallow slope and a concave base. It varied in width between 2.25m at the south terminal to 5.3m on the west, and was up to 0.65m deep. A narrow curvilinear gully was present along the inner edge of the ring-ditch and a shallow oval pit [993] was cut into the base. The pit contained small charcoal pieces that may have been the remains of a burnt wicker vessel.

A large amount of stone was located within the ring-ditch, some of which may have been the remains of internal stone structures (Illus. 5.12). Close to the south terminal of the ring-ditch was a slightly curved arrangement of stones, which may have formed a step or threshold into the deepest part of the ditch. Abutting the step was a short length of wall. Spreading out from the wall was a large amount of tumbled stone located along the outside edge and base of the ring-ditch along its western half. These stones were interpreted as the (displaced) remains of paving on the base of the ring-ditch and a revetment wall that would have lined the outer edge of the ring-ditch.

A large amount of carbonised timbers was present in the basal fills of the ring-ditch and these fragments of planks and small posts were identified as remains of in situ joists and flooring. Other larger loose timbers may represent structural elements of the house that collapsed into the ditch during or after being destroyed by fire. Overlying the carbonised timber was an ash-rich layer of bright orange sandy silt (1624) up to 0.18m thick, interpreted as the burnt remains of a collapsed turf wall. This was visible, to a lesser degree, in shallower areas of the ring-ditch, where contemporary deposits (1715), which were very dark and charcoal-rich with lighter brown and orange patches, were also thought to represent a turf wall in situ within the interior of the ditch. An iron file with traces of an offset wooden handle (SF0195), was recovered at the base of (1715).

The excavators saw the carbonised timber, and the burnt turves, as evidence that the house had been destroyed by fire. Certainly, for the timber to be preserved in this way it seems likely that the turves smothered the burning wood and prevented it from turning to ash. Whether this is evidence that the entire building was destroyed by fire or of a more localised event within and surrounding the ring-ditch is not clear.

The uppermost fill of the ring-ditch was a deposit with abundant heat-fractured stone and charcoal (775 – Illus. 5.13). Several pieces of copper alloy strips and sheet were recovered from this deposit including a folded and flattened strip (SF0173a), part of a vessel represented by two fragmentary sheets held together with three rivets (SF0173b), a slightly tapered sheet fragment (SF0231a), two non-joining sheet fragments (SF0231b), a possible mount formed by a sheet cut into an isosceles triangle (SF0232) and an offcut (SF0241). An iron offcut (SF0188) and two pieces of iron slag were also recovered.

The cobbled yards

Two cobbled surfaces were identified, one located immediately to the east of House 10/3, and one some distance to the east of House 4 (Illus. 5.1). These were similar levelled areas of stones, presumably created as hard standings for human and animal movement.

Cobbled yard by House 10/3

A cobbled surface (1945/2130) had been laid immediately to the east of House 10/3 (Illus. 5.14 and 5.15). It had been truncated on its south-west and north-east sides but survived as an area *c*.28 × 18m. The cobbles were small, sub-angular and tightly packed within a black, charcoal-rich matrix that formed a uniform, even surface. The yard had been repaired and resurfaced in places, with patches of cobbling identified beneath and above the surface.

The yard is likely to have been broadly contemporary with the construction of House 10/3 as, where extant, it respected the

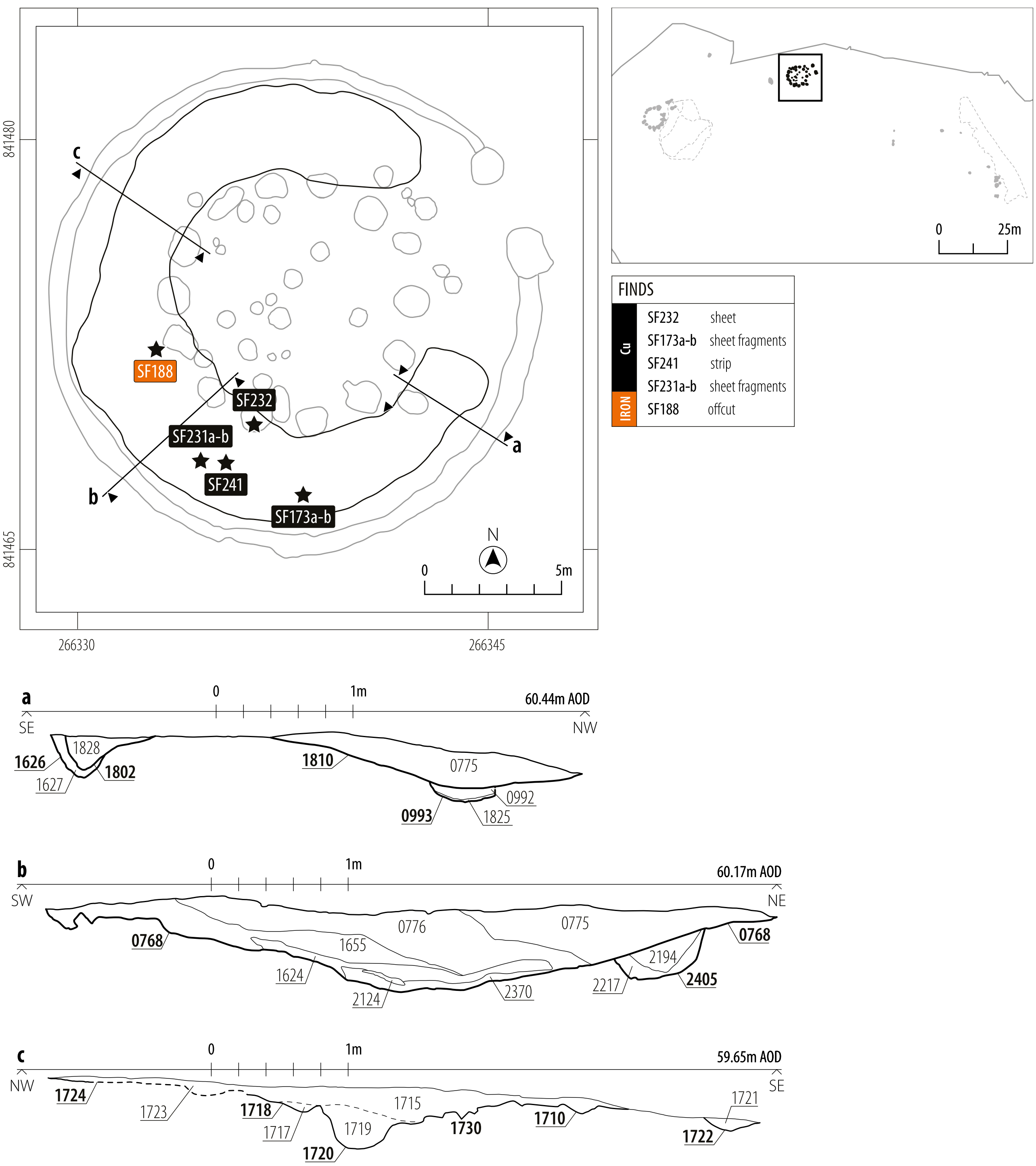


Illustration 5.13
House 4 – Plan of abandonment layers showing finds distribution; Sections through ring-ditch and ring-groove

Illustration 5.14
House 10/3 – Cobbled yard 1945

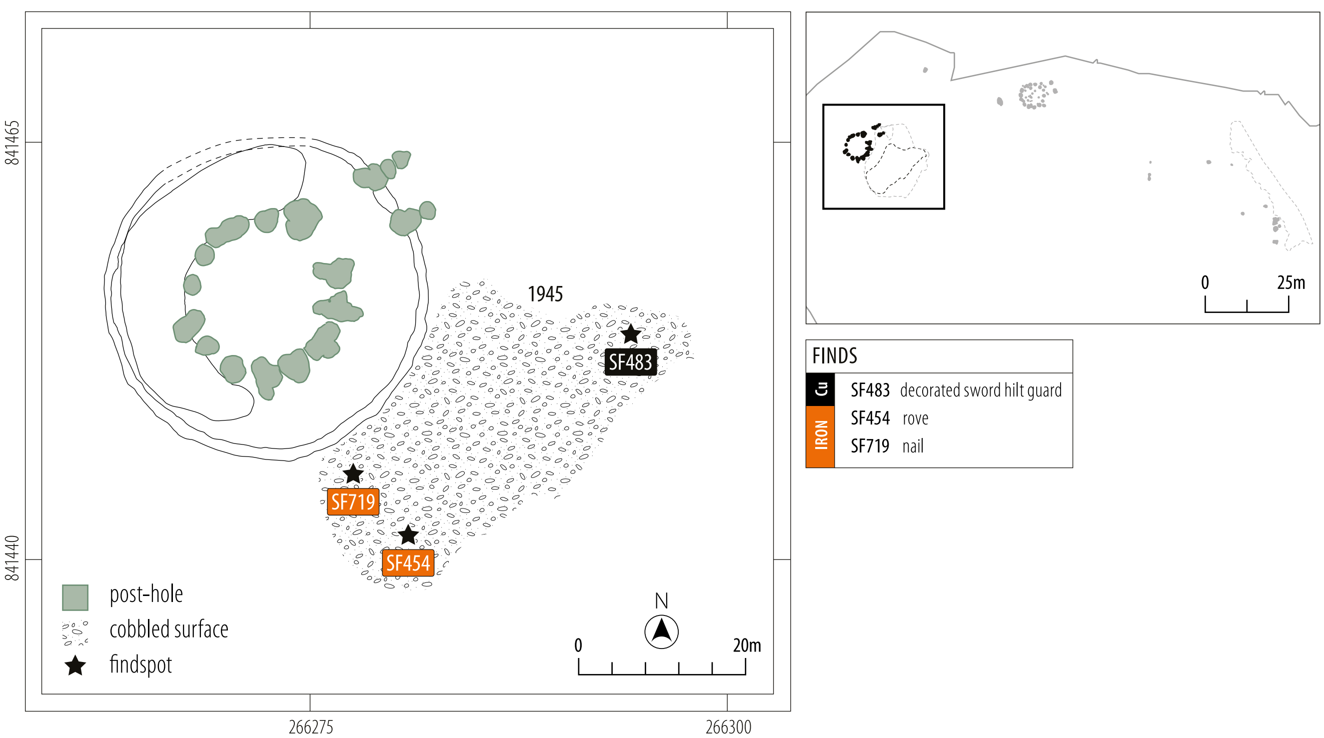


Illustration 5.15
Plan of cobbled yard 1945

ring-groove of the house's outer wall. It was certainly laid prior to the construction of the stone wall base (1853) interpreted as the foundations of a turf-and-stone wall that encircled the house in Stage 2. The cobbles respected the glass and copper alloy working structures (Workshop 11 and the stone-paved hearths) and these structures were almost certainly extant when the yard was laid and were probably in use. Deposits overlying the workshop and the hearths were also spread over the surface of the yard. A single AMS date from charcoal retrieved from one of the spreads (2100) returned a date of 90 cal BC–cal AD 90 (SUERC-30371).

A total of 8kg of iron slag was either incorporated into or on top of the cobbles along with large fragments of burnt clay with adhering slag. The yard was rich in iron artefacts, including a possible offcut (SF0562), a diamond-shaped rove (SF0454 – Illus. 6.47) and a nail (SF0719). The most outstanding artefact was a worn copper alloy decorated sword hilt guard (S0F483), the first hilt guard found in northern Scotland and most probably dating to the 2nd–1st century BC. Its location and wear suggest that the sword may have been stripped down to be re-hilted and the old hilt was discarded in the yard, perhaps awaiting recycling in one of the hearths close by.

A patch of rougher cobbling (2982 – not illustrated) overlying the cobbled yard contained a thin-walled pottery sherd decorated with two incised lines (V13). This cobbling respected the edge of Workshop 11 but capped Workshop 15.

Cobbled surface east of House 4

Far to the east of the extant settlement was a rough cobbled surface (227) (Illus. 5.1). It measured *c*.50 × 12m and had been built into a natural hollow. The cobbles comprised two layers of sub-angular stones with smaller stones and fragments packed into gaps to create a more even surface. Towards the western edge of the surface large flat stones were laid in two roughly linear parallel arrangements. These were possibly the bases of drystone walls. The cobbled surface had a band of pale grey ash (226) along its western edge. A dark (almost black) sandy silt (225) sealed both the cobbles and the ash and contained a small body sherd of a Roman vessel. A radiocarbon date of cal AD 130–340 was made on the charcoal within (225) (SUERC-30359).

This area was one of the last to be investigated during the excavations and only two 1m wide slots were excavated through the cobbled surface and its associated deposits. These slots showed that the deposit sealing the cobbles (225) was *c*.0.25m deep and that the cobbles had been laid directly onto the natural subsoil at the base of the hollow. The blade of a reaping hook (SF082) was recovered from within the cobbles and iron slag and burnt clay was identified within and overlying the cobbles.

Pits

Eight pits were identified to the west of the cobbled surface (Illus. 5.1). They each contained large quantities of heat-shattered stone, charcoal and iron slag and two contained an abundance of metalworking debris ([185] and [200]). Both of these were heavily truncated 'keyhole' shaped shallow pits of similar dimensions and contained large quantities of iron slag and burnt clay. A large, dense piece of slag (SF015) situated at the base of pit [185] may indicate that it was an iron smelting furnace.

Two further oval pits were identified to the west of House 4. Pit [3599] overlaid the porch of Workshop 18 and contained large pieces of charcoal and some possible structural timbers, as well as small fragments of burnt bone, iron slag (SF0687) and a fire-cracked fragment of a cobble rubbing stone (SF0658). A single radiocarbon date of AD 80–240 (SUERC-30396) was made on the charcoal within the pit. The upper fill of pit [1615] (1616) located immediately to the west of House 4 contained small amounts of iron slag, a small, rectangular sectioned whetstone with a pendant hole drilled at one end (SF0247 – Illus. 6.18) and an iron nail (SF0262). The basal fills were rich in charcoal and contained abundant charred hulled barley.

The end of the craftworking centre

Overlying the deposit sealing House 10/3 (1671) and spreading over the entire eastern side of the house was a vast spread of black silty loam with abundant fire-cracked cobbles (798/1680-1) (Illus. 5.16–5.18). It measured *c*.27m × 24m and was up to 0.4m deep, giving the deposit an approximate volume of 260m^3. It completely covered the cobbled yard, the glass/copper alloy workshop and hearths and Workshops 13 and 15. Overlying this spread was a thick band of hillwash (2101).

The sheer scale of this deposit meant that a methodology had to be designed that allowed for the spread to be thoroughly investigated and removed. The first stage was to excavate a series of test pits in order to determine its nature and depth. Following the test pitting, a mechanical mini-digger was deployed to remove the bulk of the spread, with a final clean done by hand. A baulk was left across the centre of the deposit to further understand the stratigraphy of the spread (Illus. 5.17 and 18).

Metal-detectors were used across the surface and during the excavation to retrieve as many metal finds as possible. The spread contained large quantities of iron slag and other metal-working debris. A significant amount (over 40kg) of iron slag was recovered by hand during excavation. This sample is estimated to be between 5 and 10% of the total iron slag contained within this spread of material. Numerous fragments of burnt clay were also retrieved, many identified as cast-offs from furnace structures.

The spread also contained a total of 29 iron objects (Illus. 5.16 shows only the finds with locational information) including a square-sectioned rod (SF1017), decorative objects such as a projecting ring-headed pin (SF0181 – Illus. 6.46), several tools including an awl (SF0326 – Illus. 6.44), possible iron offcuts (SF0177, SF0185, SF0203 and SF0291), a hook mount (SF0285 – Illus. 6.46), nails (SF0289 – Illus. 6.47) and a holdfast (SF0183 – Illus. 6.47). Non-ferrous metalworking debris was less common. Three sherds of crucible (SF0351), a flawed casting of a ring-shaped copper alloy object (SF0333 – Illus. 6.57), and a lump of copper alloy casting waste (SF0288) were recovered. A small non-ferrous bar with three transverse grooves (SF0309 – Illus. 6.59) and an undiagnostic pottery sherd (V16) were also recovered.

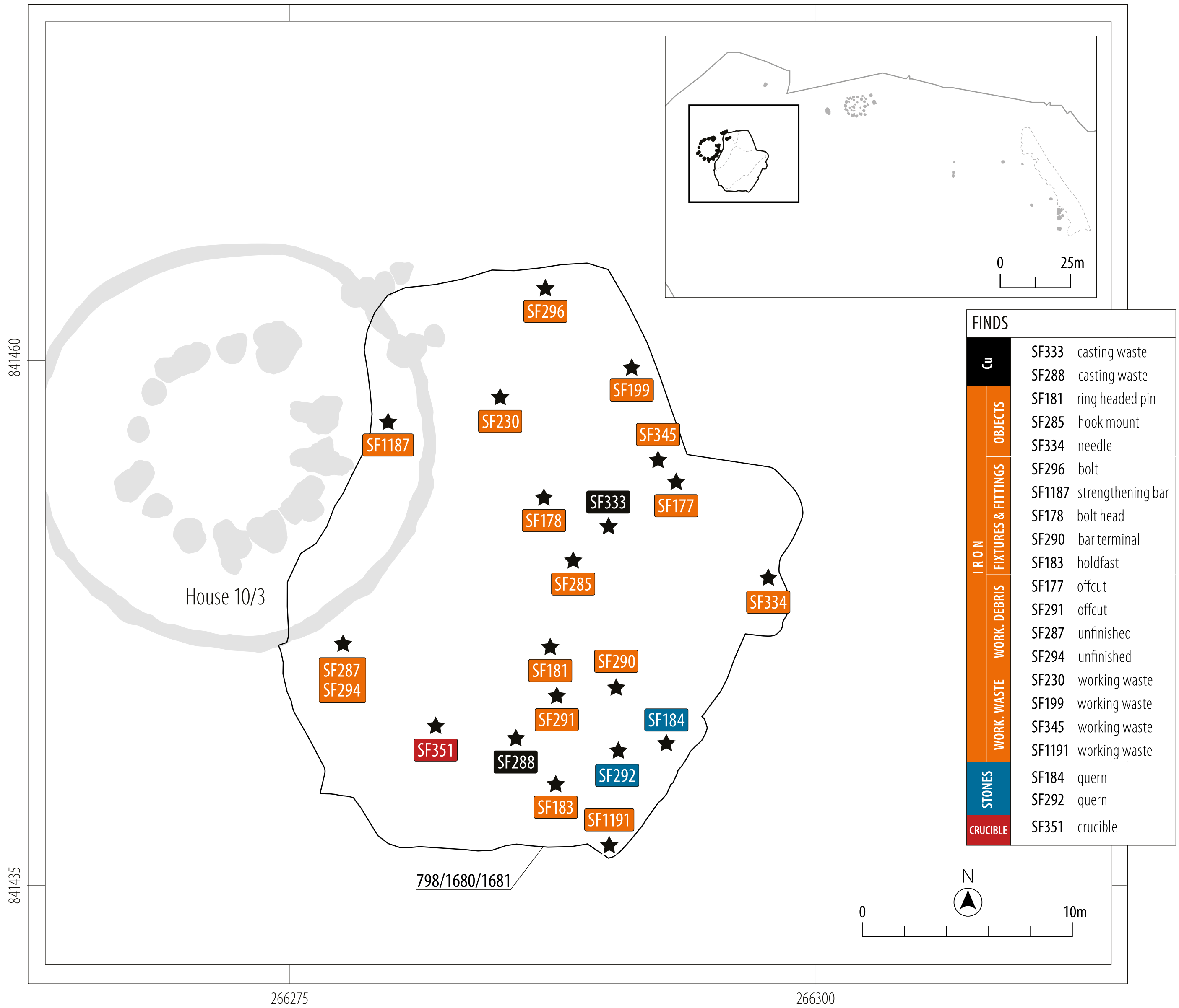


Illustration 5.16
Plan of abandonment layers and distribution of finds

Environmental summary of Period 3b

Scott Timpany, Sarah-Jane Haston and Abby Mynett

House 10/3

Samples were analysed from three post-holes of the post-ring ([1881], [2213] and [2209]), a thin patch of occupation surface within the house (2180) and the basal fill (2179) of the ring-ditch [2155]. The four samples from the internal features contained small quantities of charred grain: oats, naked barley and hulled barley (6-row type). Hulled barley grains were also recovered from the ring ditch, alongside a single grain of oat grain and a single grain of spelt wheat. Two of the post-holes contained hazel nutshell fragments and a range of arable weeds were present within the samples, with particularly high numbers of goosefoot sp., and seeds, common chickweed, redshank, probable meadow buttercup (cf. *Ranunculus repens*), mustards, pale persicaria, sheep's sorrel, ribwort plantain and nipplewort. The occurrence of heath grass and a number of other grasses (small to large-grained), together with sedges, including possible common sedge (cf. *carex nigra*) within post-hole [2213] may tentatively suggest that turf may have been used as part of the roof construction.

House 4

Material from the fill of three post-holes was analysed, two from the post-ring ([1620] and [2352]) and one [2174] from an internal

Illustration 5.17
Industrial waste (798) overlying cobbled yard (1945)

Illustration 5.18
Baulk across the cobbled yard and overlying waste

post-hole. A small amount of hulled barley grains was recovered from all three post-hole samples, with evidence of both 6-row hulled and 2-row hulled barley grains present.

The wild taxa assemblage provides evidence for collection of wild foodstuffs with the recovery of charred hazel nutshell fragments. There are a number of arable weed taxa within the assemblage indicating accidental inclusion with the grain, such as goosefoots, common chickweed, corn spurry, ribwort plantain and grasses. A small number of grass species could be identified within Sample 2351 from post-hole (2352), with brome/false brome, tufted hair grass (*Deschampia cespitosa*) and heath-grass (*Danthonia decumbens*) recovered. The presence of these grasses could provide some indication of turf being used as a construction material for the roof. A single radiocarbon date obtained from hulled barley grains within post-hole (2352) has provided a date of cal AD 80–240 (SUERC-30380)

To the west of House 4 was pit (1615), which contained evidence for metalworking activity with the presence of iron slag, whetstones and an iron nail. Three samples (466, 467 and 468) have been analysed from the upper (1616), middle (1617) and basal (1637) fills of the pit. The fills contained varying quantities of charred plant remains with the most grain coming from the middle fill, which contained 86.2 grains per litre and the least grain being present in the lower fill at 5.5 grains per litre. Despite the variance in the quantities of grain within the individual fills the overall grain assemblage is similar, consisting mainly of hulled barley, thought to represent 6-row hulled barley with grains of both 2-row and 6-row identifiable. A small number of naked barley was also present, which again may represent a 6-row variety. Wheat was also identified within the middle fill of the pit with the occurrence of small numbers of wheat sp., bread/club wheat and probable bread/club wheat grains. A limited number of wild taxa were present within the pit fills and, akin to the grain, the greatest quantity was recorded in the middle fill. The overall wild taxa assemblage comprises mainly arable weeds such as goosefoots, corn spurry, common chickweed, grasses, redshank and small nettle (*Urtica urens*).

Pit 316

This pit was located within a cluster of pits located to the west of cobbled surface (227). A single sample (121) was analysed from the fill (315) of pit [316], which contained an abundant amount of charcoal but no evidence of metalworking waste. The fill of this pit was unique across all of the analysed samples as it contained the only charred grain assemblage to contain a higher proportion of oat (61.25%) than barley (7.19%). Abundant quantities of both oat and probable oat were recovered, with a small number of oat grain and glume bases present that could be identified as common oat, suggesting this was the variety of oat being cultivated. Barley was the only other cultivar present within the pit, and the majority of that which could be identified was hulled barley, likely to represent a 6-row hulled barley variety. A single probable naked barley grain was also identified within the assemblage, which may represent a remnant crop. A small amount of chaff was recovered from this sample through the presence of three culm node fragments, which are likely to have survived the early processing stages of the grain rather than represent on-site processing activity. The wild taxa assemblage consisted predominantly of arable weeds such as sheep's sorrel, goosefoots, redshank and corn spurry, together with the only appearance of wild radish (*Raphinus raphinistrum*). A small number of damp/wet ground taxa were also identified such as meadow buttercup (*Ranunculus acris*) and grey club-rush (*Schoneoplectus tabernaemontani*).

Discussion

The final occupation at Culduthel is dominated by two very similar and likely contemporary roundhouses, which were built in the early part of the 1st millennium AD. The *sestertius* found in House 10/3 confirms that the building was likely to have been in use until at least the early part of the 2nd century AD. The cobbled yard to the south-east of House 10/3 connects the occupation of the house to the bronze, glass and ironworking surrounding it. As ferrous and non-ferrous metalworking was incorporated into the cobbled surface and the boundary of the yard respected the copper alloy/glassworking hearths and workshop it is highly likely that the manufacture of bronze, glass and iron objects was ongoing while the house was occupied. Another cobbled yard and a series of metalworking pits to the east of the surviving settlement show that the manufacture of iron objects was not restricted to the cluster of workshops seen on to the west.

The date for the abandonment of the settlement at Culduthel is unknown. The suite of radiocarbon dates for the final firings of the furnaces and hearths and the *sestertius* found within the backfill of the ring-ditch of House 10/3 suggest that most activity had ceased by the early 2nd century AD. Prior to the abandonment of the large roundhouses some exceptional artefacts were deliberately placed within their interiors. Many of these were exotic objects and must have been highly prized within the community. For House 10/3 this practice was revived once the house was a roofless shell. After the settlement was abandoned thick layers of waste debris, the by-products of decades of industry, spread and sealed parts of the site. This waste debris was in turn sealed with layers of hillwash.

The roundhouses

Houses 10/3 and 4 were both substantial timber structures (*c.*17–18m in internal diameter) that were well-maintained and modified over their lifetimes. The size of these buildings and the range of high-status artefacts recovered from within their interiors suggests that these were important buildings within a community of considerable status and connections. The range of tools and debris recovered from both houses show that these buildings were deeply connected, if not intertwined, with the surrounding industries. Given their scale and grandeur these buildings could have been multifunctional spaces within the craftworking centre; domestic housing, secure storage for precious raw materials, studio space for clean crafts such as leatherworking and a gathering place for the community.

External appearances

The deeply cut wall-slots revealed that the walls were constructed from closely set timber posts set with stones. The roofs were supported by the inner ring of posts, with additional support at the weakest structural point of the building provided by the porch at House 10/3 (Pope 2003, 196). The inner post-ring posts were all large and deeply set, with some up to half a metre in diameter and many almost one metre in depth. These proportions, along with the heavy use of packing stones and evidence for numerous replacements, suggest that their roofs were substantial, and an upper storey or mezzanine floor may have been present in each.

The entrance porch into House 10/3 was wide (*c*.2.3m) with large posts defining each side. These had been replaced several times, presumably a requirement after being exposed to the elements. The corridor of the porch was enclosed with wattle and daub and led to the main door of the building. Once across the threshold, a flagstone surface formed an inner porch with internal doors set to the left and right.

From the early part of the 1st millennium AD large roundhouses were increasingly common in Scotland (e.g. Bellfield in North Kessock (Jones 2009), Birnie and Clarkly Hill (Hunter 2007b, 2011a and 2012) and Broxmouth (Armit and McKenzie 2013, 179)). Ring-groove roundhouses are frequently identified in this period and are often at a larger scale than many equivalent post-ring structures, and it is possible that the building of very large houses may have been easier with this technique and more structurally sound. The ring-groove design was also popular in the north-east in the first centuries of the 1st millennium AD (e.g. in Angus at Ironshill East – McGill 2003; Culhawk Hill – Rees 1998; Seafield Road West – Cressey and Anderson 2011) and may well have been the preferred design in the region at this time. A brief review of the current corpus of cropmark sites termed 'palisaded enclosures' that enclose single post-ring roundhouses indicates that more large ring-groove roundhouses may be extant in the region than are currently identified (e.g. at Wardend of Durris, Aberdeenshire (Russell-White 1995), Fairy Knowe Broch at Buchlyvie, Stirlingshire (Main 1998) and Scotstarvit, Fife (Bersu 1947)). In close proximity to Culduthel the 17m dimeter ring-groove house (Structure A) at Seafield Road West in Inverness was similar in size to House 10/3 and 4 and may have been contemporary with the 1st century BC to 3rd century AD settlement surrounding it (Cressey and Anderson 2011, 6–7). Further to the north-east the later Iron Age settlement at Birnie in Moray has identified ring-groove roundhouses of similar date and size to Houses 4 and 10 (Hunter 2003).

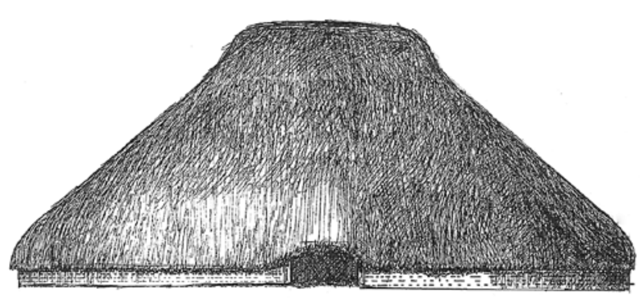


Illustration 5.19
Reconstruction of House 10/3

The use of ring-grooves for Houses 10/3 and 4 is in complete contrast to the post-ring design of the workshops and other roundhouses in Period 3a. These large buildings would have dwarfed the surrounding structures and been of notably different appearance. The only other certain ring-groove house on site was built in the Early Iron Age (Period 2 House 3) and was of considerably smaller scale. Another possible ring-groove roundhouse, Structure 20, was not excavated and its date is unknown.

The late great architectural historian Bruce Walker worked with Ross Murray on the possible appearance of the large ring-groove roundhouses. His reconstruction of the exterior of Stage 1 of House 10/3 forms the basis for Illus. 5.19.

Interior designs and activities

The most dominant feature within the interiors of each house would have been the ring-ditch in the western arc. These were deliberately cut complex features with stone and wooden partitions, floors and steps.

It is not known what activities were undertaken within these subterranean chambers. Artefacts incorporated into the primary backfill of both ring-ditches appeared to have been deliberately deposited and their presence might suggest that the cellars were used to store the community's most precious items. The richest cache of artefacts was deposited within the ring-ditch of House 10/3 and included an iron sickle, three copper alloy Roman coins and the probable shank of a copper alloy ring-headed pin. In the ring-ditch of House 4 a cluster of copper alloy strips and sheets may have been a horde from bronze-working. The ring-ditch of House 4 also captured and sealed evidence of a fire. Alongside burnt timbers (identified as the suspended wooden floor of the ring-ditch and structural timbers from the house) was a considerable amount of burnt turf that survived as a thick orange ash layer. This material may represent turf insulation, roof material or walls that collapsed and sealed the burning timbers in the ring-ditch.

House 6 at Douglasmuir in Fife (Kendrick 1995) had a similar deeply cut ring-ditch, which Kendrick interpreted as a covered cellar. Other similar 'cut' ring-ditches have been interpreted as souterrains located within the interiors of roundhouses. At Dubton Farm East in Angus (Ginnever 2017) and Dalladies in Aberdeenshire (Watkins 1980), the ring-ditches both showed evidence for wood and stone linings and these cool dank cellars may have served as sunken larders for the storage of dairy products such as cheese and yogurt. The ring-ditches of Houses 4 and 10/3 were floored and partitioned spaces, potentially self-contained working and storage areas separated from the central space by the inner post-ring.

For both houses the area enclosed by the post-ring was sub-divided by internal walls, with their north-west and southern arcs partitioned into separate spaces. No internal features were identified within the north-west 'room' of either house and these areas may have had clearly defined functions such as sleeping bays or working areas.

From the assemblage of stone and iron tools recovered from the interior of House 10/3, lighter industries may have been taking place. Hide-, leather- and woodworking are all represented by the range of fine tools. A full complement of leatherworking tools represents the entire process, from hide preparation to decoration. These tools include stone smoothers for scraping and preparing hides, iron objects for fine leatherwork (such as curved knife SF1019) and snips for cutting and shaping, scribers, engravers and an embossing tool for decorating, an awl for piercing and triple toothed handled tools and punches for making perforations. Other tools include a very small iron axe, perhaps designed for delicate woodworking such as shaping or carving, and a palette fragment, possibly for grinding pigments for painting or dyeing. Textile production is represented by one unfinished spindle whorl and an iron needle (for leather working or textiles).

Secondary additions

Modifications to House 10/3 would have altered the external appearance of the building dramatically. A wall, the stony base of which survived, curving around the south-east side of building, was constructed on top of the cobbled yard. This stone base may have been for a turf or stone-and-turf wall that now clad the exterior of the outer wall and porch, extended out beyond the entrance and formed a C-shaped cell in front of the porch. If the wall had risen to the height of the eaves it would certainly have made the house appear more robust, the walls wider and taller, and the entrance longer and more imposing.

The two large ring-groove roundhouses at Aldclune in Perthshire had similar secondary stone walls built onto their exteriors. At Site 1, a house of comparable dimensions and date to House 10/3, a stone wall base encircled the outer edge of the ring-groove (Hingley 1997, Illus. 3 and 7). The earlier house, Site 2, also had a surviving length of stone wall, which flared to one side of its entrance (ibid). Closer to Culduthel, and of similar design to House 10/3, was a large post-ring roundhouse at Bellfield in North Kessock (Structure 1, Jones 2009). This was an impressive building *c*.18m in internal diameter with an elongated porch *c*.6m long, built on the site of a smaller house that had burnt down between 90 cal BC and cal AD 80 (Headland 2012 – SUERC-39712). An arc of stones survived on the north-west side of the house *c*.1m from the outer edge of the post-ring (Illus. 5.20). This was a single course of large cobbles *c*.1.4m wide which was interpreted as the base of a freestanding stone or stone-and-turf wall encircling the building. Stake-holes around the outer and inner edges of the wall indicated that a wattle fence would have been extant on both sides of the wall to support the turf element of the structure.

The embellishment of Iron Age roundhouses by extending and widening their walls is seen in Scotland in both timber (e.g. Culhawk Hill in Angus – Rees 1998) and encasing in stone (e.g. Tofts Ness, Quanterness – Dockrill 2007; Loch Glashan in Argyll – Henderson and Gilmour 2011; Phase 6 at Broxmouth Hillfort – Büster and Armit 2013). Romankiewicz (2009) suggests that additional walling may have been constructed to enhance or alter the appearance of the house and, in the case of stone buildings, create higher walls. These modifications may have been done to mark significant moments within the household such as new ownership or to memorialise important community events (Brück 1999). They could also have been done for practical structural reasons. If, as postulated, House 10/3 stood for several decades or longer, the stability of the timber superstructure may have become weak. The archaeological record shows that posts had certainly failed and been replaced. The turf-and-stone 'apron' wall may therefore have been constructed to give additional support to a sagging outer wall and to further insulate the now decrepit building.

Additions to entrances, such as those built of turf at the timber roundhouse at Culhawk Hill in Angus (Rees 1998), would have embellished the entrance to the building and added some sheltered space. The C-shaped cell built in front of the porch echoes the location and dimensions of the 'guard cells' identified at the entrances to some complex Atlantic roundhouses (e.g. at Carn Liath in Sutherland – Love 1989). What purpose this 'cell' served is unclear but for House 10/3 it would have certainly narrowed and restricted entrance into the building.

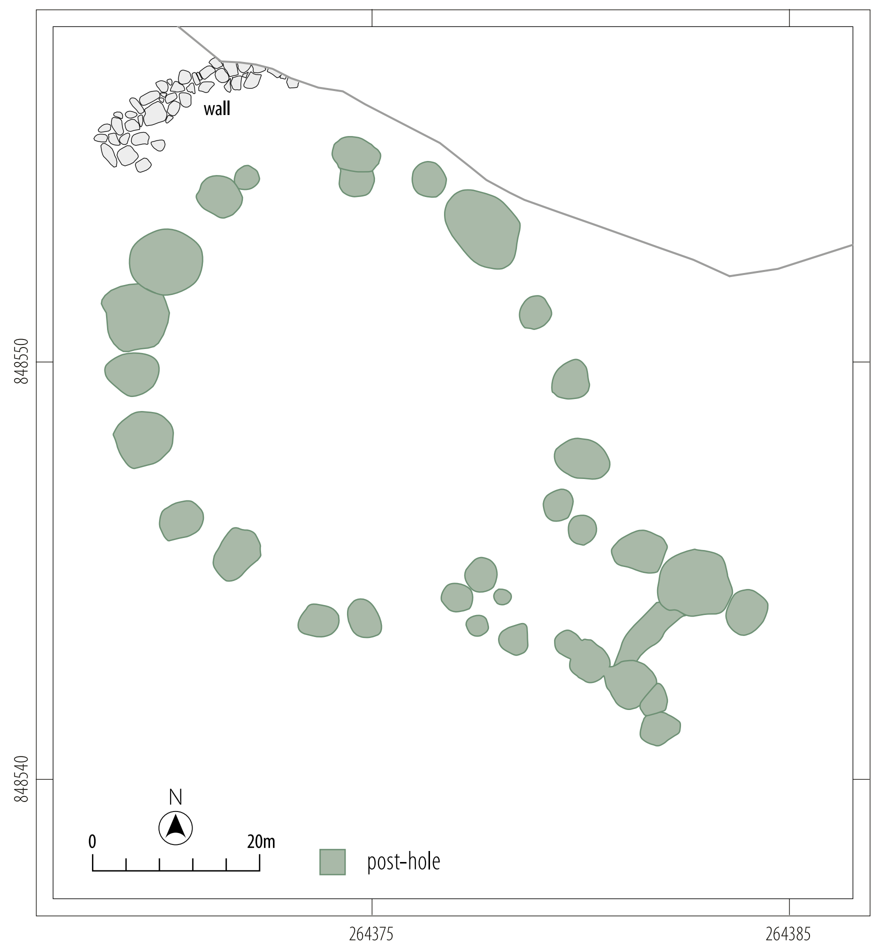


Illustration 5.20
Structure 1 at Bellfield, North Kessock

Longevity and location

That House 10/3 and 4 were both maintained during their lifetime and House 10/3 was substantially remodelled suggests that these buildings may have been in use for several decades if not longer. The House 10 plot had a considerable history of continuous occupation with three houses built in succession onto the exact same stance. This longevity of occupation in one location is a phenomenon frequently seen in the Iron Age (e.g. at Phase 6 at Broxmouth – Armit and Mckenzie 2013, 175 – and at the Howe in Orkney – Ballin Smith 1994). This routine may have been purely practical to replace a dilapidated house or to build a larger house as requirements changed. However, the effort to rebuild on the same plot rather than start anew would have been considerable and other driving forces such as the inheritance of land, the need to define increased status or announce new ownership of the plot must also be considered (Brück 1999; Armit and McKenzie 2013).

The yards

Hard-standings such as cobbled surfaces rarely survive the plough in lowland locations and the information gleaned from these rare occurrences gives an insight into the contemporary working and walking surfaces of the settlement. The yard next to House 10/3 was clearly a heavily used area, which had been repeatedly repaired with stones and debris from iron and non-ferrous metalworking. This yard must have been a busy place for a considerable period of time and demonstrates that House 10/3 must have played a considerable role in the settlement.

The cobbled surface and pits to the east of House 4 demonstrate that iron production was taking place in other areas of the site and that the entire enterprise at Culduthel was of a larger scale than the surviving archaeological record alludes to.

The abandonment of Culduthel

Deliberate deposition

The final acts within the large roundhouses appear to have been rituals to mark the end of the lives of these buildings. In House 4 the deposition of copper alloy strips in the upper fill of the ring-ditch may commemorate the decommissioning of the building after a fire. At House 10/3 three Roman coins, an iron sickle and a copper alloy ring-headed pin were deposited in a thick layer of homogeneous compacted black silty sand at the base of the ring-ditch. This deposit, rich in burnt bone and ash, could have been accumulated floor sweepings or midden material brought in specifically for this task. Either way, the dumping of this deposit was the primary act in 'closing' the ring-ditch and the placing of these artefacts here may have been done to mark this significant event in the life of the house.

The structured deposition of objects can be seen throughout the life of House 10/3. Items were placed within the post-holes during construction (Illus. 5.8 – notably an iron linchpin and quern fragments), a Roman glass vessel was placed within a pit during occupation and objects were deposited across the interior of the house particularly at the entrance after its abandonment (Illus. 5.9). This final deposition is puzzling as this layer covered the entire internal post-ring and the house must have been a roofless shell at this time but, as the layer sits within the bounds of the footprint of the building, the outer walls must still have formed some kind of physical barrier. The artefacts within this deposit are some of the most exceptional from the site and include fine copper alloy artefacts (a Roman disc and fantail brooch, a cruciform harness strap mount and a ring-fitting), a miniature iron axe and a group of tightly coiled strips of lead.

Several interesting observations can be gained from the structured deposition of items during or after the abandonment of Houses 10/3 and 4. The departure from these structures must have been planned and the range of objects carefully curated as they were clearly chosen for their individual symbolic value and for their significance as a collection of the memories of the community, the industry and individuals. The deposition of manufacturing items in the ring-ditches – iron fragments and tools, the copper alloy ring-headed pin and the copper alloy strips and sheet – directly symbolises the death of the industries on site. In House 10/3 these items were buried alongside three Roman coins, clearly valuable and significant items to the craftworkers. The final disposition of artefacts occurred when House 10/3 was decrepit but the entrance and walls still visible on the ground. Several of these items were high-status, unusual artefacts, including an imported copper alloy Romano-British enamelled plate and fantail brooch, an unfinished copper alloy cruciform harness strap mount clearly made on site, a miniature iron axe and coiled lead objects. These items again appear to represent the industries that were once present on site alongside a prestigious non-local item that must have been treasured by individuals, both for its intrinsic value and for its ability to demonstrate cultural identities and connections. To bury items in this way at this location could be recognised as similar to the Iron Age deposition rituals seen at culturally or naturally significant foci such as caves, springs or early prehistoric monuments (Hunter 1997; 2010; 2015) as they must have deliberately been brought on a journey for burial within the surviving footprint of the house. The site of the building metamorphosed into a shrine, and the abandoned settlement transformed into an ancestral landscape of special meaning.

The structured deposition of items can also be identified in the Early Iron Age (Phase 2) and during the lifetime of the craftworking centre (Period 3). Saddle querns and their associated rubbing stones were placed within the post-holes and ring-groove of House 3 (Period 2) during its construction, presumably as foundation deposits. These querns must have been long-serving family tools, perhaps incorporated into the building to keep memories of ancestors alive and close at hand.

The most unusual deposition occurs within Period 3, with iron weapons and other intact iron objects (e.g. tools and a linchpin) incorporated into post-holes of buildings. The weapons (two daggers and a spear) form an interesting and rare group. Each had been set in a similar fashion into the post-holes, potentially during the building's construction. The short dagger (SF0363 – Illus. 6.46) within House 7 was clearly a prized possession and had been resharpened towards the end of its active life, while both the dagger outside of Workshop 19, and the spear within Workshop 6, had been carefully placed, tip down.

The deliberate deposition of weapons is uncommon throughout Iron Age Britain, and the Culduthel weapons are exceptional items, both in terms of their siting and their completeness. A striking parallel to the short dagger was seen at Clarkly Hill in Moray where an iron dagger within its sheath was located alongside an intact iron sickle and a steatite lamp on a layer overlying a ring-ditch house (Hunter 2012, 8).

Similar forms of structured deposition appear to span throughout the Iron Age occupations of Culduthel, each associated with key moments in the history of the settlements, such as the construction, modification or abandonment of buildings. The placement of the weapons within post-holes is reflected in the deposition of other intact iron objects (i.e. other weapons, tools and a linchpin) in post-holes or ring-ditches in the roundhouses of Period 3b, and suggests that the structured deposition of powerful and valuable items was a significant act at Culduthel, repeatedly undertaken at keys moments in the history of the settlement such as birth, death or momentous significant changes in the community's structure.

The placing of significant items to mark specific lifecycles of Iron Age households has been widely identified as common practice across Britain (Waddington 2014; Armit and McKenzie 2013; Hill 1995; Parker Pearson 1996), and it may be that this rite is a non-negotiable part of Iron Age life where rituals were frequently carried out for the house and within the house to define and redefine experiences, events and relationships, with the symbolism of these acts spanning centuries (Webley 2007). It is well-documented in northern Scotland with a wide range of artefacts placed within walls, thresholds and post-holes of well-preserved stone buildings such as brochs (e.g. at Howe in Orkney – Waddington 2014), wheelhouses (Cnip in Lewis – Armit 2006) and simple Atlantic roundhouses (e.g. Bu in Orkney – Hedges 1987).

At the Iron Age hillfort at Broxmouth in East Lothian, structured deposition was so frequently seen in Phase 6 (the Late Iron Age village) that the authors state that the rite was seemingly practiced at every event in the lifecycles of the buildings (Armit and McKenzie 2013, 184–5). Liminal and focal locations, such as entrances and thresholds, clearly also played an important role in this deposition at Broxmouth. Other similarities with Culduthel can be seen with the deliberate deposition of exotic or remarkable finds in artefact-rich pits (ibid). Pits within House 6 at Broxmouth contained copper alloy objects including a harness strap junction, iron, bone and antler objects (ibid, 160) while a pit associated with the end of House 1 contained a hoard of Roman material including glass vessels and bangles and Samian pottery all dating to late 1st to early 2nd century AD (ibid, 123). Strikingly similar rituals took place at the Middle Iron Age settlement at Birnie in Moray where prestige Roman and indigenous objects were buried within a range of houses, many of which had been deliberately burnt down (Hunter 1999; 2000; 2002; 2003; 2004; 2005a; 2005b; 2005c; 2006c; 2007b; 2008a; 2008b; 2009a; 2009b; 2009c; 2010).

The degeneration of the site after abandonment

There is evidence that the occupants of Culduthel may have abandoned the settlement and their industrial practices wholesale, and not relocated further afield. Many reusable or useful items were left on site including iron tools, rods of glass and sheets of copper alloy. The timbers of the large houses and the workshop were left to rot in situ and the furnaces and hearths were undisturbed. From the thick spreads of waste material identified across the site, spoil heaps rich in broken, discarded or recyclable objects and debris from their production were left to slump and spread naturally over time, eventually flattened and covered by hillwash.

Chapter 6

THE FINDS

Introduction

The excavation at Culduthel produced an extensive assemblage with a rich range of material that is highly significant for the study of the Scottish Iron Age. It is rare to find such a productive site in the cropmark zone of Scotland; the range of material has painted a detailed picture of a wide range of activities at the site, including the craft processes at play, the contacts and networks for the procurement of raw materials and the exchange of both utilitarian and exotic objects. The assemblage has also informed wider research topics for the Iron Age in the north-east and other areas of Scotland, illuminating the contact between Scotland and Rome in the early 1st millennium AD and adding to our knowledge of how status was defined and displayed in this period. These wider topics are expanded on here and in greater depth within the concluding Chapter 7.

The excellent preservation of areas of the site sealed by hill-wash, and the excavation strategies adopted to deal with this phenomenon (including dry sieving many deposits during the excavation and wet sieving in the lab), meant that the recovery of artefacts was maximised. As many of the artefacts were presumed to be found in the location they were lost or discarded, the record of their exact locations (which were three-dimensionally recorded) meant the spatial distribution of artefacts are considered to be detailed and accurate. This data has allowed for the location of certain activities, such as the glassworking areas of the site, to be pinpointed and has aided the recognition of structured deposition of objects.

Of particular importance from the assemblage is the evidence for glass- and enamel-working, which is unique in Iron Age Scotland and very rare in Britain generally. The working debris recovered, alongside the information gained from the in situ hearths and workshop identified on site, has shed much light on the technology of glass and enamel in the Iron Age. The working debris indicates that the site was reworking imported glass ingots to produce beads and for enamelling, some of this material coming into the site from the Roman world as pre-formed dual colour cables or trails. As the majority of working debris, and a high percentage of the beads, were recovered during the post-excavation processes through wet-sieving and sorting, the identification of such large quantities of glass can be directly linked to the extensive sampling strategy adopted across the site. This wealth of information obtained for Iron Age glassworking in Scotland will assist future researchers of Iron Age material culture, especially personal adornment, and later prehistoric technology.

The quantity of ferrous metalworking waste (over a third of a tonne of slag and associated vitrified debris) and its recovery in situ within furnaces and from spreads of material formed from multiple heaps of debris has allowed an understanding of the technology of iron, from ore to artefact; this is exceptionally rare, especially in an Iron Age context. The assemblage of iron objects is one of the largest and most important from Iron Age Scotland, with a number of unusual items such as daggers, a spearhead and a file. The iron tools give some incredible insights into life on an Iron Age settlement and the craft activities underway: the knives, awls and decorating tools for the working of wood, leather, horn, antler and bone; a possible iron mandrel for making glass beads; and a needle for stitching fabric or leather.

The non-ferrous metalworking debris is also some of the largest and most important from Iron Age Scotland and has illuminated the technology of copper alloy manufacture utilised at Culduthel. The objects, the working debris and the analysis of the alloys has allowed for a better understanding of the technology used for copper alloy manufacture and the sources of the raw materials. Sheet copper and the casting of objects was taking place. Remarkable objects such as the harness strap mount were being made, and objects such as the hilt guard were being brought onto site for repair by a specialist team of copper alloy workers.

Other elements of the assemblage also help to illustrate the activities of the artisan community. A wide range of stone tools, including smoothers, polishers and grinders for preparing leather and finishing metal items and potentially crushing down pigments for painting and dyeing, were identified within the workshops, roundhouses and spreads.

There are a number of notable absences from the assemblage that are significant and informative. Not a single piece of bog ore was identified across the site, suggesting that its storage and initial processing was undertaken at another location. The absence of ore and the clearly defined areas of ferrous, non-ferrous and glass-working identified on site shows that different processes were segregated in a highly organised enterprise. Domestic pottery is also minimally represented. While this lack of later prehistoric pottery is unsurprising in this period in north-east Scotland, it is more intriguing when viewed alongside the large assemblage of ceramic material clearly made on site, including crucibles and complex moulds. Finally, the lack of whetstones defies explanation on a site where sharp knives and tools must have been indispensable.

Together the finds assemblage indicates that Culduthel was a major production site and a specialist craft-working centre, producing a diverse range of objects ready for use or exchange, with accessories in leather, wood and textile to compliment them. These craftworkers were clearly a creative, experimental, ambitious and well-travelled group.

For ease of reference, Chapter 6 has been divided into four parts by material. Part A covers the pottery and fired clay; Part B the stone; Part C the metal and Part D the glass.

Part A

Pottery and fired clay

Prehistoric pottery

Ann MacSween

The pottery assemblage comprises 236 sherds (mostly small body sherds), fragments and crumbs, from which 21 vessels could be distinguished. The majority of the pottery could be identified as early prehistoric with both the Early and Late Neolithic represented. The meagre assemblage of later prehistoric pottery is unsurprising for Iron Age north-east Scotland. Ceramics were certainly widely used in this period on site in the manufacture of copper alloy and glass, and clay and the technology to produce pots was clearly widely available to the occupants. The absence of pottery within this period may show a society using other materials (wood, iron, leather) for cooking and storing food or it may simply be a reflection of the main purpose of this site (a non-domestic craft centre) with the domestic occupation perhaps located beyond the excavation to the north.

Pottery was recovered across the site, much of it from the backfill of pits. No radiocarbon dates were obtained from contexts containing prehistoric pottery. The full assemblage is described and discussed by period of activity below.

Early prehistoric pottery

Carinated bowls

Sherds of carinated bowls dating to the early Neolithic were recovered from a number of contexts:

Context 98: fill of shallow pit 97

A rim sherd with a lip slightly rolled to the exterior, possibly from a round-based bowl, was recovered from context 98, the fill of pit 97. From the rim profile, burnished exterior and fabric (fine clay with *c.*10% of larger quartz), it could be from a Neolithic bowl.

Context 156: upper fill of pit 153

Eleven sherds and two crumbs of pottery, including a rim and a carinated sherd from the same vessel (V1 – Illus. 6.1), were recovered from the upper fill of pit 153. Three body sherds, also from V1, were found in the middle fill of pit 153 (context 155), and two small sherds and two fragments, probably from two different vessels, were recovered from the sampling of that context. A sherd and two fragments from a different vessel (V14, undiagnostic) were also recovered from the middle fill (context 155). The lower fill, context 154, produced a tiny rim fragment (V15) from a sample.

Context 815: fill of pit 2172

A rim and four body sherds (one carinated) from the same vessel (V3 – Illus. 6.1) were recovered from 815. The rim is perforated.

Unstratified

A further carinated vessel (V2 – Illus. 6.1) was represented by a rim sherd and three body sherds (two carinated), which were unstratified. A further three rim sherds, five body sherds (two carinated), three fragments and two basal fragments (flat bases) were recovered during the topsoil strip.

Discussion

The vessel that gives the best indication of vessel profile is V3 (context 815), which has a long flaring neck. V1, V2 and V3 are burnished on the exterior and all are of fine sandy clay with a low percentage of rock fragments. Where vessel form could be identified, most were, either from the presence of carinated sherds or from the rim form, thought to be from round-based, carinated vessels (V1; V2; V3; V8; V20).

Dates from Scottish sites indicate that simple carinated bowls were in use from around 4000 BC (Sheridan 1997, 219–20), with 'modified assemblages' (characterised by the use of fluting, the addition of lugs, and a preference for shallow forms) following a couple of centuries later, but the simple carinated bowls continuing to be made. Carinated bowls continued to be made in some areas into the later Neolithic (e.g. at Kintore in Aberdeenshire some of the carinated bowls dated to *c.*3000 BC (MacSween 2008, 179)).

Beaker

Sherds from four decorated vessels are probably from Beakers, although the sherds are very small. The sherds are generally thin-walled with fine fabrics. Sherds from two vessels were recovered from pit fills, one sherd was recovered overlying the external cobbled yard adjacent to House 10/3, and the sherds from the fourth possible Beaker are uncontexted.

Context 402: the fill of stone-lined pit 401

Sherds from a decorated vessel, possibly a Beaker, were recovered from context 402 (V18 – Illus. 6.2). The exterior surface was smoothed and decorated with evenly spaced lines of impressed twisted cord. The fabric is fine sandy clay with some coarse quartz. A body sherd and two fragments from a different vessel

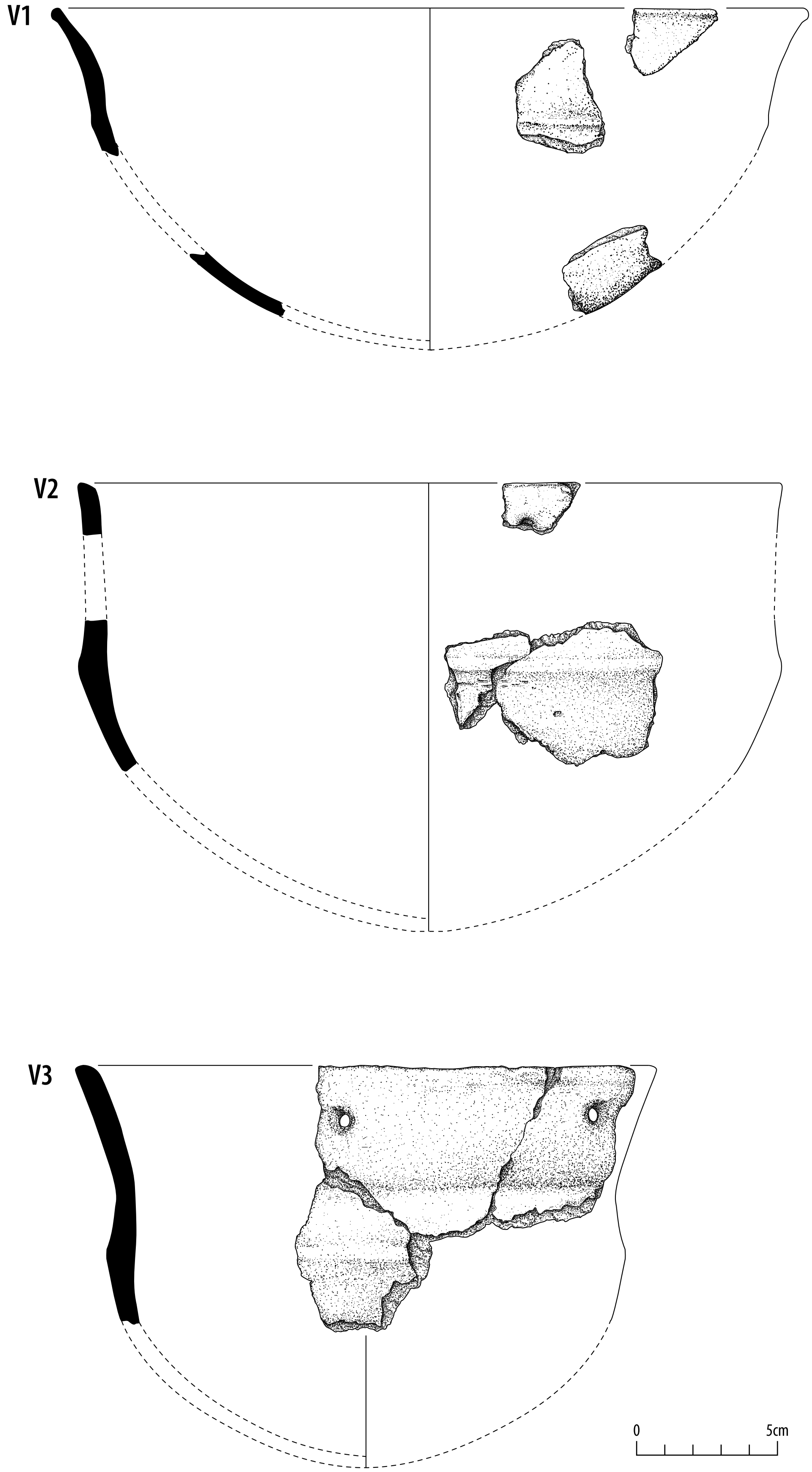


Illustration 6.1
Prehistoric pottery (Vessels 1–3)

(V21) were recovered from the same context.

Context 429: basal fill of pit 428
Two small sherds of possible Beaker pottery (V10) were recovered from the sampling of context 429. The larger fragment has three closely spaced rows of comb impressions.

Context 2982: external cobbled yard to the east of House 10/3
A small, thin-walled sherd decorated with two incised lines (V13) from sampling of 2982 may also be from a Beaker. The fabric is fine sandy clay.

Unstratified
Two small sherds, one with a line of impressed cord, were recovered during surface cleaning.

Discussion
Beakers are a frequent find from excavations in the north-east of Scotland, many from burial contexts (see for example Shepherd 1986). The sherds from Culduthel are too small for detailed discussion of their decoration etc. but they are important as a marker for activity on or near this part of the site at around 2600 to 1800 BC (Kinnes et al 1991).

Later prehistoric pottery

A total of 31 probable later prehistoric pottery sherds were recovered from two separate contexts. This very small assemblage represents the total Iron Age pottery recovered from Culduthel. The two contexts are associated with two separate phases of the site. An undated cobbled surface, likely to be associated with the Early Iron Age settlement (Period 2), contained sherds of flat rimmed pottery, while a single rim of decorated pottery was recovered from an occupation deposit within the interior of the final phase of House 10/3, occupied between the 1st and 3rd centuries AD.

The paucity of ceramics in the northern Scottish Iron Age is a well-known phenomenon. The lack of domestic later prehistoric pottery at Culduthel could suggest that the settlement fits within this tradition but could equally indicate that the later prehistoric settlement identified was purely the industrial zone of a much larger (unseen) settlement.

Period 2

Flat-rimmed
Sherds of flat-rimmed pottery, probably later prehistoric domestic pottery, were recovered from an area of cobbling.

Context 3651: Cobbled surface
Eight flat rim sherds, 22 body sherds and 8 fragments (V4 – Illus. 6.2) were recovered from context 3651. The exterior surface is smoothed and the fabric is fine sandy clay with *c*.60% of crushed rock fragments.

Period 3

Possible decorated Iron Age pottery
One rim sherd with a rounded lip and a long neck, decorated with incised motifs may, from its decoration, be Iron Age in date (V19 – Illus. 6.2).

Context 2470: occupation deposit, House 10/3
Rim with a rounded lip and a long neck, decorated with incised infilled triangles. The fabric is fine clay with organics (grass).

Pottery unattributed to period

Much of the pottery is undiagnostic, and many of the sherds are too small to enable attribution to fabric type with any confidence. These are listed here by context, and under the catalogue by vessel:

Context 83: fill of post-hole 85
Body sherd with traces of incised decoration on the exterior surface, and a smaller fragment from a different vessel.

Context 142: fill of pit 140
Five sherds and two crumbs.

Context 346: secondary fill of pit 344
Abraded body sherd with *c*.20% of igneous rock (from samples).

Context 432: fill of pit 431
Thirteen fragments and crumbs of pottery (from samples). The fabric (fine clay with a low percentage of rock fragments) is similar to the carinated bowl pottery. Three body sherds and three fragments from another vessel were also recovered. The fabric is similar to the Neolithic bowls but the vessel walls are much thicker.

Context 521: pit within the interior of the palisade enclosure
Seven body sherds, one decorated with criss-crossed incised lines (V17). The fabric is fine sandy clay with *c*.20% of coarse quartz.

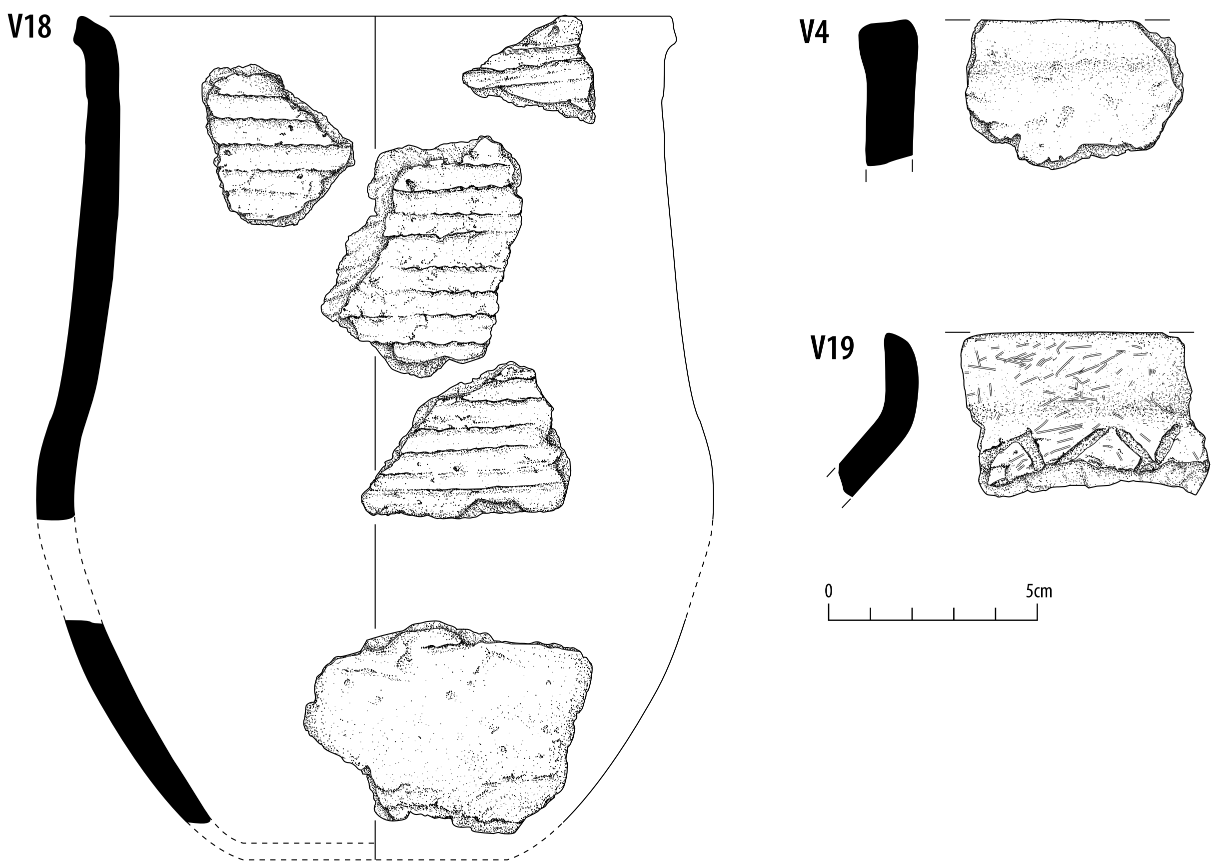


Illustration 6.2
Prehistoric pottery (Vessels 4, 18 and 19)

Context 741: primary fill of post-hole 740
Body fragment (from sampling). The fabric is fine sandy clay.

Context 798: spread of industrial waste
Body sherd (V16) of fine sandy clay.

Context 1725: fill of post-hole 1726
Abraded body sherd (from sampling)

Context 2169: fill of post-hole 2167
Body sherd (from sampling). The fabric is fine clay with *c.*10% of larger quartz.
Upper fill of pit 2172
Rim sherd (tapered) and a body sherd were recovered from the upper fill of pit 2172.

Context 2816: fill of post-hole 2815
Body sherd (from sampling). The fabric is fine clay with *c.*10% of rock fragments, again similar to the fabric of the carinated bowl pottery.

Context 2930: fill of post-hole 3635
Body sherd (from sampling). The fabric is sandy clay.

Catalogue

Vessel 1

Context 156; Find 2; 10 small body sherds (one carinated) and 2 crumbs; Wt 14g; Th 6mm

Context 156; Find 8; Vessel 8; Rim sherd with a slightly flattened lip; Wt 4g; Th 7mm

Context 155; Find 7; 2 body sherds; Wt 21g; Th 4–7mm

Context 155; Find 5; 1 body sherd; Wt 2g; Th 6mm
From a coil-constructed vessel with diagonal junctions. The exterior surface is burnished. The fabric is fine sandy clay with occasional large quartz and angular rock fragments, which has fired hard and is grey with brown surfaces. There is light sooting on both surfaces.

Probably from a Neolithic carinated bowl.

Vessel 2
u/s; Rim sherd and 3 body sherds (two carinated)*;* Wt 49g; Th 9mm

Rim sherd has a slight interior bevel. The exterior surface is burnished. The fabric is fine sandy clay with occasional large quartz/mica which has fired hard and is grey with brown surfaces. The interior surface is sooted. Carinated bowl.

Vessel 3

Context 815; Find 191*;* Rim, 2 body (one carinated), 2 fragments, 1 crumb; Th 9mm; Dia 220mm; Wt 97g

Below the lip of the vessel are two perforations (14mm and 17mm below the lip), 94mm apart. The body sherds are more abraded than the rim sherd. The exterior surface is burnished. The fabric is fine sandy clay that has fired hard and is grey with brown margins. The interior surface is sooted and there are patches of light sooting on the exterior surface. Carinated bowl.

Vessel 4

Context 3651; Find 937; 13 fragments, 6 crumbs; Th 11mm; Wt 35g (residue)

Context 3651; Find 930; 1 rim, 5 fragments, 2 crumbs; Th 11mm; Wt 28g

Context 3651; Find 930; 1 rim (broken in 2); Th 11mm; Wt 45g

Context 3651; Find 913; 1 rim; Th 11mm; Wt 34g

Context 3651; Find 917; 1 rim; Th 11mm; Wt 30g

Context 3651; Find 932; 1 rim; Th 13mm; Wt 26g

Context 3651; Find 930; 1 rim (broken in 2); Th 11mm; Wt 45g

Context 3651; Find 918; 1 rim; Th 10mm; Wt 20g

Context 3651; Find 934b; 1 rim; Th 12mm; Wt 25g

Context 3651; Find 935b; 1 body sherd; Th – abraded; Wt 12g

Context 3651; Find 936; 1 body sherd; Th 8mm; Wt 8g

Context 3651; Find 916; 2 rims, 7 body sherds, 2 fragments; Th 10mm; Wt 51g
Sample 1754; 2 rim fragments, 2 body sherds, 29 crumbs; Wt 26g

Flat-rimmed later prehistoric vessel. The exterior surface is smoothed. The fabric is fine sandy clay with *c.*60% of crushed rock fragments, which has fired hard and is grey with brown surfaces. The interior surface is sooted.

Vessel 5

Context 2170; Find 421b; Rim sherd; Th 10mm; Wt 7g

Context 2170; S 739; 1 body sherd; Th 9mm; Wt 26g
Rim sherd and body sherd from a vessel with a tapered rim (probably slightly inverted). The exterior surface is smoothed. The fabric is fine sandy clay with *c.*20% of angular quartz and large mica that has fired hard and is grey with a red exterior margin. There is light sooting on both surfaces.

Vessel 6

Context 1725; S 753; 1 abraded body sherd; Th 8mm; Wt 6g
The fabric is coarse clay that has fired hard and is grey with a brown exterior surface. The interior surface is sooted.

Vessel 7

Context 142; S 51; 5 body sherds, 2 crumbs; Th 7mm; Wt 9g
The exterior surface is burnished. The fabric is sandy clay, which has fired hard and is grey with a brown exterior surface.

Vessel 8

Context 98; S 41; rim sherd; Th 7mm; Wt 6g
Rim sherd, the lip slightly rolled to the exterior. The exterior surface is burnished. The fabric is fine clay with *c.*10% of larger quartz, which has fired hard and is grey with brown surfaces. Neolithic carinated bowl.

Vessel 9

Context 432; Find 92; 3 body sherds; 3 fragments; Th 15mm; Wt 28g

The exterior surface is smoothed. The fabric is fine sandy clay with *c*.10% of large quartz, which has fired hard and is grey with a red exterior surface.

Vessel 10

Context 429; S 181; 2 small fragments; Th 5mm; Wt 1g
The larger fragment has three closely spaced rows of comb impressions. The fabric is fine sandy clay with *c*.10% of coarse quartz that has fired hard and is grey with red margins.

Vessel 11

Context 2816; S 1106; Body sherd; Th 12mm; Wt 6g
From a coil-constructed vessel with N-shaped junctions. The fabric is fine clay with *c*.10% of rock fragments, which has fired hard and is grey with red margins.

Vessel 12

Context 741; S 330; 1 fragment; Wt 4g
The fabric is fine sandy clay that has fired hard and is grey with a buff exterior surface.

Vessel 13

Context 2982; S 1218; body; Th 8mm; Wt 2g
Small body sherd decorated with incised lines. The exterior surface is smoothed. The fabric is fine sandy clay that has fired grey. Possibly Beaker.

Vessel 14

Context 155; Find 4; 1 body sherd; 2 fragments; Th 6mm; Wt 3g
Body sherd. The fabric is fine clay with *c*.20% of large quartz inclusions, which has fired soft and is orange. From same feature as V1.

Vessel 15

Context 154; S 69; Tiny rim fragment; Th 5mm; Wt <1g
The exterior surface is burnished. The fabric is fine clay with *c*.10% of large quartz, which has fired hard and is grey. The exterior surface is sooted. From same feature as V1.

Vessel 16

Context 798; Find 196; 1 body sherd; Th 8mm; Wt 4g
The fabric is fine sandy clay that has fired hard and is grey with a red exterior margin.

Vessel 17

Context 521; Find 96; 7 body sherds; Th 7mm; Wt 28g
The fabric is sandy clay with *c*.20% of coarse quartz, which has fired hard and is grey with a brown exterior surface. One sherd is decorated with ?criss-crossing incised lines.

Vessel 18

Context 402; Find 87; 9 body sherds and 2 crumbs; Th 8mm; Wt 96g
The exterior surface is smoothed and decorated with evenly spaced lines of impressed twisted cord *c*.1mm thick and *c*.5mm apart. The fabric is fine sandy clay with coarse quartz, which has fired hard and is red with a grey interior margin. The interior surface is sooted. Beaker.

Surface cleaning u/s
Two small sherds, one with a line of impressed cord; Th 7mm; Wt 3g. Grey with red margins. Fired hard.

Vessel 19

Context 2470; Find 666; 1 rim; Th 8mm; Dia 180mm; Wt 45g
Rim with a rounded lip and a long neck (broken in four). Below the neck is incised decoration, possibly infilled lozenges or triangles. The fabric is fine clay with organics (grass), which has fired hard and is red. Possible decorated Iron Age pot.

Vessel 20
Topsoil strip
Three rims (one broken in two), five body sherds (two carinated), two basal sherds and three fragments; Th 11mm; Wt 114g

Rounded rim with a carination 20mm below the lip. The exterior surface is slipped. The fabric is fine clay with *c*.40% of large angular rock fragments, which has fired hard and is grey with brown surfaces. The exterior surface is sooted. Neolithic carinated bowl.

Vessel 21

Context 402; S 162; 1 body, 2 fragments; Th 8mm; Wt 7g
Exterior surface smoothed. The fabric is coarse sandy clay that has fired hard and is grey with brown surfaces. From same feature as V18 (Beaker).

Roman pottery

Colin Wallace

A small body sherd of a Roman oxidised ware vessel came from the western part of the excavated site. The dark sandy silt, full of metalworking debris (context 225 – a radiocarbon date of cal AD 130–340 was made on the charcoal within (225) (SUERC-30359)) above the cobbles in the long hollow (Cobbled surface 227), produced a body sherd (SF046: now broken in two: weight 3.0g) that has lost both its surfaces. The fabric, from the fresh break, is a fine oxidised one, orange with a darker core and very sparse fine quartz inclusions. This might originally have been from a fine oxidised ware beaker or bowl, or even a colour-coated vessel, of 1st or 2nd century AD date. While the suggested date-range is a broad one, it compares well enough with the other Roman-period material from the rest of the site, and the Culduthel Roman pottery looks to belong to the same horizon as the material from northern sites such as Birnie, Brackla, Deskford and Tillydrone, but not as late as the pottery from Kintore, Keiss or Crosskirk (Hunter 2005a, 93; Hunter 2001a, table 1; Wallace 2008; Robertson 1970, table 1; Fairhurst 1984, 115). Locally, and unfortunately only vaguely identified, there is the ‘grey Romano-British coarse ware’ sherd from the earlier cairn at Stoneyfield, Raigmore, a short distance away to the north-east (where there was also an early Roman headstud brooch: Simpson 1997, 56, 65, 74 and 77).

Ceramic whorl

Dawn McLaren

One small fragment of a biconical, fired clay spindle whorl was recovered from a post-hole within Workshop 22. This is the only finished spindle whorl fragment from the site, although one stone roughout (SF0584) came from a post-pipe within the latest phase of the substantial roundhouse House 10/3. The rounded biconical form of the ceramic example is comparable to that found at the Iron Age wheelhouse at Cnip, Western Isles (Hunter and MacSween 2006, 131–3, SF 284, Illus. 3.18e).

SF0158 Spindle whorl fragment. Small, rounded-edge fragment from a biconical ceramic whorl. Buff-coloured fine-grained fabric. No central perforation remaining. D 43.5 T 20mm. Context 525, Upper fill of post-hole (context 597), Workshop 22.

Fired clay

Gil Paget and Dawn McLaren

A large assemblage of fired clay fragments was recovered throughout the excavated area at Culduthel. The total of 29.7kg of fired clay was examined macroscopically, allowing classification based on form, colour, fabric type and condition. Petrological analysis of a small sample has been undertaken and is reported on separately. The majority of pieces have probably been burnt unintentionally. The assemblage is dominated by small, fractured and abraded fired clay fragments, most lacking any original surfaces. In most cases, insufficient material survives to allow reconstruction of their original form. A small quantity of more significant pieces, with evidence of shaping, wattle impressions and finger impressions, are the main focus of this report. A small proportion of the assemblage comprises tiny abraded crumbs of fired clay; it is possible that included within this material are abraded undiagnostic pottery fragments. A full catalogue of the material is contained in the archive. Although often described as burnt daub, such undiagnostic fired clay fragments do not necessarily derive from burnt clay walls of houses. As such, the term fired clay is preferred to describe this material unless it is more diagnostic.

Fabric and material analysis

Fabric

Due to the fractured and often abraded condition of the fired clay, identification of specific fabric types was problematic. However, three main fabric types can be identified among the assemblage: fabric A with organic inclusions as temper; fabric B with fine-grained quartzite/sand inclusions; and fabric C, a combination of both organic and quartzite/sand inclusions (Table 6.1). Many fragments have no definable inclusions and are categorised as untempered clay.

Fabric A used organic fibres, possibly grass, disaggregated straw or animal manure. These organic inclusions are present on the surfaces of the fired clay as fine linear, often tapering, voids. Due to the abraded condition, it is not always possible to determine whether these voids represent inclusions within the clay matrix or impressions on the surface made during production. No attempt to distinguish these has been made. The inclusion of fine-grained quartzite and sand grains was noted within fabric B. Petrographic analysis indicates that these inclusions comprise poorly sorted fine quartz and feldspar grains as well as some larger gabbro inclusions. It is not certain whether these inclusions are a feature of the natural clay or were deliberately added as temper. A small proportion of the raw clay used (4%) appears to be natural, lacking distinctive evidence of deliberate tempering such as the addition of larger crushed rock fragments, grog, shell or bone. This is confirmed by petrological analysis which indicates the use of fine or very fine, poorly mixed clay with unsorted fine quartz and feldspar inclusions.

Table 6.1
Summary of fabric types present

Type	Description	Weight	Percentage
Fabric A	Fine to very fine-grained matrix with organic inclusions	9.5 kg	32%
Fabric B	Fine to very fine-grained matrix with poorly sorted quartzite/sand inclusions	3.9 kg	13%
Fabric C	Fine to very fine-grained matrix with organic impressions and poorly sorted quartzite/sand inclusions	15.1 kg	51%
Untempered	No distinct inclusions	1.2kg	4%

Condition

The fired clay present displays varying degrees of oxidation (Table 6.2). The vast bulk has been lightly fired (67%), in most cases probably accidentally, and is red-brown or orange-brown in colour. A small proportion has sooting on the surface from direct exposure to intense heat and flame (1%). Only 3% (0.9 kg) is unfired clay with little evidence of any deliberate modification or use.

Table 6.2
Summary of condition of the fired clay

Condition	Weight	Percentage
Unburnt	0.9 kg	3%
Burnt	20.1 kg	67%
Burnt & abraded	6.4 kg	22%
Vitrified	8.7 kg	30%

Illustration 6.3
Fired clay

Approximately 30% of the fired clay assemblage has been exposed to prolonged, intense heat, causing the vitrification of at least one face, and is likely to have derived from a hearth or furnace associated with a high-temperature pyrotechnic process such as metalworking. This material forms as a result of a high temperature reaction between the clay lining of the hearth/furnace and the alkaline fuel ashes or slag. Often the material shows a compositional gradient from unmodified fired clay on one surface to an irregular cindery material on the other (Starley 2000, 339). There will be a certain amount of overlap between the vitrified ceramics discussed here and the more diagnostic furnace lining fragments analysed alongside the ferrous metalworking waste. A large proportion of the fired clay fragments are highly abraded (22%). The external surfaces have been worn smooth through weathering, many with few discernible edges or original surfaces remaining. The abraded condition of such a large proportion of the assemblage suggests it may have been left lying around on site for an extended period of time after collapse, dismantling or destruction of the features. These amorphous rounded fired clay nodules are light sandy brown through to orange-brown in colour and are often friable and powdery in texture.

Significant pieces

Shaped fragments

A significant proportion of the assemblage (23%) comprises fragments with evidence of deliberate shaping in the form of smoothed rounded (56%) or flattened surfaces (35%). In the majority of instances, the fragments are so small and fractured that one cannot determine what form the original object or structure took. Some original surfaces preserve finger smears from smoothing by hand when wet. Others have distinct finger impressions produced when pressing, pinching or moulding the clay to shape. A small quantity (1.5kg) of the fired clay bears impressions that indicate it had been pressed against flat stones, or into corners formed by flat stones, suggesting use in a structural feature. Wattle impressions were found on 5% of the shaped fragments. These will be discussed further below.

In addition to these undiagnostic shaped pieces are a small quantity of more unusual or identifiable forms. These include six fragments of possible furnace or hearth rims. Recognisable fragments of the upper structure of a clay-built furnace or hearth are very rare. These have been identified due to the robust, heavy-duty form of the rim itself, the coarse fabric of the clay and the light patches of vitrification present. The lack of adhering slag makes it impossible to relate them directly to a particular high-temperature pyrotechnic process. However, their recovery from a series of furnace features associated with ferrous metalworking debris suggests that they are likely to be pieces of the upper structure of ceramic shaft furnaces.

Also present is a small quantity of thin curving clay plates that appear to be a relining of a furnace structure. This confirms the evidence from the vitrified ceramic associated with the ferrous metalworking debris of the repair and reuse of at least one of the furnaces.

Furnace/hearth rim fragments

SF0139 Two joining fragments of fired clay forming a fairly straight, rounded thick rim. Both ends are broken and the base is fractured; thus original depth is unknown. Fabric A. L 54, W 21 remaining D 22mm. Mass 19.8g. Context 675. Clay lining of furnace [681], Workshop 2. (Illus. 6.3)

SF0852 Shaped sub-cylindrical amorphous lump of fired clay with distinct finger impressions produced when pinching the clay to form an irregular sloping corner or rim; possibly a furnace rim but lacks any evidence of vitrification. Both ends are broken and it has been detached from a larger object or structure. An angular flat impression on the fractured edge (41 × 8mm) indicates the clay had been pressed into and against a stone. The irregular finger impressions are particularly clear on one face; some attempt has been made to smooth the surface of the opposite face after shaping. Fabric A. L 68 W 29 remaining T 35mm. Mass 55.3g. Context 4257, Basal fill of furnace 4262, Workshop 15. (Illus. 6.3)

SF0891b Shaped, elongated triangular-sectioned nodule of fine fired clay, pinched and smoothed to form a conical rim or edge. The clay has been shaped around horizontal stone fragments. The piece has been constructed by building two elongated cylindrical lumps on top of one another, with little attempt to conceal the join. One face has been smoothed after shaping, with finger impressions present. The other face is lightly vitrified. Fabric B. L 61 W 38.5 remaining T 50mm. Mass 69.5g. Context 4258, Primary fill of furnace 4262, Workshop 15. (Illus. 6.3)

SF0895 Thick rounded clay rim produced from light buff-coloured clay with frequent small to medium sized angular quartz inclusions. The piece is fairly straight along its length, broken at both ends. Both faces are lightly vitrified towards the broken edge. Fabric *c.*L 48.5 W 29 remaining T 26mm. Mass 36.6g. Context 4258, Primary fill of furnace 4262, Workshop 15. (Illus. 6.3)

SF0898 Thick vitrified rounded clay rim fragment. The clay is light buff in colour, with frequent small to medium angular quartz inclusions. The fragment curves slightly along the length but insufficient quantity survives to determine the original diameter. The rim runs parallel to a slightly uneven rounded linear wattle or stone impression (D 16.5mm) on the fractured edge. Both faces are lightly vitrified from exposure to intense heat. Fabric A. L 65 W 30 remaining T 44mm. Mass 53.25g. Context 4258, Primary fill of furnace 4262, Workshop 15.

SF1149 Large robust sub-cylindrical fragment of coarse clay with large angular quartz inclusions. Much of the surface has been lost on one face but the other has been flattened and smoothed. The piece curves slightly in length, indicating it formed part of a circular or sub-circular structure. Smooth, curving impression on the fractured edge indicate the clay had been formed around rounded pebbles. Fabric *c.*L 86 W 62 remaining T 72mm. Mass 307.7g. Context 4127, Fill of post-hole 4126, House 10/3. (Illus. 6.3)

Furnace relining

SF1148 Furnace relining. Fourteen thin irregular curving plates of fired clay. Possibly a thin skim of material applied to a pre-existing curved surface, perhaps also of clay. The convex rounded surfaces, which would have been in contact with the existing material, are pitted and uneven, preserving an impression of the underlying surface. The opposite, concave faces are smooth with finger smears remaining from shaping. The pieces range in thickness from 5.5 to 12mm. Untempered fabric. Mass 71.5g. Context 677, Primary fill of furnace (681), Workshop 2.

Wattle impressions

A small percentage (9%) of the fired clay fragments preserve wattle impressions in the form of linear notches of varying diameters that indicate the former presence of a framework of wooden withies around which the clay was applied (Table 6.3). Wattle (the timber framework) and daub (the clay) have been used since early prehistory to construct walls, partitions and other structures. The use of wattle and daub structures at Culduthel is consistent with similar material recovered from other later prehistoric settlements such as Seafield West, Inverness (Hunter 2011b) and Fairy Knowe, Stirlingshire (Willis 1998, 332–5).

Table 6.3
Summary of range of wattle impressions present

Impression description	Weight	Quantity
Single narrow withy	1.19kg	multiple fragments
Single wide withy	0.29kg	5
Two angled withies	0.03kg	1
Two parallel withies	0.14kg	multiple fragments
Three parallel withies	0.01kg	1
Angular timber	0.03kg	3
Frame	0.39kg	multiple fragments

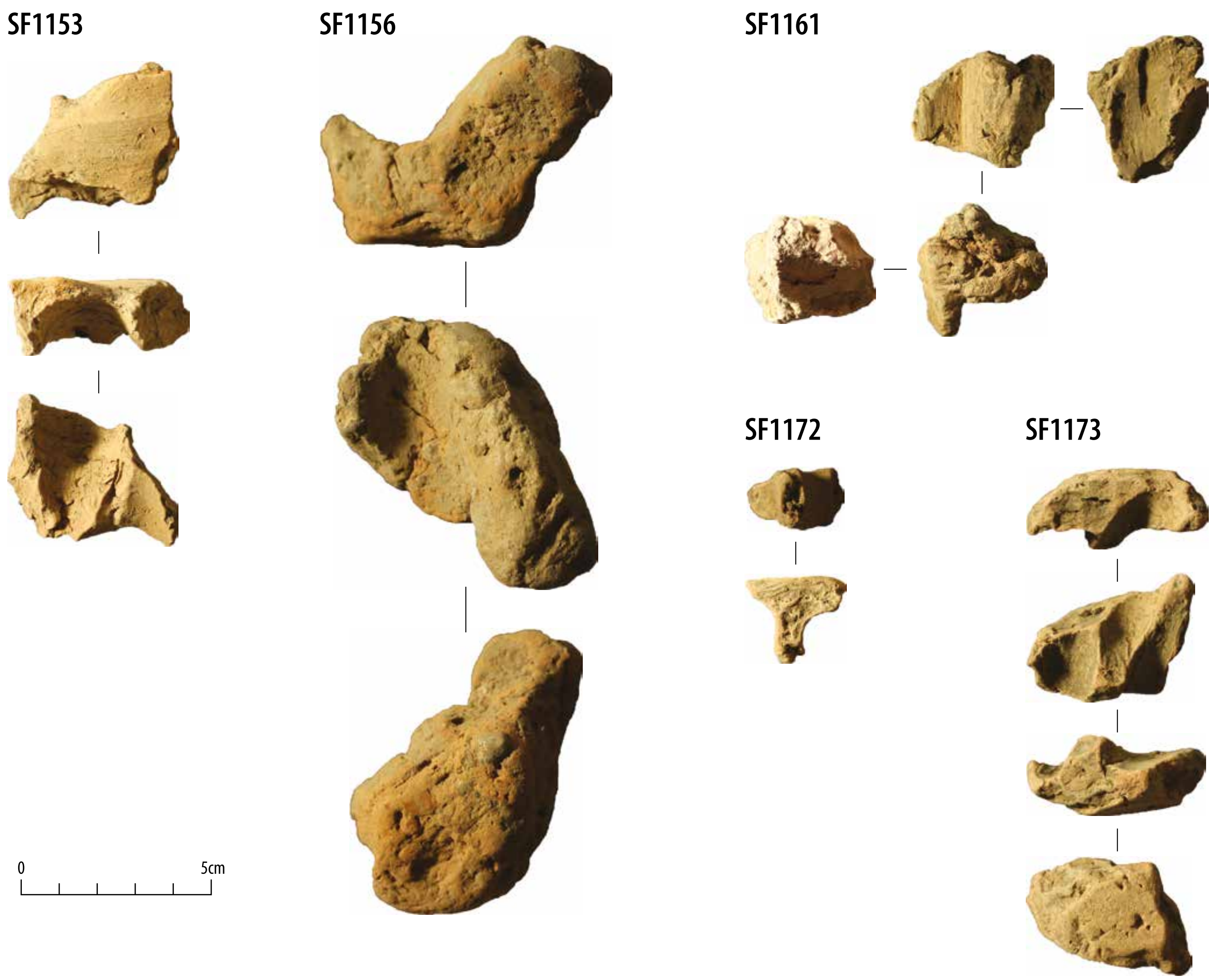


Illustration 6.4
Fired clay

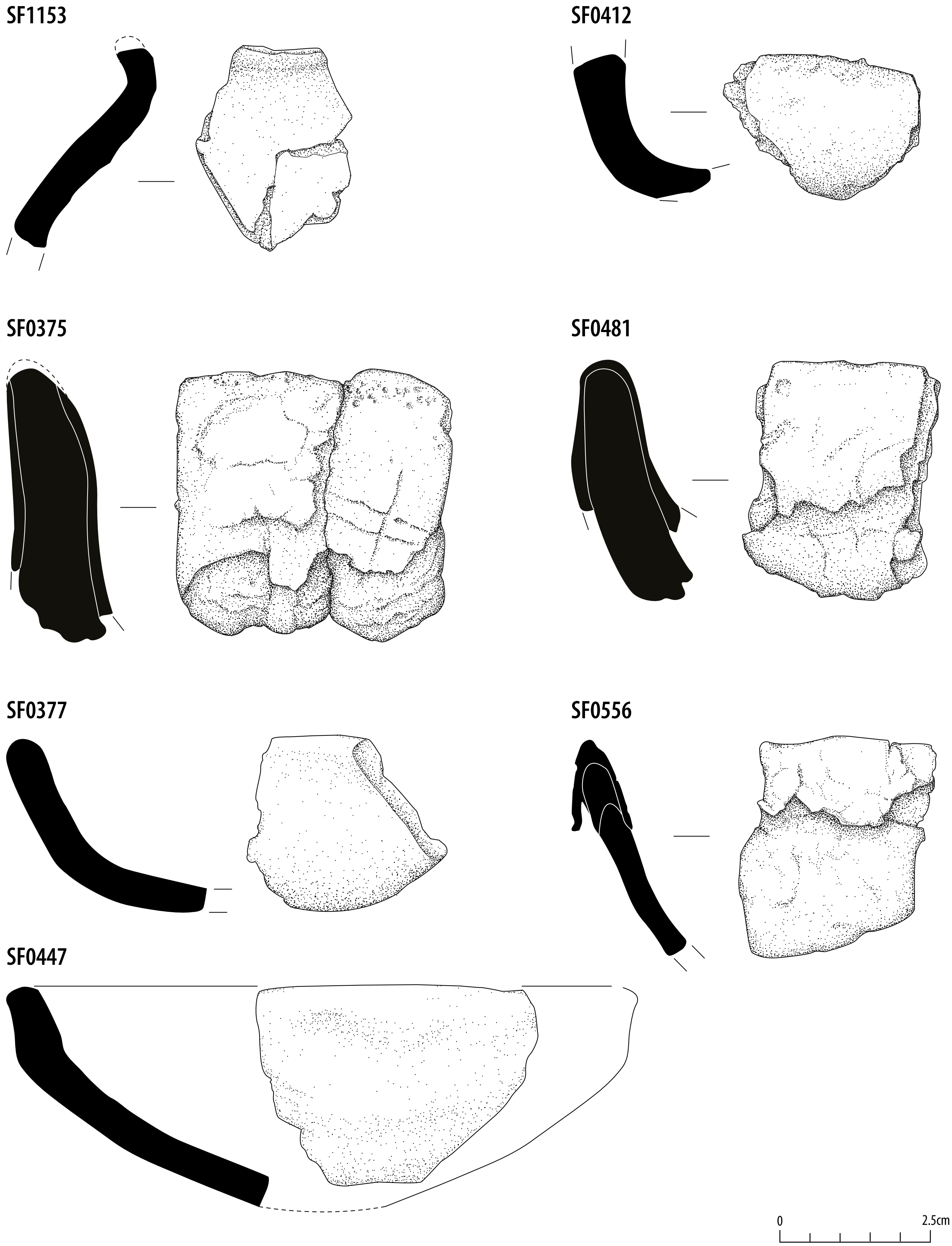


Illustration 6.5
Crucibles

The majority of the fragments (54%) are highly abraded, making identification of the form and orientation of the withies difficult to determine.

The majority of the recognisable fragments have the impression of a single narrow circular-sectioned withy ranging in diameter from 7 to 17mm. Wider withies were also used, sometimes in conjunction with the narrower pieces (e.g. SF1153 – Illus. 6.4 and 6.5), and range in diameter from 19 to 33mm. The average diameter used was 13mm. Examination of the interior of these impressions provides further detail of the materials used. Most of the wattle impressions are smooth, suggesting that the bark had been removed from the withies prior to their use. A small number of impressions have ribbed, textured impressions, implying that the bark had been left on.

Three fired clay fragments (SF1145, SF1161, SF1162) have angular impressions, indicating the use of cut timber rather than circular-sectioned withies. Due to their fragmentary condition it has not been possible to estimate the original size of the timbers used, but they must be from squared timbers or planks. The grain of the wood is clearly visible. In most cases, insufficient clay surface survives to allow reconstruction of the orientation or configuration of the withies. However, a small number of pieces provide more detailed information. SF1150 preserves the impressions of three separate withies; two parallel impressions and a third, perpendicular impression with a much wider diameter. This suggests the use of a simple framework of thick vertical struts, cross-cut by a series of narrow horizontal withies (Illus. 6.3). Others, such as SF1165 and SF1173, are slightly more haphazard, indicating the use of near-parallel, but differently aligned, narrow withies. Both circular-sectioned withies and prepared squared or rectangular-sectioned timbers (as in SF1161 – Illus. 6.4) were used to create a frame around which the wet clay was applied.

Catalogue of illustrated fragments

SF1156 Wide, single withy impression. Abraded amorphous fragment of orange-brown fine clay. No original surfaces remaining. Along one elongated face is a wide tapering wattle impression (D 16.5–25.5mm); slight ridges in the interior suggest that the bark was not removed. Fabric *c.*L 75 W 51.5 T 41.5mm. Mass 71.8g. Context 1864, fill of pit 1863. (Illus. 6.4)

SF1153 Parallel withy impressions. Fine-grained burnt clay; the original slightly rounded surface has clear finger smears from smoothing while the surface was wet. An impression from a wide, thick, circular-sectioned vertical withy (D 20.5mm) runs perpendicular to the original surface. The ribbed interior surface suggests that the bark was not removed from the withy. 3mm from the edge of this impression is a further ribbed wattle impression from a narrow withy (D 12.5mm) set at a sharp diagonal angle. Fabric A. L 44.5 W 33.5 T 16mm. Mass 15.2g. Context 3218, fill of post-holes 3531 and 3532. (Illus. 6.4 and 6.5)

SF1172 Parallel withy impression. Small, lightly abraded fragment of orange-brown fired clay with impressions of two parallel circular-sectioned narrow withies (D 12–15mm) running perpendicular to a smoothed original face. Fabric *c.*L 24 W 22 T 15mm. Mass 4.8g. Context 2685 (=798 spread of waste debris). (Illus. 6.4)

SF1173 Three withy impressions. Rounded fragment of fired clay, one rounded smoothed face remaining. The opposite face has three parallel circular-sectioned narrow wattle impressions (D 11.5mm, 12mm, 13mm), the middle withy orientated at a slight angle. Fabric *c.*L 37.5 W 32 T 17.5mm. Mass 13.6g. Context 2685 (=798 spread of waste debris). (Illus. 6.4)

SF1161 Angular timber impression. Small angular fractured fragment of fine-grained fired clay with three wattle impressions. A right-angled corner impression comes from a modified square or rectangular-sectioned timber baton (17.5 × 11mm). Linear ridges on the interior indicate that this was core timber rather than a branch or twig. Running diagonal to this angled impression are two parallel circular-sectioned withy impressions (D 6.5–14mm). No original surfaces remain to confirm the orientation of the withies. Fabric A. L 38 W 33 T 27mm. Mass 16.4g. Context 2685 (=798 spread of waste debris). (Illus. 6.4)

SF1150 Framework impression. Sub-rectangular fragment of fine-grained fired clay. While wet, the clay has been pressed firmly around one large vertical circular-sectioned withy (D 27.5mm), leaving three distinct, regularly spaced finger impressions on the opposite face. At right angles to the wide-sectioned lateral withy are two evenly spaced, parallel horizontal narrow withy impressions (D 11–12mm), indicating the clay had been applied around a built framework of withies. The ridged interior of the narrow impressions suggests that the bark was left on the withies. In contrast, the interior of the wider impression is smooth, suggesting that the bark had been removed. Fabric A. L 55.5 W 19 T 19mm. Mass 15.2g. Context 3218, fill of post-holes 3531 and 3532.

Distribution

Fired clay was recovered from across the main occupation areas within the excavation area. The vast bulk (89% 26.3kg) was recovered from within House 10/3, and Workshops 13 and 15. A detailed consideration of the distribution by area follows.

Workshop 2

Within Workshop 2 is an iron smelting furnace (F681). A total of 8.8kg of fired clay was recovered from this structure, 83% from deposits relating to the furnace (contexts 674, 675, 677, 678, 680). Only 0.6kg displayed any evidence of vitrification or exposure to intense heat. Five samples directly related to the furnace had been deliberately shaped, including thin fragments of possible relining (SF1148), and these are interpreted as fragments of the upper structure of the furnace. Unfortunately, despite their fairly fresh condition, insufficient details remain to allow any reconstruction of the form of the upper structure.

The remaining 147g of fired clay was recovered from post-holes (contexts 411, 464, 594, 613, 634, 639, 646, 649, 670, 671, 698, 704).

House 3

This structure has been preserved as a partial ring-groove and a series of internal post-holes and pits. Only 5.9g of fired clay was recovered from this structure (ditch fill 724 and fill of post-hole 852), the majority highly abraded.

House 4
Only 63g of fired clay was recovered from this roundhouse, 69% from the ring-ditch and ring-groove (contexts 775, 776, 871, 1627, 1629, 1784) and the remaining 31% from post-holes within the interior of the structure (contexts 1706, 1708, 1708, 1710, 1795, 1918, 2356, 2360). The final structure was destroyed by fire, which may account for the formation of some of the material. 32% of the fired clay was abraded, suggesting it had been exposed to weathering prior to deposition. Two fragments from the ring-ditch (contexts 871 and 1784) had narrow wattle impressions, perhaps indicating the former presence of internal wattle and daub screens or other structural elements. One fragment of vitrified ceramic (sample 242) came from the upper floor deposit in ring-ditch 1810 (context 775).

Workshop 6
One fragment of vitrified ceramic was recovered from post-hole 889 (context 890) within this partially excavated post-ring structure. A total of 190.4g of abraded amorphous fired clay was recovered from context 1632 associated with Structure 22. This context has been described as a dump of material from a furnace. None of the fired clay fragments bore evidence of vitrification or adhering slag.

Cobbled surface 227
A total of 514g of fired clay was recovered from this large, cobbled surface (context 221, 225, 226). 75% was vitrified from exposure to intense heat. It was found in association with significant quantities of ironworking slag and is likely to have derived from the upper structure or lining of a ferrous metalworking feature such as a hearth or furnace.

Other
A further 59.8g of amorphous, undiagnostic fired clay was recovered from isolated pits, post-holes and deposits surrounding cobbled surface 227 (contexts 393, 430, 447, 510, 529, 532, 642).

Workshop 12
Only 6g of fired clay was recovered, all of it vitrified, from the secondary fill of post-hole 2444 (context 2447).

Workshop 16
A total of 1.4kg of fired clay was recovered from Structure 16, a roundhouse. 99% of it came from an iron smelting furnace (2246) and is interpreted here as fragments of the upper structure of the furnace itself. 0.72kg of the clay from the basal fill of the furnace (2288) is interpreted as the in situ remains of the last firing. 0.71 kg came from the post-abandonment fill of the furnace (context 2247, 2248), approximately 88% of which is highly abraded, suggesting that it had been left to weather and erode for some time prior to deposition.

House 17
Only 11.7g of fired clay was recovered from this structure, deriving from post-holes 2263, 2240 and pit 2410. The pieces are amorphous in shape, with few original surfaces remaining, and were insufficient to allow reconstruction.

Workshop 18
8.8g of abraded, amorphous fired clay was recovered from post-hole 3540 of this small roundhouse.

Workshop 19
Only 9.1g of fired clay was recovered, from post-holes 2535 and 2522 of this large roundhouse. One piece showed signs of being deliberately shaped and smoothed, the other was highly abraded.

North-west edge of site
A further 5.9g of highly abraded fired clay came from post-hole and pit features within this area (contexts 2314, 2319, 2418, 2593, 2649).

House 9
Only 3.1g of amorphous fired clay was recovered from this structure, all coming from post-hole fills (context 1762, 1861, 2108, 2112).

Workshop 13
A total of 5.68kg of fired clay was recovered from this small two-phase roundhouse.

0.4kg derived from iron smelting furnace 3050 (Phase 1) and is likely to represent fragments of the upper structure or lining of the furnace. Very little of this material (126.3g) preserved any evidence of deliberate shaping, making reconstruction of its form impossible. 91% of this fired clay was vitrified, indicating exposure to intense heat. The majority of material associated with this structure came from iron smelting furnace 3790 (Phase 2). A total of 5kg of fired clay came from this furnace; 50% of it was vitrified, confirming its interpretation as lining or fragments of the furnace structure. Cross-cutting wattle impressions on a small quantity of the material (216g) indicate the use of a wattle framework around which the raw clay was applied. In addition, a small quantity (56g) displays evidence of deliberate shaping, with smooth, rounded surfaces remaining. Only 0.4kg of the fired clay was highly abraded, suggesting that the clay upper structure was deposited fairly soon after destruction. A further 0.28kg of material was recovered from post-holes (contexts 2819, 2898, 2912, 2919, 2936, 2987, 3793, 4194, 4272), including one fragment of unburnt clay from post-hole 2936 and a fragment with wattle impressions from post-hole 2819.

Pit 3744 (close to Workshop 13)
A total of 0.74kg of fired clay was recovered. Just under half of this clay (315.2g) had wattle impression. These indicate that both circular-sectioned withies with the bark remaining and prepared squared or rectangular-sectioned timber battens were used to create a frame around which the wet clay was applied. Only one fragment (SF1167) had enough original surfaces remaining to indicate that the surfaces had been deliberately smoothed and rounded. Two pieces (from samples 292 and 1039) were vitrified.

Hearth 2434
76.1g of fired clay came from the charcoal-rich spread surrounding this hearth. Over 50% of the clay was highly abraded (40.7g) with many of the original surface features being removed by weathering

and erosion. Only one fragment displayed evidence of deliberate shaping, and none was vitrified.

Hearth 2166

Just under 1.2kg of fired clay was recovered from the vicinity of this hearth (contexts 2165 and 3180). 67% bears traces of deliberate shaping to create smooth, round external surfaces, including SF1145 with a single, angular wattle impression. Only 4% of this material was vitrified.

Workshop 15

A total of 10.1kg of fired clay was recovered from this roundhouse, with significant quantities coming from each of the three furnaces

Furnace 4355

A total of 2.15kg of fired clay was recovered from this middle furnace (contexts 4354, 4217, 4148). Large quantities of smelting slag confirmed its use for iron bloomery smelting (Dungworth & McLaren, Chapter 6, Iron). The majority of the clay pieces were small and fractured but lacking evidence of prolonged weathering. The fabric is fairly coarse with distinct angular quartzite inclusions. Four samples (samples 781, 785, 1682, 1683 and context 4345) displayed evidence of deliberate shaping with flattened, smoothed surfaces, some with finger impressions. In addition, samples 1682 and 1683 have partial wattle impressions, indicating the clay was built up around a framework of narrow withies. Only 12% of the fired clay was vitrified, but it is likely that all of this material represents the dismantled upper structure of the furnace.

Furnace 4147

3.1kg of fired clay came from furnace 4147 (contexts 4141, 4176, 4122, 4146). 69% of the clay was abraded, suggesting it had been left to weather for some time prior to deposition. Only 741.6g of the clay was severely vitrified (24%). Three fragments had evidence of deliberate shaping; two pieces with smoothed, rounded external surfaces and one piece with a flattened, vitrified, slag-attacked surface from the interior of the furnace.

In addition, just over 1kg of fired clay was recovered from context 4121, an upper fill within both furnaces 4355 and 4147, which represents deliberate backfilling after use. Over a third of this material (39%) is vitrified, suggesting that it represents further fragments of one or both dismantled furnaces. No differences in the fabric of the clay used in each furnace could be detected and only 9% of the material from this context was abraded. Three samples (SF0761, 7692 and 774) contained fragments that had deliberately smoothed and rounded surfaces, presumably deriving from the exterior surface of the furnace.

Furnace 4262

A total of 1.35kg of fired clay was recovered from this furnace feature. Two distinct fills were noted during excavation. 36% derived from the primary fill (context 4258) and 39% from the upper fill (context 4257). Little difference in clay morphology was noted between the two deposits. Only 21% of the material was vitrified. Less than 1% of the clay was distinctly abraded, suggesting deposition soon after destruction and limited weathering. A significant amount of the clay from this furnace was shaped, including four fragments of rounded or slightly flattened thick robust clay furnace rims (SF0852, SF0891, SF0895 – Illus. 6.3 and SF0898). Three fragments were recovered from the primary fill (SF0891b, SF0895 and SF0898), one from the upper deposits (SF0852). Differences in fabric type suggest that these derive either from two separate phases of furnace use or from at least two separate furnace structures. Fragments 895 and 898 are very similar in thickness, form and, more crucially, fabric type, comprising a coarse, light-buff-coloured fabric with frequent small to medium sized angular quartz inclusions. Both are likely to have derived from the same furnace structure. SF0852 and SF0891 are very different. They comprise crudely shaped pinched rims with distinct finger impressions and finger smears. They have been produced from fine-grained clay with some possible organic impressions. Angular impressions on the basal fracture surface indicate that the clay had been constructed around small flat, regularly spaced angular stones. None of the furnace rim fragments show heavy vitrification. Unfortunately, all four fragments are so small that the original diameter cannot be determined.

Pit 4369

This circular pit, immediately east of the above furnaces, was associated with significant quantities of iron smelting slag and may represent either a dismantled furnace or a dump of waste material. The pit was clay-lined, with 2kg of fired clay recovered from the interior, the majority amorphous lumps lacking any distinctive features. 15% had smoothed and rounded surfaces and 10% was abraded. None of the material was vitrified.

Workshop 15 post-holes and occupation deposits

A further 0.5kg of fired clay was recovered from Structure 15, 26g from occupation deposits (context 4342) and 472g from the fill of the inner post-holes (context 4132, 4268, 4289, 4295, 4297, 4311, 4312, 4322). 85% of the pieces recovered from the post-holes preserved wattle impressions. Only 8% of the material is abraded and 1% of pieces are vitrified. This fired clay could indicate the presence of an internal partition within the roundhouse or suggest the distribution of the spread of debris from the nearby furnaces.

House 10

A total of 2.3kg of fired clay was recovered from Structure 10. Only 39% has been assigned to the three identified structural phases, 99% of which comes from the final phase in the sequence.

10/1 3g of fired clay was recovered from post-hole 3601.

10/2 Minute crumbs of abraded fired clay weighing a total of 0.3g were recovered from post-holes 2488, 2771, 3338, 3613 and 3615. No external surfaces were preserved.

10/3 0.9kg of fired clay was recovered from postpipes, stake-holes and post-holes (contexts 2587, 2842, 2873, 2842, 3460, 3605, 3623, 3746 and 3750). The greatest concentration came from post-hole 3750, which contained 0.8kg of fired clay, the majority of which was vitrified and is probably furnace lining. 7.7g came from the ring ditch and outer ring-groove (contexts 1764, 2203, 2215).

Small quantities of undiagnostic material also came from surface deposits (34.6g from contexts 2450, 2452, 2470, 3113, 3567), from the stone wall base outside the ring-groove (9.5g, context 1853), from abandonment deposits (1.05kg, contexts 1671, 2199), and hillwash overlying the structure (17g).

Phase unassigned 1.4kg of fired and vitrified clay from Structure 10 derived from features and contexts that cannot readily be assigned to a particular phase. Over 85% (1.2kg) was recovered from post-holes (contexts 2211, 2539, 2606, 2701, 3680, 2680, 2860, 2887, 2889, 2891, 3019, 3045, 3286, 3449, 3468, 3603, 3680, 3868, 4061, 4126, 4185). A further possible furnace rim fragment (SF1149) was recovered from post-hole 4126.

Features to the east and south-east of House 10
In addition to the fired clay from distinct features described in detail above, a large quantity of fired clay pieces derived from pits, post-holes and other deposits within this area. 2kg comes from various pits (pits 1863, 1936, 2143, 2454, 2777, 3517, 3051, 3564, 3756, 3808, 3811, 4134, 4375, 3795), 0.9 kg from post-holes (post-holes 1972, 1981, 1997, 2541, 2547, 2796, 2811, 2815, 2905, 2925, 2929, 2934, 3150, 3161, 3278, 3455, 3531, 3532, 3626, 3653, 3703, 3772, 3758, 3814, 3816, 3829, 3886, 3933, 3953, 4030, 4094, 4101, 4283, 4292, 4298), 0.3g from hillwash (contexts 3435 and 2102), 175g from occupation deposits (context 1896), 4.6g from turf wall (context 2477), and 0.78 kg from various deposits (contexts 798, 2102, 2187, 2191, 2682, 3883, 4279) and cobbled surfaces (SF1945 and SF2130).

Discussion

Although much of the fired clay is small, fractured and abraded, limiting the information it can provide, a small quantity of more significant pieces are present, including pieces with wattle impressions and evidence of deliberate shaping. 70% of the fired clay assemblage (20.9kg) was recovered in association with metalworking structures including iron smelting furnaces and possible smithing hearths. It is likely that this material derived from the clay-built upper structures of these features. The examination of the fired clay has provided a complementary picture to the furnace lining fragments analysed alongside the ferrous metalworking waste assemblage. Significantly, this assemblage provides a wealth of information about the above-ground structural element of the iron smelting furnaces in use at Culduthel. Very little information is available on the upper structure of Iron Age furnaces due to the rarity of their preservation, so this evidence is of importance. Identifying the form of the furnace, particularly distinguishing between bowl or shaft furnaces, is near-impossible when only the base of the furnace remains (Tylecote 1986, 133), and identifying the furnace form is normally not possible. Although vitrified ceramic fragments, interpreted as pieces of furnace or hearth lining, are commonly encountered within later prehistoric slag assemblages, they generally provide only limited information about the construction and form of the structure. This is due to four main reasons. Firstly, the fragments are often slag-attacked or highly vitrified, indicating that they derived from near the base of the furnace and can tell us very little about the overall construction. Secondly, such vitrified ceramics often consist of small fractured pieces with only the internal, slag-attacked face intact. The unvitrified external surface will be very friable and liable to degrade rapidly, if left exposed. Thirdly, if fragments of the upper structure survive, they will not necessarily be vitrified, sooted or severely heat-affected, and are more fragile and vulnerable to erosion. Lastly, any unvitrified fired clay is commonly separated out from the vitrified material, often resulting in the material being examined by two separate specialists. Our impression of Iron Age furnaces is often constructed with reference to later, Roman shaft-furnaces rather than from contemporary evidence, which is sadly lacking in Scotland. This has always left the interpretation of the form of later prehistoric iron-smelting furnaces on shaky ground. The recovery of a small number of thick, robust furnace rim fragments are a significant find, unparalleled within a Scottish context of this date. Their identification confirms the use of cylindrical shaft-furnaces at Culduthel; an element of Iron Age ironworking technology that has always been assumed in Scotland but never demonstrated. Unfortunately, due to the small, fractured condition of these pieces, it is possible to determine neither the diameter of the shaft top nor its height. The wattle impressions present on many fragments indicate the use of a framework of withies around which the clay structure was moulded. These were predominantly roundwood, both with and without bark, but also included some squared timbers.

The fired clay also provides plausible evidence for the relining and repair of the upper structures. This is present in the form of thin skims of clay that appear to have been deliberately moulded against an existing curved wall, and confirms the evidence of relining noted within the vitrified ceramics from the ferrous metalworking debris.

In addition to the material recovered in association with the metalworking structures, 3.9kg of material, representing 13% of the total assemblage, came from post-holes across the site. These pieces concentrate within the interiors of Houses 10 and 4, perhaps indicating the former presence of internal wattle and daub screens.

Metalworking ceramics

Crucibles and moulds

Fraser Hunter

with scientific analysis by Susanna Kirk and Jim Tate

The Culduthel excavations produced 72 sherds and fragments (318g) of crucibles (Illus. 6.5 and 6.6) and 60 fragments (215g) from at least 10 moulds (Illus. 6.7 and 6.8), the vast majority from the craftworking area to the east and south-east of House 10.

Crucibles
The fragmentary nature of crucibles often inhibits reconstruction of their form. Here, diagnostic fragments indicate that the typical deep triangular crucible was predominant, the sides either straight or convex in plan. A few sherds represent other, more unusual forms. There is at least one large thick-walled shallow triangular crucible with rounded sides, a type more typical of southern

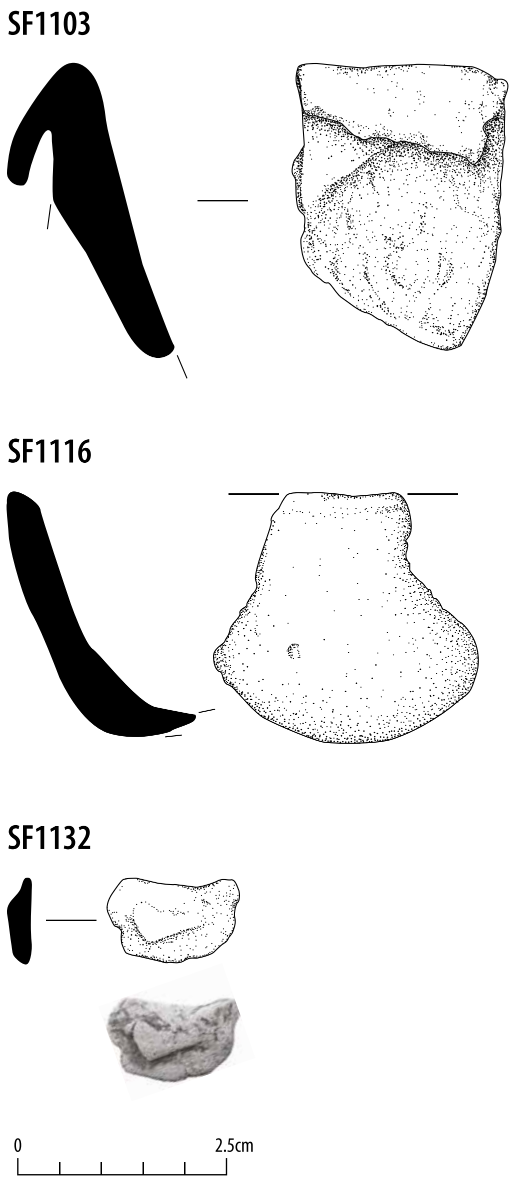


Illustration 6.6
Crucibles

England (Spratling 1979, 130) but known occasionally in Scotland (for instance at Midhowe (Orkney; NMS GVM 160), Birnie (Moray; unpublished) and perhaps Traprain Law (East Lothian; NMS GVM 583 (C14) and 585 (C24)). More unusual are sherds of a globular crucible, the neck everted into a lost rim. This form is extremely unusual for Scotland, not represented in Heald's (2005) Scottish crucible typology of the period *c.*700 BC–AD 800. Bayley's (1990) type-series indicates such forms are found in both the Roman period and the 9th–12th centuries, and there are very rare Scottish parallels: a carinated sherd from Dunadd (Lane and Campbell 2000, illus. 4.42 no. 666), and a poorly dated globular vessel with everted rim from Bretta Ness, Rousay (Hunter [forthcoming a]). The profile can also be affected by sagging or deformation during use; a near-intact triangular crucible from Traprain Law (NMS GVM 579a) has a sinuous profile in one area caused by distortion. However, that does not seem to be the case here.

There are no complete profiles to allow a better assessment of size, but SF1116 has an internal height of *c.*35mm, quite typical for Iron Age crucibles (Illus. 6.6); SF0412, again a near-complete profile, is rather smaller, its internal height *c.*20mm (Illus. 6.5). The shallow triangular crucible SF0377/SF0447, with a height of *c.*30mm and a diameter of at least 100mm (Illus. 6.5), was rather larger, giving it a bigger capacity, while the substantial bases SF0332 and SF0384 point to notably larger crucibles, which are unusual in surviving assemblages. Wall thickness may act as a crude proxy for crucible size, although it is complicated by variation along the profile (being thicker near the base) and by relining (see below). Thickness varies from 3.5 to 12.5mm with a cluster from 3.5–8mm, suggesting a range of vessel sizes. Some fragments provide clues to the technology of forming the crucibles. The unusual globular crucible SF0374/SF0656 has split along a construction line (not a relining; the indistinct boundaries indicate it had formed while the clay was still plastic); the clay used for the upper part, closing the mouth, was notably more quartz-rich. SF0384 also shows a composite construction using several pieces of clay: it is the base of a large crucible which has failed along a construction line, leaving a stepped edge where the wall attached and a raised lip around the interior. There were different methods of forming a spout. In some cases the corner was everted; in others the inner side of the lip was thinned. These minor variations in habitual procedures suggest the hand of different individual craftworkers. See Sahlén (the section on petrographic and technological analysis of ceramic materials below) for discussion of fabrics. The location of vitrification indicates crucibles were heated from both above and below. The rims are consistently the most heavily vitrified areas, while most of the five preserved bases show evidence of heating (one base was unused, and one unheated). On two fragments (SF0332.5; SF0332.6), the distorted vitrified surface preserves rectangular indents, probably from tongs; in one case these are on a base, but the other is less clear. The degree of vitrification and other signs of heating (such as the reduction of the fabric from the freshly manufactured light brown to various stages of grey) shows that crucibles in all stages of use are present, from barely used to heavily used, reused and failed.

Relining and repair

A most intriguing feature is the evidence for relining of crucibles to extend their lives. Eighteen of the 72 fragments had been relined with a layer of clay 1.5–4mm thick. Where the rim was preserved, the lining was normally either stacked on the rim or wrapped round it, in the process raising the vessel's height; this would provide compensation for the corresponding loss of capacity in the interior. In a number of cases, the original surface was grooved to increase adhesion of the new lining. Twelve fragments had been relined once, and two fragments twice. There were also four instances with an unfired clay patch, presumably an unfired lining. In one case, the relining clearly covered only part of the interior, suggesting it was a response to damage in one area. Relining was not just a response to heat damage, but was used to extend the life of a crucible. In the eight instances where evidence was visible, six showed signs of use damage (only lightly in two cases) and two showed none. This suggests relining was actively used as a deliberate strategy to curate the crucibles and extend their lives, sometimes long before substantial damage occurred. The assemblage produced other evidence of repair. On SF1103 the relining was an unusual one, as it hooked over the back but did not lie flush on the rear face (Illus. 6.6). This was probably to accommodate and restrain a partly spalled area, in an attempt to extend the crucible's life. There were also two small sub-oval patches (SF1132 – Illus. 6.6 and SF1138) with marks of keying; these seem to have been pushed into a crack that had been keyed to hold it. They show no signs of significant heating.

Relining has been noted in other assemblages, though not so frequently and with a variety of interpretations. Bayley and Rehren (2007, 50) note that thin-walled crucibles often had an outer layer of less refractory clay. This was a sacrificial layer that would quickly vitrify; it was intended to insulate the crucible, distribute heat more evenly and reduce thermal shock (see also Bayley 1992, 755). Other interpretations are possible. At Dunadd, Lane and Campbell suggested that relining was connected with fixing lids to crucibles (2000, 205). At Mote of Mark, occasional relining was noted both externally and internally (Laing and Longley 2006, 31–2), the latter clearly indicating reuse of damaged crucibles. Relining could also be confused with construction lines. Since the phenomenon has only been systematically reported in modern studies of larger assemblages, none of Iron Age date, published data provide a poor basis for establishing how common relining was. To set the Culduthel evidence in context, a sample of crucibles in the national collections was examined in two ways. Material from 20 small Iron Age/Early Historic assemblages from across Scotland was examined, to give a presence/absence indication of relining, while from three larger assemblages (Traprain, Dunadd and Brough of Birsay), a substantial sample of sherds was examined to give an idea of the frequency and nature of relining. It is clear that relining, in various forms, was a common phenomenon. It was noted in nine of 20 small assemblages (representing 12 of 33 crucibles), and is present in all the large assemblages studied. Samples from these gave the following, notably consistent figures: 9/73 sherds (12%) from Dunadd, 13/138 (9%) at Birsay and 4/51 (8%) from Traprain. There are obvious problems in using a simple sherd count for such calculations, with issues such as differential fragmentation on different sites, multiple sherds from one vessel, and so forth, but even so, the figures from Culduthel are notably higher, with *c.*25% of sherds relined. Study of the Traprain, Dunadd and Birsay material shows some diversity to the relining process. There are very occasional examples of layering from construction lines, while Dunadd in particular shows layers from the attachment of lids. However, the bulk of the evidence most plausibly relates to repair: there are internal and external linings, both partial and total, fired and unfired, sometimes with a clear focus on the rim area. There are also examples from all three sites of layering over both unvitrified and vitrified surfaces. This is closely comparable to the evidence from Culduthel, and seems to represent both repair of damaged but favoured crucibles, and preventative maintenance of effective specimens. In contrast to Bayley and Rehren's (2007, 50) observations, the clay from the relining seems as good in quality as that of the original, suggesting this is not some sacrificial layer, while the evidence of relining over heat-affected surfaces indicates it represents repair rather than extra insulation.

In the vast majority of cases the crucibles show little or no sign of wear after use, and this clearly represents a primary or near-primary deposit. One item (SF1103) does provide rare evidence of reuse after breakage, with one end oxidised and worn, and traces of a clay skin over it (Illus. 6.6). This suggests the fragment was built into another structure, presumably to take advantage of its refractory properties.

The moulds

The clay mould fragments are frustratingly incomplete, as is so often the case, and it is uncertain what was being cast. The 60 fragments represent at least 10 different moulds (based on the minimum possible numbers from each context). They come from piece-moulds, predominantly two-piece, but one shows clear signs of being more complex (SF1108 – Illus. 6.7); it appears to be the head portion of a composite (three-piece?) mould, perhaps for pins, although this seems a little unnecessary for what are normally simple items. The moulds often show evidence of luting or cladding to seal them (or in one case to strengthen a thin area); there are also grooves from binding the halves of the mould together. Two of the small fragments preserve keying marks, in one case a protruding lug, in the other a rectangular hollow. The larger fragments, by contrast, do not show keys; they use either concave and convex valve surfaces or longer channels/ridges along the valve edges.

None of the products can be securely identified. Most distinctive is SF1125, for a linked pair of rings, slightly asymmetrical in detail. SF1110 is from another, larger ring, but there are hints of a more complex, decorative lobed form in places; too little survives to identify the product. The surviving face of SF1104 (Illus. 6.7) and SF1109 (Illus. 6.7) would produce a parallel pair of bars, slightly sinuous in profile. SF1108 might be a pin mould although, as discussed, it seems to be from a complex three-part mould, unusual for a pin (Illus. 6.7). Too little of SF1105 survives to hazard a guess, while SF0433b revealed the protruding circular edge of something reasonably tall (Illus. 6.8).

The stone mould SF0339 (Illus. 6.17) is discussed elsewhere. It most likely represents a blank for sheetworking; the product is uncertain, though it may have been a vessel.

The casting alloys

Susannah Kirk, Jim Tate and Fraser Hunter

Sixty-eight crucible fragments and 20 mould fragments were investigated by X-ray fluorescence analysis (XRF) to assess the alloys being cast; see archive report for methodology. Areas with apparent residues were analysed in the first instance, with generally two more analyses being taken from each fragment. In the smallest fragments (less than 10mm across) usually only a single area could be analysed. All the moulds produced very low X-ray counts, with the metal peaks being just above the background. Both crucibles and moulds showed a similar range of elements from the ceramic component: iron, manganese, calcium, potassium, titanium, strontium, rubidium and occasionally zirconium. Full results are available in the archive report; this section provides a synthesis.

Illustration 6.8
Mould

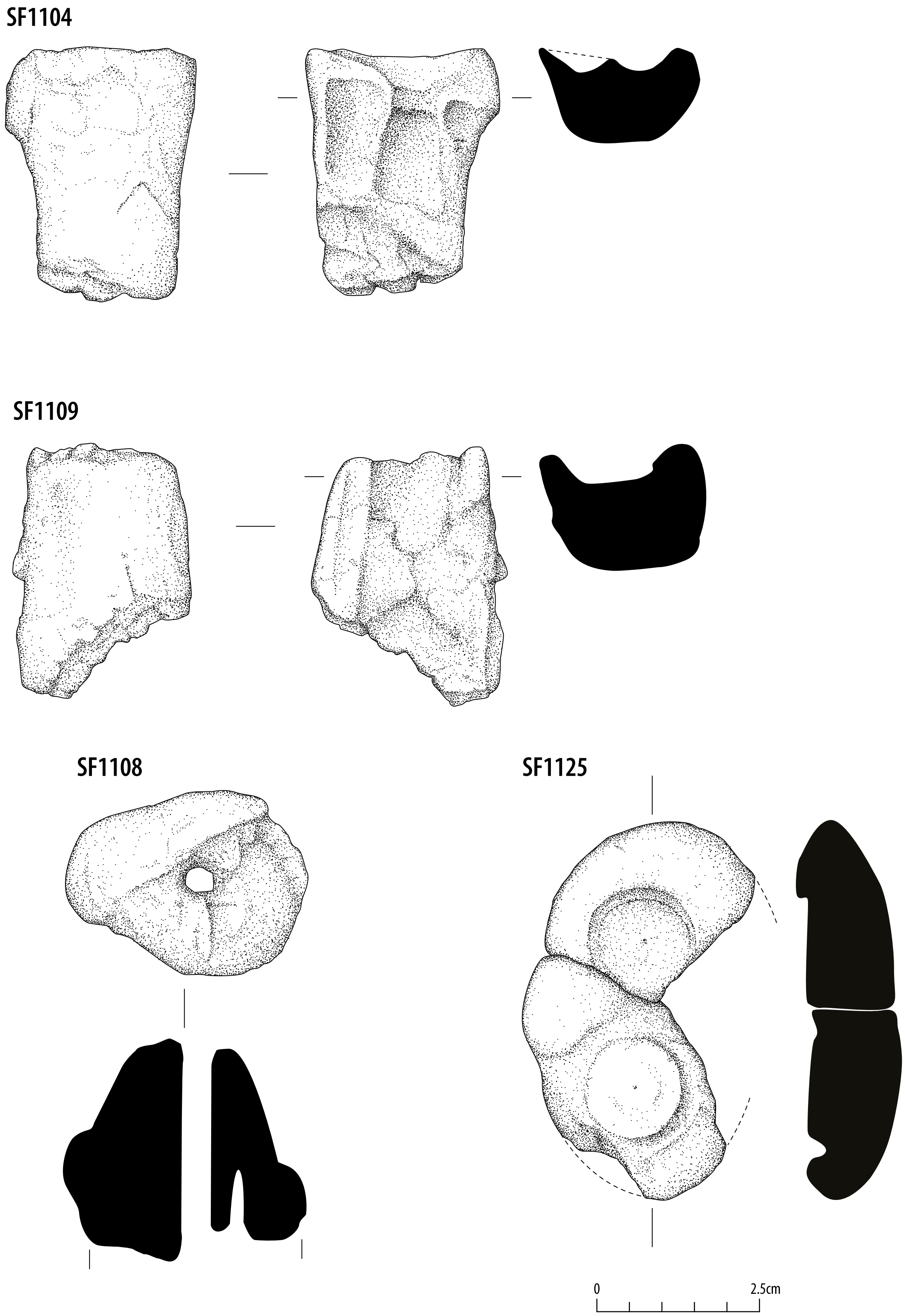


Illustration 6.7
Moulds

There are difficulties in assessing alloy type from such evidence. It is well known that certain elements can be present in crucible residues even when they were present at only very low levels in the original metals. Zinc, lead and tin can all be enriched compared to their level in the original metal due to the volatility of these elements during melting (Barnes 1985; Dungworth 2000). Zinc has the highest volatility, and Dungworth (2000) suggests that very low levels of zinc in the original metal can give rise to significant levels within the crucible residues. This means that definitive extrapolation of the original metals from refractory ceramics is unlikely to be possible. Other factors, such as the reuse of crucibles and corrosion of metallic residues, may also complicate results, although metal residues will give more reliable results than ceramic surfaces.

Illus. 6.9 summarises the data as a bar chart for each of the key elements, showing how many sherds had a peak, a trace or a blank for that element. It is immediately clear that the vast majority of sherds provide evidence of the casting of copper alloys. Only one mould fragment lacked such traces, and of the two blank crucible fragments, one had lost its surface, and the other was so heavily vitrified it may well have failed before being used. There are clear differences between the results for moulds and crucibles; the moulds show no tin and a markedly greater presence of zinc, due to a systematic bias in the absorption of metal traces in moulds compared to crucibles (Barnes 1985; Dungworth 2000). They thus give less reliable results than the crucibles and will not be considered in detail here; their results essentially support the crucible analysis.

A key question in such analysis is the presence of zinc, as this is not present in typical Iron Age alloys and is thought to derive from recycled Roman metal (Dungworth 1996). Given the well attested dominance of zinc in XRF spectra where even minor amounts were present in the alloy (Barnes 1985; Dungworth 2000), it is notable that only 10 crucible sherds showed a significant zinc peak, compared to 58 which did not (sherds with only traces of zinc are treated as insignificant, since this probably represents enhancement of the very low levels of zinc (0.1–0.3%) found in quantitative analysis of the leaded bronze casting waste; given the dominance of Roman alloys in the casting pool in and after the Roman Iron Age (Dungworth 1996; Heald 2005), this strongly suggests that the bulk of the casting evidence is pre-Roman. The presence of lead in most of the crucible and mould analyses confirms that leaded bronze was the main alloy type.

Of the 10 crucible sherds with significant zinc peaks, three are from upper levels (1681, 2100, 2102) that are likely to run into the Roman Iron Age. Seven sherds from five different contexts do seem to be securely pre-Roman; Hearth 2166 (with a radiocarbon date of 350–50 BC), Hearth 2434 (with a radiocarbon date of 150 BC–AD 30), 2778 (underlies Hearth 2166, date to 200 BC–AD 0), 3035 (underlies fill of Hearth 2434, 2677 dated to 170 BC–AD 20), and 3153 (Hearth 26, under 1896). There are a number of possible explanations. It may be that pre-Flavian Roman material did reach the area, and was melted down; this seems unlikely, however, as there is very little material of this date from Scotland (Hunter 2007a, 22). It may be that the supposed 'zinc horizon' is illusory, although it has found general support in large analytical programmes (Dungworth 1996, 407–10; Heald 2005). Apart from extremely rare imports (Craddock et al 2004), pre-Roman alloys containing zinc have only been found in areas using naturally zinc-rich ore, and there is no hint of that in the quantitative analysis of the casting debris. The other possibility is that mixing of the deposits has caused some stratigraphic intrusion. This is plausible in an active craft zone such as this, and evidence of joining sherds across contexts is noted below. Of the seven sherds in early contexts, three are small (maximum dimension 8–16mm), and thus potentially easily displaced; two are larger (33–39mm) but, significantly, show a moderate degree of wear. This is unusual for the assemblage, almost 80% of which shows no or only limited wear (Illus. 6.10). It suggests these sherds have moved around and become worn; they are likely to be intrusive. A further sherd (SF0656, 3153) joins SF0374 in 2100 (abandonment of Workshop 11 dated to 60 BC–AD 90), and thus could be Roman Iron Age. Only SF1138 (3035), a patch 23mm long, lacks clear signs of being intrusive, but a single sherd is a weak basis. The possibility of pre-Roman zinc-containing alloys is tantalising, but this detailed examination of context and taphonomy suggests Culduthel does not provide sufficiently robust evidence for this. It seems that zinc-containing alloys became a small part of the metalworkers' resources as they became available from recycled Roman metal during the Roman Iron Age, but leaded bronzes were the dominant alloy. This is consistent with the results of the metal analysis.

Eleven crucible sherds show trace levels of other elements: arsenic, antimony, nickel and silver, which were all found as minor elements in analysis of the copper alloys from the site. In nine of the 11 sherds, visible metal residues or globules were present, and these are the likely origin of these elements. There is, however, one intriguing exception. Of the eight sherds with a silver trace, five are readily explicable as minor elements in copper

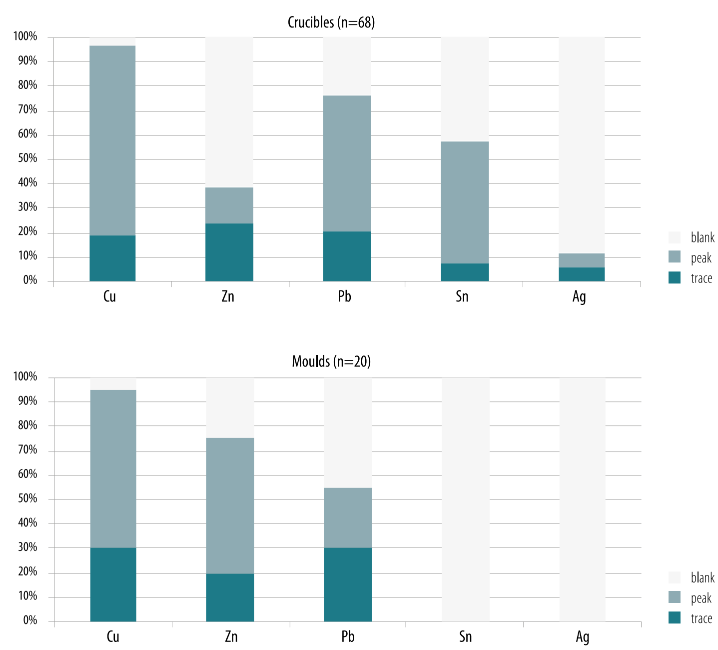


Illustration 6.9
Proportion of analysed sherds showing a peak, a trace or no evidence for key elements (Cu, copper; Zn, zinc; Pb, lead; Sn, tin; Ag, silver). (a) crucibles (68 sherds analysed); (b) moulds (20 sherds analysed)

alloy globules surviving in residues, but three are not: sherds SF0396.3–5, from the abandonment deposit 2101. These had a significant silver peak; indeed, SF0396.4 had only traces of elements apart from silver. This is rare and potentially significant, since there is no secure evidence of casting silver in Scotland before the 4th century AD (Heald 2005; Hunter 2007c, 218–19). These three sherds thus merit more attention. It is likely they come from a single crucible; they were found together, along with two other crucible sherds, but are substantially more worn than them. As noted above, this is unusual in the assemblage, and strongly suggests they are not in situ, in contrast to most of the assemblage. These three sherds from this high level are likely to be later, intrusive material. Unfortunately they are too small to determine their form; but given the Pictish activity at the neighbouring Headland Phase 7 and 8 site, it is possible they are

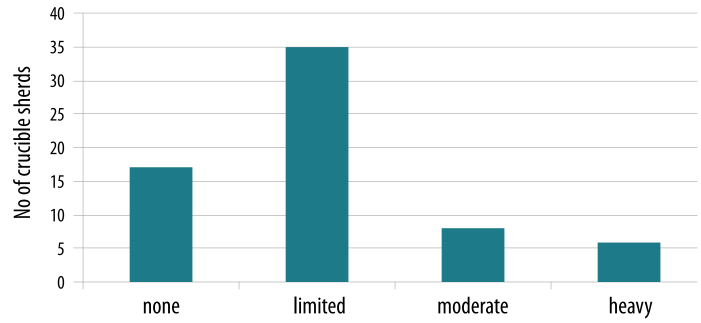


Illustration 6.10
Degree of wear on crucible sherds (excluding items recovered from sieving, since this process caused wear)

Table 6.4
Distribution of crucibles and moulds by context (by fragment count and weight). Joining fragments in a context are counted as one. 'p/h' = post-hole; 'craft area' = area of deposits to south-east of structure 10

		Crucible		Mould	
Context	**Feature**	**Sherds**	**Mass/g**	**Sherds**	**Mass/g**
220	Pit, near cobbled surface 227	1	3.93	–	–
1681	Area to the east and south-east of House 10	3	15.46	–	–
1861	House 9 posthole 1860	1	6.35	–	–
1952	Area to the east and south-east of House 10	2	6.57	–	–
1978	Area to the east and south-east of House 10	6	23.26	–	–
2100	Area to the east and south-east of House 10	14	97.89	–	–
2101	Area to the east and south-east of House 10	7	20.41	–	–
2102	Area to the east and south-east of House 10	7	24.75	–	–
2165	Area to the east and south-east of House 10	1	9.67	2	35.29
2166	Area to the east and south-east of House 10	1	4.42	–	–
2187	Area to the east and south-east of House 10	2	41.34	1	9.91
2264	House 17 posthole 2263	–	–	1 (v worn)	6.00
2419	Posthole 2416, nr Workshop 19	1 (tiny)	0.04	–	–
2435	Area to the east and south-east of House 10	2	8.92	–	–
2471	Compacted sand layer underlying Workshop 11	–	–	2	33.21
2544	Posthole 2543 ass w Hearth 2434	2	1.94	23	33.07
2548	Posthole 2547 ass w Hearth 2434	3	2.65	–	–
2677 = 3022	Hearth 2434	9	42.26	23	85.35
2778	Pit 2777 associated with Hearth 2166	4	2.10	–	–
3035	Hearth 2434	2	2.30	7	9.46
3038	Heat-affected under Hearth 2434	3	0.38	–	–
3153	Heath 26 posthole 3152	1	2.71	–	–
3830	Posthole 3829 within Workshop 11	–	–	1	2.39
	Totals	**72**	**318.47**	**60**	**214.68**

Table 6.5
Catalogue of illustrated crucibles

SF no.	Context	Description	H/mm	W/mm	Wall T/ mm	Max T/ mm	Mass/g	Residues	Relined/ repaired
332.5	1978	Thick base sherd, cracking and glazing on the exterior indicating heating from below. Two fragmentary sub-rectangular impressions (W 10.5mm, L 10+mm) are probably from tongs. Size indicates a substantial crucible. Slightly worn	40.0	36.0	12.0	—	11.26	Grey glassy exterior	—
341	2102	Triangular crucible fragment with rounded sides; tapers slightly in to rounded rim, which is vitrified. Interior uneven from use-damage. Unworn	18.0	31.5	5.0	—	3.34	Red glaze at rim; clear glaze externally	—
351.1	1681	Rounded crucible rim, relined on the interior (T 2.5) and hooked over the rim, raising its height by 7.5mm. Moderate wear	25.0	23.0	7.5	10.5	4.97	Red glassy residue on rim and interior; dark area on lower interior	Relined
364.1	2102	Curved sherd tapering to rounded rim. Slight wear	27.0	32.0	8.0	—	6.21	Opaque yellow-brown glaze on interior; overlying patches of darker slag	—
374 / 656	2100	Unusual globular crucible form, with evidence of a construction line at the shoulder, the upper part more quartz-rich. (Interpreted as construction line rather than relining as the indistinct boundaries show it formed when the clay was plastic). Sinuous profile with globular body and everted (lost) rim. Unworn	39.5	24.0	5.0–6.5	—	9.65	Dark to pale brown residue on exterior at neck and all over interior	—
375 / 481	2100, 2187	Two fragments from an upright, near-straight-sided crucible tapering to a rounded rim; upper wall curves slightly, lower more tightly, suggesting a thick-walled, shallow form. Remains of two relinings on the interior and wrapped round rim (interior up to 4mm T, exterior 2.5). Each inner face has vitrified residue, indicating very heavy use. Grooves on the exterior surface were probably for adhesion. Top very vitrified. Slightly worn	46.0	48.0	10.0	15.0	49.11	Red-brown glassy residue and vitrification on the rim and interior; petrographic section revealed drops of trapped copper alloy	Relined twice
377 / 447	2100, 2187	Non-joining fragments of a shallow triangular crucible with rounded edges; estimated height 30mm. Profile slightly irregular; SF377 is less curved in plan and has a regular curve in section. Section shows a clear colour gradient, vitrified at the top, grey in the middle of the vessel and brown at the base, indicating heating from above. Very slight wear	59.0	49.0	6.5–8.5	—	35.31	Red glaze at rim; dark residue in base	—
384	2101	Rounded base from large crucible; cracking and heating indicating it was heated from below. Fracture follows construction lines; it seems the base failed along a stepped edge in places, with a raised collar defining the rather irregular interior. Edge probably stepped to maximise adhesion. Probably a large vessel. Some wear	37.5	34.0	12.5	—	11.06	Small area of dark staining	—
412	2165	Near-complete profile with tapered, rounded rim; probably a small, shallow, rounded triangular crucible. Unworn	29.0	33.0	7.0	—	9.67	Thick attached slag with charcoal and small copper alloy droplets	—

Table 6.5
(continued)

SF no.	Context	Description	H/mm	W/mm	Wall T/ mm	Max T/ mm	Mass/g	Residues	Relined/ repaired
417	2101	Rim sherd with tapered, flattened rim, the edges rounded. Some vitrification. Remains of a layer of light brown clay (with similar temper) in a patch on the exterior suggest repair or relining in progress; it overlies an area of slight rim damage. Very slight wear	37.0	21.5	8.0	—	7.10	Red glaze on top of interior; uneven deposits in base	Unfired relining
556	2677	Upright rim, slightly curved into a rounded tip; slightly curving sides indicate rounded triangular form. Two relinings, stacked on top of the original rim, leading to the crucible gaining in height as it loses in depth. Both are hooked over the existing rim, although damage means their full extent on the faces is unclear. On the exterior, an uneven area for *c*.11mm below the rim has been deliberately roughened for adherence. Layers *c*.1.5mm T, increased the height by 11mm and 5mm respectively. Slight red glassy residue on inner rim of primary face; second one obscured; third lining has red glass on interior and rim. Moderate wear	39.0	32.0	4.5	11.5	9.01	Red and brown glaze on rim and interior	Relined twice
1101	1952	Heavily vitrified crucible fragment; inner surface lost integrity. Wall very thin as it survives. Relining covers earlier use-residues. Slight wear	22.0	14.0	3.5	6.0	1.59	Copper-staining on interior and original exterior	Relined (1.5mm thick)
1103	2100	Upright rim sherd from triangular crucible, tapering to rounded rim. Outer side spalled; a relining has sought to repair this, standing proud of the outer surface, presumably to fit round the part-spalled wall. Lower end of sherd is oxidised to red and more worn, and there are traces of orange clay over various parts, suggesting the sherd was reused or built into something. Slight wear	38.5	25.0	8.0	12.5	7.37	Vitrified at rim	Exterior relined to repair; also reused
1116	2677	Near-complete profile from corner of triangular crucible, with slightly curved upright sides tapering to a narrow rounded rim; outside of base lost, inside near-complete, giving an internal height of *c*.35mm. Inner surface narrowed to form pouring spout at corner. Slight wear.	39.0	32.0	6.0	—	7.14	Scattered dark grey residue internally	—
1127	2778	Relined crucible rim sherd. The original vessel tapered to a slightly angled rim with an internal bevel; the relining (T 1.5mm) raised the height by 5 mm, forming a rounded rim.	28.5	12.0	5.5	—	1.67	Patches of light brown deposit on interior	Relined
1132	3022	Patch from a crucible? Irregular but complete sub-oval object, flat on one side, the other with a raised sub-triangular area with a few lower diagonal lines extending from it; these are probably keys cut into a damaged surface to take the patch. No sign of any heating effects. Slight wear	16.0	10.5	3.5	—	0.41	—	—
1138	3035	Crucible patch? Sub-oval object, broken at one edge; one surface flat, the other bossed with short linear indents on each side. A further fragment, no longer joining, probably comes from the broken edge. Light grey fabric. Unworn	23.0	15.0	9.0	—	2.30	—	—

Table 6.6
Catalogue of illustrated moulds

SF no.	Context	Description	L/mm	W/mm	T/mm	m/g
433b	2187	Mould fragment preserving part of a near-flat circular base and a barrel-shaped form, with remains of clay luting up to 4mm thick. This has been smeared in certain places rather than being continuous, and was perhaps intended as a support where the object to be cast was too close to the edge, as seems to be the case, No valve surface survives, but remains of a casting face preserve a circumferential hollow, rounded in section against the mould's wall. If circular, it would be *c*.20–25mm in diameter. Unidentified. Slight wear	32.0	33.5	15.0	9.91
1104	2165	Head of the female valve of a D-sectioned two-part mould with expanded dished ingate. Broken at end and one side. Partial remains of thin luting. Remains of a deep channel on the edges of the valve to engage the other half. The casting surface is a flared rectangle in section, expanding from 7 to 9mm, 4mm deep, with two parallel channels separated by a ridge; this has mostly broken off in removing the object, but part of the upstand survives, giving channels 3–3.5mm W and a ridge of 3mm. The form is closely similar to that of SF1109; they do not join, but could be from the same mould, although SF1109 is rather thicker. They are certainly for casting the same type of object, although its identification remains elusive	38.5	31.0	22.5	15.13
1105	2165	Fragment of male half of a two-piece mould, lacking ends and one edge. Thin clay luting (T 1mm) in places. Oval section, the valve face slightly convex to engage with the other half. All that remains of the casting face are two indents (the centres 16 mm apart); the better-preserved one is D-shaped with a rounded tip (W 8, H 5, D 4mm) and traces of a channel leading from this to a lost feature. Unidentified	39.0	32.0	20.0	20.16
1108	2471	Large fragment of mould with remains of luting up to 5mm thick; this has a horizontal notch in one area for binding the mould. Conical fragment, oval in section, from the end of a mould with a longitudinal cylindrical hollow (D 4mm). This suggests a pin mould, but in the fracture surface is a parallel D-sectioned hollow tapering to a rounded tip pointing to the top of the mould. This is unlikely to be part of the casting, as it would not be gravity fed, and thus is probably keying. If so, it suggests a multi-part mould, with a conical head separate from ?two lower pieces. The top of the cone lacks a gate (though about two-thirds of the rim is damaged), but notches cut into the surviving part may have been intended as seating for a separate gate component	34.0	37.5	25.0	19.35
1109	2471	Two joining fragments from the female half of a two-piece mould, broken at both ends (though its form suggests it is part of SF1104. Sub-square in section, rounded at the back and expanding to one end. Remains of clay luting with a slightly angled notch (W 6mm) to bind the two halves together. Remains of two shallow channels on the edges of the valve faces acted to engage the other half. These flank a deeper channel (12mm W), rectangular in section with rounded corners, which is deeper at one end, rises up to a damaged area and then deepens again at a slight curve. The middle of the casting surface is lost on both this and the similar SF1104; this consistency suggests there was a central ridge which came away with the casting, and there is the vestigial stub of such a feature towards one end. The object being cast is unclear, but it consisted of two parallel struts (2.5–3.5mm W and 6.5mm apart), sub-square in section and rising towards the middle	39.5	29.5	20.0	13.86
1110	2544	Multiple fragments from a bivalve mould; three preserve significant parts of the casting surface, indicating this was a ring-like object, U-sectioned in the surviving portion (external D 45mm, W 7mm). One fragment, perhaps from the other valve, has what appears to be a slight lip on the edge of the ring and two conjoined lobes protruding from it, perpendicular to its plane. This suggests something more decorative than a simple ring, although too little survives to identify it. Orange-brown fabric, reduced to pale grey on one valve only. Remains of an irregular clay cladding with fingerprints on the exterior. Fragment sizes 32 × 28 × T 14, 18 × 11 × T 10, 29 × 17 × T 15 (other valve)	32.0	28.0	14.0	33.07
1120	2677	Rounded, slightly everted fragment, perhaps the lip of the cup at the head of a mould. Worn	14.0	9.0	10.0	1.01
1125	2677	Two joining fragments of the male / back half of a mould, the valve slightly convex for engagement; around a third is missing, but it was probably oval in form and D-sectioned; there is no trace of luting. The ingate is broken but the channel for the metal indicates its position. The object being cast was a pair of conjoined rings, the upper with a U-section, the lower with a stepped profile comprising two concave steps (in the surviving portion). A shallow channel at least 6 mm wide joins the two, its width suggesting it was structural rather than a casting strut. There is a boss in the centre of each ring, broken in the lower one. This might suggest a bossed centre, but the surface of the intact one is a different colour from the ring casting surface (very dark rather than pale), suggesting the metal did not flow over it and thus the rings were open. Upper ring: external D 20, internal 13.5mm; lower, external 17mm, internal 12.5mm	58.0	33.0	16.0	23.18

linked to this. It is regrettable that they cannot be more closely dated, or indeed linked to the main phase of metalworking in the craft area, as this would be highly significant, but evidence for the casting of silver is still a valuable addition to the developing picture of its use. The analysis suggests either casting of a fairly debased alloy, or use of the crucible for both copper and silver alloys.

The context

The vast majority of moulds and crucibles cluster in the sequence of spreads to the south-east of Structure 10; Table 6.4 summarises the data. Key concentrations (>5 fragments) are associated with Hearth 2434, restricted spreads 1978/2102/2677/3022, and more general spreads 2100/2101 overlying the stone hearths and Workshop 11. This area also produced most of the copper alloy casting debris (>80%), the stone mould SF0339 (Illus. 6.17) and a cluster of glassworking debris. The lack of significant wear on most of the fragments (Illus. 6.10) indicates deposition soon after breakage; the spatial concentration indicates this was the locus of manufacture. This is supported by evidence of sherds from the same vessel in different layers (linking 3153 and 2100; 2187 and 2100; probably 2165 and 2471), suggesting the deposits represent a connected series of events. The few finds not in this area are generally small and worn, suggesting they are secondary, residual material; there is no sign of any other concentration of casting activity.

The wider significance

The Culduthel assemblage is a significant one for the study of Iron Age metalworking, and is among the largest known. Heald's (2005) appraisal of Scottish non-ferrous metalworking evidence from the long Iron Age (700 BC–AD 800) identified over 100 sites, but most produced only a handful of mould or crucible fragments. Even with due caution over the material's fragility and the resulting bias against its survival, this suggests most are the residue of small-scale casting events. Evidence of larger-scale or longer-term manufacturing episodes is rarer. If we consider sites of Roman Iron Age date or earlier that have produced 10 or more crucible/mould fragments (an arbitrary but useful limit), only eight other examples are known: from the north-east, Birnie (Moray); from the lowlands, Traprain Law (East Lothian) and Fairy Knowe (Stirlingshire); from Argyll and the Western Isles, Dun Mor Vaul (Tiree), Dunagoil (Bute) and Loch na Beirgh (Lewis); and from the northern Atlantic zone, Gurness and Mine Howe (both Orkney). This evidence reflects rather different activities on these sites. Some represent the fortunate survival of a single event. The 27 sherds from Fairy Knowe represent only two crucibles and four moulds, dispersed in the dark layer that covered the interior (Willis 1998); they are clearly not in situ, but suggest debris from a single short-lived casting episode. This is likely to be the case also at Beirgh, where material was concentrated in a small area (Heald 2001, 689–90; Harding and Gilmour 2000, 39–40, 63–4). Other sites suggest a series of such short-lived events: at Dun Mor Vaul, small numbers of finds came from several different locations in different phases (MacKie 1974, 150–2). The same is true of Birnie, while at Gurness the middle Iron Age finds show two different concentrations (Close-Brooks 1987). The evidence from Traprain Law is also spatially dispersed (Burley 1956, 219–21), again suggesting a series of events rather than a sustained workshop. By contrast, Mine Howe provides a clear picture of a long-lived workshop, used so intensively that the floor was stained green from copper droplets (Harrison 2005, 10–15). Dunagoil may also have produced a dump of material from a sustained workshop; the records are poor, but suggest the material was found at one location within the fort (Mann 1925, 58). The Culduthel evidence fits best into this latter category. The evidence points to sustained use, with the remarkable evidence for curation, relining and repair suggesting intensive activity; this is supported by its spatial concentration and the associated hearths.

It is regrettably unclear what was being made: the mould evidence, as so often, is too fragmentary to be diagnostic. However, size variation in the crucibles suggests they included large specimens capable of substantial castings. The part-finished items provide further clues, notably the unfinished harness strap junction, SF0278; there is also a failed casting SF0333, perhaps of a ring, while the fine bar ingot SF0844 is a reminder that much casting was directed towards creating roughouts for sheetworking. This is true also of the reused quern SF0339 (Illus. 6.17) with its moulds for a bar ingot and a remarkable fish-shaped form, most likely a roughout for something like a vessel.

The typological variation within the crucible assemblage is another unusual feature; while triangular crucibles dominate, the evidence of other forms in the same suite of contexts is rare. In the Early Historic period diversity in crucible form is typical, due in part to the range of different alloys being cast, but it is much less common in the Iron Age, although to some extent this is because the amount of fragmentation makes reconstruction of the form difficult. However, there are local parallels for unusual crucible forms, perhaps suggesting a degree of experimentation in the area: the shallow triangular form, unusual in Scotland, is paralleled along the coast at Birnie, while Cullykhan has a unique lipped and lugged form alongside more conventional triangular crucibles (Greig 1972, 230).

Birnie and Cullykhan are the only other Iron Age sites along the Moray Firth littoral with evidence of Iron Age non-ferrous metalworking so far; that from other sites, such as Lesmurdie Rd, Elgin (I Suddaby, pers comm) or Green Castle, Portknockie (Ralston 1987) is a few centuries later. This strongly suggests that non-ferrous metalworking was a restricted skill in the area, highlighting the importance of Culduthel as a sustained craft centre.

Tuyères

Dawn McLaren

In order to achieve high temperatures within non-domestic hearths and furnaces such as those used for metalworking, a consistent flow of air would be directed into the interior by the use of hand-operated bellows. Although no later prehistoric bellows have been preserved, it is assumed that they were produced from leather with a non-heat-conducting nozzle produced from an organic material, such as bone, to direct the flow of air (Cleere 1971, 210). In order to shield the nozzle from the intense heat of the hearth or furnace interior, a heat-resistant tuyère or bellows shield was used for protection. Tuyères are known in a range of forms, from simple conical, block or cylindrical examples with single central bellows holes, to more complex examples that could accommodate multiple bellows (Tylecote 1986, 142). The British and Irish forms are usefully summarised by Tylecote (1986, 141–3, fig. 86–7) and Scott (1994, 162–3, 167, fig. 6.5.7). In Scotland, they are typically produced from fired clay, but steatite examples are known from later prehistoric/Norse levels at sites such as Burland, Sandwick and Scatness, Shetland (Heald 2010; Ballin Smith et al 2019; Bond 1998, 90, fig. 17) and Skaill, Deerness, Orkney (Porter 1997, 105, fig. 8.13, no. 3000). Tuyères are not chronologically distinctive and are not diagnostic of a particular high-temperature pyrotechnic process (Tylecote 1986, 141).

At Culduthel, a minimum of 18 fragmentary ceramic tuyères were recovered (Table 6.7). These comprise small fractured pieces of fired clay with one heavily vitrified, often slag-attacked face, with partial remains of circular bellows holes and curving, convex edges. Due to their similarity to vitrified hearth and furnace lining, most were identified during post-excavation work within the slag and fired clay assemblages. Recovery of a complete ceramic tuyère is rare; an unused example from Arnbathie, Perth and Kinross, is a notable exception (NMS: x.CM 40; Tylecote 1986, 142, fig. 86). Typically, only the vitrified layers of the ceramic tuyères, those in direct contact with the heat of the fire or furnace, are preserved. The external ends, which are not in direct contact with the fire, do not become vitrified and rarely survive. No complete examples were identified among the Culduthel assemblage. Three distinct forms of ceramic tuyère have been identified within this assemblage, comprising conical (approximately 90–92mm diameter), narrow cylindrical (approximately 67mm diameter) and flat-faced thick cylindrical examples (ranging from 90–150mm diameter), all with single, central perforations. The bellows holes range from 14–26mm in diameter, averaging 20mm. Subtle differences in the use of these different forms can be identified. The conical and narrow cylindrical tuyères are less heavily vitrified in comparison to the flat-faced cylindrical examples, but show a greater area of vitrification, extending further up the length of the tube. This suggests that a far greater length of the tuyère was exposed to the fire, indicating use in the more focused heat of a hearth rather than a built-up furnace. It is likely that the robust flat-faced examples were built into iron-smelting furnaces, based on the form and extent of vitrification. In contrast, only fragments of a thin vitrified, slag-attacked disc have been preserved from the thick cylindrical examples, indicating that only the internal face of the tuyère was directly exposed to high temperatures. It seems likely that this represents a distinction between those used in conjunction with hearths or furnaces and non-ferrous metalworking in contrast to ironworking, although this is not proven. This interpretation is reinforced by the analysis of the glassy residues on the exterior surface of one conical example (SF0524 – Illus. 6.11), indicating the presence of high levels of copper. The bulk of the fragments were recovered from the main focal area for craft activities on the site to the east and south-east of House 10. None of these fragments came directly from a furnace or hearth, but they were associated with a series of spreads and deposits deriving from the metalworking features in the area. Apart from one conical fragment (SF1175), which came from waste deposits associated with hearth 2166, it is not possible to identify which exact feature these tuyère fragments derived from. Concentrated around and associated with hearth 2166 are quantities of glassworking waste and a suite of debris from non-ferrous metalworking, and it is likely that this particular example was associated with one or both of these craft processes.

In addition to the examples associated with the foci of craft activities, a further fragment (SF0524) was recovered from the outer ring-groove of adjacent roundhouse House 10/3, relating to its final phase of construction.

Two, one conical example and one thick, flat-faced cylindrical example (SF0116 and SF0133), came from the fill of iron-smelting furnace 681, located within Workshop 2. It is unclear whether the presence of two examples from this furnace indicates the contemporary use of multiple bellows during a single smelt, or whether the tuyères represent separate phases of use. A further

Table 6.7
Distribution of tuyère fragments by form

Structure	Feature	Conical	Narrow cylindrical	Thick, flat-faced, cylindrical
2	Furnace 686	SF116		SF133
Cobbled surface 227	Possible furnace 185			SF70
10	Outer ring groove 1763	SF524		
	Fill of posthole 3635			SF1179
11	Concentration of burnt material 1952			SF431, SF1182
	Abandonment phase deposits 2100			SF1180
Area to the east and south-east of House 10	Waste associated with industrial hearth 2166	SF1175		
	Posthole 4001		SF1176	
	Spread of industrial waste 798			SF1181
	Spread of dark brown burnt clay 2102			SF1183, SF1184, SF1185
	Post-abandonment deposit 1681			SF1177, SF1178 a & b
Unstratified				SF1186

fragment came from the fill of a possible ironworking feature (context 185) associated with the cobbled surface 227.

This large quantity of tuyère fragments is difficult to parallel, but is not unexpected given the scale of high-temperature craft processes that were undertaken at the site. The identification of various forms of tuyère from the same site is also unusual. The evidence suggests that these distinct shapes saw different uses, and it is suggested that this relates to a difference between non-ferrous/glass and ferrous processes. There may also be chronological differences, although only three fragments derive from dated features, making chronological comparisons difficult. Fragments of two conical tuyères were associated with Heath 2166, dated to 350–40 cal BC (SUERC-30376). A much later date of AD 130–340 is suggested for cobbled surface 227, which produced one thick, flat-faced cylindrical tuyère (SF070). Although this could suggest that the conical examples are an earlier type, a third dated feature puts this chronological distinction in doubt. Fragments of both a conical and a thick, flat-faced tuyère (SF0116 and SF0133) were associated with a furnace in Workshop 2 (context 681). Charcoal from this furnace has produced a date of 40 cal BC–cal AD 120 (SUERC-30365). The recovery of two distinctive tuyère types from a single metalworking feature suggests that the different forms were used contemporaneously, or at least that their currencies overlapped.

Catalogue

Conical tuyères

SF0116 Thick, triangular-sectioned, wedge-shaped fragment of coarse, quartz-rich vitrified clay, with remains of a longitudinal circular-sectioned smooth bellows hole (D 23mm) at one edge; other three edges broken. This fragment represents approximately 15% of the circumference of an expanding, conical fired clay tube, the surface of which is heavily vitrified. Diameter of heat-affected face approximately 92mm; remaining thickness 48mm. Mass 51g. Context 675, clay lining associated with furnace 681, Workshop 2.

SF0524 Wedge-shaped, triangular-sectioned fragment of conical tube of fired clay, heavily vitrified on the remaining curving face with distinctive glassy, bright red residue from copper-alloy-working. Only one original edge remains, preserving the curving edge of a slightly counter-sunk circular bellows hole (D 22.5mm) that perforates the clay cylinder longitudinally; the other three edges are broken. The glassy vitrified face indicates that the tuyère projected at least 42.5mm into the hearth or furnace; the unvitrified portion has not survived. Diameter approximately 90mm; remaining thickness 42.5mm. Mass 36g. Context 1764, fill of outer ring-groove context 1763, House 10/3. (Illus. 6.11)

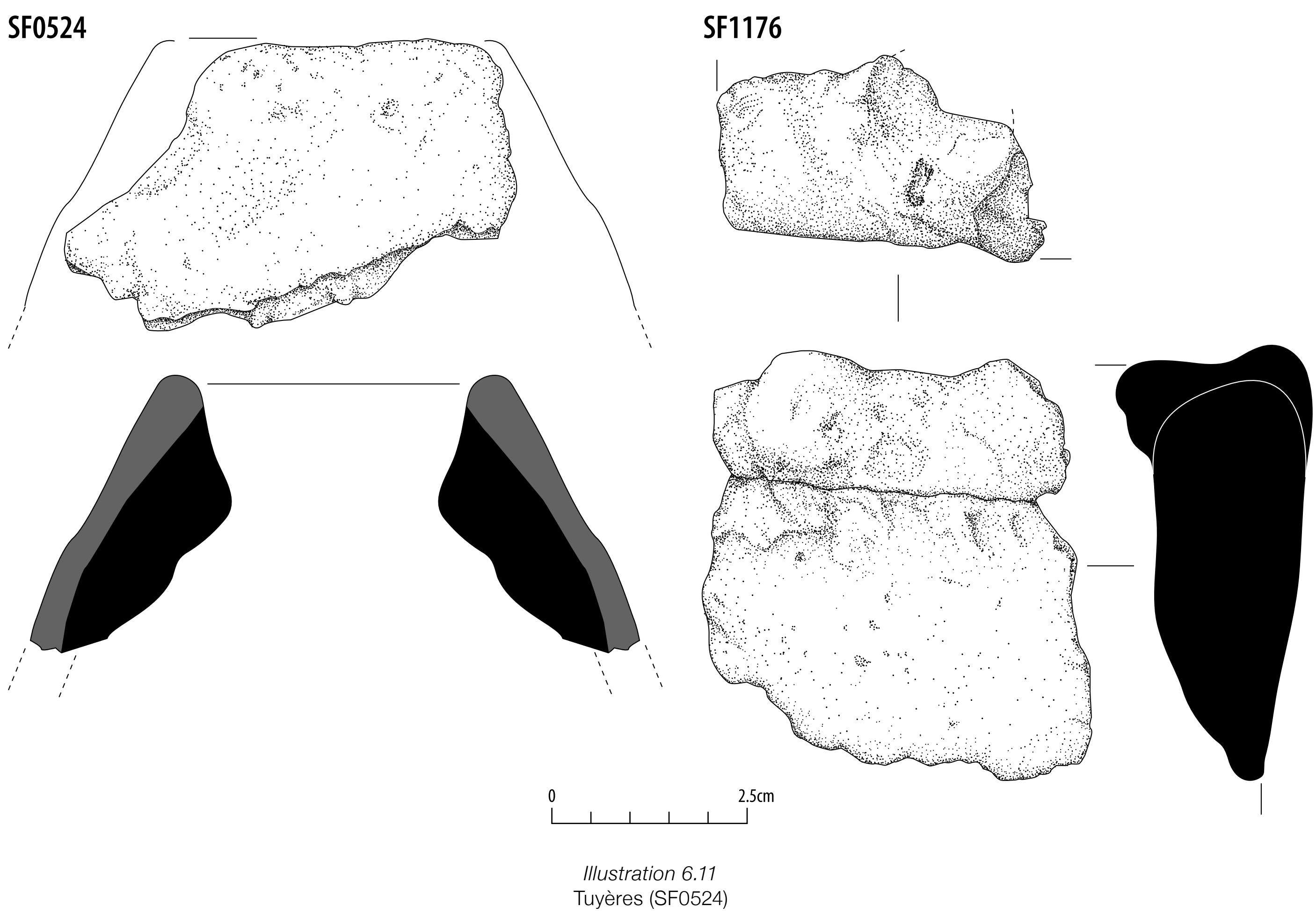


Illustration 6.11
Tuyères (SF0524)

SF1175 Seven fragments representing possibly two tuyères, both of conical form. Two non-joining fragments preserve steeply sloping, curved edges from expanding, narrow, conical fired-clay tuyères. The external surface of each piece is heavily vitrified, glassy and similar in form, but the clear differences in colour and morphology indicate the presence of two separate objects. Partial, smooth edge fragments from a circular bellows hole indicate original diameters of approximately 20mm and 26mm respectively. The full thickness and height of the tuyères are unknown as only the vitrified surfaces were preserved, giving a minimum height of 44mm and approximately 90mm diameter. Mass 109.7g. Sample 904. Context 2165, waste deposit to the north of Hearth 2166.

Narrow cylindrical tuyère

SF1176 Twelve vitrified ceramic fragments including two rejoining pieces from a narrow cylindrical clay tuyère, longitudinally perforated with circular bellows hole (D 20mm), representing approximately one-quarter of the circumference. The rounded edge surrounding the bellows hole and the upper 32mm of the convex, curving side is heavily vitrified, indicating the extent to which the tuyère projected into the hearth or furnace. Original diameter approximately 67mm; remaining H 55mm. Mass 102.8g. Context 4002, fill of post-hole 4001, area to east and south-east of House 10/3. (Illus. 6.11)

Thick cylindrical tuyères

SF070 Thirteen flat, non-joining fragments of heavily vitrified fired clay, preserving approximately 15% of the vitrified face of a thick cylindrical, flat-faced tuyère. One fragment preserves a partial smoothed curved edge of the central bellows hole (14–22mm). Only the thin glassy vitrified face of the tuyère remains; the unvitrified section, not in direct contact with the heat of the furnace or hearth, has not survived. Diameter approximately 120mm; remaining thickness 42mm. Mass 351.5g. Context 182, fill of furnace base context 185.

SF0133 Single flat rectangular fragment of heavily vitrified ceramic circular clay disc with partial remains of a circular bellows hole (D 26mm) preserved on one edge; the other three sides are broken. The ceramic displays a gradient in colour and texture from the fractured buff-orange fired sandy clay interior through to a dark-brown, glassy, heavily vitrified face. Only the slag-attacked face of this circular-sectioned, thick-walled fired clay cylinder has been preserved, giving it the appearance of a flat perforated plate; the original thickness is unknown. Diameter at least 100mm; remaining thickness 34mm. 62.6g. Context 680, fill of furnace cut 681.

SF0431 Four joining fragments of a flat, circular, centrally perforated fired clay tuyère, heavily vitrified on one face; the other

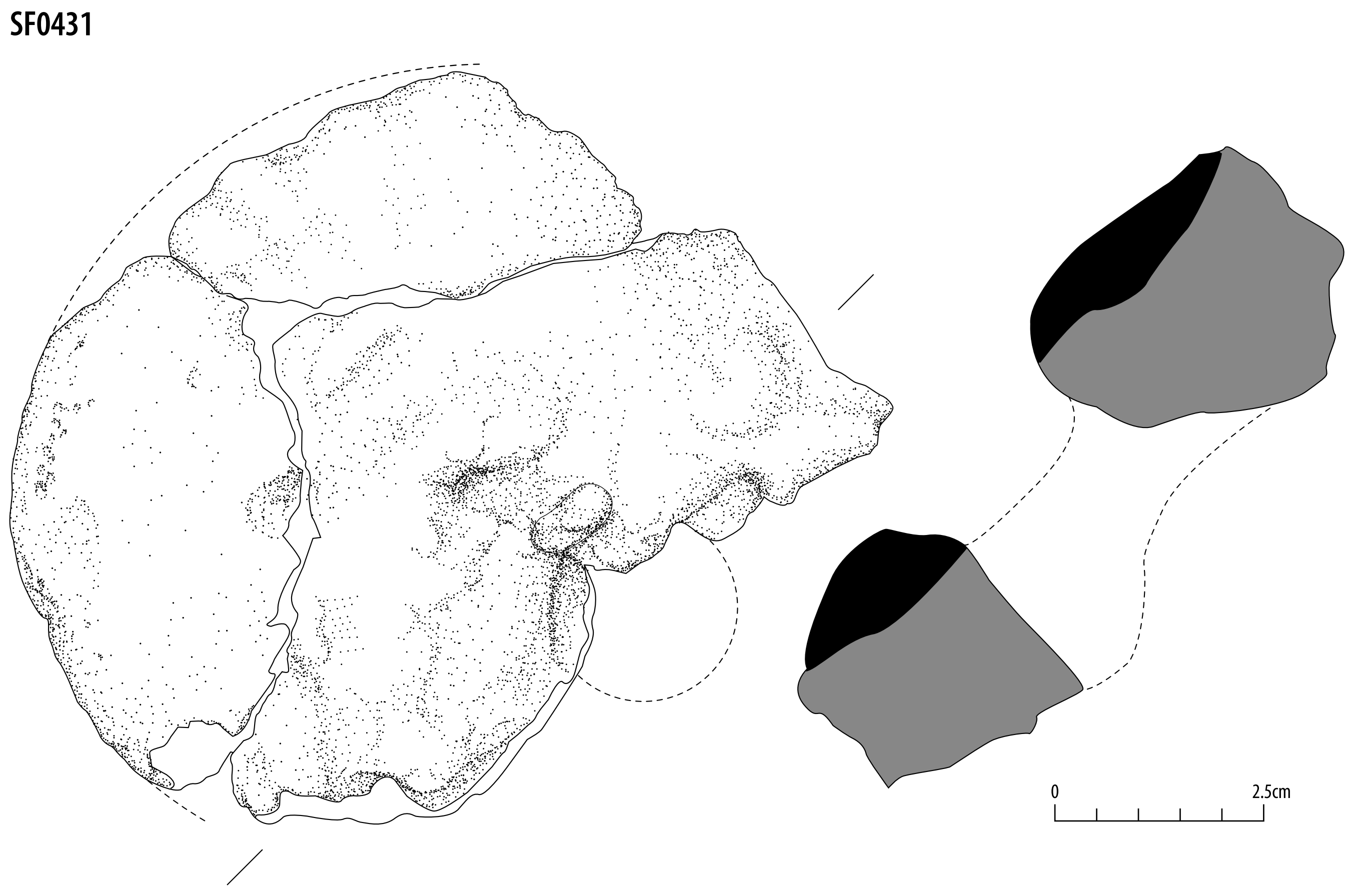


Illustration 6.12
Tuyères (SF0431)

face is fractured, indicating the full thickness has been lost. The central circular bellows hole (D 22mm) is almost complete. Approximately one-third of the circumference is present, indicating a slightly irregular, thick-walled smoothed cylinder with longitudinal perforation. The original height cannot be reconstructed. Twenty-four small undiagnostic vitrified fragments may be further pieces of the tuyère. Original diameter approximately 124mm; remaining H 59mm. 315.9g. Context 1952, concentration of burnt material, Workshop 11. (Illus. 6.12)

SF1177 Twenty-two flat, non-joining fragments of heavily vitrified fired clay, representing part of at least one flat-faced, thick cylindrical tuyère. The majority of fractured pieces preserve one slag-attacked, glassy vitrified surface, indicating contact with the interior of the furnace. One fragment preserves a partial curved edge of the central bellows hole; the diameter is difficult to estimate but was at least 12mm. Little of the unvitrified, fired clay portion of the tuyère survives beyond the slag-attacked face, but where present, smooth curving surfaces suggest a short, thick, cylindrical form. Diameter at least 90mm; remaining T 38mm. Mass 287.6g. Context 1681, post-abandonment deposit to the east and south-east of House 10/3.

SF1178 Four fragments, possibly representing two thick, flat-faced cylindrical tuyères. Three flat, non-joining, abraded fragments represent 15–20% of the flat, circular surface of a tuyère. Each piece preserves a partial circular edge of the central bellows hole (D 24mm). Two fragments preserve the smooth rounded edge of the face and indicate the body of the tuyère had curving smoothed sides One surface is heavily vitrified and glassy; the opposite surface is fractured and abraded where the unvitrified portion of the cylinder has not survived. Diameter approximately 110mm; remaining thickness 25.4mm. Mass 126.3g.

The fourth fragment is very similar in shape but the colour and texture of the vitrified surface is distinctly different, suggesting the presence of a second tuyère. This fragment is sub-rectangular in shape, heavily vitrified on one face, with three sides broken. One original edge preserves a partial edge from a circular bellows hole but not enough survives to allow an estimation of diameter. It is not possible, from the small fragment remaining, to estimate the original diameter of the tuyère with any accuracy but the slag-attacked face must have been at least 120mm in diameter. Remaining T 17.5mm. Mass 28.5g. Context 1681, post-abandonment deposit to the east and south-east of House 10/3.

SF1179 Three joining, smoothed curving edge fragments from a thick flat-faced cylindrical fired-clay tuyère, representing approximately one-third of the circumference. The circular vitrified face has not survived and no trace of the bellows hole remains. The fired clay shows a gradient in colour and morphology from light-buff sandy clay through to dark-brown vesicular vitrified material. A small leaf impression is preserved near one broken edge. Original diameter approximately 140–150mm; remaining H 39mm. Mass 116.4g. Context 3636, fill of post-hole context 3635, House 10/3.

SF1180 Twelve flat, non-joining fragments of a flat-faced thick cylindrical fired clay tuyère, heavily vitrified on one face. Two flat vitrified fragments have curving edges from the circular, central bellows hole (approx. D 18mm) and preserve portions of the rounded edge of the tuyère, suggesting a smooth, cylindrical form with longitudinal perforation. Only the vitrified surface remains. Original diameter 128mm; remaining H 48mm. Mass 310.7g. Context 2100, abandonment phase associated with the industrial use of Workshop 11.

SF1181 Eighteen fragments of fired clay, each with one heavily vitrified face. Five fragments are consistent with tuyère fragments due to their flat, glassy faces and curving edges but only one preserves a small curving edge of a possible bellows hole. The remaining 15 fragments are undiagnostic. It has not been possible to estimate the original dimensions, but it appears to be consistent in form and size with the flat-faced cylindrical examples. Mass 210.8g. Context 798, spread of industrial waste to the east and south-east of House 10/3. Abandonment.

SF1182 Four non-joining flat heavily vitrified fragments of a flat-faced, cylindrical tuyère. The vitrified face is porous, vesicular and light yellow-green in colour, distinguishing it from SF0431 from the same context. Only one diagnostic piece is present with a small crescentic edge from a circular bellows hole estimated at *c*.15mm in diameter. No edge fragments remain to confirm the original diameter but it appears consistent in form and size with the other examples. Only the vitrified face, in direct contact with the heat of the furnace, has been preserved. Remaining H 15.5mm. Mass 83.7g. Context 1952, concentration of burnt material, Workshop 11.

SF1183 Single flat sub-rectangular fragment of fired clay, heavily vitrified on one face; broken on two sides. One original edge preserves the curving edge of a central circular bellows hole (D. 20mm), the opposite edge is the curving convex edge of the flat face of the thick cylindrical tuyère. Only the vitrified face has survived. Original D approximately 124mm; remaining H 20mm. Mass 30.5g. Context 2102, spread of dark-brown silt with burnt clay, Hearth 26.

SF1184 Eight, non-joining, flat angular fragments of a heavily vitrified fired clay disc, representing approximately 15% of the surface of a thick cylindrical tuyère with slightly bevelled, curving edges. Only the vitrified surface has survived. Original diameter approximately 125mm; remaining H 31.5mm. Mass 388.5g. Context 2102, spread of dark-brown silt with burnt clay, Hearth 26.

SF1185 Single flat, sub-rectangular fragment of fired clay, heavily vitrified on one face, representing approximately 10% of the surface of a thick cylindrical tuyère. The curving edge of the central bellows hole (D 19mm) is present on one edge; the other three sides are broken. Only the vitrified face of the tuyère has been preserved. Original diameter approximately 136mm; remaining H 33.5mm. Mass 91.6g. Context 2102, spread of dark-brown silt with burnt clay Hearth 26.

SF1186 Three non-joining fragments of a flat-faced cylindrical tuyère with partial bellows hole notches preserved on two edges (D 19mm). A fourth fragment may also be a tuyère fragment but no diagnostic features are present to confirm this. Original diameter approximately 100–110mm; remaining H 19mm. Mass 61.75g. Unstratified.

Petrographic and technological analysis of ceramic materials

Daniel Sahlén

The discovery of a wide range of domestic pottery and technical ceramics at Culduthel, particularly crucibles for the melting of non-ferrous metals, provides a valuable opportunity to study variation in ceramic production. It was anticipated that a thorough investigation of ceramic technology and the use of raw materials would provide important evidence for production and industrial activities at the site and the broader Moray Firth region in the prehistoric period. This investigation focuses on petrographic and technological characterisation of the ceramics through a combination of macroscopic observations and microscopic examinations frequently applied in ceramic studies (Tite 1999; Sahlén 2011).

The intention of the present study was to examine the main groups of ceramics recovered from Culduthel (crucibles, clay moulds, pottery, furnace lining and daub) with the goal of comparing material and technological approaches in the production of ceramics at the site. The pottery from the site is predominantly Neolithic and early Bronze Age, while the technical ceramics are all of Iron Age date. This made it impossible to compare pottery and other ceramic materials from the same period, but it was still possible to contrast technology and materiality between two separate periods and between different materials. It was decided to use two complementary techniques for analysis: ceramic thin section petrography and scanning electron microscopy (SEM).

Ceramic thin section petrography has long been central to the investigation of ceramic technology and material composition (Williams 1983); it has occasionally been employed on Scottish materials (MacSween 1990). SEM, in combination with energy-dispersive X-ray fluorescence analysis (EDAX), is a powerful tool for the study of material composition and technology due to its possibility to analyse the microstructure and micro-topography of the material as well as provide quantitative data on element composition (Tite 1992). It was judged that these two techniques combined would give reliable evidence of ceramic manufacture and the diversity of clay material used at the site during the Iron Age and earlier periods.

Sampling strategy and analytical methodology

The whole assemblage was first examined with a stereomicroscope and a hand lens to characterise the different groups and select samples for detailed material examination, building on existing reports. The metalworking ceramics show little variation in fabrics, generally being made from sandy clays or possibly sand-tempered clay. The crucibles are made of a sandy fabric with fine quartz sand, feldspars and some mica. Some fragments contain a proportion of coarse sand and larger sandstone inclusions (e.g. SF0447), but it is not possible from macroscopic investigation to assess if this material forms a separate fabric/sub-fabric or is a variation within the same fabric. The moulds are made from a sandy fabric, similar to that of the crucibles, but appear to contain larger amounts of coarse quartz sand and sandstone inclusions, albeit with some variation. The furnace lining and tuyere are tempered with considerable amounts of coarse sand and sandstone grits. The fired clay that was found in high quantity at the site in association with the furnaces seems to be unprepared raw clay, which has been heated during the use of the furnace. There is some evidence of the use of straw and/or fibre as temper, seen from the presence of fine linear voids, particular in the mould material. The thickness of some of the voids suggests that the tempering material used was a fibrous material, possibly hair or disaggregated straw; the surface of one fragment shows a couple of voids and their fibrous structure. Fabrics and characteristics of the prehistoric pottery are discussed in detail by MacSween (Chapter 6, Prehistoric pottery).

Fourteen samples were selected: six crucible sherds; one each of furnace lining, mould, daub and fired clay; and four pottery sherds (Table 6.8). Six samples were selected from the crucibles because these were one of the largest ceramic groups from the site and the material showed considerable variation. Three samples of thick-walled crucibles (average thickness 6.8mm) and two samples of thin-walled crucibles (average thickness 4.7mm) were selected, along with one sample of heavily vitrified crucible. Only one sample each was selected from the moulds, furnace lining, daub and fired clay since this material showed considerable macroscopic homogeneity. Three samples of Neolithic pottery and one of Early Bronze Age pottery were sampled. This was only a selection of the different pottery wares discussed by MacSween, but the focus of this study was to compare different ceramic materials rather than give full details of the pottery from the site. The samples were prepared as thin sections, by mounting a polished fragment of the ceramic with epoxy resin to a glass slide and grinding the ceramic material down to an average thickness of 30μm (Humphries 1992). The thin sections were used for petrographic thin section examination, investigation of the microstructure and analysis of the composition of selected major and minor elements. The petrographic analysis was carried out at the Department of Geology, NMS, using a Leica polarising microscope, and aimed to characterise the mineral contents and technological modifications of the material. The study of SEM images and element calculations was carried out at the Analytical Research Section, NMS, as a supplement to the petrographic analysis.

Results and discussion

The petrographic analysis had two goals: to characterise the ceramic material and the technology used for its manufacture; and to evaluate whether the material was produced locally. Full details of the petrographic analysis are within the archived petrographic report (Appendix 1 within the petrographic report held within the CDF05 archive at the NRHE) and a summary is presented in Table 6.9. The material background of the different ceramic materials and the possible provenance is discussed, and the ceramic technology compared between the different Iron Age materials, and between the Iron Age ceramics and the Neolithic/Early Bronze Age pottery. The evaluation of provenance is based on examination of the thin sections and comparison with the local geology (Auton et al 1990; Fletcher et al 1996), supported by chemical analysis of the material (Appendix 2 within the petrographic report held within the CDF05 archive at the NRHE). It is not possible to give a precise origin for raw materials, only to assess the relation between the ceramic

Table 6.8
List of ceramic samples selected for petrographic and technological analysis

Sample no.	Find no.	Context	Material category	Date	Description
Culd1	0344	1861	Crucible	Iron Age	Pale grey fine silty fabric, thick sherd
Culd2	0356	2100	Crucible	Iron Age	Pale brown fine silty fabric, thick sherd
Culd3	0362	2102	Crucible	Iron Age	Pale brown fine silty fabric, thick sherd
Culd4	0375	2100	Crucible	Iron Age	Heavily vitrified rim sherd, dark grey to black
Culd5	0396	2101	Crucible	Iron Age	Pale grey to pale brown silty fabric, thin sherd
Culd6	1211	2544	Crucible	Iron Age	Pale grey fabric, thin sherd
Culd7	None	3456	Tuyère	Iron Age	Reddish brown to pale grey clay fabric
Culd8	1469	3467	Furnace lining	Iron Age	Pale reddish brown silty clay, partly grey from heating, occasional grits and larger gravels
Culd9	1037	2677	Mould	Iron Age	Dark grey core and one pale yellow-brown outer surface
Culd10	0833	4311	Daub	Iron Age	Dark reddish brown, sandy clay
Culd11	0087	402	Pottery	Early Bronze Age	Gritty fabric with quartz and mica inclusions
Culd12	0092	432	Pottery	Neolithic	Coarse sandy fabric with large amount of quartz inclusions; the material is unevenly fired
Culd13	0330	741	Pottery	Neolithic	Fine clay with large dark mica inclusions; one surface possibly covered with slip
Culd14	0916	3651	Pottery	Neolithic	Gritty dark fabric with large angular rock inclusions

material and the local geology. A close parallel between the ceramics and a defined geological locality can be used to argue for the provenance of the material, but it is often only possible to assess whether the material is likely to be local or not. For the purposes of this paper the definition of what is local is based on Arnold's (1985) study of clay collection in traditional societies, in which he concludes that potters would rarely go beyond 7km to collect clay. The comparison between ceramics and the local geology in ceramic thin section petrography is often based on the identification of mineral and lithic inclusions in the ceramic material, since clay minerals are generally too small to be identified in the microscope.

The Iron Age material contains predominantly sedimentary minerals and rock inclusions most likely originating from the nearby surroundings of Culduthel, which is dominated by sedimentary glacial deposits (Illus. 6.13). But it seems that two different clays or clay pastes were used during the Iron Age: one for the manufacture of crucibles, and one for the manufacture of other ceramic materials. The composition of the clay used for the crucibles in particular is generally high in alumina and low in alkali and earth alkali oxides, giving it high refractory properties (cf. Martninón-Torres and Rehren 2009, 54). The daub (Culd10), mould (Culd9), furnace lining (Culd8) and fired clay (Culd7) are instead made from clay lower in alumina and/or higher in alkalis, which would be less suited for high temperatures. But there is some variation and the material does not form uniform groups (Illus. 6.14). Interestingly the heavily vitrified crucible sample (Culd4) is chemically more closely related to the sampled mould with low refractory properties, which could explain why this crucible is so badly vitrified. It should be noted that the sample population in the current chemical analysis was limited; this assessment is indicative rather than conclusive.

The Neolithic pottery (Culd12–14) has mineral and rock inclusions associated with metamorphic and igneous rocks, while the Bronze Age pottery (Culd11) has inclusions more related to sedimentary deposits, but of a different nature than the Iron Age material. Although both metamorphic (towards the south-west) and igneous rocks (on the east side of the River Nairn) would have been on the limit of Arnold's (1985) threshold, this material could possibly have been accessible at a much shorter distance, transported by glacial movement from the last ice sheet that covered the region (Merritt 1990). It was not possible to carry out any clay sampling around the site to check this, but it seems to imply that Neolithic potters went further to obtain their clays than the Iron Age craftsmen. It has not been possible to identify the location of the sedimentary inclusions in the Bronze Age pottery, but it is interesting to note the apparent difference between this material and the sedimentary inclusions in the Iron Age material, suggesting that they used different but related sources.

The production of Iron Age material shows the use of two distinct methods of preparing the ceramic material. The sample size is small, but there are trends that are comparable with materials from other sites in Scotland (Sahlén 2011). The crucibles can be divided into two groups: thick crucibles (Culd1–3)

Table 6.9
Summary of petrographic analysis

Sample no.	Material category	Colour	Description of thin section
Culd1	Crucible	2.5Y5/3; light olive brown	Fine porous matrix with occasional medium-sized quartz and angular sandstone inclusions, and possible grog inclusions
Culd2	Crucible	2.5Y 5/3; light olive brown	Fine matrix with occasional medium-sized quartz and lithic inclusions, and some possible grog inclusions
Culd3	Crucible	2.5Y5.3; light olive brown	Fine porous matrix with occasional medium-sized quartz inclusions, and some possible grog inclusions
Culd4	Crucible	2.5Y3/1; very dark grey	Heavily vitrified fragment; the matrix is isotropic, but some fine to very fine and medium-sized quartz inclusions are identified
Culd5	Crucible	2.5Y4/1; dark grey	Severely vitrified fragment, with fine to very fine quartz inclusions
Culd6	Crucible	2.5Y4/1; dark grey	Severely vitrified fragment, with fine to very fine quartz and medium sized quartz. One edge has severe staining
Culd7	Tuyère	2.5YR4/6; red	Very fine fabric with frequent fine quartz grains and occasional subangular sandstone fragments
Culd8	Furnace lining	10R4/4; weak red	Fine matrix with plenty of fine quartz and feldspar grains, some larger mineral grains and some larger lithic inclusions. The material is poorly mixed
Culd9	Mould	7.5YR4.3; brown	Silty matrix with predominantly fine to very fine quartz and feldspar grains and a few medium-sized mineral grains and sandstone inclusions
Culd10	Daub	10R4/6; red	Fine matrix with plenty of fine quartz and feldspar grains, some larger mineral grains and some larger gabbro inclusions. The material is poorly mixed
Culd11	Pottery	10R4/6; red	Sandy micaceous with medium to large feldspars and augite inclusions
Culd12	Pottery	5Y2.5/2; black	Coarse porous fabric with large metamorphic rock fragments and feldspar inclusions
Culd13	Pottery	2.5Y3/2; very dark greyish brown	Sandy matrix with predominantly fine- to medium-sized quartz grains, a few metamorphic and igneous rock fragments and feldspar inclusions
Culd14	Pottery	2.5Y3/2; very dark greyish brown	Coarse porous fabric with large probable gabbro rock fragments, feldspar inclusions

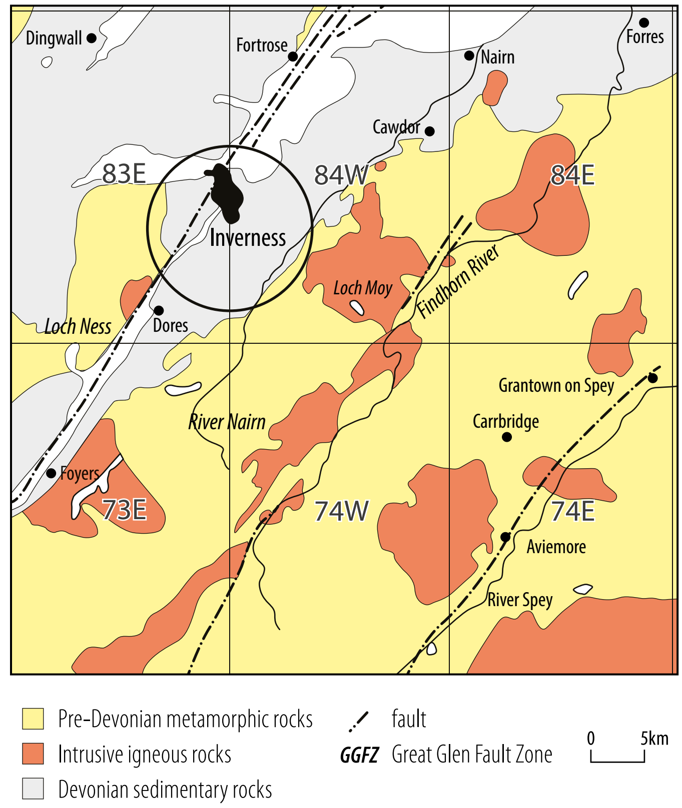
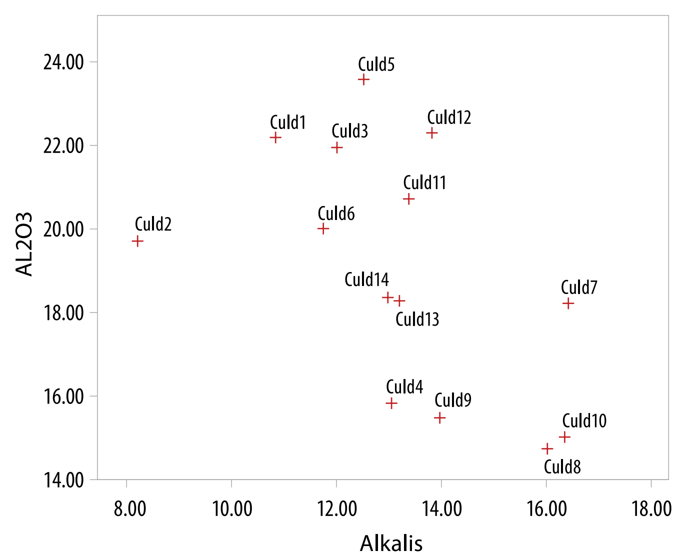


Illustration 6.13
Geological setting of the district around Culduthel, Inverness, after Fletcher et al (1996)



Comparison of amount of alumina versus alkali elements for the different samples; values are percentages

Illustration 6.14
Comparison of amount of alumina versus alkali elements for the different samples; values are percentages

tempered with angular sandstone fragments and small rounded grog inclusions; and thin crucibles (Culd5–6) with fine quartz inclusions (but note that both Culd5 and Culd6 are severely vitrified and the analysis of these samples was limited). It has not been possible to assess the technology of Culd4 since this sherd was largely destroyed by vitrification. The difference in size and technology can possibly be related to the thickness of the vessel, something that is seen at other contemporary sites in Scotland (Sahlén 2011). The furnace lining and the daub show little evidence of preparation; inclusions present could either have been added or be natural to the clay. It is likely that the mould has been made from the same clay with a large amount of fine quartz grains added. This is supported by examination of the fired clay (Culd7), which in appearance is similar to the mould, furnace lining and the daub, but lacks the quantity of quartz and auxiliary minerals, suggesting that sand has been added to the clay to make different ceramic materials. It is not impossible that the crucible has been made from the same clay, with the addition of a different sand material.

The rock fragments present in the Neolithic pottery seem to have been added as temper, and it is possible that at least some of them come from crushed rocks. The size and amount of inclusions indicate a consistent practice, and there was also a consistent use of certain types of rock temper. The material present in the Bronze Age sherd does not seem to have been added deliberately since this is very uneven in size and type of inclusion; it is likely that the Bronze Age sherd was untempered.

In conclusion, it seems that prehistoric craftworkers at Culduthel used a series of resources for the production of different ceramics, and the material shows both chronological and technological differences. In the Neolithic period the potters seem to have been more systematic in their selection of tempering materials and possibly travelled further to obtain this material. In later periods sedimentary deposits close to Culduthel seem to have been exploited, although the uses of different sources are possible. It is quite clear that Iron Age craftworkers used different ways to prepare their clay and in this way were able to produce materials fit for purpose.

Part B

Stone

Lithics

Torben Bjarke Ballin

A total of 630 lithic artefacts were recovered. The vast majority of the finds are in flint (92%), supplemented by some quartz (6%), and small numbers of artefacts in rock crystal, chalcedony, quartzite and sandstone. Almost the entire assemblage is based on material from local pebble sources, although 13 pieces in grey flint are thought to represent importation from primary flint sources in Yorkshire, or possibly even south-east England. Approximately 10% of all lithic artefacts have been exposed to fire, either in their primary settlement contexts or, later, during the intense industrial activities taking place in the Iron Age. A burnt cobble, some glassy slag and 1,300 pieces of crushed, burnt quartz are thought to be directly related to the latter.

Practically the whole assemblage represents redeposition, as almost all artefacts were recovered from post-holes, hillwash layers or post-abandonment contexts. Only knapping debris from three waste pits was found in situ and, as it would not have been possible to sub-divide the assemblage into its original chronological units, it was decided to deal with the lithic collection as a whole.

The three main artefact categories – debitage, cores and tools – make up approximately 90%, 2% and 8% (22% if chips are disregarded), respectively. In total, 565 pieces of debitage were retrieved, with chips amounting to 73%, flakes 22%, blades/microblades 2% and indeterminate pieces 3%. The high tool ratio is almost impossible to interpret, as it is unknown which chronological unit may be responsible for this ratio, and the exceptionally high chip ratio is most likely a result of the recovery of three waste pits with chip-sized knapping debris. The blanks were mainly detached by the application of hard percussion (66%), supplemented by some use of bipolar technique (28%). Only three pieces (4%) were manufactured in soft percussion. As almost two-thirds of the debitage are tertiary pieces, it is thought that most raw material must have been decorticated at the source, but 13 primary pieces (or 10%) indicate that some nodules were brought to the site with their cortex intact. No core preparation flakes were recovered.

The 16 cores include four single-platform cores, two of which are early prehistoric specimens, whereas one may be the exhausted remains of a Late Neolithic Levallois-like core. The remaining cores are all simpler, probably later prehistoric, forms, embracing one irregular core, one Kombewa core, eight bipolar cores and two core fragments. The tools are dominated by 19 scrapers (40%) and 15 pieces with edge-retouch (29%), supplemented by three knives, three combined scraper-knives, one piercer, three truncated pieces, four notched pieces and one piece with invasive retouch. The most regular pieces are three early prehistoric blade-scrapers, and Early Bronze Age thumbnail scrapers, scale-flaked knives and scraper-knives, but the majority of the tools are expedient, probably later Bronze Age pieces produced for *ad hoc* tasks.

The technological composition of the assemblage clearly defines it as a pell-mell collection of finds from various parts of Scottish prehistory: it includes small numbers of finds from early prehistoric microblade and macroblade industries, elements from Late Neolithic Levallois-like production, neat Early Bronze Age pressure-flaked tools, and expedient later prehistoric tools.

Apart from diagnostic technological attributes, the lithic collection is also dated by elements such as raw material preference, diagnostic types and, to a minor degree, find contexts. The 13 grey flints are clearly exotic pieces, and they represent importation from south of the border. This form of flint is mainly recovered from Scottish Late Neolithic sites, where they are associated with the manufacture of chisel-shaped arrowheads and cutting implements. Diagnostic types include: two conical microblade cores (Late Mesolithic/Early Neolithic); intact and recycled pressure-flaked thumnail-scrapers (Early Bronze Age); scale-flaked knives, some of which are combined with a scraper-edge (Early Bronze Age); and a Kombewa core (later prehistory). The only safely stratigraphically dated finds are the chips from Pit 3026, which are thought to be contemporary with Cairn 2671.

Due to the generally residual character of the Culduthel material, the research potential of the lithic assemblage must be classified as low. The most important data provided by the site's lithic finds is the chronological evidence, clearly testifying to an extended period of settlement continuity at Culduthel. Apparently, people lived on, or near, this site for several millennia, as evidenced by lithic finds from the Late Mesolithic/Early Neolithic, Late Neolithic, Early Bronze Age and later Bronze Age periods – before the Culduthel site became the focus for an industrial complex in the Iron Age period.

The stone artefacts

Dawn McLaren with contributions on the mould and the shale by Fraser Hunter and geological identifications by Fiona McGibbon

Summary

The excavations at Culduthel recovered a total of 68 stone tools, dominated by quern fragments and prosaic, everyday tools. All of the tools have been produced from locally sourced stone, exploiting both glacial erratic cobbles and boulders as well as local outcrops of schists and granites. The small quantity and restricted range of the cobble tool assemblage is surprising considering the large scale of excavation, and contrasts sharply with the large number of querns represented. Only one decorative or personal object, a shale bead, was identified, although simple decoration was noted on three upper rotary quern stones.

The catalogue, which follows the discussion, is split into broad functional groups within which typological categories are described and discussed. To aid comparative analysis of the cobble tools, the classification system utilised at the Howe (Ballin Smith 1994, 196), based on wear type, has been used.

Discussion

The excavations at Culduthel recovered a sizeable quantity but a limited range of coarse stone tools, dominated by quern fragments and prosaic, everyday tools (summarised in Table 6.10). Food processing tools are the most frequent tool type from the site, in the form of rotary querns, saddle querns and rubbing stones. Also present are small quantities of smoothers, sharpening stones, whetstones and working surfaces, which hint at craft activities such as leatherworking and hide-processing, as well as the maintenance of metal blades and tools. General purpose cobble tools, such as grinders and pounders, which could have been used for a range of tasks are present, but in surprisingly small quantities compared to the large numbers of querns. Hammerstones and spindle whorls, typical finds on Iron Age sites, are notably absent, although a roughout for a spindle whorl is present.

Table 6.10
Range and quantities of coarse stone tools present

Function	Type	Qty
Food processing	Saddle querns	4
	Rubbing stones	6
	Rotary querns	21
Tools	Grinders	2
	Pounders	3
	Smoothers	6
	Combination tools	5
	Whetstones	2
	Sharpening stones	1
	Grinding stones/working surfaces	8
	Unidentified tool fragments	2
Household	Pivot stones	1
	Perforated stones	3
Other	Basin	1
	Spindle whorl roughout	1
	Palette	1
Personal	Shale bead	1
Total		**68**

Quern stones

Thirty-one quern stones (saddle and rotary) and associated rubbing stones were recovered throughout the excavated area, accounting for over 45% of the total coarse stone assemblage.

The six rubbing stones and four saddle querns form an interesting group in both spatial and chronological terms. Saddle querns and their associated upper rubbing stones were used to grind grain and other foodstuffs and had a long currency of use, continuing even after the advent of the rotary quern (Caulfield 1978; Armit 1991, 190–5). All of the saddle querns from Culduthel (apart from one unstratified find) and the majority of rubbing stones were recovered from secondary contexts in the Early Iron Age roundhouse (House 3). They were incorporated into the structure of the building, either coming from the walls of the roundhouse (SF0204, SF0205 and SF0206) or being used as post-pads within the post-holes (SF0233, SF0234, SF0235 and SF0428). None of the food processing tools from this structure appear to have been in use during its occupation. A multifunction cobble tool (SF0223 – Illus. 6.15), a whetstone (SF0244) and a grinding surface (SF0238) were also recovered from pits and post-holes associated with the roundhouse. It is unclear whether these were also incorporated as packing material around post-holes or are related to the structure's use.

The deposition of quern stones is often interpreted as a significant act (Heslop 2008, 73–80; Hingley 1992, 32; Williams 2003, 237). These grain processing tools would have been an integral tool within the household. It has been suggested that querns would have been valued beyond their functional qualities due to their connection to the agricultural cycle (Hingley 1992, 32). The intentional fracturing, and selective and deliberate deposition of some quern stones after their practical use had come to an end suggests that such objects were seen not just as functioning tools, but as potent symbols relating to concepts of life-cycles, fertility, longevity and memory (Heslop 2008). Although not all quern stones appear to have been deposited in a meaningful, structured way, widespread evidence of such a practice is observed in later prehistoric contexts. The incorporation of saddle querns within structures can be widely paralleled, as at Dryburn Bridge, East Lothian (Cool 2007, 75–7), Kintore, Aberdeenshire (Engl 2008, 223–6).

At Culduthel, no obvious patterning to the distribution of the saddle querns could be observed within this structure, although one large, substantially complete saddle/trough quern (SF0147 – Illus. 6.15) was placed with the grinding face upwards, orientated north-south, among the stones outside the entrance to the roundhouse. The concentration of these early querns in the construction of this building, and the lack of any associated rotary quern fragments,

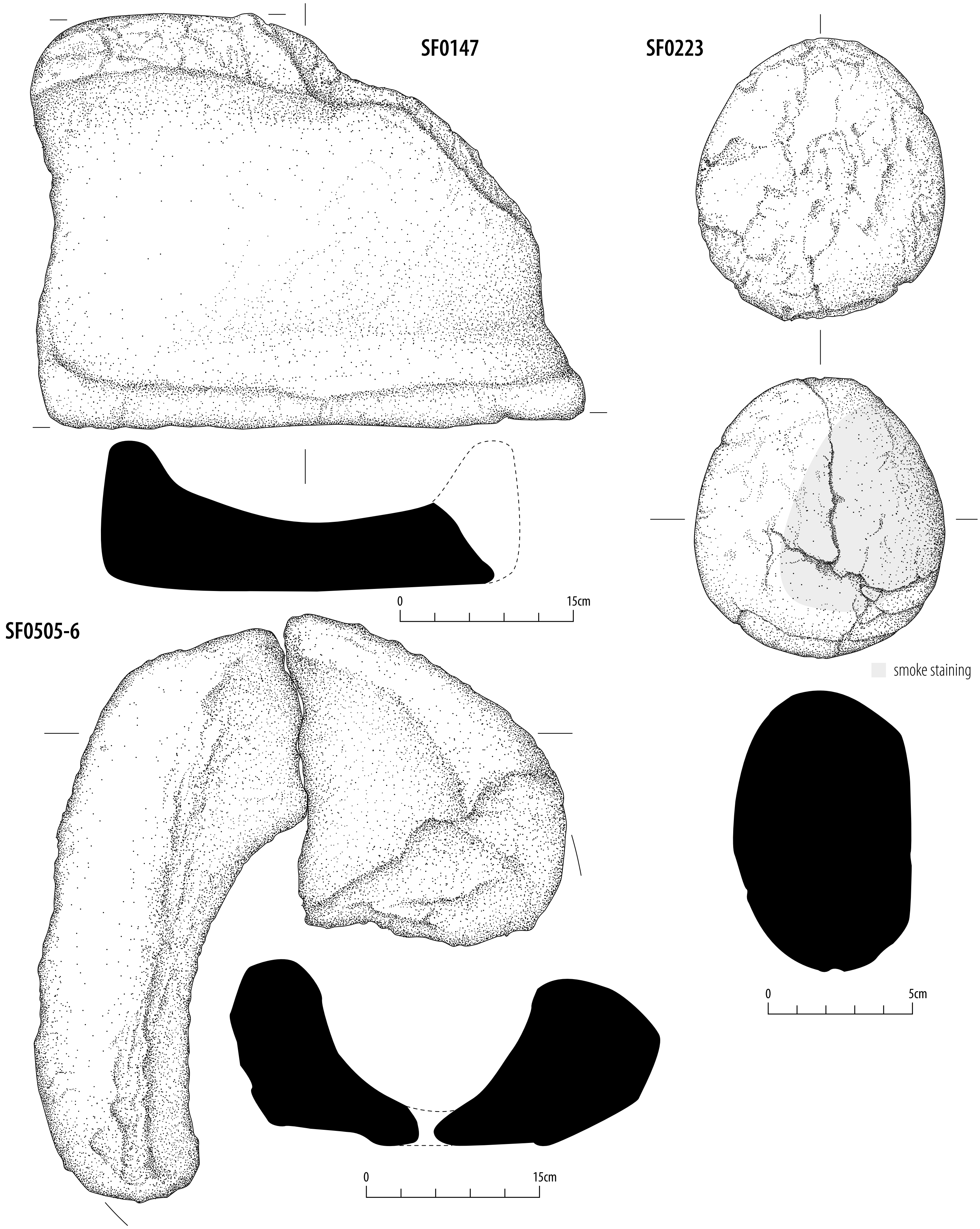


Illustration 6.15
Saddle querns and a cobble tool

confirms the early date of this roundhouse in the site's sequence. All of the saddle querns and rubbing stones were produced from local rock types, the majority from rounded glacial erratic boulders with minimal modification to the stone prior to use. The large saddle/trough quern (SF0147) is likely to have come from a local sandstone outcrop. Only one of the saddle querns (SF0428), a very small plano-convex stone, is complete, which contrasts with the rubbing stones, which, apart from one fire-cracked example (SF0658), are all intact. Three of the rubbing stones have evidence of secondary use in the form of peckmarks and gouges from expedient use as working surfaces (SF0204 and SF0205, SF0206 and SF0235) and one (SF0206) has a small pecked facet that may be from use as a pounder.

Twenty-one rotary querns are represented among the 29 fragments recovered; four complete examples and fragments of a further 17 stones. It has not been possible in all cases to identify whether an upper or lower stone is present due to the level of fragmentation or post-depositional damage, but the majority are upper stones (13 examples). Only three possible lower stones, one of which is unfinished, have been identified. The greater number of upper stones is not entirely surprising as these are more easily identified than lower stones due to the presence of features such as handle sockets and hoppers. Despite this, a disproportionate quantity (80%) of the identifiable stones are upper stones, suggesting that differential retention or depositional practices were taking place at Culduthel (although further lower stones may be present among the small unidentified fragments). Where handle sockets are present they are all vertical. Two querns (SF0328/ SF0365/ SF0654 and SF0508) have two handle sockets, implying heavy use resulting in repair.

Normal models of Iron Age rotary quern use in north-east Scotland would suggest a dominance of disc-querns (MacKie 1971; 1987, 5), but low bun-shaped querns are more frequent at Culduthel, with nine examples identified. Only five possible disc-querns are present although there may be disproportionately more among the unidentified examples as most are broken thin fragments. The difference between the two types is typically based on the identification of specific features of the upper stones: disc-shaped querns are thin, wide stones with flat upper surfaces that contrast with the generally smaller bun-shaped stones, which are thick in proportion to their diameter and have distinct rounded upper surfaces. Some examples inevitably combine features of both. MacKie's consideration of rotary quern use in Scotland during the Iron Age identified a significant difference in distribution between disc- and bun-shaped querns (1971, fig. 5), with disc-querns predominating in the north and west, and bun-shaped querns being more common in the south and east. The dominance of bun-shaped querns at Culduthel is somewhat unexpected and suggests that the traditional model of quern distribution may merit revisiting.

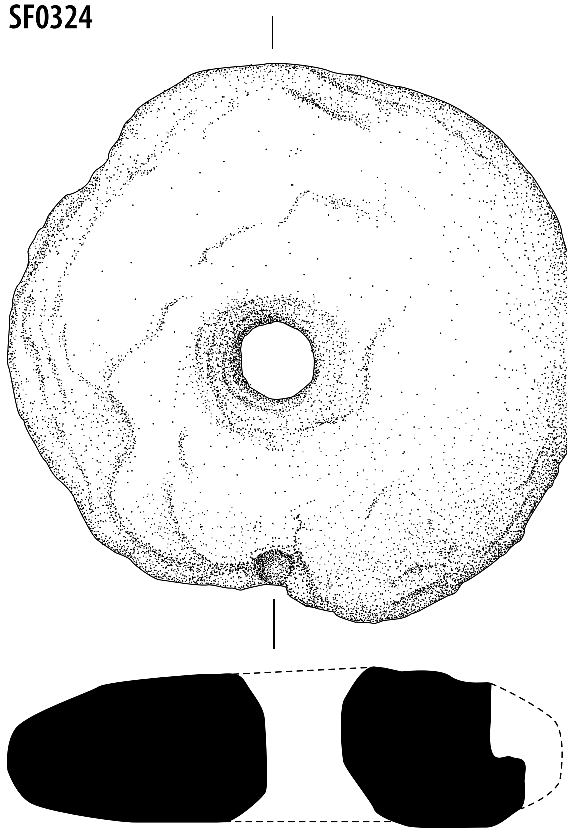
All of the rotary querns have been produced from local schists. Biotite schist was favoured but garnet-rich mica schists, psammitic schists and talc/muscovite schists were also used. Many of these rock types are very friable, leading to frequent spalling of mineral grains. At first glance, these rock types appear an odd choice for use as quern stones since any detached stone would have been incorporated within the ground flour. Yet detailed lithological analysis has identified deliberate selection strategies of the stone used for production of some querns that aimed to minimise spalling. In some examples, such as SF0324, SF0465/0471 and SF0685, the quern has been cut parallel to the natural banding of the stone with the grinding face exploiting dense, quartz-rich layers that occur naturally in the rock. In the case of SF0324, this quartzite layer appears to have been almost completely worn away, probably contributing to the stone's abandonment. The use of rocks with large mineral inclusions (such as garnet-rich mica schists and talc/muscovite schists) also appears to be a deliberate choice for querns at Culduthel; they have not been used for any other tool type at the site. Although minerals will frequently detach during use, they are of such a size that they could be quite easily picked out of the flour.

Two examples among the assemblage provide insights into specific elements of manufacture. SF0339 (Illus. 6.17) is an unfinished, possibly lower quern. The stone, produced from a slab of biotite schist, has seen little modification in shape with the flat smooth 'grinding' face being formed by splitting the slab across a natural bedding plane. At the centre of the face is a biconical perforation, its irregular shape suggesting that it had not been finished or used. Evidence of production is also present on SF1004, a low bun-shaped quern, where the beginnings of a shallow hopper and vertical handle socket had been started on one side but abandoned and used as the grinding surface instead.

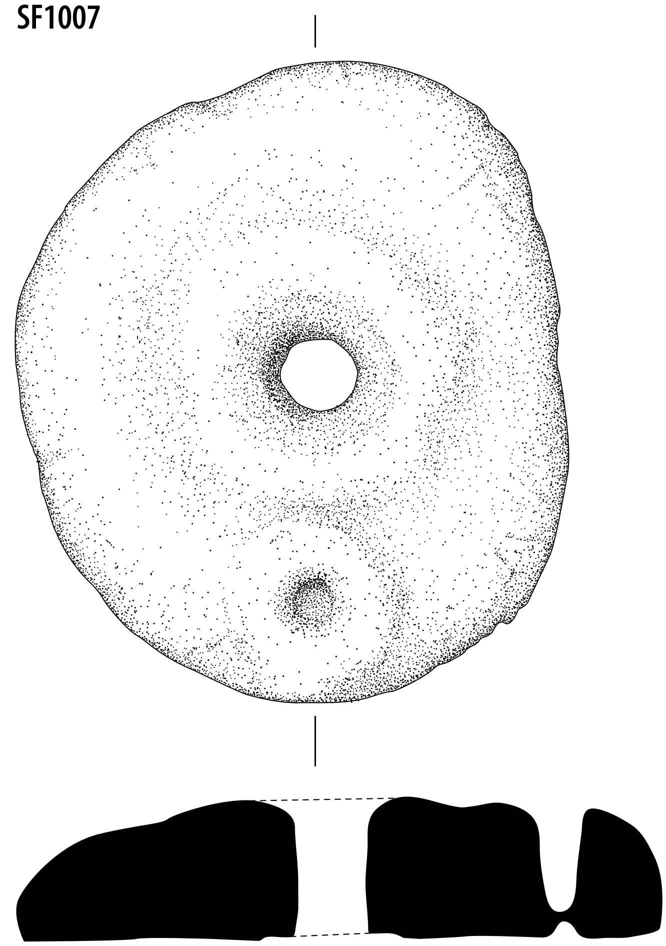
Three of the upper stones have simple embellishment consisting of peckmarked or raised collars surrounding the feeder pipe or handle socket: SF1007, with wide but shallow raised collars around the feeder pipe and vertical handle socket (Illus. 6.16); and SF0631 and SF0184 (Illus. 6.17), with pecked grooves defining slightly raised collars encircling the feeder pipes. Raised collars around feeder pipes are fairly common. Although an embellishment of the quern, they are not necessarily primarily decorative, often fulfilling a functional purpose by creating a broader hopper to hold the grain (McLaren and Hunter 2008, 115). Raised collars around vertical handle sockets are more likely to be decorative, although they might give extra reinforcement to strengthen the handle socket during use. Decorated quern stones are not common in Scotland and are notably rare in north-east Scotland (McLaren and Hunter 2008, 114), with only four other examples known: from Mill Farm and West Grange of Conan in Angus; Kirkton of Bourtie, Aberdeenshire; and Roy Bridge, near Inverness (NMS: BB 134; Coutts 1971, 78, no. 179; Howard 2002, 8, fig. 1; Anon 1892, 70). Some forms of decoration, like that on the Roy Bridge quern, continued into the post-medieval period. One example from Culduthel, SF0631, was incorporate into an industrial hearth (Hearth 2166), which has been dated to 350–40 cal BC, providing a useful *terminus ante quem* for the use of this decorated quern.

Only four complete rotary querns were recovered, with 80% being fragmentary. These fragments range from less than 10% to 85% of the original stone. There does not appear to be any pattern to their fragmentation and none of the quern fragments have clear evidence of deliberate fracturing or destruction; most either broke during use or were discarded due to extensive wear. In six examples (SF0184, SF0324, SF0465 and SF0471, SF0605, SF0630, and possibly SF0328, SF0365 and SF0654 (Illus. 6.16)), the quern has broken across a vertical handle socket. In half of these cases, extensive use led to the handle socket perforating the grinding surface and causing a major point of weakness in the stone. It is likely that in these cases the continued use of the quern resulted in the stone fracturing from this weak point, either causing a large portion of the edge to detach or the stone to split. Several of the

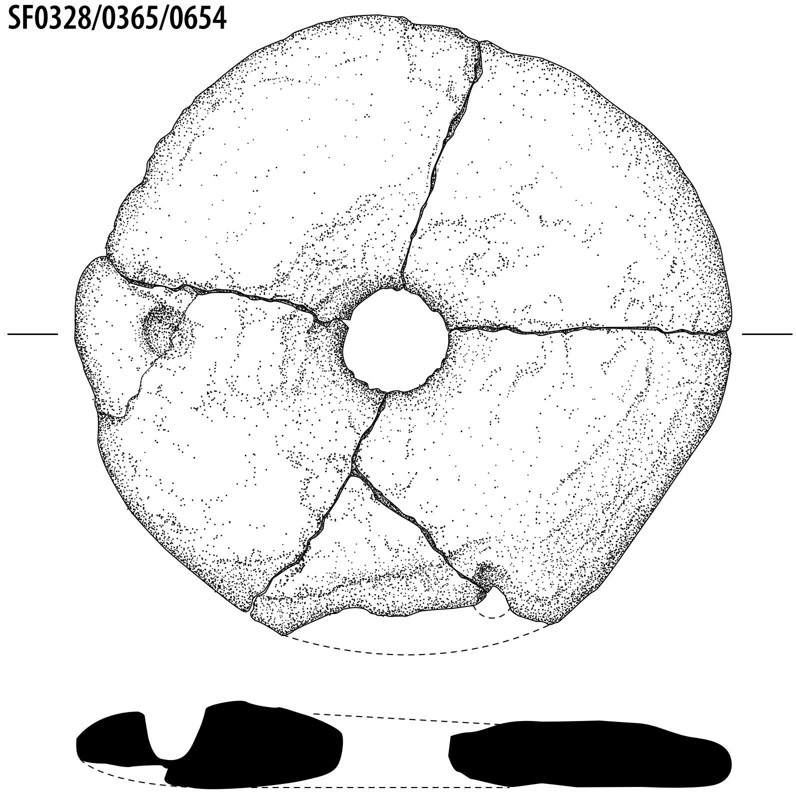
SF0324



SF1007



SF0328/0365/0654



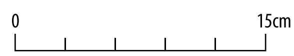


Illustration 6.16
Rotary querns

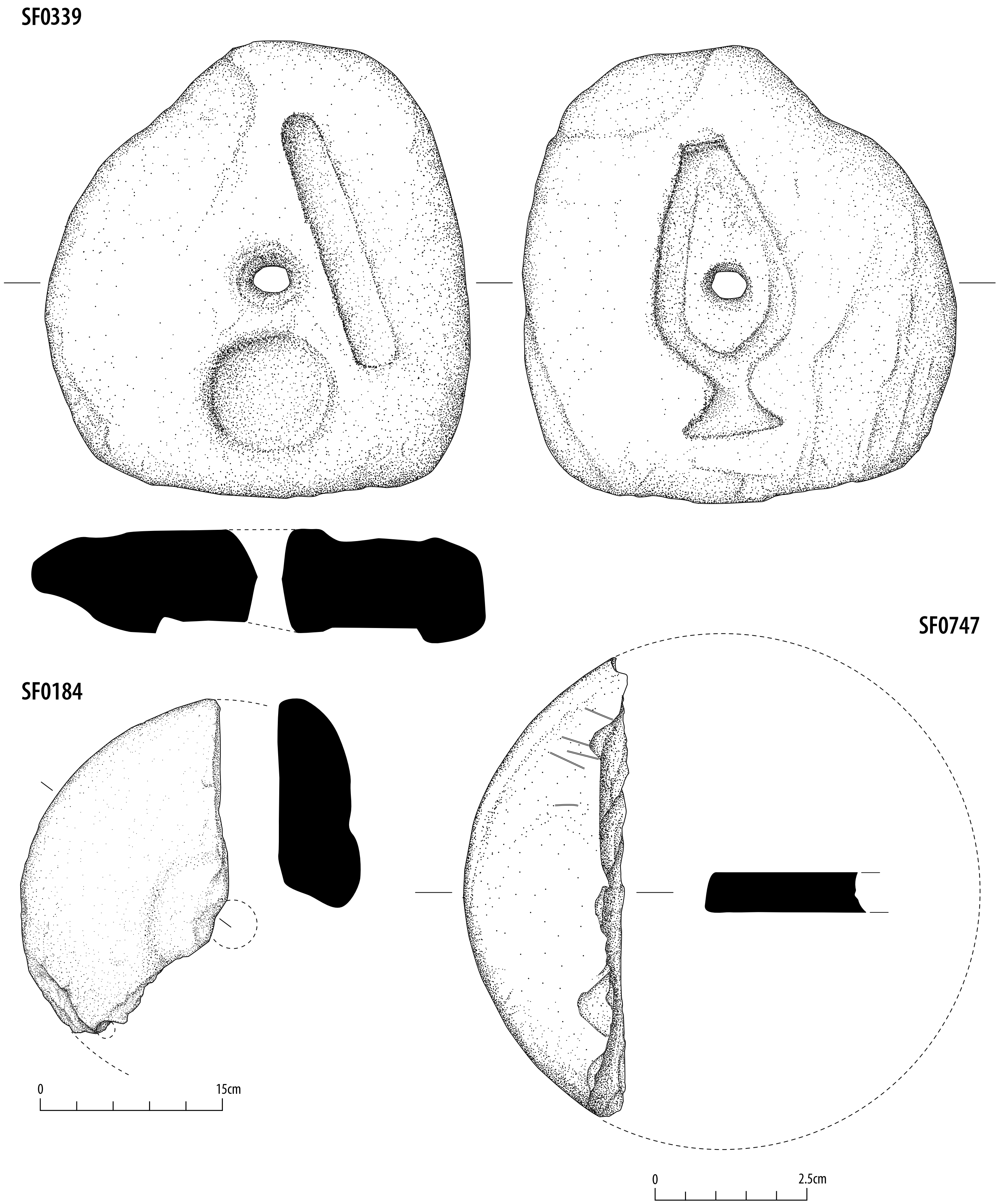


Illustration 6.17
Rotary querns

bun-shaped querns are very thin, suggesting that they had seen extended use with much of the thickness of the stone, or the specifically selected hard layers, being worn away.

Despite only three possible lower stones being identified within the assemblage, they show a consistency of form. The central socket, in which the spindle is inserted to connect the upper and lower stones, perforates the entire thickness of the stone in every example. Such a feature, typically seen on disc-querns, may have allowed the height of the upper stones to be adjusted without having to remove the upper stone to insert washers (MacKie 1987, 5). This would enable different grades of flour to be milled: the closer the stones, the finer the flour would be. One, SF0457 and SF0458, was incorporated into the fill of an iron-smelting furnace (context 2246), which has been dated to 200–0 cal BC (2σ % age probability) (GU-21919 2080 ± 35 BP).

The most significant of the stone tools and perhaps the most intriguing stone find from the site was an unfinished lower rotary stone (SF0339 – Illus. 6.17), reused on both faces as a mould for non-ferrous metal casting. It was recovered from an ephemeral structure (Workshop 11) within the main focal area of industrial activity on the site, and may have been left in situ after use. A disc- and a bar-ingot mould have been carved into one face and a unique 'vase'- or 'fish'-shaped mould has been cut into the unused grinding face. It is clear that the central perforation was present prior to the addition of the moulds, as the disc and bar moulds are arranged around it and the 'fish'-shaped mould centres upon it. The surface of the stone at the edge of the bar mould has fractured, probably during removal of the ingot, but the interior of the disc mould appears unfinished and there is no evidence of use.

The 'fish'-shaped mould is more complex. This mould is, to our knowledge, unique, making it difficult to identify what the intended casting was for and how it was made, but detailed examination of its features reveals some interesting points. Firstly, it is likely that this is the upper half of a two-part mould, with the unfinished quern's perforation used as the casting channel for the molten metal. The central area of the mould surrounding the spindle socket has been left in relief, indicating that the cast metal would have flowed into the edges of the mould; this has fractured when the casting was extracted. The form of the lower half can only be speculative. The surviving shape does not match any known object, but was clearly carefully designed, and it may have been a pre-form intended for sheetwork. Given this, one plausible interpretation could be as a vessel, with the lower half forming the bowl and the upper half forming a thick rim that could be hammered out, the wide 'fish-tail' at one end of the mould destined to become the handle. While feasible, the form of the vessel (both in the presence of a handle and its non-circular form) would be unique in the Scottish Iron Age repertoire, although it is equally certain that our knowledge in this area is partial. The 'fish'-shaped mould is unique and difficult to compare to existing Iron Age moulds. Iron Age stone moulds have never been studied in detail, but they are a widespread category. A similarly enigmatic example from the later prehistoric fort at Ardifuar, Argyll (Christison and Anderson 1905, 268–9, fig.8) is similar in overall form, consisting of a large sub-circular green micaceous schist slab with three large moulds on one face, and a further mould on the opposite surface. These comprise a long, wide, curving bar, a narrow, pointed bar and an elongated ox-hide-shaped object. Near the centre of the opposite face is a fractured flat oval mould. A shallow circular hollow towards one fractured edge of the stone gives the object the appearance of a reused rotary quern stone, but there is no evidence of such use.

Moulds reusing the flat, grinding faces of quern stones are not common but a small number of examples are known from both Bronze Age and Iron Age contexts. At East Cruchie (or Cruichie), Aberdeenshire, the mould for a Bronze Age flat axe has been carved into the prepared surface of a possible saddle quern (Cowie and O'Connor 2009, 317, fig.3). Similarly, two bar-shaped moulds, one possibly for an awl, were carved into the grinding face of a saddle quern fragment from Tweedsmuir, Peebleshire (*Proc Soc Antiq Scot* 100, 201, No. 17; NMS: x.CM 49). Turning to the Iron Age, at Lochlee, Ayrshire, a bar mould appears to have been carved into the lower, fractured surface of a dished and abraded stone, possibly a saddle quern, which has further secondary evidence of use as a whetstone on one smooth, concave edge (Munro 1882, 104–5, fig. 54; NMS: x.HT 2). A small bar mould reuses the grinding face of a fragment of an already broken upper bun-shaped rotary quern stone at Dun Beag, Highland (Callander 1921, 122; NMS: x.GA 1068), and Whitekirk, East Lothian (D. Clarke, pers comm; NMS: unregistered), while at Baleshare, North Uist, a bar mould was carved into the face of a probable saddle quern (Hunter, pers comm; Heald 2007, 203). A bar and two ring moulds have been carved into the abraded face of a stone slab at St Blane's, Bute, although its fractured condition makes it impossible to confirm it was a quern (Anderson 1900; NMS: GQ 39).

The reuse of quern stones as moulds for metalworking is rare and has not been studied in detail. The examples cited above, however, demonstrate that this form of reuse was widespread and long-lived. The reuse of quern stones for other purposes such as whetstones and working surfaces is well attested, and in many cases appears to take advantage of the fine-grained stone, or pre-prepared smoothed and abraded grinding surface. Their reuse as moulds is not so straightforwardly pragmatic. Where the quern was of fine-grained stone, this would be useful for a mould, but this is by no means always the case. It suggests a more deliberate and symbolic form of reuse. Quern stones, already discussed here as symbols of agricultural fertility, may have shared a special association with metalworking (Hingley 1997). Both querns and metalworking draw on associations of creation, fertility and life-cycles, and the reuse of such tools as moulds fits well with these concepts (Williams 2003, 233). Some querns may have been used to grind iron ore, as well as being used as food processing tools (Heslop 2008, 65–6). Such a use is hinted at on one rubbing stone from Culduthel (SF0204 and SF0205); its grinding face is darkly stained from grinding something other than grain, possibly ore or pigment. A further connection between quern stones and metalworking is present at Culduthel with the incorporation of rotary quern fragments (SF0457 and SF0458, SF0630 and SF0631) within metalworking features; such reuse may have performed a significant or symbolic role within the structures, although there is no consistent pattern to their use.

Cobble tools

Cobble tools are a typical component of most later prehistoric stone tool assemblages, but only a small quantity and restricted range were recovered from Culduthel. This is surprising considering the large scale of excavation and the quantity of quern stones present, and contrasts sharply with the quantity of such

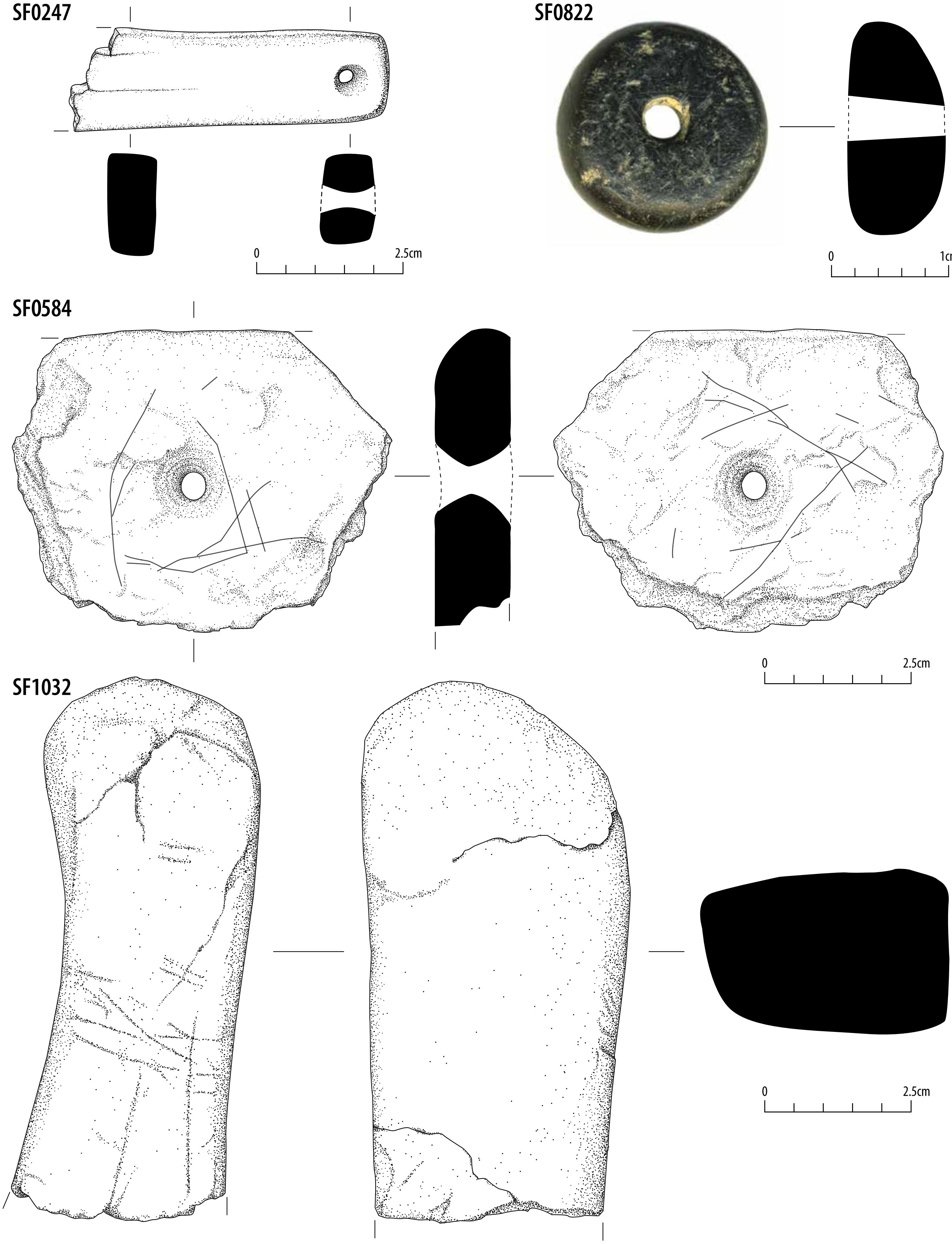


Illustration 6.18
Worked stone – Whetstone, shale bead, spindle whorl and a pounder

tools from the later prehistoric settlement at Birnie, Moray (Hunter [in prep.]). As a result, detailed comparative analysis of wear patterns is limited. It is likely that cobble tools, particularly grinders, pounders and hammerstones, were used for a variety of tasks, from processing grain and other foodstuffs to minerals for pigment, ores for metalworking or clay for potting, inter alia. Even if the processes by which these wear patterns formed are not always fully understood, differentiating the form and character of the wear allows a level of detailed comparison.

Only grinders, pounders, smoothers, whetstones and multifunction tools are present among the cobble tools. No hammerstones were identified. These cobble tools were everyday implements, some of which show multifunctional wear. The wear on the single-function grinders and pounders, defined by areas of abrasion and pitting respectively, is generally restricted to one end or one edge, and in some may only be the result of use on a single occasion. One ovoid pounder has light pecking around three-quarters of the circumference, a widespread pattern (e.g. Braehead, Renfrewshire (McLaren and Hunter 2007); Langskaill, Westray (McLaren and Hunter [forthcoming])). The general lack of developed wear on these tools contrasts with the smoothers and whetstones that appear to have been used more heavily, many having well developed wear facets associated with areas of polish from extended use. The relative lack of whetstones is surprising, given the amount of ironworking at the site.

Smoothers, plausibly hide-processing tools, are the most common cobble tool type at Culduthel, with six single-function tools and evidence of such use on two multifunction cobbles. They are identified by their smoothed, often polished surfaces and dark organic staining (Lane and Campbell 2000, 179). At Culduthel, wear is generally confined to the faces of the cobble but in two examples (SF0335 and SF0757), the rounded sides and ends have been utilised.

Only five multifunction cobble tools were recovered, displaying a limited range of wear. Three show two distinct types of wear, while only two tools show more than two different wear types.

All of the cobble tools have been manufactured from unmodified water-worn or rounded glacial erratic cobbles. Only one, SF0413, has been shaped prior to use. It is clear that the form and rock type of the cobbles was a consideration in their selection. Although the larger stone tools from Culduthel utilise a wide range of schists and sandstones, the cobble tools use a different range of stones. Ovoid quartzite cobbles were favoured for use as grinders and pounders, probably due to their hard wearing, durable properties, although fine-grained microdiorite and schist cobbles were also used. Quartzite also dominates as the rock type of choice for smoothers. The fine grain of such stone and the naturally smooth faces of the cobbles provide good surfaces for this purpose.

Personal and decorative items

Personal or decorative objects are notably rare. The most significant is a single annular oil-shale bead (SF0822 – Illus. 6.18), which came from hillwash deposits to the east and south-east of House 10. It is likely that this was worn as part of a necklace, although no further beads were recovered. The source of shale was probably at Brora (Sutherland). This source was exploited in the Iron Age, with the products travelling north to Caithness and the Northern Isles, and south at least as far as the southern coast of the Moray Firth. A number of Iron Age sites in the Inverness area have such finds, notably bangles from Balloan Park and Knock Farril (Wordsworth 1999, illus. 6; NMS HH 900), while further along the Moray Firth coast there are finds from Culbin Sands, Tarra (Forres), Covesea, Birnie and Green Castle (Portknockie) (Callander 1916, 223; Will 1998a, 66; Benton 1931, 201, fig. 19 no. 12–14; Hunter 2006c, fig. 16a–b; Ralston 1980, fig. 2.12). This shows something of contact networks. In most cases it was the finished objects that travelled, but one of the Birnie finds is unfinished, indicating the movement of raw materials or roughouts.

Apart from the shale bead, only three other stone objects from the site have seen decorative embellishment, consisting of the upper stones of three rotary quern stones that have been discussed in detail above. Although not decorative, one whetstone (SF0247) had been perforated at one end so that it could be suspended either from a belt or around the neck, suggesting it was a personal tool.

Household items

Very few of the worked stone objects shed any light on the furnishings of the structures at Culduthel. One possible pivot stone has been identified (SF0725), a flat irregular schist slab with a smooth shallow circular hollow, slightly off-centre, on one face. Although the hollow lacks any rotational wear that would confirm its use as a pivot stone, it came from a paved surface associated with the substantial roundhouse (House 10/3) and may have been in situ.

Two perforated stones, possibly used as weights, were recovered from occupation deposits to the east and south-east of House 10, but were not associated with a particular structure, and their function cannot be confirmed. A further fragmentary perforated stone, from the fill of a post-hole in Workshop 15 (context 4331), was apparently reused as post-packing.

Craft activities

Although the assemblage is dominated by food processing and general purpose tools that could have been used for a range of everyday tasks, a few hint at more specialist tasks, such as the mould for use in non-ferrous metalworking. Smoothers are interpreted as hide processing tools (cf. Lane and Campbell 2000, 178, 179, 185). Three of the single-function smoothers and one combination tool with evidence of such use come from House 10, suggesting that hide-processing or leatherworking was taking place in and around this building. There is no evidence of textile production among the stone tools, with only one unfinished spindle whorl recovered (SF0584); this rarity is a regular phenomenon on later prehistoric sites (Hunter et al, 2018), perhaps because people tended to spin (and lose whorls) while they were out in the fields; in the house, a lost whorl would generally be found.

Numerous working and grinding surfaces are present among the assemblage, while several rubbing stones and cobble tools show expedient use as working surfaces. Many are deeply scarred and fractured from having been used with fairly vigorous physical force. The three grinding slabs, possibly used to shape or sharpen iron, bone or wooden objects, all come from around the cobbled surface 227, two (SF0238 and SF1226) from within post-holes, and one (SF0317), from a wall in House 4. The working surfaces are more prevalent in the western areas of the site with two (SF0519 and SF0670a) associated with House 10, and one (SF0464) from a post-hole associated with Workshop 16. A further example (SF1227) was recovered from a waste deposit to the north of hearth [2166] and may have been associated with metalworking.

Table 6.11
Distribution of stone artefact types by area and structure

	Food Processing			Tools								Household		Personal	Other		
Structure	**Saddle querns**	**Rubbing stones**	**Rotary querns**	**Grinders**	**Pounders**	**Smoothers**	**Multifunction**	**Whetstones**	**Sharpening stone**	**Grinding/ working surfaces**	**Misc tools**	**Pivot stone**	**Perforated stone**	**Shale bead**	**Basin**	**Whorl roughout**	**Palette**
2																	
3	SF147 SF222 SF428	**SF204/205 SF206 SF233 SF235**		SF209	SF219		SF223	SF244		SF238							
4			SF1007			SF335				SF317							
No structural association						SF323	SF247	SF247									
10			SF324 SF328/365/654 SF443 SF605 SF653 SF685	SF495	SF421a	SF432 SF529 SF1224	SF413 SF477 SF1225		SF329	SF519		SF725	SF527a SF527b			SF584	SF757
11			SF339 SF507 SF508												SF505/ 506		
13										SF599							
15			SF835 SF836										SF842				
No structural association		SF598	SF184 SF292 SF418 SF681			SF757				SF1226				SF822			
Industrial hearth 2166			SF630 SF631							SF1227							
Furnace 3790											SF1228 SF1229						
12							SF1032										
16			SF457/458 SF465/471							SF464							
17			SF476														
18		SF658															
Unstratified	SF707																

Many of the stones (10), particularly the cobble tools, are severely heat-affected and fire-cracked, suggesting reuse as pot-boilers or within furnaces or hearths.

Chronology and contextual analysis

Few stone tools are chronologically distinctive but the assemblage as a whole is consistent with the later prehistoric date of the structures, particularly the stone palette, the perforated whetstone and the rotary querns. The dates obtained provide valuable *termini ante quem* for many object types. Stone tools were found throughout the site, concentrated particularly around the cobbled surface 227 and House 4 on the east of the site and around House 10 (Table 6.11).

The majority of stone is associated with House 10/3, most from residual or secondary contexts. Some quern fragments and a working surface were reused in walls and post-holes as post-packing and four objects, a working surface (SF0519), a smoother (SF0529), a multifunction cobble tool (SF0477) and fragments of a rotary quern (SF0365), came from the main fill of the ring-ditch. Most of the stone associated with this structure came from post-abandonment or decay deposits overlying the structure. Only four objects may be directly related to its use: a possible grinder (SF0495), fragments of a rotary quern (SF0605) and smoother (SF1228) came from occupation deposit (context 2198), and a possible pivot stone (SF0725) was part of a paved surface within the structure (context 1979).

In two cases, fragments of a single quern were found in separate contexts. Several small fragments of a thin garnet-rich schist disc-quern (SF0328, SF0365 and SF0654) all derive from House 10/3 but came from several contexts and deposits, such as the fill of the ring-ditch, the fill of post-hole 2209 and the post-abandonment layer overlying the roundhouse. The fragments cluster in the south-west quadrant of the roundhouse.

Similarly, fragments of one bun-shaped quern (SF0465/0471) came from Workshop 16. One fragment, SF0465, came from the fill of a circular pit immediately behind the south-east entrance post (context 2238), while the joining fragment, SF0471, was recovered from the fill of another post-hole towards the back of the roundhouse (context 2253). The fragment from 2238 appears to be severely weathered, contrasting sharply with condition of the other piece, which is quite fresh, suggesting a significant difference in the treatment of the two fragments after the stone was broken. This adds to other evidence of quern having a post-use life, their treatment and deposition suggesting they were seen as significant objects (see Heslop 2008, 73–80).

Three fragmentary querns (SF0457/0458, SF0653 and SF0836) have evidence of heat damage and were associated with possible metalworking features. Fragments of one quern (SF0457/0458) were directly associated with a furnace feature [2246]; and one very friable fragment of this quern has carbonised material adhering to one face. The intense heat it was exposed to has severely degraded the strength of the rock. The burnt material adhering is neither vitrified nor magnetic, but may represent fragments of charcoal and ash from the interior of the smelting furnace. It is possible that this quern fragment therefore had been used to support a ceramic tuyère, with the notch from the central perforation forming a convenient aperture in the structure of the furnace, or had simply been reused within the furnace's stone lining. A further two rotary quern fragments were incorporated in an industrial hearth (Hearth 2166) (SF0630 and SF0631), but the lack of heat damage or adhering slag suggests that these were used as convenient building stones rather than a support for the tuyère or bellow.

A further significant concentration of stone comes from House 3, including saddle querns, rubbing stones, a multifunction cobble tool, a whetstone and a grinding surface. As discussed in detail above, all of the saddle querns (apart from one unstratified find) and the majority of rubbing stones from the site were associated with this structure. Although the majority of the querns and rubbing stones had been reused, either in walls or in post-holes as post-pads or packing material, the presence of so many saddle querns and no associated rotary querns suggests this structure is one of the earliest on site, confirmed by its Late Bronze Age/Early Iron Age radiocarbon date, 810–540 cal BC (2σ % age probability) (GU-21912 2565 ± 35 BP). The presence of so many of the saddle querns and rubbing stones within this single roundhouse suggests that they had been deliberately incorporated into the structure during construction, as symbolically charged objects (Hingley 1992), although no distinctive patterning or clustering was observed to indicate the deliberate placement of the stone within specific areas of the structure. Rotary quern stones do not appear to have been systematically treated in the same way on the site. Although rotary querns were associated with eight structures at Culduthel, no clear pattern of deliberate placement or structured deposition was observed. However, the potential significance of their association with furnaces in three instances has been discussed above, and the patterns of fragmentation noted with the joining fragments (above) point in these cases to the quern having an afterlife, which indicates the fragments were seen as significant.

Comparanda

Comparative analysis of the stone assemblage from Culduthel is faced with several problems, not least of which is the paucity of later prehistoric sites in northern Scotland (outwith Orkney and Shetland) that have been excavated using modern methods and techniques. This makes any detailed analysis of coarse stone use and deposition in Iron Age northern Scotland difficult, as the information from many earlier excavations is either insufficient to allow detailed analysis or difficult to interpret. In many early excavations, worked stone was not routinely retained and generally only unusual or decorative items were kept. All-encompassing terms such as 'hammerstones' were often used as a generic term for cobble tools with signs of use, and quern stones have typically been mentioned only briefly, making it difficult to conduct detailed comparative analysis.

The most comparable site in terms of scale of excavation, size and complexity of the settlement evidence is Birnie, near Elgin in Moray (Hunter [in prep]). Excavations at Birnie have focused primarily on a series of roundhouse structures and associated features. Since 1998, more than 750 items of stone have been collected through excavation and field walking. Post-excavation analysis of these finds is at an early stage and the figures quoted here are necessarily provisional, but a rapid assessment provides interesting comparable details to Culduthel. The substantial quantity of coarse stone recovered at Birnie is striking in comparison to the relatively conservative assemblage from Culduthel. The reason for this is not clear, as both sites had access to good quality, local stone. This may be due to chronology, with more intensive occupation in the Late Bronze Age to Middle Iron Age at Birnie, or simply a longer sequence of occupation with evidence of activity in the area from early prehistory through to the medieval period. Alternatively, this could suggest distinctive approaches to stone use between the two sites.

Of the stone tools from Birnie, 70% have been provisionally classified into specific tool types such as querns and cobble tools, including grinders, pounders and whetstones. Among these identified tools, as at Culduthel, quern stone fragments have been found in quantity, with more than 50 saddle quern fragments and approximately 20 rotary quern fragments, dominated by disc-querns. Similarly large quantities of rubbing stones, used in conjunction with saddle querns, were noted (57). At Culduthel quern stones and rubbing stones represent over 45% of the stone assemblage, while at Birnie they comprise over 40% of the identified stone tools. A further consistent aspect of the Birnie and Culduthel stone assemblages is the relative lack of spindle whorls; only one has been recovered from the excavations at Birnie to date. As noted above, this fits broader patterns.

Despite these points of similarity, the cobble tool assemblage from Birnie stands in contrast to that at Culduthel, comprising over 55% of the identified stone assemblage, whereas at Culduthel, the cobble tool assemblage was limited, making up just over a third of the stone tools. The contrast between the quantities of possible whetstones is particularly striking; at Culduthel, only two examples are present, comprising less than 1% of the cobble tool group. At Birnie, over 100 examples have been recovered, comprising over 40% of the cobble tool assemblage.

Conclusions

Despite the limited range and quantity of stone artefacts from Culduthel, they comprise a significant and interesting assemblage. Grain processing tools in the form of quern stones and rubbing stones dominate the assemblage, many displaying extensive use. Wear patterns on the rotary stones in particular suggest that most were used until exhausted, or discarded due to damage through wear. Detailed geological examination of the querns indicates that the stones used were carefully selected, using garnet-rich schists or coarse schists with distinctive quartz-rich seams. There are also hints at deliberate deposition of quern stones, with the incorporation of several saddle querns and rubbing stones within one Late Bronze Age/Early Iron Age roundhouse. Their reuse within the structure, as post-packing and building stones, is interpreted as indicating some symbolic connection with concepts such as fertility and the agricultural cycle. Such a practice was not observed within any other structure at Culduthel, and it is interesting to note that rotary quern stones were not reused in this way. Symbolic associations between quern stones and metalworking are highlighted by the reuse of an unfinished lower rotary stone as a mould for non-ferrous metal casting, and the incorporation of some rotary quern fragments within metalworking features. The mould is one of the most significant and enigmatic objects from the site; the large 'fish-shaped' mould, interpreted here as a pre-form mould for casting a vessel, is unique. The reuse of a quern stone for a mould is likely to have had a significance beyond any purely functional qualities; the schist it is made of is not inherently better than the sandstones readily available from the surroundings.

The general lack of cobble tools from Culduthel is intriguing given the long period of occupation at the site and the scale of the excavation. The small quantities of whetstones and the lack of hammerstones is particularly interesting given the amount of metalworking that was taking place, where such tools might be expected to find a role. This is in stark contrast to the later prehistoric settlement site at Birnie, Moray (Hunter [in prep]), where cobble tools are common, whetstones making up a significant proportion of the assemblage. The small quantity and range of cobble tools from Culduthel is difficult to explain. It is possible that this is a reflection of different chronologies (with Birnie perhaps having an earlier 1st millennium BC evidence) or access to resources. Alternatively, the rich assemblage of iron and iron production at Culduthel could suggest that tool types commonly present in stone at other sites were here being made from iron. Future work could usefully compare and contrast assemblages from the area in more detail, as the results of other recent excavations become available.

Catalogue

Geological identifications are incorporated in the catalogue descriptions, with their wider significance discussed by Fiona McGibbon below.

Food processing equipment

Quern stones: saddle querns

Three saddle querns and one large saddle/trough quern were recovered. Only one (SF0428), a very small plano-convex example, is complete. A range of rock types have been used: schist, sandstone, microgranite and biotite granite. Three have been manufactured from large glacial erratics with limited shaping prior to use. The trough quern is likely to have derived from a local sandstone outcrop. Although this example takes advantage of naturally straight edges, the ends and surfaces have been extensively shaped prior to use. Three saddle querns were recovered from House 3: the fourth example was unstratified.

SF0147 Large sub-rectangular slab of coarse arkosic sandstone, worn on one face from use as a saddle/trough quern. The basal surface is naturally flat with only occasional peckmarks present along one edge from an attempt to flatten a rough, irregular patch and to make the stone more stable to work. Both longitudinal sides were originally straight (one has been damaged, resulting in the loss of one corner) and appear to take advantage of naturally straight edges. The ends are also squared; occasional peckmarks indicate that these have been shaped. They are high steep-sided ridges with rounded edges that curve towards the grinding face (undamaged edge H 133 W 48mm). One edge ridge appears to be higher than the other but it is difficult to confirm due to later damage. On the working surface, a wide linear U-shaped concave facet runs parallel to the elongated sides (L 440 W 240 D 35–80mm) with concentrated abrasion at the centre (L 290 W 250mm) from use perpendicular to the elongated edges. There is no corresponding ridge around the ends; the grinding surface extends to the very edges. L 460 W 370 T of grinding face 56–85mm. Possible wall base/collapse, context 796, House 3. (Illus. 6.15)

SF0222 Large sub-rectangular fragment of a biotite schist block. The edges are naturally rounded but irregular and the basal surface is angular throughout. The grinding surface is dished with distinct pitting from use. L 390 W 242 T 164mm. Possible wall base/collapse, context 796, House 3.

SF0428 Small plano-convex oval microgranite saddle quern produced from a glacial erratic boulder. The grinding surface is dished and lightly pitted with areas of polish visible towards both ends, one of which has been lost. The remaining end is rounded with some peckmarks, probably from manufacture. L 236 W 168 T 57mm. Fill of post-hole [1646], context 1647, House 3.

SF0707 Fragment of a large sub-rectangular coarse biotite granite slab, three rounded corners remaining, one edge lost. Some peckmarks on the edges remain from basic shaping. One face has been flattened and is slightly dished towards the centre where crystals have been planed off and abraded from use with associated polish. L 312 W 250 T 105mm. Unstratified.

Rubbing stones

Six rubbing stones are present, characterised by their smooth, rounded abrasion facets formed by grinding grain or other substances on a saddle quern. Contact with the dished face of the quern gives the rubbing stone its convex, rounded working surface which is sometimes polished from wear. One large rubbing stone, SF0204 and SF0205, has dark staining on one face, indicating that it was used to process something other than grain; it may have been used to grind pigment or iron ore. Five examined examples are complete, while one is fragmentary as the result of exposure to intense heat. All of the rubbing stones have been produced from locally sourced glacial erratic boulders, four of which were unmodified prior to use. Three have evidence of secondary use in the form of peckmarks and gouges from expedient use as working surfaces (SF0204/0205, SF0206 and SF0235) and one (SF0206) has a small pecked facet that may be from use as a pounder. Four were recovered from House 3: two built into the rubble foundations for a wall (context 723) and two incorporated into post-holes, perhaps as post-pads.

SF0204 and **SF0205** Four joining fragments of an ovoid amphibolite boulder, shape unmodified prior to use. Both faces are flattened through use, one more extensively than the other with a large oval area of abrasion and polish. Associated with this facet is a dark red-brown area of staining, indicating that this face, at least, was used to grind substances other than grain or foodstuffs. Small patches of bright red-brown residue adhere to the edges, suggesting that this might have been used to process ore prior to smelting. Irregular pitting on this surface cuts through the polished facet, indicating expedient use as a working surface. The opposite face also has a flattened abraded facet covering most of the surface but lacks associated staining and polish. L 337 W 216 T 120mm. Rubble foundation within cut [724] for wall of House 3, context 723.

SF0206 Irregular sub-rectangular boulder of coarse granodiorite. The shape, unmodified prior to use, is natural apart from an oval pitted facet on one rounded corner, which may be the result of use as a pounder (57 × 48mm). The grinding face is flat and smooth with well-developed use-polish. Concentrated towards the middle of this face, overlying the polish, is an irregular oval area of distinct pitting. Although some of these hollows are due to detached crystals, others appear to be deliberate peckmarks, suggesting expedient use of the face as a working surface. L 253 W 177 T 100mm. Rubble foundation within cut [724] for a wall of House 3, context 723.

SF0233 Plano-convex ovoid coarse granodiorite cobble, surfaces heavily pitted throughout from manufacture. The grinding surface is severely pitted from use with the large feldspar crystals planed off, particularly at one wide, rounded end. Elsewhere the crystals have been detached during use, resulting in a heavily pitted surface. L 249.5 W 130–185 T 65mm. Fill of post-hole, context 959, House 3.

SF0235 Irregular sub-square boulder of biotite schist, all edges naturally rounded with no evidence of modification prior to use. Both surfaces are rounded; one is natural, the other, the grinding face, has been smoothed and abraded from use. The surface has areas of polish, particularly around the edges, and the face is highly pitted from wear. Some deeper peckmarks (D 15mm) near the centre of the face may be the result of expedient use as a working surface. L 227 W 212 T 71mm. Cut of post-hole, context 962, House 3.

SF0598 Plano-convex ovoid rubbing stone produced from a glacial erratic garnet biotite schist boulder. Both smooth rounded ends have been abraded to shape; one has recent damage. The grinding face is flattened and pitted from use. L 226 W 180 T 73mm. Packing stones within post-hole [2912], context 2914, Workshop 13.

SF0658 Fire-cracked fragment of an ovoid psammitic schist cobble with one smoothed, flattened surface remaining, with an associated light sheen. The opposite surface is heavily sooted. The edges are fractured as the result of heat damage. L 76 W 91 T 60.5mm. Fill of pit [3599], context 3600, Workshop 18.

Quern stones: rotary querns

Twenty-nine fragments of 21 rotary querns are represented among the assemblage. Although rotary querns are typical finds from later prehistoric settlement sites in Scotland, their quantity, particularly in comparison with the limited cobble tool assemblage, is significant. Only four stones are complete (including an unfinished example), the rest being fragmentary. The majority of these fragments are from upper stones (13) with three possible lower stones present. The remaining fragments could not be classified due to a lack of distinguishing features. Contrary to the pattern expected for north-east Scotland (MacKie 1971, fig. 5), low bun-shaped querns dominate the assemblage, with only two definite disc-shaped upper stones identified. All were produced from locally sourced schists.

SF0184 Approximately 30% of an upper quern stone produced from biotite schist. Despite the thinness of the stone, this appears to be a shallow bun-shaped quern that has seen extensive use. The upper surface is rounded with peckmarks remaining from manufacture. A raised collar surrounds the biconical feeder pipe (D 37mm), which is then surrounded by a wide pecked groove (W 28.5mm). A conical vertical handle socket (D 17mm) can be seen in section on one broken edge and has worn through to the grinding face. This is likely to have caused a point of weakness in the stone and may have resulted in the stone fracturing and being discarded. The grinding face is convex through extensive use, with planed-off garnet/feldspar crystals and frequent pitting due to such inclusions detaching. Original D *c*.345 T 54.5–69mm. Spread of dark humic loam with abundant fire-cracked stones and ferrous metalworking waste, context 798, spread of burnt debris beside House 10/3. (Illus. 6.17)

SF0292 Approximately 20–25% of a rotary quern stone produced from coarse biotite schist. Very few original features of the stone remain; the edges have broken off, the grinding surface has been lost and no handle socket remains to confirm whether this is an upper or lower stone. The pecked central perforation, seen in section on the broken edge is *c*.25mm diameter. Due to the loss of the edges, the original dimensions are unclear but it must have been over 300mm in diameter. L 157 W 149 remaining T 62mm. Dumped deposit, context 1680 beside House 10/3.

SF0324 Complete low bun-shaped upper rotary quern stone produced from garnet-rich mica-schist with frequent talc inclusions. Although such a coarse-grained schist seems an unlikely and unsuitable rock type for such a purpose due to the frequent spalling and friable character of the stone, the grinding face has been produced parallel to the mineral alignment in the rock, showing a deliberate attempt to exploit the harder, denser layers of the stone. Much of this layer had been worn away. The central biconical feeder pipe (D 80mm) has a smoothed interior from use. One small edge fragment has broken off adjacent to a well-used conical vertical handle socket (D 32mm), presumably during use. It is likely that a replacement handle socket was not produced as the hard layer of stone used as the grinding surface had been almost exhausted. D 358 T 190mm. Post-abandonment/decay deposit overlying House 10/3, context 1671. (Illus. 6.16)

SF0328, SF0365 and **SF0654** Almost complete disc-shaped upper rotary quern stone of garnet-rich mica schist in seven fragments from three contexts; only one small edge fragment is missing. The upper surface is naturally irregular and uneven with no obvious attempts to flatten or smooth it. Some rough irregular pecking around the central feeder pipe appears to be an attempt to produce a shallow hopper but this is obscured by later post-fragmentation damage. Only small sections of the original edges remain but where present they are rounded and smoothed in places, while other areas have fairly straight natural edges which have seen little attempt to shape. The biconical central feeder is wide in comparison to most of the querns from the site (D 61mm) and two small shallow vertical handle sockets (D 23 and 24mm) are present, the second possibly a replacement for the primary handle, which looks damaged. The grinding face shows extensive use with planed-off garnet crystals and frequent pitting from detached crystals. D 368 T 51.5mm. SF0328 from post-abandonment/decay deposit overlying House 10/3, context 1671. SF0365 from main fill of ring-ditch [2215], context 2155, House 10/3. SF0654 from fill of post-hole [2209], context 2837, House 10/3. (Illus. 6.16)

SF0339 Intact unfinished ?lower disc-quern stone of biotite schist, slightly oval/sub-square in shape and reused on both faces as a mould for non-ferrous metalworking. There appears to have been little attempt to modify the shape of the stone; one squared end has a small oval area of peckmarks, while the other surfaces are naturally irregularly rounded. Similarly, there is no obvious attempt to dress the surfaces but an uneven oval biconical perforation has been pecked into the centre of the stone (50 × 46mm). The interior of this perforation is uneven and almost sub-square in shape, suggesting that it had seen minimal use, if any. One naturally rounded face has a disc and a bar ingot mould carved into the surface. The position of these moulds adjacent to the central hole confirms that they were added after the perforation had been made. The bar ingot mould has a smooth interior with carefully rounded ends (L 210 W 29–20 D 22–24mm). Slight spalling of the stone between the central hole and the edge of this mould may indicate damage in removing the cast ingot. In contrast, the disc mould shows no use, the uneven basal surface (D 101 Depth 16–18.5mm) suggesting it was unfinished. On the opposite surface (the intended grinding face), a more complex mould has been carved, centred on the central perforation. This mould (L 190mm) has a wide fan-shaped end (W 85mm) that tapers sharply, forming a narrow neck (W 34mm) that expands gently to a rounded vase-shaped body (W 115mm). This tapers to a narrow squared end (W 36.5mm). At the centre of the mould is a raised teardrop-shaped area (D 18mm), which is damaged from removal of the cast object. This raised area would create a depression in the casting, leaving a deeper casting around the edges and ends (D 22–24mm) only. It is suggested that this is one half of a two-part mould of a vessel, this one, the rim and the handle, sitting on top so that the molten metal could be poured into the mould using the central perforation as an ingate. L 361 W 362 T 93mm. Concentration of burnt material, context 1952, Workshop 11. (Illus. 6.17)

SF0418 Small flat wedge-shaped fragment of psammitic schist with one rounded original edge remaining. The slightly convex upper surface and both broken edges are coated in a glassy vesicular residue. This could be a reused fragment of rotary quern but there are no diagnostic features remaining to confirm that this. L 125.5 W 102 T 47.5mm. Hillwash, context 2101.

SF0443 Approximately 35–40% of a rotary quern stone produced from coarse talc/muscovite schist. None of the original edges remain. The grinding face, which is distinctly sloped towards the feeder pipe (D 39.5mm), has little evidence of wear except from smoothing of the talc crystals. The surface is severely pitted due to such minerals detaching through use. The opposite surface is flat and pitted with frequent detached talc crystals. Due to the loss of the edges, the original dimensions are uncertain, but it must have been at least 340mm diameter. T 75mm. Post-abandonment/dumped deposit overlying House 10/3, context 1671.

SF0457 and **SF0458** Three non-joining fragments of very friable, very unstable ?lower rotary quern stone produced from garnet-rich mica schist. Approximately 75% of the stone is represented. Very little of the original edges or surfaces remain, having been lost to heat damage. No handle socket remains. The central biconical perforation is approximately 59mm in diameter. It was found in a furnace and the field interpretation was that the central perforation acted as a bellows hole. The heat damage indicates that all of the fragments had been built into the furnace structure but worn fracture surfaces suggest that this was after the quern was broken up, destroying the perforation. One fragment has burnt deposits adhering to one face, which is severely degraded through exposure to intense heat, and the broken notch of the perforation may have supported a ceramic tuyère that has since degraded. Original diameter at least 330 T 59–57mm. Fill of furnace [2246], context 2288, Workshop 16.

SF0465 and **SF0471** Two conjoining fragments representing approximately 85% of a bun-shaped upper rotary quern stone produced from coarse talc mica schist. The upper surface has been carefully shaped to create a smooth rounded profile with occasional peckmarks remaining from manufacture. Significantly, the upper surface of one fragment (SF0465) is more coarsely weathered, suggesting differential deposition conditions. In contrast to the well-shaped surfaces is the irregular feeder pipe (D 67mm), which appears to have been bored or drilled at a slight angle from both sides, creating a distinct asymmetric notch at the narrowest point of the perforation (D 47.5mm). The grinding face is smooth and flattened from use with areas of polish, particularly around the circumference. No handle socket is present. D 360 T 86mm. SF0465 from Fill of pit [2238], context 2239, Area E. SF0471 from fill of post-hole [2253], context 2255, Workshop 16.

SF0476 Approximately 80% of a bun-shaped upper quern stone of coarse biotite schist in two joining fragments. The upper surface is gently rounded and evenly shaped with frequent shallow peckmarks remaining from manufacture. The central biconical feeder pipe (D 34mm) widens significantly at the upper surface to create a hopper (D 63mm). One vertical handle socket remains (D 43mm), showing signs of significant use as it is highly smoothed and polished and has worn down through to the grinding face. A small oval indentation (22 × 17mm) on the grinding face adjacent to the hole made from the handle socket may have been caused by the abrasion of the detached stone fragments. The grinding surface has areas of polish, particularly around the circumference and is lightly pitted from use. D 356 T 85mm. Spread of large stones in [2403], context 2404, House 17.

SF0507 Small fragment (approximately 25%) of an upper rotary quern stone of biotite schist with the remains of the feeder pipe (D 33mm) and shallow hopper (D 52mm) visible in section. Both the upper surface and grinding face have been lost due to the friable rock type, so the original dimensions are unknown. Original D at least 300mm, remaining T 14.5–32.5mm. Remains of a stone wall, context 2456, Workshop 11.

SF0508 Fragment of the upper stone of a rotary quern of biotite schist. This may be a further fragment of SF0507 as the rock type and colour are so similar, but no joins are present. The fragment represents less than 15% of an upper stone. None of the original edges remain but a slightly curved and smoothed notch on one edge is likely to be the edge of the feeder pipe. A further narrower notch on the adjacent break surface is from a conical vertical handle socket (D 25mm). A small crescentic notch on the opposite break surface may be a second handle socket. The upper surface is gently sloping with occasional peckmarks from manufacture. The grinding surface has been lost and the original thickness of the stone is unknown. Original D at least 340mm, remaining T 26–34mm. Remains of a stone wall, context 2456, Workshop 11.

SF0605 Approximately 50% of a highly degraded small disc-shaped upper rotary quern stone produced from biotite schist. Identification as a disc-quern is based on the proportions of diameter and thickness, although much of the thickness has worn away through use. The pecked biconical feeder pipe (D 57mm) and a vertical conical handle socket can be seen in section. The handle socket appears to have perforated the grinding surface, which suggests that the quern had seen extensive use, and which may have resulted in the fracture and discard of the stone. D 382 T 51.5mm. Occupation surface, context 2198, House 10/3.

SF0630 At least 15% of a bun-shaped upper stone of psammitic schist with a rounded upper surface, regularly pitted from manufacture. No central perforation remains but a narrow, ?drilled vertical handle socket (D 19mm) is present in section on one broken edge. It appears to have worn down through the grinding surface, creating a point of weakness and perhaps leading to the fracture of the stone in use. L 260 W 173 T 90mm. Industrial furnace [2166], context 2166.

SF0631 Approximately 45% of an upper bun-shaped rotary quern of psammitic schist. The upper surfaces are quite steeply rounded with distinct peckmarks remaining from manufacture. A slightly rounded pecked collar (W 35.5mm) defines a shallow hopper that surrounds a narrow biconical feeder pipe (D 28mm). The grinding face is coarse and pitted with severe damage, particularly around the circumference. Original D 305 T 85.5mm. Industrial Hearth [2166], context 2166.

SF0653 Approximately 30% of a possible adjustable lower disc rotary quern stone produced from garnet-rich mica-schist. Most of the original rounded lower surface or edges have been lost due to exposure to intense heat but where present, peckmarks are visible from manufacture. No handle socket is present, suggesting that this is a lower stone, as does the narrow conical central spindle socket (D 22.5mm) that perforates the stone. The grinding surface is distinctly dished and pitted from use with some concentric striations visible. The grinding surface has many hairline cracks and the edges are friable, suggesting it was exposed to high temperatures. Original diameter *c*.380mm, T 67mm. Remains of wall base, context 1853, House 10/3.

SF0681 Approximately 40% of a bun-shaped upper quern stone of biotite muscovite schist. Fragment of a short feeder pipe (D 29mm) and a narrow hopper remain in section. The edges and rounded upper surface are well shaped with peckmarks remaining from manufacture. No handle socket is present. Original diameter *c*.320mm, T 49–66.5mm. Packing within post-hole [3714], W of Workshop 13, context 3713.

SF0685 Approximately 20% of upper stone of a bun-shaped rotary quern stone produced from psammitic schist. The upper surface, originally rounded, is damaged but a slightly oval conical vertical handle socket remains (D 42mm, *c*.30mm deep). The interior of the socket is smooth from the rotational wear of the handle. The grinding surface is flat and polished in places with light pitting from use. Such a friable schist is not the best rock type for quern use due to the frequent shedding of mineral grains but the grinding surface, in this case, exploits a layer of dense quartzite-rich stone. Original D 350–370 T 84mm. Fill of post-hole [3549], context 3551, House 10/3.

SF0835 Approximately 40% of a rotary quern produced from a slab of coarse garnet-mica schist. All of the edges have been lost, as has most of the upper surface, leaving only grinding face and feeder pipe (D 37.5mm) identifiable. It is not clear whether this is an upper or lower stone. Original D at least 350mm, remaining T 65mm. Fill of post-hole [4306], context 4304, Workshop 15.

SF0836 Approximately 15–20% of a rotary quern stone produced from coarse biotite schist. The well-used, flat, smooth grinding face and a fragment of rounded edge remain but the upper surface has been lost, possibly due to heat damage, making it impossible to confirm the quern's profile and whether it was an upper or lower stone. The central pecked perforation can be seen in section (D *c*.30mm) but no trace of handling system is present. Original diameter *c*.405mm, remaining T 36.5mm. Fill of post-hole [4306], context 4304, Workshop 15.

SF1007 Near-complete sub-oval low bun-shaped upper rotary quern stone produced from densely bonded garnet-rich mica-schist. One section of the edge is missing, resulting in its sub-oval shape; it would originally have been more circular in plan. Shallow collars encircle both the feeder pipe (D 52mm, collar W 18mm) and the vertical handle socket (D 27mm, collar W 31mm). The collar surrounding the feeder pipe creates a narrow, shallow hopper whereas the one around the handle socket has little functional use apart from giving the handle a little extra reinforcement. The grinding face is pitted and polished in patches from use, with a small narrow angled pecked band (W 17mm) encircling the feeder pipe and a shallow conical hollow (D 14mm) on the grinding face positioned directly under the handle socket on the upper surface. The purpose of these features is unclear but it is possible that the grinding face was originally designed to be the upper surface. D 380 T 80mm. Fill of cable trench, context 712, House 4. (Illus. 6.16)

Cobble tools

All of the cobble tools from Culduthel have been produced from local water-worn or rounded cobbles, sourced from local riverbeds or naturally occurring glacial erratics. None display any evidence of modification prior to use, with one possible exception (SF0413). Classification of tool types here is based on the nature of the wear, following the scheme used in the Howe report (Ballin Smith 1994, 196; Table 6.12). This approach is not without problems as it describes wear rather than function, and more experimental work is required to understand these tool types more directly. In addition, different stone types will wear differently due to their varying properties, and many tools display combinations of wear patterns indicating a range of functions. These are discussed after consideration of single-function tools.

Grinders

SF0209 Thin, naturally curved sub-square flake of arkose, formed from exfoliation weathering of a larger cobble. All four edges are irregular and fractured. One rounded edge and corner has been abraded from light use as a grinder. L 106 W 89 T 15mm. Possible wall base/collapse, context 796, House 3.

SF0495 Flattened spherical waterworn cobble of quartzite/psammite. The surfaces are weathered throughout, making identification of any wear difficult. One slightly smooth, flattened area may be the result of abrasion (29.5 × 26mm). L 91.5 W 85 T 40mm. Occupation deposit, context 2198, House 10/3.
(See also SF0223 and SF0477)

Pounders

SF09 Flattened ovoid quartzite cobble with a small oval pitted facet (46 × 18.5mm) on one edge towards one broad rounded end. L 100.5 W 89 T 70.5mm. Fill of post-hole [085], context 083.

SF0219 Flattened ovoid quartzite cobble with a band of light pitting (W 13mm) present around three-quarters of the circumference. L 83 W 78 T 57mm. Topsoil derived deposit sealing House 3, context 725.

SF0421a Possible pounder. Coarse psammitic schist cobble, the edges pitted throughout, possibly the result of use. L 107 W 81 T 57.5mm. Post-abandonment/decay deposit overlying House 10/3, context 1671.

(See also SF0206, SF0223, SF0477 and SF1032.)

Smoothers/polishers

Both smoothing stones and (more rarely) whetstones show surface smoothing and staining; they are differentiated here by the concavity of the surface as an indicator of whetting. This follows the criteria adopted at Dunadd, where a large number of smoothing stones/polishers were found (Lane and Campbell 2000, 178, 179, 185). The light polish and/or organic staining are interpreted as arising from animal fat used in hide processing.

SF0323 Small ovoid rounded cobble of dark-brown microdiorite. The surfaces are very smooth with a slight sheen throughout. One surface has become flattened and highly polished from use. L 71.5 W 58 T 45.5mm. Fill of pit [1863], context 1862.

SF0335 Ovoid quartzite or psammite cobble, with smooth rounded surfaces. The shape of the stone is unmodified but both rounded sides and ends are heavily stained, possibly from use. This is very similar to SF0757. L 96 W 59 T 39mm. Ring-ditch of House 4, context 1920 (1924).

SF0432 Small flattened ovoid quartzite pebble with one rounded and one dished face, both of which are smoothed and slightly polished from use. Patches of dark staining are associated with this use-wear. L 66 W 56.5 T 33mm. Post-abandonment/decay deposit overlying House 10/3, context 1671.

SF0529 Ovoid microgranite cobble, surfaces severely weathered throughout. In contrast to the rest of the stone is a small oval area of light abrasion and smoothing (40 × 31mm), possibly the result of use. L 83 W 75 T 61mm. Fill of outer ring-groove [1763], context 1764, House 10/3.

SF0757 Flattened ovoid psammitic schist cobble. The rounded edges and ends are smoothed and stained through use. Slight traces of abrasion are associated suggesting extensive wear. L 91.5 W 67 T 34.5mm. Fill of post-hole [4089], context 4090.

SF1224 Waterworn quartzite pebble, with one smoothed, slightly polished surface from use. L 49 W 45 T 33.5mm. Occupation deposit, context 2198, House 10/3.

(See also SF477 and SF1033.)

Multifunction tools

SF0223 Pounder/grinder. Flattened ovoid granite cobble with a small oval flattened pitted facet (49 × 41mm) at one end. The cobble is cracked and fractured from subsequent use as a pot-boiler. L 109 W 87 T 61mm. Secondary fill of post-hole [927], context 929, House 3.

SF0413 Whetstone/working surface or pounder. Flat ovoid psammitic schist cobble with rounded edges. Both faces are flat and smooth, one slightly dished from use as a whetstone. Many of the edges are pitted, either from use as a working surface or light pounder. A small flattened band of abrasion is present on one edge, suggesting that the edges had been shaped prior to use, but is now obscured due to secondary pitting. L 105.5 W 59.5 T 20mm. Post-abandonment/decay deposit overlying House 10/3, context 1671.

SF0477 Smoother/pounder/grinder. Ovoid quartzite cobble, one slightly concave face smoothed and stained from use, probably as a smoother or rubbing stone. One wide rounded end has an oval concentration of distinct peckmarks (27 × 20.5mm). The opposite blunt narrow end is slightly abraded from light use as a grinder. L 86.5 W 77 T 53.5mm. Main fill of ring-ditch [2215], context 2155, House 10/3.

SF1032 Whetstone/sharpening stone/pounder. Elongated ovoid coarse sandstone cobble, all surfaces modified by wear and severely heat-affected. One irregular rounded end has an oval faceted area of peckmarked wear (40 × 28mm) from use as a pounder; the opposite end has been lost. Both faces and edges are smoothed and abraded from use as a whetstone, particularly one face that has become severely dished from extended use. Overlying the whetting on one edge is a closely grouped series of parallel and overlapping linear sharpening grooves (23 × 22mm). L 93 W 45.5 T 30.5–26.5mm. Context 1110, Workshop 12. (Illus. 6.18)

SF1225 Smoother/working surface. Small ovoid microgranite cobble with patches of dark-brown and red-brown staining on one edge and adjacent face suggesting light use as a smoother. In the centre of the opposite surface is an irregular, indistinct narrow band of pitting running across the length of the stone, possibly from expedient use as a working surface. L 78 W 51.5 T 31mm. Cut of post-hole/pit, context 1882, House 10/3.

Whetstones

SF0244 Flat elongated rectangular siltstone cobble with naturally rounded corners. One surface is flat and fairly smooth, possibly from use, but is obscured by specks of dark-brown residue. This residue is present on all surfaces but is concentrated on the possible worked surface. L 162 W 48.5 T 24mm. Fill of pit [918], context 919, House 3.

SF0247 Fragment of a flat rectangular dark-brown siltstone whetstone with a small biconical perforation at the centre of one squared end that has been deliberately shaped by abrasion; the other end has been lost. Both faces and edges are slightly dished and polished from extensive use. L 59 W 15–19 T 9mm. Upper fill of pit [1615], context 1616. (Illus. 6.18)

(See also 413 and 1032.)

Tools: sharpening stone

SF0329 Irregular flat sub-rectangular fragment of microgranite, broken from a larger rock or outcrop. Two surfaces are weathered; one slightly convex face has a closely grouped series of seven diagonal, parallel incised sharpening grooves, varying in length (L 63–108mm) but consistent in thickness (2.5–3mm) and depth (1mm). L 197 W 126 T 58mm. Post-abandonment/decay deposit overlying House 10/3, context 1671.

(See also 519, 670a, and 1032.)

Grinding and working surfaces

SF0238 Grinding surface. Flat triangular slab of microgranite, broken from a larger natural slab. The edges and one face are irregular but unworked. Although slightly uneven with no obvious attempt to flatten prior to use, the other surface is smoothed and lightly polished in patches from abrasion. This polish has been cut through in places by small irregular peckmarks, indicating expedient use as a working surface. L 175 W 142 T 28.5mm. Fill of post-hole [958], context 959, House 3.

SF0317 Grinding surface. Large flat irregular sub-rectangular slab of fine-grained granite detached from a larger boulder or outcrop. Little attempt has been made to shape the stone beyond unifacial trimming of the ends to the desired length. One naturally smooth face has been smoothed and abraded with associated light polish. L 350 W 285 T 64mm. Stone tumble/wall base within ring-ditch, context 1822, House 4.

SF0464 Working surface/mortar. Large irregular microgranite erratic boulder showing little modification to the stone prior to use. Despite the uneven face, one surface has been smoothed, perhaps from use as a grinding surface, creating a slightly dished, highly polished surface. This is overlain with distinct but irregular, dispersed peckmarks from use as a working surface. The opposite

Table 6.12
Range of wear identified on the grinding and working surfaces from the site

SF no.	Context	Grinding	Pounding	Sharpening	Polish	Mortar	Heat-affected
238	959	×	×		×		
317	1822	×			×		
464	2308	×	×			×	
519	1853		×	×			
599	2902		×			×	
670a	3655	×	×	×	×		
1226	629	×			×		
1227	2165	×					×

face is naturally smooth with a distinct circular peckmarked hollow (57 × 51mm, *c.*17mm deep) towards one uneven edge, which is surrounded by an irregular spread of small distinct peckmarks, perhaps indicating use as a mortar. L 405 W 237 T 102mm. Fill of post-hole [2306], context 2308, Workshop 16.

SF0519 Working surface. Sub-rectangular microgranite boulder with naturally rounded corners and irregular surfaces. One face is severely fractured and pitted with frequent sub-circular and angular scars from detached flakes, suggesting that the surface has been subjected to heavy blows. Irregular but distinct circular peckmarks (D 2–4mm) are also present, some cutting through the flake scars. A series of six parallel and overlapping diagonal linear scores (L 16.5–49mm, W 2–2.5mm), possibly sharpening grooves, are present on the same surface, concentrated at one rounded corner. L 286 W 160 T 191mm. Remains of a wall base, context 1853, House 10/3.

SF0599 Working surface. Flat triangular fine arkosic sandstone block, the shape unmodified prior to use. One surface is naturally pitted and hollowed due to the erosion of softer mudstone darts within the sandstone matrix. In addition to the natural hollows, there are four man-made pecked circular hollows, three of which centre on and take advantage of natural mudstone inclusions. Three of the hollows are arranged in a row across the length of the stone, being 32mm, 42mm and 25mm in diameter respectively. A slightly more irregular hollow (25 × 18mm) is present at one rounded corner and peckmarks are present on the edge of a further natural dart hollow on the opposite corner. L 242 W 213 T 76.5mm. Packing within post-hole [2900], context 2902, Workshop 13.

SF0670a Working surface. Large flat irregular fine sandstone slab cleaved from a larger block along the bedding plane. The basal surface appears freshly broken but the opposite face shows smoothing from abrasion, possibly as a grinding surface/whetstone with a light sheen in patches. Cutting through this polish are a series of linear sharpening grooves (*c.*L 150mm, W 2mm) of which two are more distinct due to repeated use. Distinct peckmarks and gouges are irregularly distributed across the working face; one peckmark cuts across the sharpening grooves, suggesting that this was the latest use of this tool. L 275 W 272 T 16–51mm. Packing stones in post-hole [3653], context 3655.

SF1226 Grinding surface. Angular corner fragment from a sub-rectangular felsite/microgranite block with one squared end and edge remaining. One face is flat and smooth with a slight sheen from use. L 101.5 W 57.5 T 48mm. Fill of isolated post-hole [600], context 629.

SF1227 Working surface? Flat sub-rectangular slab of psammitic schist, highly fire-cracked, particularly on one face. Both ends and one side have been lost and the angular fractures suggest this is due to heat exposure. One face is slightly convex on both planes and smooth throughout with a concentration of dark staining in the centre of the face. The staining is sub-circular, suggesting it was formed by an object being placed on it. L 200 W 115 T 45mm. Waste deposit to the north of Hearth [2166], context 2165.

(See also SF0204–6, SF0235, SF0413, and SF01033.)

Miscellaneous cobble tool fragments

SF1228 Tool fragment. Small angular fire-cracked fragment of a microgranite cobble with a small smooth patch of light abrasion remaining, possibly from use as a rubbing stone or smoother. L 55 W 40.5 T 26mm. Ash fill of furnace [3790], context 3467.

SF1229 Tool fragment. Fire-cracked fragment from a coarse-grained microgranite or felsite cobble. Only one face, dished from use, and one rounded edge remains. This is likely to be a saddle quern or grinding surface fragment. L 86.5 W 36 T 53.5mm. Ash fill of furnace [3790], context 3467.

Household items

Pivot stones

SF0725 Flat irregular slab of biotite schist with mica-rich and quartzo-feldspathic layers. One edge is naturally rounded with two small indistinct circular pecked facets (D 17mm), the function of which is unclear. The naturally flat surfaces of the stone show no evidence of modification prior to use; one has a small shallow pecked hollow (D 39mm) adjacent to the straight broken edge. The interior of the hollow is smoothed, suggesting use as a pivot stone. L 313 W 234 T 74.5mm. Paved surface within House 10/3, context 1975.

Perforated stones

Three fragmentary perforated stones are present among the assemblage. Due to the lack of distinguishing features and their fragmentary condition, it has not been possible to identify their function. It is possible that they may have functioned as weights for holding down roofing material, loomweights or other household functions.

SF0527a Flat sub-square fragment of coarse talc biotite schist. Only one original face is present and all edges are broken, one with the remains of a perforation (D 29mm) seen in section. L 141 W 138 T 48mm. Occupation deposit to the east of House 10/3, context 1896.

SF0527b Very fragmentary perforated slab of biotite schist. Both surfaces have been lost and only one rounded edge remains. A well-formed drilled perforation (D 16mm) can be seen in section on the broken edge. L 195 W 121 T 60mm. Occupation deposit to the east of House 10/3, context 1896.

SF0842 Small irregular angular fragment of psammitic schist with the remains of a biconical perforation (D 37mm) seen in section on one broken edge. Only one small section of original edge and surface remain. The distance from the remaining edge to the perforation makes it unlikely that this is the feeder pipe or handle socket of a rotary quern. L 141 W 106 T 54mm. Fill of post-hole [4330], context 4331, Workshop 15.

Personal items

Shale bead

SF0822 Annular oil shale bead, tapered in section, with a central drilled perforation (D 3.5mm). The faces are barely modified, with only some abrasion to smooth them, but the edge is highly polished with evidence of wear and use, including edge-flaking in one area. Given this, the unprepared state of the faces implies not that the object was unfinished but that they were hidden in use, since only the polished edge was seen when it was worn in a necklace; the tapered section is also consistent with a necklace, to fit better on a curve. The surface and signs of laminar cracking are consistent with oil shale. D 18, T 5.5–9.3mm. Hillwash, context 3720. (Illus. 6.18)

Other

SF0505 and **SF0506** Basin. Two joining fragments of an incomplete sub-rectangular basin with rounded ends, produced from a large block of coarse tectonised granite. The edges and ends have been carefully shaped, with large peckmarks remaining from manufacture. The basal surface is fairly angular and only initial shaping appears to have been attempted. The hollowed basin is sub-rectangular with rounded ends and steep pecked sides (L 455 W 160–220mm). The large feldspar crystals are slightly rounded towards the base of the hollow but not planed-off as would be expected if used as a quern or knocking stone. L 480 W 400 T 140mm. Remains of a stone wall, context 2456, Workshop 11. (Illus. 6.15)

SF0584 Spindle whorl roughout. Flat, angular fragment of fine sandstone or siltstone, very roughly flaked around three-quarters of the circumference in an initial attempt to shape. In the centre is a small biconical bored perforation (D 4.5–10mm), which is surrounded, on both faces, with a series of intersecting incised lines. They appear to mark out the intended position of the perforation rather than being an attempt at decoration. L 67 W 52 T 13.5mm. Post-pipe within post-hole [2873], context 2874, House 10/3. (Illus. 6.18)

SF0747 Palette fragment. Curved edge fragment from a thin stone disc, representing approximately 20% of the original palette, possibly used to grind pigments or other substances. Both surfaces have been flattened and smoothed prior to use. This appears to have been attempted with more care and success on one face, suggesting that only one surface was prepared for display and use; the thickness of the disc is uneven as a result. The remaining edges have also been abraded smooth. D 85–90 T 5–7mm. Post-pipe within post-hole [2869], context 3973, House 10/3. (Illus. 6.17)

The geology of the coarse stone artefacts

Fiona McGibbon

The geological setting

The 1:625,000 geological map (north sheet) shows the Culduthel site to be in an area of potentially outcropping Middle Old Red Sandstone strata. Such lithologies would typically be unmetamorphosed sedimentary rocks, specifically buff and grey sandstones and siltstones know as Caithness Flags, and indeed the 1:10,000 sheet confirms the presence of flaggy sandstones and thin silty mudstones in the area. These Devonian rocks have been deposited unconformably onto a complex metamorphic basement of metasedimentary Moine Supergroup rocks. The Moine rocks are exposed to the east and south-east of the site across a vast belt and comprise a wide range of rock types (summed up on the map as undifferentiated schists and gneisses), mainly schists and quartzites with intrusions of granite and diorite, which themselves are texturally complex depending on the timing of intrusion relative to the deformation history of the Moine rocks. The hardness contrast of the Devonian and Moinian rocks is responsible for the topographic contrast of this low-lying coastal site and the highland areas surrounding it. This geological setting will result in a wide range of lithologies potentially outcropping in the general area of the site.

A more specific description of the Moine follows and is included as it so perfectly describes many of the querns examined. The Moine are schists and pelitic gneisses that had their origins as bands of muddy and sandy sediments. They consist of 'Coarse flaky gneiss with wavy corrugated folia of felted black and white mica in large plates and filled with strings, lenticles and knots of quartzo-feldspathic material along the planes of foliation. The rock is also characterised in many parts by large rounded plates or spangles of muscovite at various angles to the bands of felted mica' (Horne and Hinxman, 1914). In finer grained varieties the quartz and feldspar component decreases or entirely disappears and the rock passes into a flaggy biotite or biotite/muscovite schist. Garnets are generally abundant, especially in the coarser grained rocks.

Topographically the Culduthel site lies in the coastal plain about a mile from the course of the River Ness. Such a low-lying area is unlikely to have much outcropping rock but would have been blanketed by glacial deposits as well as alluvial deposits from the nearby river. Inspection of the 1:63,360 series solid geology and drift maps show the area to be covered in boulder clay and undifferentiated drift. Glaciation in this part of Scotland has a long and complex history with three distinct phases of advance and retreat. At times this has been the site of large confluent glaciers such that material could have been glacially transported into the area from several directions although the overall general trend of glacial transport was from south-west to north-east. Glacial deposits in the area are up to 20–50 feet thick and are described as typical yellowish clay with boulders chiefly of Moine schists but also containing igneous rocks (e.g. granite and diorite) as well as Old Red Sandstone materials and clasts derived from Devonian conglomerates. This thickness will have been extensively reworked by glacio-fluvial and laterally fluvial action redepositing material according to the current topographic dynamic. Suffice to say, the early inhabitants of Culduthel would have had a wide variety of materials to choose from in the local drift deposits that surrounded them.

Discussion of the artefact lithologies

Eighty-seven stone items were inspected (some of which were natural and unworked) and are described within the archive catalogue. The most significant observation is that despite the large number of items and their lithological variety, all are expected rock types likely to be available locally in the fluvial and glacial drift deposits and are typical of glacial debris seen elsewhere in the Highlands. From a geological perspective the worked items can be sub-divided into three groups: larger items (querns and rubbing stones), cobble tools, and whetstones.

The rotary querns were almost exclusively crafted from schist slabs. Although five specific schist mineralogies were distinguished, they all share similar properties in being rich in large platy micas and all are likely local Moine rocks. The textural variety and mineralogical types of schist match that described earlier as being typical of the region. Schists are metamorphic rocks that are mineralogical transformations of layered sedimentary rocks, usually meaning that they change mineralogy and hence physical properties on a small scale. Many slab-like rotary querns have this quartz-rich and quartz-poor layering, with the more quartz-rich layers showing better mineral bonding and hence strength. Some schist querns that seemed made from entirely inappropriate materials when the top surface was examined, in fact had a quartz rich layer (effectively quartzite) on the grinding surface. This lithological variation within the schistose querns probably resulted in a limited lifespan for their use. It appears that many schist slabs were chosen and fashioned into querns with this more quartz-rich layer on the grinding surface, which was like a thin layer of quartzite, a rock type with excellent grinding properties. When this layer was worn away however, the more micacious lens would have been exposed, rendering the stone quite useless. This might explain the large number of querns in that the lithological variation eventually rendered an ideal stone useless. In some cases the useful surface might now be entirely absent, leaving the impression that very poor choices had been made. Even so, there would have been a great deal of mineral debris added to the flour and there is evidence of whole plucked garnet grains on some grinding surfaces. This shed material would have caused serious dental attrition. On the whole, schist seems far from ideal material for quern stones and it seems that this has been used due to local availability rather than appropriateness, even though attempts were clearly made to make the most of this material. It is likely that the slabs of schist were found lying detached in the local environment rather than quarried from outcropping rock although without ground truth this cannot be confirmed. The use of these non-ideal lithologies when a thicker quartzite slab or even sandstone slab might have been available not too far distant, suggests that only immediately local materials were used.

The textural heterogeneity of schist means that use wear will also be heterogeneous and needs to be interpreted with caution. In other words, a grinding surface that has quartz-ofeldspathic layers intermingled with more micaceous layers is likely to show heterogeneous wear with the well bonded quartz-rich layers able to take on a polish while the schistose micaceous zones are more prone to mineral loss due to this same abrasion. This leaves the use surface with alternating zones of rough and smooth finish.

One quern stone (SF0471) seems to be of a superior lithology and is considerably better shaped. Many others are talc rich and this may be a lithology that was exploited intentionally as this mineral would have had a lubricating effect on the grinding surface. The saddle and trough querns are less numerous but of the five mentioned only one is schistose, the others being of more homogeneous materials such as granite and granodiorite with one of arkosic sandstone. These more robust materials also dominate the rubbing stones. This material is likely to be available locally but as boulders rather than slabs. Granite is an ideal lithology for querns and given its likely local availability it is surprising that none of the rotary querns are fashioned from this material. It seems likely that it was unavailable in a useful shape, the flat slabs of schist being the easiest, most abundant local option.

The stone tool assemblage is dominated by water worn pebbles and cobbles. These would be abundantly available in the local environment in glacial drift, local river systems and their associated alluvia. As such, the assemblage is likely to be dominated by the lithologies that characterise these deposits. Without ground truthing it is impossible to state how the artefact assemblage compares to the lithological diversity of locally available pebbles and cobbles, but it can be said that the worked cobbles are of rock types that typically dominate such sources. These are dominated by robust rock types with well-bonded mineral grains such as quartzites and fine-grained igneous rocks such as felsite and microgranite that are strong enough to persist in an aggressively erosive environment. More than 50% of the stone tools examined were quartzites or psammites (a closely related and similar rock type), the remainder being fine-grained igneous rocks (microgranite, felsite etc.). As such, the stone tool assemblage also looks to have been entirely locally derived. The assemblage shows a clear preference for quartz-rich lithologies such as quartzite, a trend seen at sites across Scotland. Cobble shapes varied, and with a wide selection to choose from were probably picked to suit the use and user.

Of the four suggested whetstones two are siltstone, a rock type not seen in other artefact subsets at this site. This material is potentially local and should be abundant. It is an ideal whetstone lithology and again it is most likely that shape also played a major role in its selection as it is likely to be found as rod-like blocky pieces in the local drift.

Conclusions

In conclusion, a wide range of lithologies are represented in the artefact assemblage. All seem to have been sourced locally and most likely were picked up in the local environment rather than sought out and quarried from outcrops. Querns were fashioned from slabs of schist most likely lying loose, and an attempt was made to find slabs that had quartz-rich layers to be oriented as the grinding surface. Hand-held stone tools were chosen from locally available pebbles and cobbles that would have been abundant at this site near the course of a major river surrounded by thick glacial deposits. Among this subset, quartzite has been favoured and must result from active choice of this material as well as its local abundance. Whetstones have been made from rod-like stones and siltstone was preferred. This shows a familiarity with local materials and an astute knowledge of their properties and appropriateness for particular purposes.

Part C

Metal

The manufacture of iron at Culduthel: ferrous metalworking debris and iron metallurgy

David Dungworth and Dawn McLaren

Overview

The excavations at Culduthel have produced a nationally significant assemblage of ferrous metalworking waste, comprising over a third of a tonne of slag and associated vitrified debris. The significance of the material lies not only in its quantity, which represents the largest volume of iron slag to be recovered from a well dated, recently excavated Iron Age site in Scotland, but also because of the direct association of much of the material with in situ furnace and hearth features. The range of debris identified is comprehensive and indicative of all stages of ironworking, from the reduction of ore to bloom within smelting furnaces, and the processing of bloom to object by smithing. Scientific and morphological analysis have allowed us to query the traditional interpretation of certain aspects of the process, notably in identifying variant forms of hammerscale, typically associated with smithing, which in fact came from smelting. One very intriguing and significant missing component within this assemblage is ore. It is assumed that bog ore would have been exploited in this area, yet not a single piece of either bog ore or ferruginous rock was identified. Material thought to be ore was collected on site, but it turned out not to be – one stone, believed to be ore on collection, has no viable iron-rich minerals. The quality of the resulting metal was very high, with natural steel being produced.

The majority of the slag was recovered from a single area within the settlement, the area to the east and south-east of House 10/3, which appeared to form the main focus for craft activities on the site. Manufacture was not restricted solely to ferrous metalworking but included glassworking and non-ferrous metalworking. The siting of smelting furnaces within roundhouse structures is repeatedly observed and suggests that these buildings were workshops.

An additional assemblage of ferrous metalworking debris was recovered from subsequent excavations at Culduthel Mains Farm (Headland Phases 7 and 8). Unlike the vitrified material that is the subject of this contribution, the Phases 7 and 8 slag was all from secondary contexts and has been dated to the Early Historic period. However, the technology represented was essentially the same.

This report surveys the technological background of the iron bloomery process and outlines the typical products, before discussing the methodology of this study. The morphological classification of the material is then presented, followed by the results of scientific analysis of slags, microslags, bloom and iron artefacts. The distribution and taphonomy of the material are then interrogated to assess the activities taking place in different areas, whether primary smelting and smithing, secondary dumps and spreads, or reuse. Finally, comparative material is drawn into the discussion, and the significance of the assemblage is synthesised.

Technological background

There are several aspects of the Culduthel slag, in particular their morphology and their chemistry, which require careful consideration. It may be helpful to rehearse some of the previous research into comparable assemblages. Before the introduction of the blast furnace into Britain at the end of the 15th century, all iron appears to have been manufactured using a single-stage, direct process in which iron was smelted but not melted (Bayley et al 2001). This process is usually known as the bloomery process (the raw product resembled a bloom or sponge) although there were undoubtedly several different bloomery processes (Paynter 2007a). Understanding the exact nature of the bloomery process employed on a particular site is hampered by the fact that iron smelting furnaces almost never survive to their full height and may not contain in situ residues. In addition, most metalworking debris (in particular the slag) is usually found in secondary contexts such as pits and ditches. Nevertheless, slags are often the most useful evidence for ironworking due to their durability. The size and shape of lumps of smelting slag preserve traces of the ways in which they formed, flowed and solidified. The formation of a fluid slag was essential in order to separate the impurities in the ore from the solid bloom. Some types of slag (and the associated processes) are well known while others are poorly understood.

Iron smelting furnaces (and the slags produced by them) are usually divided into those in which the slag was tapped from the furnace (and solidified as ropey sheets of tap slag) and those in which the slag remained at the base of the furnace (Paynter 2007a). In Britain, tap slags are common from Roman and later medieval iron smelting sites but are rare on prehistoric and early medieval sites. If slag was not tapped, then it would have to collect at the base of a furnace and remain there until the end of the smelting process. The most distinctive slags from these furnaces are large (>50kg) furnace bottoms (Halkon and Millett 1999; Paynter 2007a); however, not all non-tapping iron smelting sites yield large furnace bottoms (e.g. Crew 1987; Dungworth 2011). The most distinctive slag from these iron smelting sites tends to be a form of flowed slag that displays signs of vertical flow (unlike tap slag, which shows signs of horizontal flow). Such iron smelting sites also produce some plano-convex cakes of slag but these are often porous and can resemble the plano-convex cakes of slag produced in a smith's hearth. The reasons why some non-tapping furnaces produced large furnace bottoms while others produced small cakes and flow slag are uncertain. It is possible that the differences in slag morphology relate to the size of the furnace employed; a small furnace would produce small volumes of slag while a large furnace would produce more slag, which could then form a large furnace bottom. Alternatively, the differences in the slag morphology might be due to differences in the ore used: a relatively poor ore would yield more slag while a very rich ore would produce much less slag.

While many bloomery sites have been identified in the Highlands of Scotland (e.g. MacAdam 1887; Aitken 1970; Photos-Jones et al 1998), few have been excavated and even fewer of these dated. MacAdam (1887, 90–1) identified three types of slag found at the sites he surveyed: 'cinder which is poorly fused'; 'dense and compact' slag; and 'fused and glassy' slag. The description of the first type of slag bears many similarities to the various types of slag from non-tapping furnaces, in particular slag cakes. MacAdam's second type of slag may be tap slag and the third type probably represents blast furnace slag. Aitken's excavations recovered examples of tap slag (Aitken 1970, pl. 18) as well as non-tapped slags. The latter included what are likely to be slag cakes: 'Close search discovered the hearth. Although it had been badly damaged it still retained a half sphere of slag within the bowl' (Aitken 1970, 194, see also pl. 18). In addition, much of the slag comprised 'small to fairly large rough cindery masses, sometimes containing small particles of charcoal' (Aitken 1970, 196). The slag collected by Photos-Jones et al from several excavations is described as tap slag; however, it is noted that most lumps were rather small – 'equivalent to a "trickle"' (1998, 23). It is possible that these 'trickles' are the flow slag noted above. Unfortunately, most of these sites remain undated, making the tracing of chronological variations in Scottish bloomery processes (and the slags produced) difficult. In his examination of the middle Iron Age slag from Howe, Orkney, McDonnell identified two types of iron smelting slag (McDonnell 1994). The first comprised randomly shaped lumps, often with a vesicular texture, charcoal impressions and a flowed surface which was described as 'raked' slag, while the second consisted of plano-convex cakes. The assemblage of slag from Culduthel lacks any tap slag but includes some slag cakes, some runned slag and a great many randomly shaped lumps of vesicular slag with abundant charcoal impressions, referred to throughout as unclassified iron slag. The types of slag and the total quantities recovered at Culduthel point to the smelting of iron using a non-tapping process that did not produce large furnace bottoms.

The chemistry of bloomery iron smelting is fairly well understood: only ores containing a fairly high proportion of iron could be smelted, and a great deal of the iron in the ore was effectively lost due to the formation of slag. Most impurities in the ore (such as silica) have such high melting temperatures that they could not be melted without the presence of another material that would lower their melting temperature. In the bloomery process the additional material that fluxes the impurities is iron oxide. Thus, an ore for use in a bloomery needs to provide enough iron oxide to form a slag before any bloom can be formed, explaining why only rich ores were suitable. While the nature of the ore plays an important role in slag formation, smaller contributions are made by the ceramic material used to construct or line the furnace and the ash from the charcoal fuel used to heat the furnace. The chemistry of early iron smelting slags shows regional characteristics that offer considerable potential for the provenancing of iron artefacts through the chemical analysis of the small inclusions of smelting slag that remain trapped in many artefacts (Paynter 2006). A thorough study of a range of smelting and smithing slag was undertaken by Gerry McDonnell, which aimed, in part, to identify criteria that would allow the identification of smelting and smithing slags (McDonnell 1986). McDonnell found that many smelting slags contained significant concentrations of manganese but that element was largely undetected (<0.3wt% MnO) in smithing slags. The presence of manganese in smelting slags reflects the fact that most iron ores contain manganese. Unfortunately, there are some ores that contain negligible amounts of manganese, and the slags associated with these ores also contain little or no manganese. Nevertheless, it is almost unknown for smithing slags to have significant manganese content. However, McDonnell (1994) applied the manganese criterion to slags from Howe, Orkney but found that all slags (including examples that had been identified on the basis of their morphology as smithing slags) contained significant levels of manganese (0.6–3.0wt% MnO).

The nature of the iron produced by the bloomery smelting process varied depending on the type of ore used as well as aspects of the smelting technology and the skill of the smelters. When smelted, ores rich in phosphorus will tend to produce iron, which contains a small but significant proportion of phosphorus. Iron-phosphorus alloys tend be stronger than pure iron and such alloys are common from the Iron Age until the early post-medieval period. Ores with little or no phosphorus could be smelted to produce pure iron or a steel, depending on the skill of the smelter and the demand for the two alloys. The smelting furnace would be operated under reducing conditions and, by manipulating the ratio of ore and charcoal (as well as the rate at which air was introduced into the furnace), the bloom could be made to absorb carbon from the charcoal to form steel. Most bloomery iron also contains a proportion of slag. While this can derive from several sources, one must be the remains of slag that formed during the smelting process and that could not be completely separated from the bloom. This phenomenon is the basis for the idea of provenancing iron through the chemical analysis of slag inclusions (Blakelock et al 2009; Hedges and Salter 1979).

Methodology

During iron production, a range of vitrified materials is produced, as outlined above. These include materials that are diagnostic of particular ironworking processes (e.g. smelting or smithing), those indicative of ironworking but not identifiable to a specific process, and those that could have been produced by a range of pyrotechnic processes and are not diagnostic of ironworking. Only a few categories of slag are traditionally considered to be truly diagnostic of ironworking (for example, tapped slag for smelting and hammerscale for smithing). Significant amounts of material within most slag assemblages are unclassifiable, making the classification of individual pieces, particularly fractured or small samples, to specific types and processes by visual examination alone difficult (Crew and Rehren 2002, 84). Certain classifications of iron slag have been more comprehensively studied and are better understood than others (e.g. plano-convex hearth bottoms and hammerscale), but it would be unwise to claim that all aspects of Iron Age ferrous metalworking technology are equally understood. It was apparent from the initial assessment stage that the slag assemblage from Culduthel had the potential to clarify (and perhaps redefine) some aspects of slag identification and enable a better understanding of aspects of early ironworking. This was due not only to the large quantities of material recovered, but also to the complete range of debris (from smelt to final product) available for study. Apart from one missing component, the ore, the assemblage included samples of all forms of vitrified waste material that one would expect from a later prehistoric ironworking site, from fragments of the furnace superstructure through to part-worked pieces of iron bloom.

Classification of the Culduthel material was based on two stages of examination. The first involved macroscopic visual examination of the slag by Dawn McLaren, categorising the material based on density, colour, morphology, vesicularity and magnetic properties. This examination formed the basis for initial classification of the material and the construction of a detailed archive catalogue to record the details of the assemblage in full. A representative sample of the assemblage was then selected for chemical analysis by David Dungworth to allow the composition of the slags to be identified and compared to the metallurgy of the iron objects from the site. The aim of this analysis was, in part, to test the accuracy of visual categorisation and also to determine whether differences in the composition of the slags could be identified across the site that could indicate use of different ores, technologies, techniques and chronological change. Samples of all the major diagnostic and undiagnostic categories were selected, including waste from both smelting and smithing. In addition, some more unusual pieces were included that were difficult to identify by visual analysis alone. These include possible smithing pan (an accumulation of smithing micro-debris built up on a floor surface within an area of bloom- or blacksmithing), bloom and a possible fragment of tapped slag. The samples selected were chosen from the main areas of the site where slag was present (around cobbled surface 227; the main industrial zone to the east and south-east of House 10/1–3) focusing, where possible, on probable in situ furnace or hearth features. A detailed description of the sampling strategy, preparation and methods of examination and analysis, as well as a full list of results, are included in the archive.

Classifications

A total of 337.5 kg of vitrified material was recovered throughout the excavated area. This quantity includes both bulk slags recovered by hand and residues from soil samples. It should be noted that, due to the exceptional volume of vitrified material encountered in some areas (e.g. context 798), only a bulk sample was collected in the field and retained for study. The total excludes the large quantities of vitrified material (vitrified ceramic furnace lining and unclassified iron slag) that remain fused to the heat-affected stones used to construct the furnaces. The total mass of vitrified material referred to in this report necessarily reflects a minimum quantity only.

The slag has been described throughout using common terminology (e.g. McDonnell 1994; Starley 2000; Bayley et al 2001) and these are outlined below. The majority of pieces were small and fragmentary. However, where discernible they appear to fall into two types: significant quantities of bulk- and micro-slags suggestive of ironworking (both smelting and smithing); and those created during a range of pyrotechnic processes, and not necessarily the result of metalworking (Table 6.13). A full

Table 6.13
Range of diagnostic and undiagnostic debris present at Culduthel

Process	Material type	Mass/g
Smelting	Plano-convex cake: furnace bottom (PCC:FB)	28,011
	Tapped slag (TS)	2,858
	Unprocessed bloom	7,250
Suggestive of smelting	Runned slag (RS)	71,095
	Charcoal-rich slag (CR)	14,971
Smithing	Plano-convex cake: hearth bottom (PCC: PCHB)	17,829
	Hammerscale flakes (HS)	1,954
	Slag spheres (SS)	59
	Smithing pan	459
	Processed bloom	2,219
Undiagnostic of particular process	Plano-convex cake: unclassified	23,346
	Unclassified iron slag (UIS)	81,144
	Slag amalgam (SA)	20,073
	Atypical hammerscale flakes (HS(a))	2,169
	Atypical slag spheres (SS(a))	50
Undiagnostic	Vitrified ceramic (VC)	56,730
	Fuel ash slag (FAS)	989
	Heat-affected stone	1,289
	Magnetic vitrified residue (MVR)	4,779
	Non-magnetic vitrified residue (NMVR)	216

catalogue of the material is given in the archive report (archived as CDF05 at the NRHE).

Smelting

Furnace bottoms

These are large accumulations of slag that form at the base of a non-tapping iron smelting furnace. Like smithing hearth bottoms, these furnace bases are generally plano-convex in shape, having accumulated at the base of a rounded pit within the furnace, and are more generally referred to as plano-convex cakes (PCC). Furnace bottoms (FB) are typically dense accumulations of grey non-magnetic slag with large charcoal inclusions and/or impressions, and can be molten or runned in appearance. Unless the furnace bottom is complete and/or preserves enough of the structure of the cake to identify conclusively, it is difficult to differentiate a fragmentary furnace bottom from smaller fragments of smelting slag. Some of the fragments of furnace bottoms from Culduthel are substantial in size (up to 200mm across, the largest typically 1.5–2.0kg in weight, with one outlier of 5kg); these have large charcoal inclusions and are undoubtedly the result of smelting. Others are much smaller and, as such, can be easily mistaken for smithing hearth bottoms, although as noted above, chemical analysis has some success in differentiating smelting from smithing slags based on high levels of manganese in the former.

Tapped slags

These are formed when the slag is deliberately released from the base of the furnace by a small, pre-formed aperture. When the plug is removed, the slag pours out, sometimes into a deliberately made channel or pit, forming a substantial linear run of dense grey slag or a compact, dense plano-convex cake. Only one possible fragment of tapped slag (TS) was identified from the site (Cat no: C237, SF015; lab no: 1148, context 182). This is a linear asymmetric horizontal run of molten-looking slag, 343mm in length and 160mm in maximum width, weighing 2.8kg. The dimensions and shape of the piece make it unlikely to have formed inside a smelting furnace but its form appears unconstrained or uncontrolled. It is not possible to confirm whether this slag was deliberately 'tapped' from the furnace; it may have been produced accidentally during the opening of the furnace to remove the bloom or due to a rupture of the furnace wall during use.

Unprocessed bloom

This is spongy, highly magnetic red-brown lightly vitrified material. Early furnaces were not routinely able to reach the temperatures required to allow iron to become molten (*c*.1200 degrees). The iron particles that were extracted from the ore formed in a spongy, lightly vitrified mass known as the bloom, typically around the tuyère or bellows hole, which was the hottest part of the furnace. Visually these may look like spongy amorphous masses of lightly vitrified red-brown slag or like a corroded mass of iron, but they can be distinguished from unclassified slag or plano-convex cakes fragments by their high magnetic response.

Smithing

Plano-convex hearth bottoms

These are plano-convex accumulations of hammerscale flakes and slag spheres that form at the base of the smithing hearth. Traditionally, these tend to be smaller in diameter, denser and far more magnetic than cakes formed during smelting (see furnace bottoms above) and have much lower levels of manganese. Charcoal inclusions are less frequent in such slags and where present, they tend to be much smaller in size. Charcoal impressions, particularly on the rounded base of the cakes, are typical. An interesting and significant aspect to the smithing hearth bottom fragments from Culduthel was revealed by detailed chemical analysis. Several of the plano-convex hearth bottoms (PCHB) fragments selected for analysis had unusually high manganese levels, which would suggest that they were the product of smelting rather than smithing. Two scenarios are suggested here: either these small, thin, dense cake pieces are edge fragments from furnace bottoms rather than smithing hearth bottoms; or these are indeed hearth bottoms from smithing but were formed during primary bloom smithing rather than from forging or welding.

Hammerscale

These are small flakes of iron produced by the impact of hammers on hot iron during either the refining of iron blooms or the working of wrought iron. When found in quantities this is indicative of in situ iron smithing. Hammerscale flakes (HS) and spheres (discussed below under 'slag spheres') are traditionally thought of as one of the few diagnostic categories of waste from ironworking, and smithing in particular. At Culduthel, two distinct types of hammerscale were identified: traditional hammerscale (small flakes of iron-rich vitrified material, highly magnetic, varying in size but typically between 2–5mm in length) and atypical hammerscale (large flakes between 5mm and 15mm in length, atypical in size and morphology). This atypical hammerscale was frequently found in association with smelting furnaces and deposits of smelting waste. Chemical analysis of this material confirms high manganese levels consistent with smelting slag, suggesting that this residue either formed in the smelting furnace, or was the product of primary bloom smithing. Much of this material appears to be thin films of slag that have formed between lumps of charcoal in the smelting furnace, rather than being associated with smithing. The compositional characteristics of the traditional hammerscale are similar to other analysed hammerscale (Dungworth and Wilkes 2009).

Slag spheres

These are small spheres ejected as spherical globules of molten slag during iron smithing. When found in quantities this is indicative of in situ metalworking. As with the hammerscale flakes, the slag spheres (SS) from Culduthel were found in two distinct forms: traditional hammerscale spheres (small, magnetic spheres, ranging from 1.5–2.5mm in diameter) that are the residue from iron smithing, and atypical slag spheres, distinguished by their larger size and misshapen form, which are generally unmagnetic or have only very low magnetic qualities. These are often found in association with smelting furnaces and deposits of smelting waste at Culduthel. Chemical analysis of a sample of these atypical residues revealed that the spheres contain elevated concentrations of a range of elements. There are several possible sources of these minor elements, including slag inclusions, furnace lining, flux and fuel ash. The increase in the minor elements in the spherical hammerscale shows closest similarities with the smelting slag.

Smithing pan

Smithing pan (SP) is where hammerscale, slag spheres and other debris (such as charcoal, soil and slag fragments) accumulate on the ground around the smithing hearth and anvil, and can become trampled into a hard layer and fused together with corrosion over time (Bayley et al 2001, 14; Paynter 2007b, 17).

Processed bloom

The iron bloom extracted from the prehistoric furnace cannot be immediately smithed into an object as there are likely to be significant slag and charcoal inclusions retained within it. As the impurities become molten at a much lower temperature than the iron, the bloom requires further heating to try and run off as many of these impurities as possible, and smithing to remove any slag trapped within the interior. The lower the impurities, the better the iron, yet a danger lies in over-working, as repeated heating and hammering can make the iron brittle. Dense lumps of bloom, often indistinguishable from corroded iron without an X-ray, suggest such initial processing, as iron of this density is unlikely to have been produced in the furnace. Many of the bloom fragments from Culduthel have been processed and some bloom offcuts are also present. The bloom fragments analysed were all carbon steels. Where slag inclusions were present they generally had compositions that provided a moderate to good match with the Culduthel smelting slag. The presence of bloom fragments of hyper-eutectoid steel confirms that the smelting process produced carbon steel in a single process (as opposed to the production of plain iron, which would subsequently be carburised). Such direct steel is often referred to as natural steel.

Undiagnostic of particular process

'Runned' slags

These are runs of dense grey slag, typically non-magnetic, liquid or flowed in appearance. Runned slag (RS) can be formed in the lower portion of the furnace where the heat is more intense, allowing the gangue to solidify and flow between and around the charcoal used as fuel. Such runs of slag can take the form of short 'drips' or larger accumulations of molten-looking grey slag. Such 'runned' slags, where found in quantity and comprising sizeable pieces, are typically seen as the debris from smelting, but this is dependent on several factors: the quantity and size of the pieces present; the presence of high or moderate levels of manganese; and its association with other residues indicative of smelting. This ambiguity is caused by the fact that small runs of slag (often referred to as prills) can also be formed in a smithing hearth. The recovery of a limited quantity of small pieces of liquid-looking slag cannot be interpreted as the residues from smelting, unless associated with other evidence diagnostic of the same process.

Charcoal-rich slags

Charcoal-rich, often non-magnetic, red-brown slags cannot be exclusively identified as smelting residues, but their association at Culduthel with significant quantities of 'runned' pieces implies that the majority of the charcoal-rich slags (CS) from the site were produced during iron smelting. These amorphous, often angular fragments, appear to have formed near the top of the furnace, where the heat was less intense. Here the gangue was starting to separate from the ore and had become amalgamated with the dense charcoal.

Unclassified iron slag

Unclassified iron slag (UIS) are randomly shaped pieces of iron silicate slag, probably rake-out material, generated either by smelting or smithing.

Slag amalgams

Slag amalgams (SA) are randomly shaped pieces of slag, including plano-convex slag cakes and hearth lining, which have fused together to form larger masses (McLaren and Heald 2008, 203).

Undiagnostic

Vitrified ceramic (hearth or furnace lining)

Vitrified ceramic (VC) is the clay lining of an industrial hearth, furnace or kiln that has a vitrified or slag-attacked face. The surviving lining is typically heavily burnt and vitrified, often with adhering slag. Often the material shows a compositional gradient from unmodified fired clay on one surface to an irregular cindery material on the other (Starley 2000, 339). Recovery of vitrified ceramic is not indicative of ironworking, but could have been produced within any clay-built high temperature hearth. In addition to the vitrified ceramic discussed here, further quantities of furnace/hearth lining, including possible rim fragments from furnace shafts, have been identified among the fired clay. Also present and discussed separately are several tuyère fragments. A small quantity of the vitrified ceramic from the furnaces appears to be double-walled, suggesting that the furnace was either repaired or relined at some stage, as there are two superimposed layers of vitrified ceramic with slag-attacked faces.

Fuel ash slag

Fuel ash slag (FAS) is formed when material such as sand, earth, clay, stones or ceramics are subjected to high temperatures, for example in a hearth. During heating these materials react, melt or fuse with alkali in ash, producing glassy (vitreous) and porous materials. These slags can be formed during any high temperature pyrotechnic process and are not necessarily indicative of deliberate industrial activity (McDonnell 1994, 230).

Magnetic vitrified residues and non-magnetic vitrified residues

These are mixtures of various types of material, fused together through heat. Two different types were recovered: those that comprised mainly sand, clay, stone and other material and were magnetic (MVR); and those that shared similar constituents but were non-magnetic (NMVR). Although it is impossible to relate these small pieces to any specific process, it is likely that much of the magnetic material was related to ferrous metalworking.

Fuel
Like most other metalworking sites, wood charcoal was used as fuel (McDonnell 1998b, 151). At Howe, Orkney, the predominant fuel used for metalworking was willow charcoal (Ballin Smith 1994, 133). At Wiltrow, Shetland, Curle suggested that peat had been used for smelting (Curle 1936, 153, 155) but as McDonnell points out, there is some question over whether the debris that Curle was referring to was actually residue from smithing instead (1998b, 151).

Micromorphology

Sampling
A total of 45 samples of slag and possible bloom were analysed. Of these, three slag samples and two possible bloom samples were too corroded to allow full investigation. The remaining 40 samples comprised two bloom fragments and 38 slag samples (one of which was tentatively identified as bloom prior to scientific examination but which is actually a slag). Thirty-six samples from bulk slags were successfully analysed. Full detailed results of this analysis are presented in the archive. Twelve samples were also taken from stones or ceramic material used to construct or line furnaces or hearths. A total of 89 fragments of hammerscale were analysed (19 sphere and 70 flake). In two cases multiple hammerscale analyses were carried out on a single sample. In the first case the sample comprised a fragment of smithing pan (a concreted mass of hammerscale and other material that formed on the floor of a smithy). In the second case the hammerscale was found trapped in the corroded surface of a slag sample. The exact formation process for this slag sample is not immediately apparent. Further samples of hammerscale were submitted for analysis but were either too corroded to allow investigation or turned out to be films of smelting slag (referred to henceforth as atypical hammerscale). In addition, 16 ferrous artefacts were selected for scientific examination, including finished artefacts as well as offcuts of iron/steel. Unfortunately, several of these artefacts proved to be too severely corroded and no original metal survived. Thirteen artefacts and five bloom samples proved fit for analysis.

Bulk slags
Most of the bulk slag samples (i.e. all samples except the hammerscale and furnace fragments) show many similarities with other bloomery iron smelting slags (Morton and Wingrove 1969; McDonnell 1986). They all contain varying proportions of the olivine iron silicate fayalite (Fe_2SiO_4). The form of the fayalite varies from large (up to 1mm in diameter) equiaxed crystals, through long, thin plates to tiny (~1 micron in diameter) crystals within the glassy matrix (Illus. 6.19 and 6.20). The chemical composition of the fayalite varied due to the substitution of a proportion of the iron by other elements (magnesium, calcium and manganese).

Most samples contain at least some wüstite (FeO); and in a few samples this is the most abundant phase. The wüstite occasionally has a morphology that suggests it is magnetite (Fe_3O_4). In addition, the iron oxide (wüstite or magnetite) in these samples often shows more than negligible proportions of elements such as aluminium, titanium and manganese.

The mineral hercynite ($FeAl_2O_4$) was present in many samples (Illus. 6.21). The hercynite was present as euhedral crystals up to 100

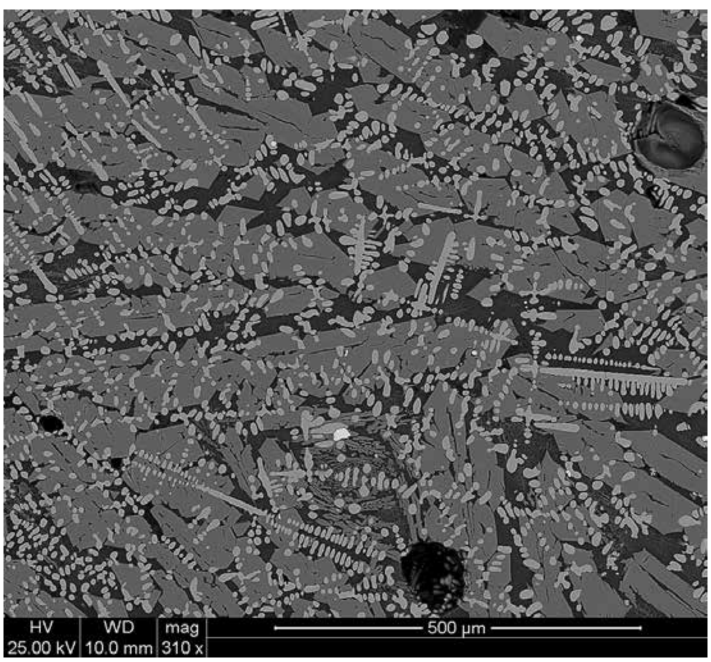


Illustration 6.19
SEM image (back-scattered electron detector) of sample 1139 (slag cake from context 411). The bright globular dendrites are the iron oxide wüstite, the light grey laths are the iron silicate fayalite

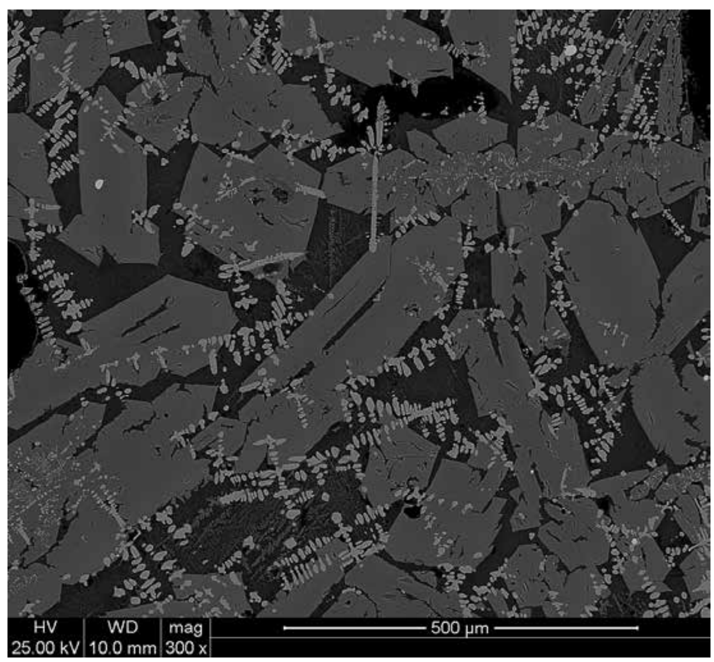


Illustration 6.20
SEM image (back-scattered electron detector) of sample 1148 (large fragment of flowed slag from context 185). The bright globular dendrites are the iron oxide wüstite, the light grey laths are the iron silicate fayalite

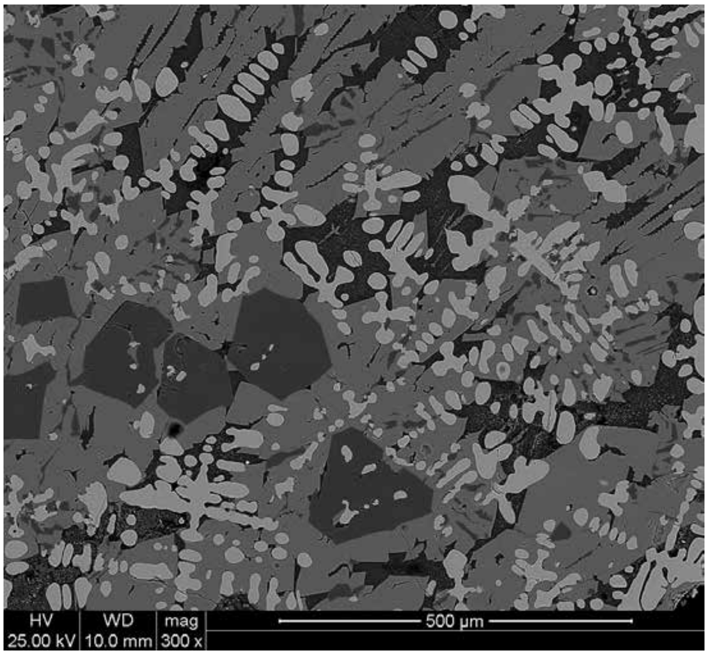


Illustration 6.21
SEM image (back-scattered electron detector) of sample 1157 (slag cake from context 4145) showing wüstite and fayalite as well as several large hercynite ($FeAl_2O_4$) crystals (mid-grey, centre and left)

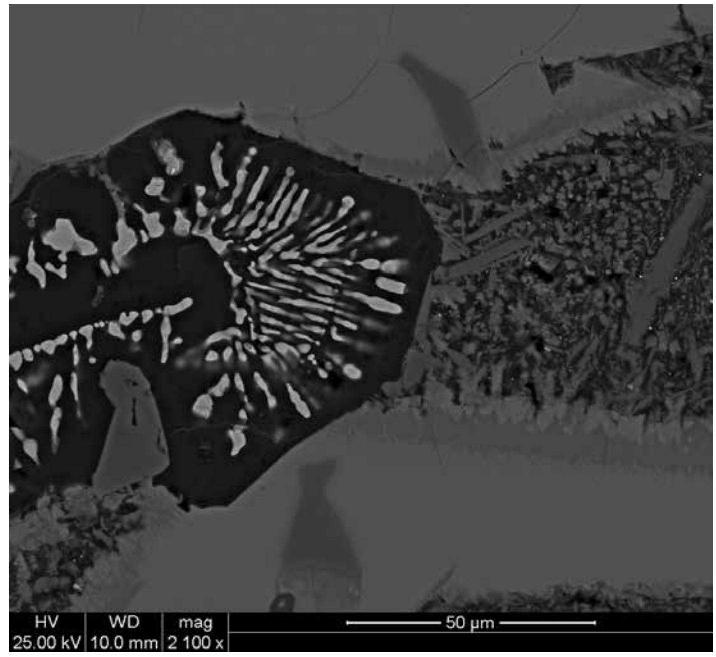


Illustration 6.22
SEM image (back-scattered electron detector) of Sample 1130 (unclassified slag with charcoal impressions and some signs of flow from context 4260) showing a crystal of leucite and leucite-wüstite (centre left)

microns across but could also be seen as much smaller crystals at the margins of fayalite crystals. The hercynite crystals often contained small proportions of magnesium, titanium, vanadium and manganese. In all of these cases the additional elements appear to have substituted a proportion of the iron oxide in the hercynite. Despite there being a solid solution between magnetite, Fe_3O_4, and hercynite, $FeAl_2O_4$, none of the hercynite contained an excess of iron that might suggest the presence of Fe_2O_3 substituting the Al_2O_3.

Leucite ($AlKSi_2O_6$) was present in about a quarter of all samples but tended to be most abundant in the slag cakes. The leucite often contained small amounts of sodium, iron and barium: the former would substitute for the potassium in the leucite but the role of the other two elements is uncertain. A negative correlation between the barium and silicon content, however, suggests that the barium may have substituted for silicon in leucite. Much of the leucite was present as a leucite-wüstite eutectic (Illus. 6.22). Leucite is only usually observed in slags that are rich in aluminium and potassium (Dungworth 2007). Even in slags with moderate aluminium and potassium content, the formation of leucite is often suppressed due to the rapid solidification of the slag. Leucite is largely absent from rapidly cooled slags (such as tap slags), which instead often contain a substantial proportion of a glassy matrix.

Sample 1152/8 (dense slag from a smelting furnace; context 4145) contained additional mineral phases including a calcium-iron pyroxene and several unidentified alkali-aluminium-silicates. The latter included both sodium-rich and a potassium-rich aluminium-silicate but their compositions could not be matched with common alkali-aluminium-silicates.

A small number of unusual microstructures were noted. Several samples contained a very high proportion of iron oxide, such that other phases were almost completely absent (Illus. 6.23). The iron oxides showed varying degrees of substitution by magnesium, aluminium, titanium and manganese. These samples were recovered from several different features and included slags with varying overall morphology.

The areas in between the main crystalline phases in most bloomery smelting slag are glassy, although this glass may contain some small crystals. In many of the Culduthel slag samples, however, what initially appeared to be a glassy matrix was actually composed of an intimate mixture of several different crystalline phases (Illus. 6.24). The small size of these crystals precluded their direct chemical analysis but it is likely that most of them were wüstite, fayalite, hercynite and leucite. The presence of crystalline phases in place of the usual glassy matrix suggests that these slags cooled extremely slowly. Alternatively, the slags may have cooled under typical conditions, leading to the formation of a glassy matrix, but then have been subject to sufficient heat for this to devitrify (crystallise). Whatever the exact mechanism responsible for the absence of the glassy matrix, it is likely that these samples remained inside the furnace for a long period.

Even those samples that contained a glassy matrix often displayed unusual texture (Illus. 6.25). Such micron- and sub-micron-sized droplets are characteristic of microphase-separated glass (e.g. Vogel 2006). Many complex silicates when melted will form two immiscible liquids, and prolonged heating of solid silica-based glass below its melting temperature will encourage the separation of these two phases. Both phases remain as glasses and the separated phase usually forms spherical droplets rather than distinct crystals. Microphase separation is deliberately employed in the modern glass industry but is rarely seen in archaeological materials. Some waste materials from post-medieval glass

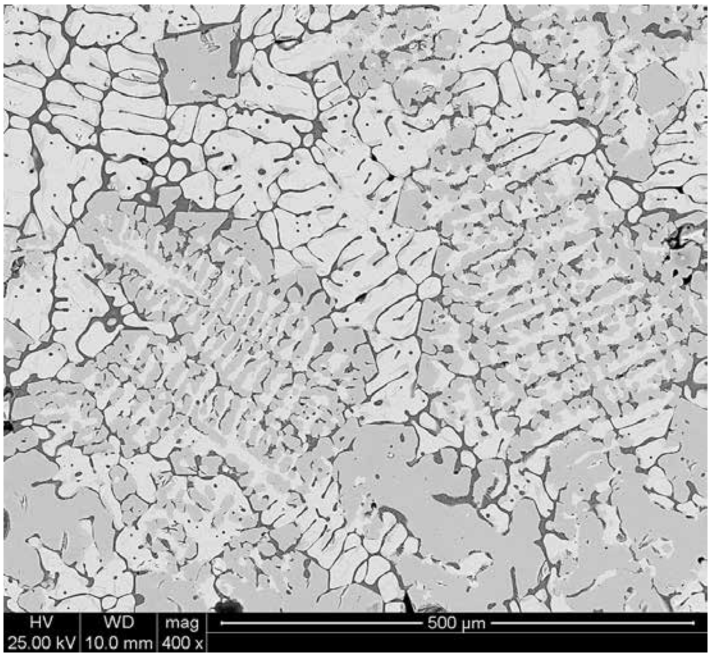


Illustration 6.23
SEM image (back-scattered electron detector) of Sample 1153 (small lump of dense slag from context 3756) showing a microstructure dominated by iron oxides. There are clearly two different types of iron oxide present: the darker phase contains a small proportion of aluminium

production sites display microphase separation and this has been interpreted as the result of prolonged exposure to high temperatures (e.g. glass waste that has fallen into a furnace; see Dungworth and Paynter 2011). Microphase separation is also evident in the vitreous surface of many of the samples of furnace lining from Culduthel (see below).

The Culduthel slags have microstructures that can in most respects be paralleled with previously published investigations of bloomery smelting slags. The range of phases present in most of the Culduthel slags and their size, shape and distribution all point to the rather slow cooling of the slag. This is likely to have taken place within the furnace, a point that is echoed by the overall morphology of the slag (i.e. the absence of tap slag which cooled rapidly when it was removed from the furnace). There were no correlations between overall slag morphology and microstructure.

Furnace/hearth lining

The vitrified ceramic examined consisted of silica-rich clay or rock with vitrified interior surfaces (Illus. 6.26). Clay seems to have been used sparingly to help bond together the stones used to build the furnace walls. Some slightly larger fragments of clay may have been used to build up a superstructure above the stone wall or for specific areas such as the tuyère hole (for discussion of superstructures, see Paget and McLaren Chapter 6, Fired Clay Both the rock and clay samples were strongly affected by exposure to high temperatures that had led to the melting of most of the clay minerals. Most samples contained angular grains of silica (from <100 microns across to several millimetres across), often with severe cracking due to heat, in a vitreous matrix. The silica-rich rock used is likely to have been Old Red Sandstone.

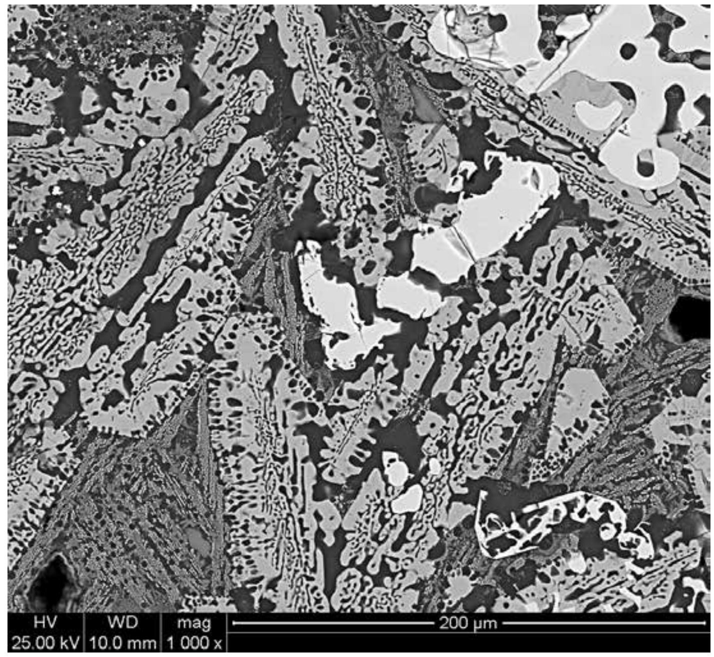


Illustration 6.24
SEM image (back-scattered electron detector) of Sample 1152 (plano-convex slag cake from context 4145) showing the complete crystallisation/devitrification of the glassy matrix

Many of the vitrified surfaces of the clay and stone furnace wall material contained small crystals and/or microphase-separated glass (Illus. 6.27).

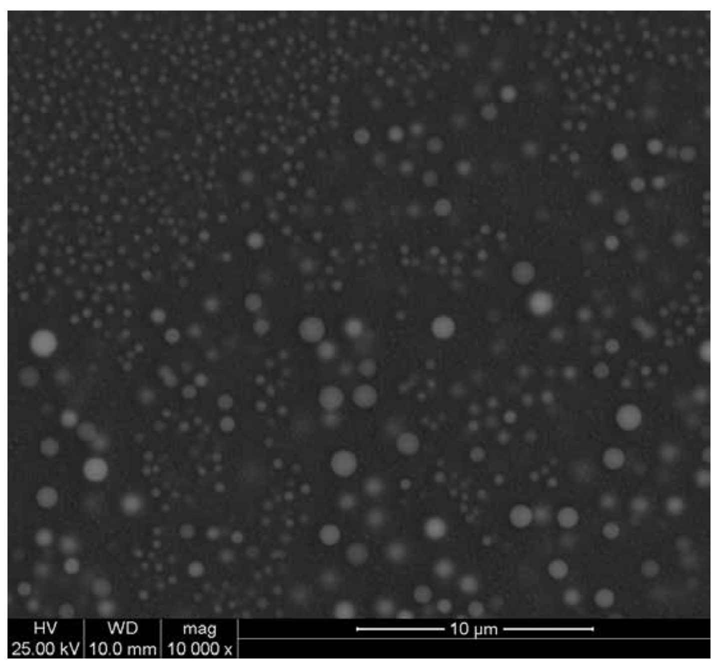


Illustration 6.25
SEM image (back-scattered electron detector) of the microphase separation in the glassy matrix of Sample 1152 (plano-convex slag cake from context 4145)

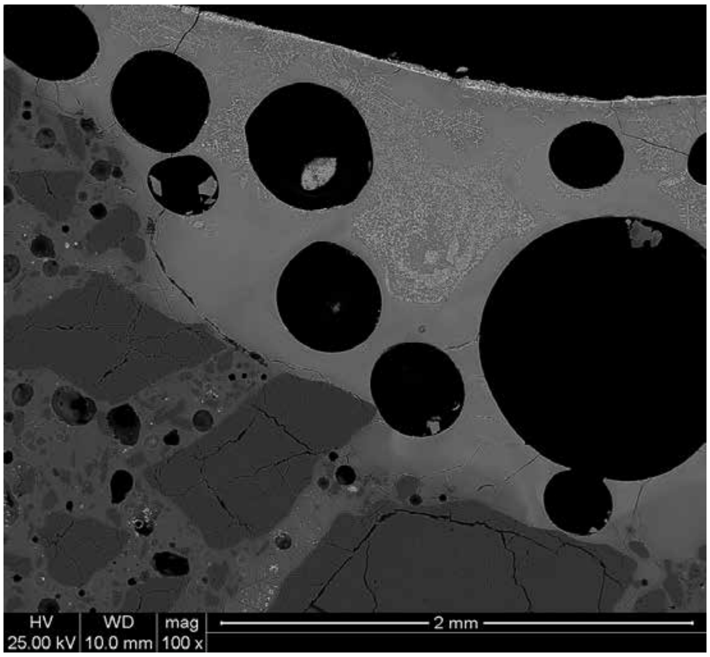


Illustration 6.26
SEM image (back-scattered electron detector) of Sample 1123 (clay furnace wall material from context 4175) showing the vitrified outer surface at the top (containing large areas of porosity (black)) and the underlying ceramic material (containing large angular grains of quartz (dark grey))

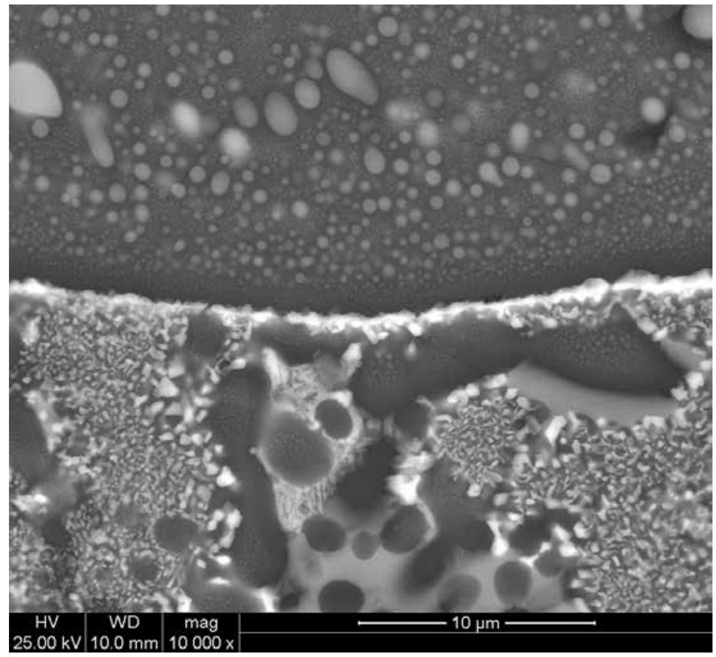


Illustration 6.27
SEM image (back-scattered electron detector) of Sample 1123 (clay furnace wall material from context 4175) showing the microphase separation in the vitrified outer surface

Hammerscale flakes and spheres

The hammerscale samples mainly comprised flake and spheres recovered from soil samples but included a fragment of smithing pan (i.e. a concreted mass of hammerscale from a workshop floor surface). Most of the flakes (Illus. 6.28) and spheres (Illus. 6.29) exhibited classic microstructures comparable with similar material from other sites (cf. Dungworth and Wilkes 2009). The flake hammerscale is composed almost entirely of iron oxides and these often occur in layers (wüstite on the surface closest to the metal on which the flake originally formed with varying proportions of

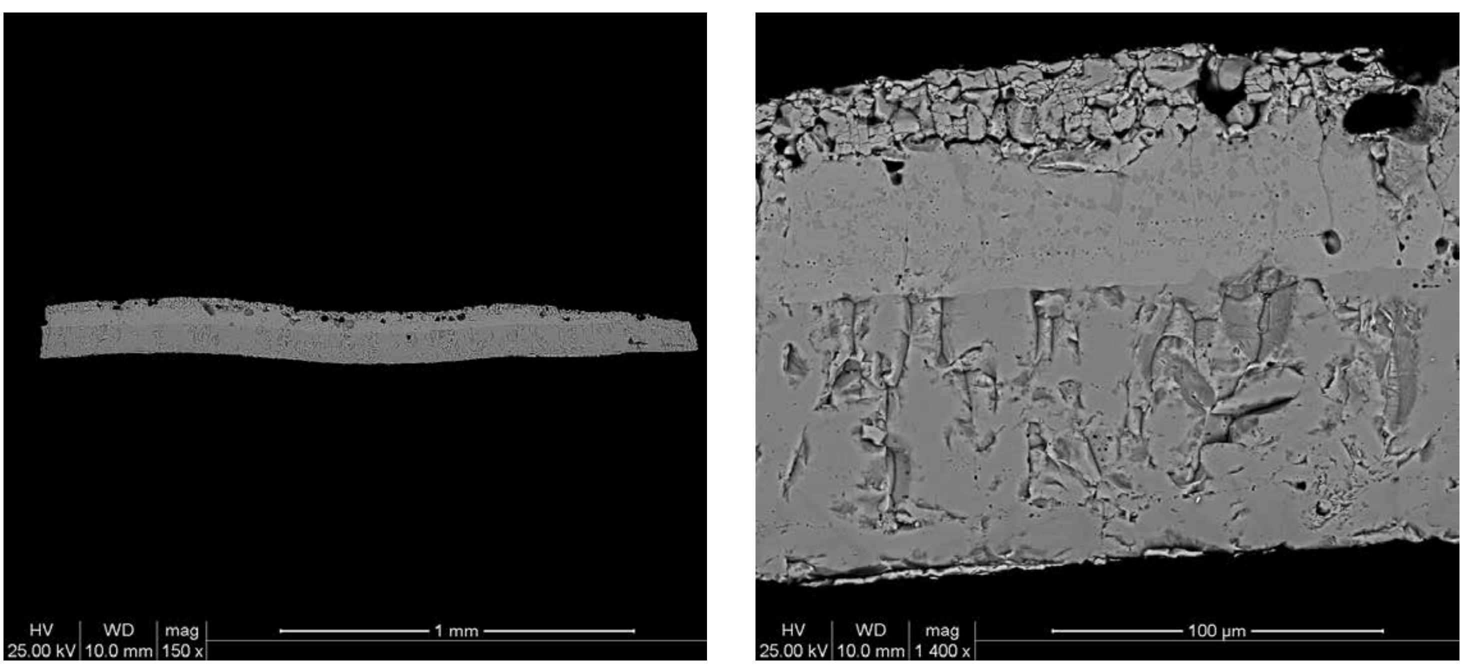


Illustration 6.28 (a and b)
SEM images (back-scattered electron detector) of Sample 1065 (flake hammerscale from context 3022) showing the layers of wüstite/magnetite

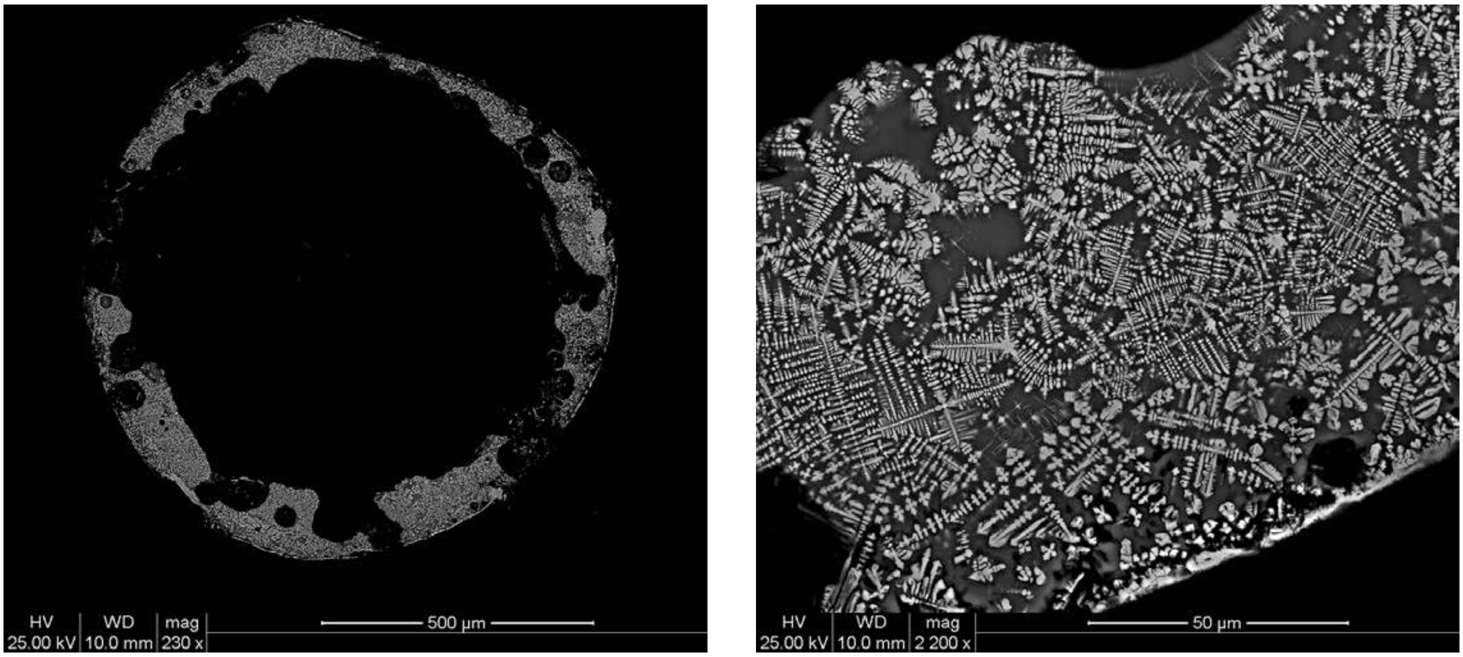


Illustration 6.29 (a and b)
SEM images (back-scattered electron detector) of Sample 1052 (spherical hammerscale from context 3022) showing the typical hollow spherical structure and dendritic microstructure

magnetite in outer layers). The spherical hammerscale samples included examples with widely varying degrees of porosity and are composed of very fine iron oxide dendrites (wüstite-magnetite) in a glassy matrix. A small number of samples initially identified as flake or sphere were recategorised as miscellaneous after SEM examination. The manganese content of many of the spheres (and some flakes) suggests that a proportion of the hammerscale was produced during iron smelting and/or bloom refining (as discussed above).

The smithing pan comprises abundant hammerscale flakes and occasional hammerscale spheres along with silica-rich rock (Illus. 6.30).

A series of samples from context 3204 (the basal fill of Furnace 3050 located within Workshop 13) submitted for analysis

Illustration 6.30
SEM image (back-scattered electron detector) of Sample 1126 (smithing pan context 412) showing the flake hammerscale and rock fragments

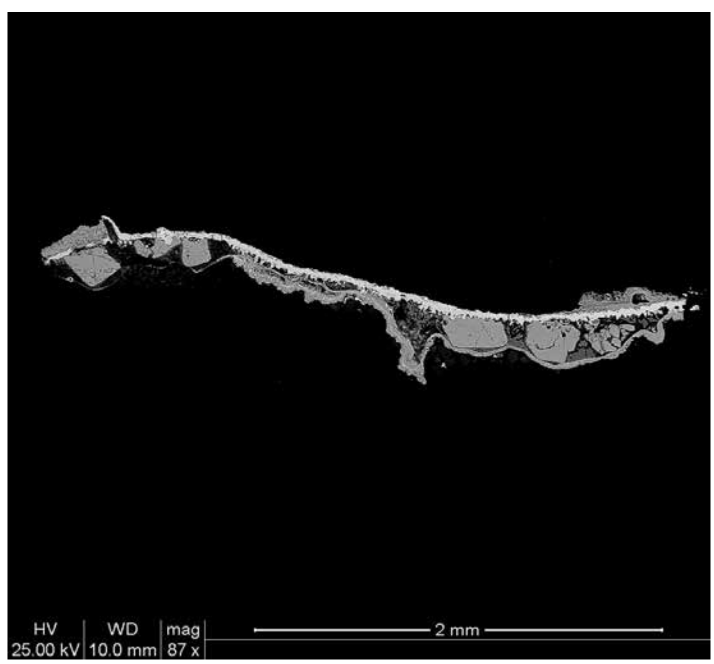


Illustration 6.31
SEM image (back-scattered electron detector) of Sample 1103 (magnetic flake from context 3050) showing the grains of fayalite (grey) and film of hydrated iron oxides (corrosion)

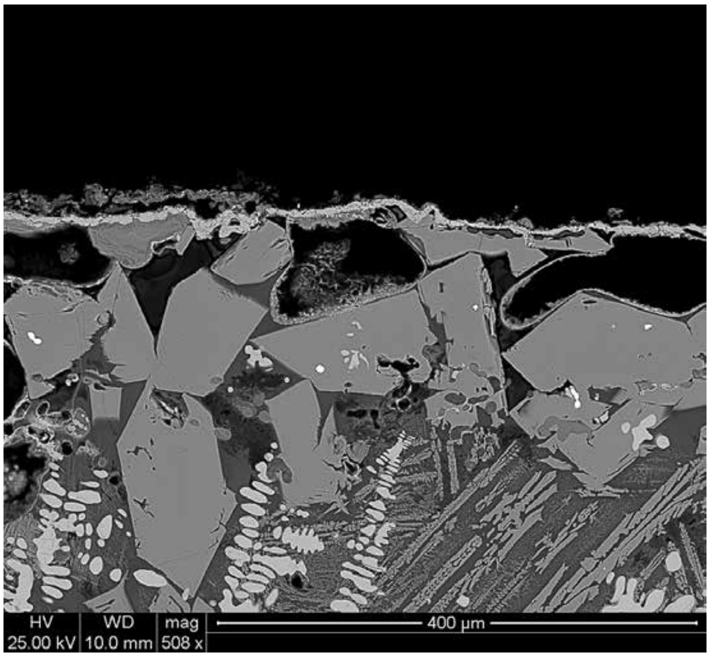


Illustration 6.32
SEM image (back-scattered electron detector) of Sample 1149 (unclassified slag lump from context 185) showing the grains of fayalite (grey) and film of hydrated iron oxides (corrosion) at the surface

consisted of small magnetic flakes that were initially identified as possible flake hammerscale. The microstructure of these samples, however, differed completely from all of the other hammerscale (Illus. 6.31). They comprise a series of fayalite grains cemented together by a film of hydrated iron oxides. This microstructure is almost identical to some of the outer surfaces of the bulk slags (Illus. 6.32). It is concluded that these magnetic flakes are not hammerscale but fragments of the outer surface of bulk slags which have become detached.

Chemical composition

Bulk slags

The bulk slags have chemical compositions that are broadly comparable with most bloomery slags from Europe: they are rich in iron and silicon (Illus. 6.33) with a range of other minor elements (aluminium, potassium, calcium, manganese, phosphorus, magnesium, sodium, barium and titanium) (Illus. 6.34 and 6.35). The vast majority of the bulk slags contain significant proportions of manganese (Illus. 6.35) and as such are likely to have been produced as a result of iron smelting rather than iron smithing. The considerable variation in the chemical composition of the smelting slag samples is typical of smelting slags produced in non-tapping furnaces. There were no correlations between overall slag morphology and chemical composition.

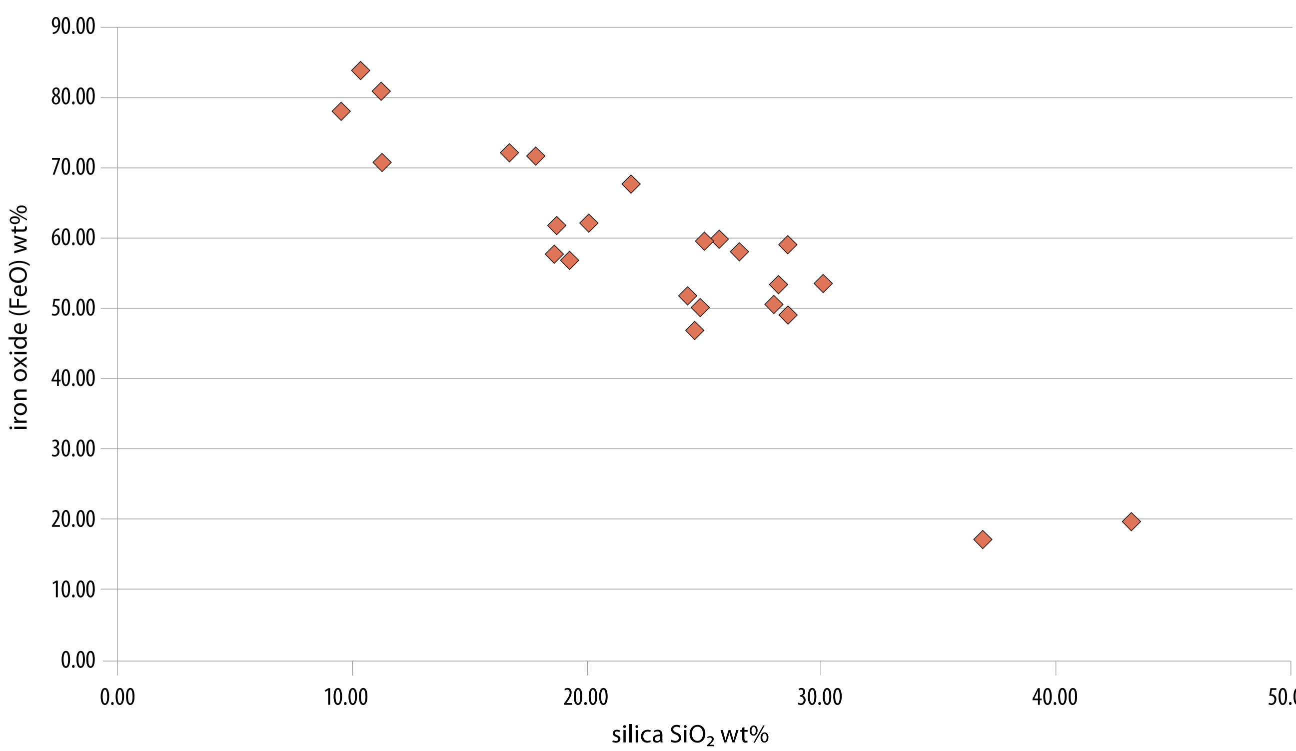


Illustration 6.33
Silica and iron oxide content of all bulk slags

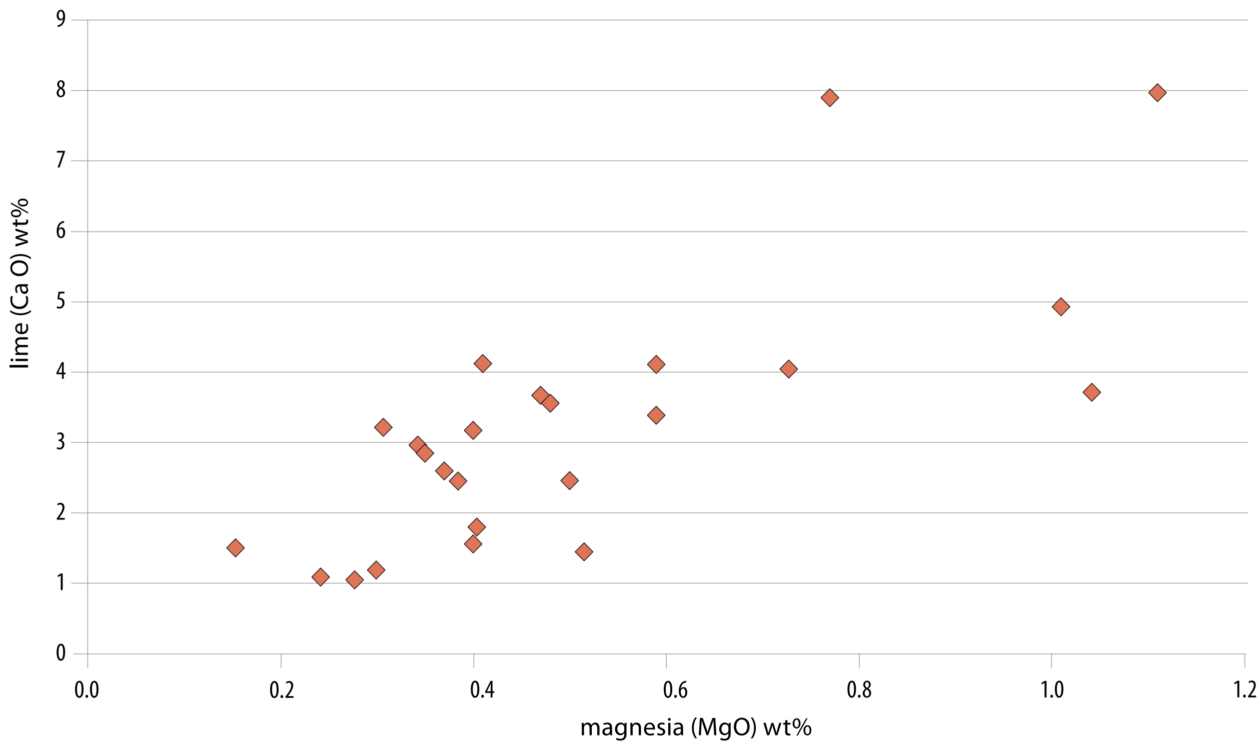


Illustration 6.34
Magnesia and lime content of all bulk slags

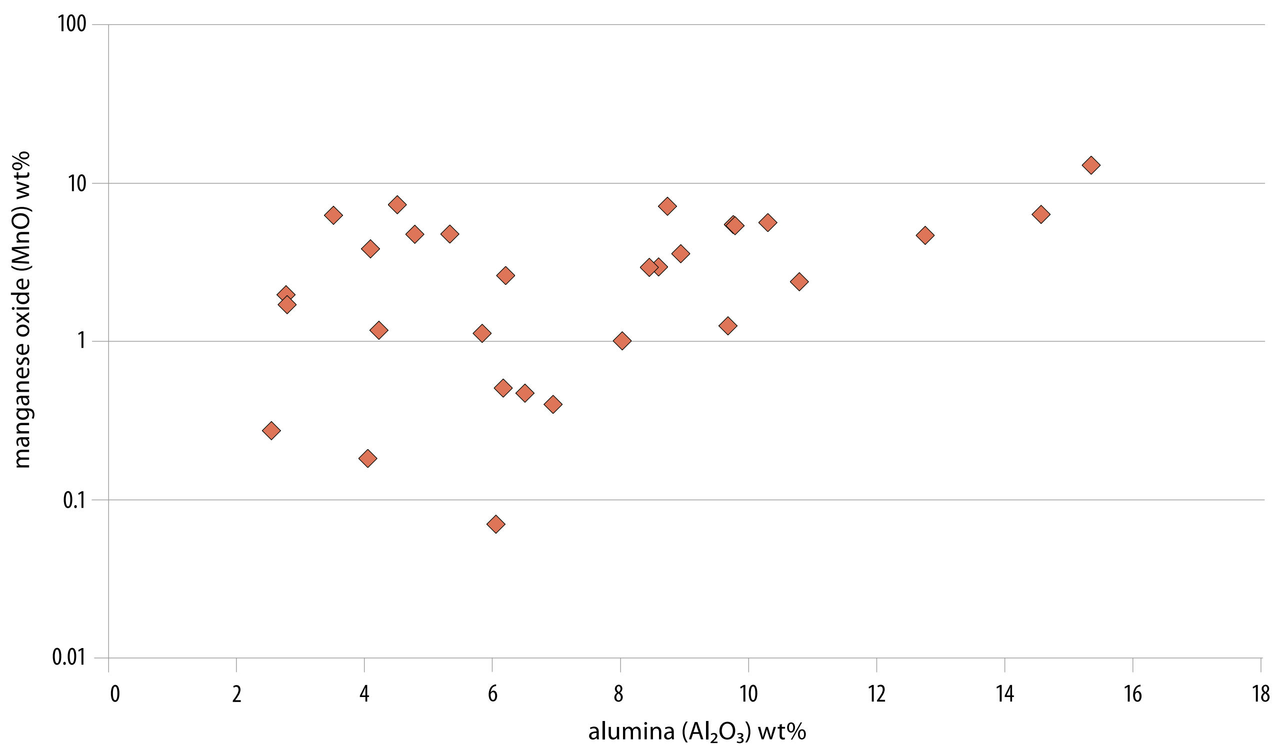


Illustration 6.35
Alumina and manganese oxide content of all bulk slags

Furnace/hearth lining

Both the clay and stone furnace wall fragments are rich in silica and alumina – these two oxides usually account for 90wt%. This composition would indicate that the materials were sufficiently refractory to withstand the temperatures required for bloomery iron smelting. The vitrified interior surfaces, however, show considerable enrichment in elements that are abundant in the slag (especially iron, manganese and calcium, see Illus. 6.36). The vitrification of the interior surface of the furnace wall is likely to have occurred in two ways. The exposure to high temperatures will have encouraged the clay or stone to vitrify and even melt. In addition, in some parts of the furnace, the furnace wall will have reacted due to direct contact with molten slag. The vitrified surfaces that have undergone little reaction with the slag in the furnace tend to be those that display microphase separation. The vitrified surfaces that have reacted with slag usually contain a similar range of phases to those seen in the slag (especially fayalite).

Hammerscale flakes and spheres

The compositional characteristics of the Culduthel hammerscale are similar to other analysed hammerscale (Dungworth and Wilkes 2009). The hammerscale samples fall into two major

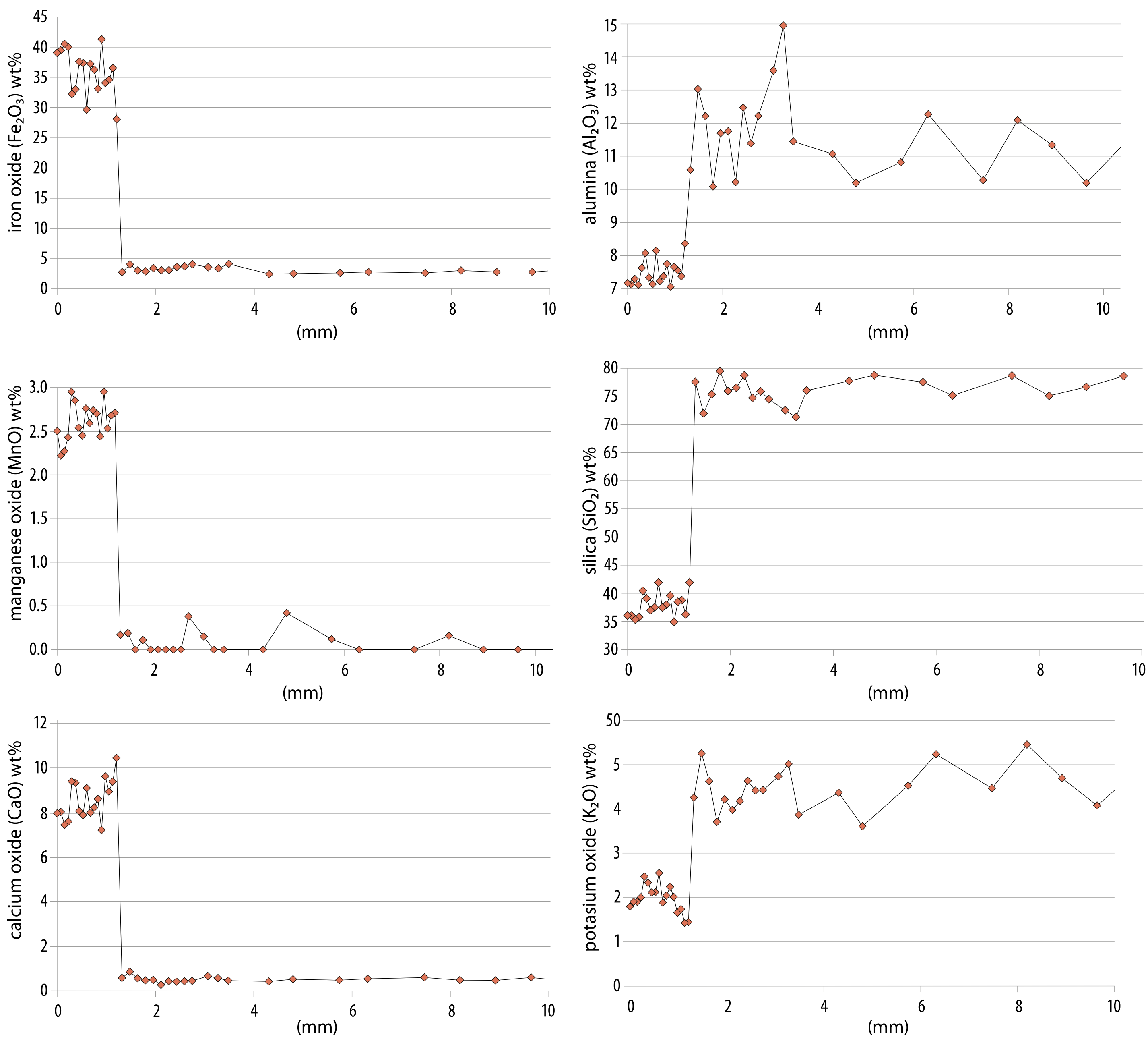


Illustration 6.36
Linescans through the thickness of a fragment of furnace wall (sample 1120, context 185)

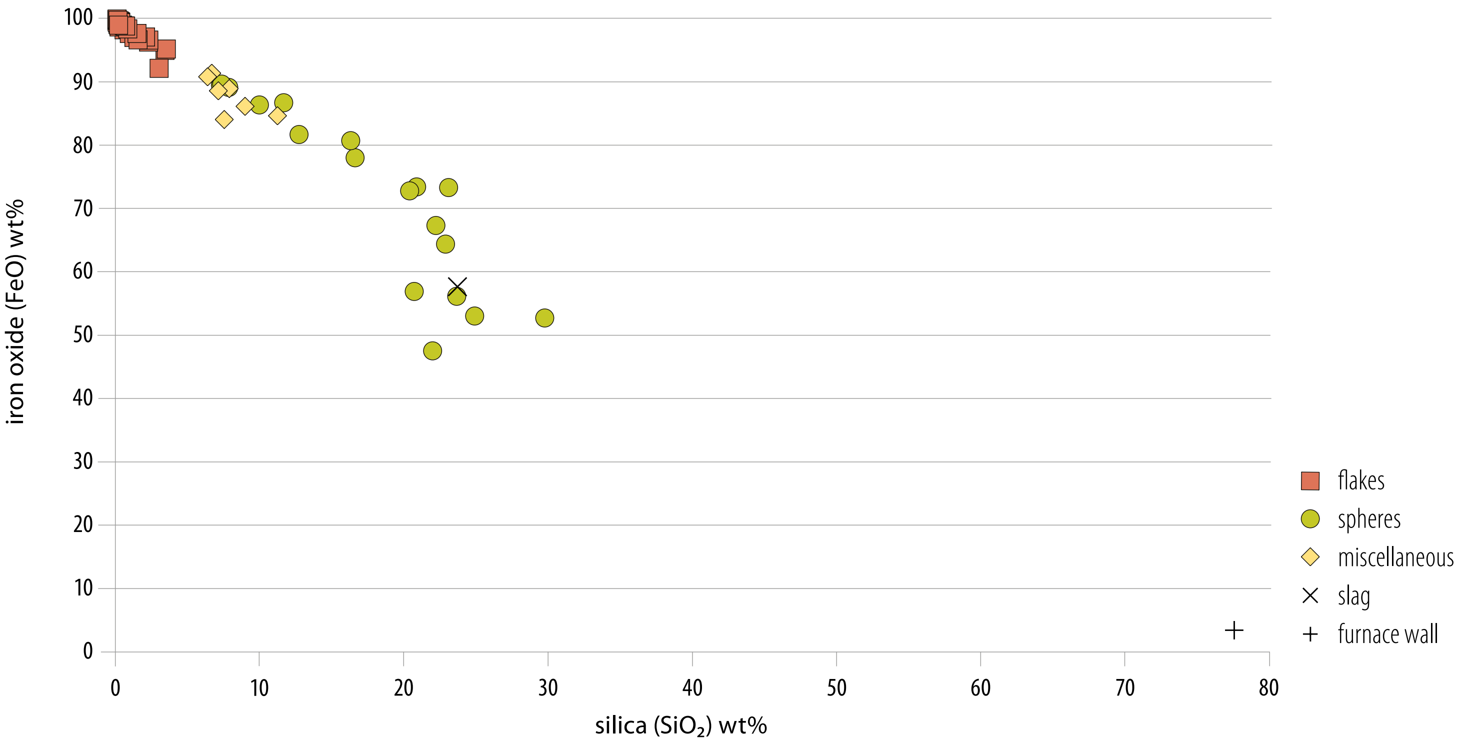


Illustration 6.37
Iron oxide and silica content of the hammerscale samples

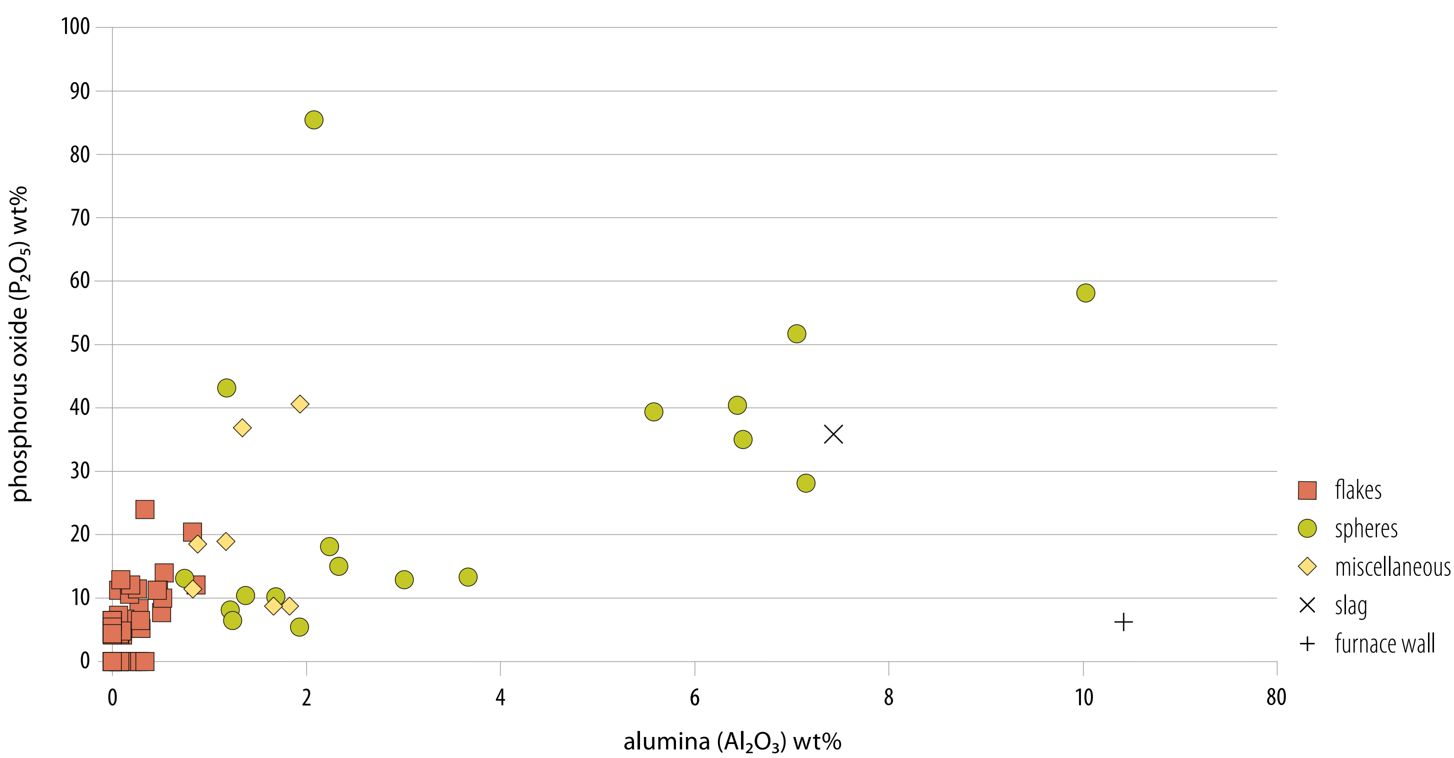


Illustration 6.38
Alumina and phosphorus oxide content of the hammerscale samples

compositional groups: the flake hammerscale is very iron-rich while the spheres contain elevated concentrations of a range of elements (Illus. 6.37 and 6.38). There are several possible sources of these minor elements, including slag inclusions, furnace lining, flux and fuel ash. The increase in the minor elements in the spherical hammerscale shows closest similarities with the smelting slag (which should correlate with the composition of the slag inclusions, see below).

Metal microstructure and slag inclusions

The metallic samples from Culduthel examined included five possible fragments of bloom, seven fragments of bars/offcuts/unfinished objects, a nail, two knife tips, a spearhead, a reaping hook and a strapping fragment. The bloom fragments were all carbon steels (Illus. 6.39). The most abundant phase present was pearlite (the iron-carbon eutectoid comprising parallel and concentric bands of alternating ferrite (pure iron) and cementite (iron carbide) (Illus. 6.40 – 6.41). A eutectoid carbon steel is one in which the only phase present is pearlite; reference to the iron-carbon phase diagram indicates that a eutectoid steel contains 0.8wt% carbon. Carbon steels are often described as hypo-eutectoid when they contain less than 0.8% carbon, the microstructure containing both pearlite and ferrite, and the carbon content can be easily estimated from the relative abundance of these two phases. Hyper-eutectoid steels are those that have more than 0.8wt% carbon – the microstructure consisting of pearlite and cementite. All of the Culduthel bloom samples are hyper-eutectoid steels. SEM-EDS analysis failed to detect any elements other than iron (ie <0.1wt% phosphorus). The carbon content of the Culduthel blooms appears to have varied from 1 to 3wt%. Where slag inclusions were present, they generally had compositions that provided a moderate to good match with the Culduthel smelting slag (Illus. 6.42 - 6.43). The presence of bloom fragments of hyper-eutectoid steel confirms that the smelting process produced carbon steel in a single process (as opposed to the production of plain iron which would be subsequently carburised). Such direct steel is often referred to as natural steel.

The bars, offcuts and unfinished artefacts were all composed of hyper-eutectoid or medium steel (0.5–1.5wt% carbon, Illus. 6.39). The slag inclusions showed varying degrees of agreement with the composition of the Culduthel smelting slags (Illus. 6.42). While some provide a good match, and so are likely to have been made using locally manufactured iron, some provide a rather poor match and probably represent iron manufactured elsewhere. The remaining artefacts were all made of plain iron (no carbon) or low- to medium-carbon steel. Their slag inclusions generally showed a poor to moderate agreement with the Culduthel smelting slag.

Distribution and taphonomy

Contextual and distributional analysis, outlined in detail in the archive, demonstrates that ferrous metalworking waste was found throughout much of the excavated area (Table 6.14). Debris from around House 10 and Workshops 11, 13 and 15 dominates the assemblage. To enable further patterns in the material it is pertinent to analyse the contextual distribution more closely.

Illustration 6.39
Optical microscope image of a bloom fragment (Sample 2006, SF0361). The sample is dominated by pearlite with laths of cementite

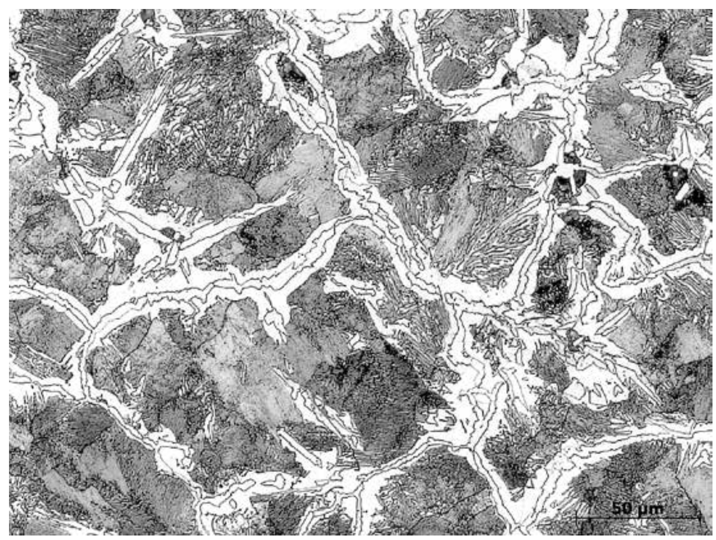


Illustration 6.40
Optical microscope image of a bar fragment (Sample 2016). The sample is dominated by pearlite with cementite at prior austenite grain boundaries

Due to the sheer quantity of material recovered and the number of contexts associated with metalworking debris, an integrated approach combining analysis of the distribution, the character of associated features and aspects of taphonomy has been applied to extract as much information as possible. This will allow a broader narrative to be developed, which aims to describe the assemblage by the significance of the associated context, with the aim of illustrating elements of the craftworking areas, the metalworking structures, and the strategies employed in reusing and disposing of metalworking debris. This approach has demonstrated that ferrous metalworking waste is present at Culduthel as five main categories of deposits (Table 6.15): in situ material associated directly with hearths and furnaces; discrete

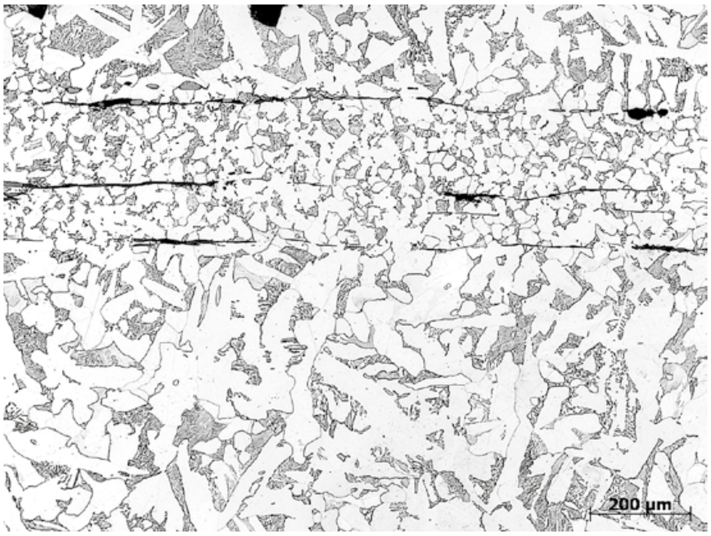


Illustration 6.41

Optical microscope image of a spearhead ferrule (Sample 2014, SF1026). The sample contains both pearlite and ferrite. Note also the dark thin bands of entrapped slag (slag inclusions)

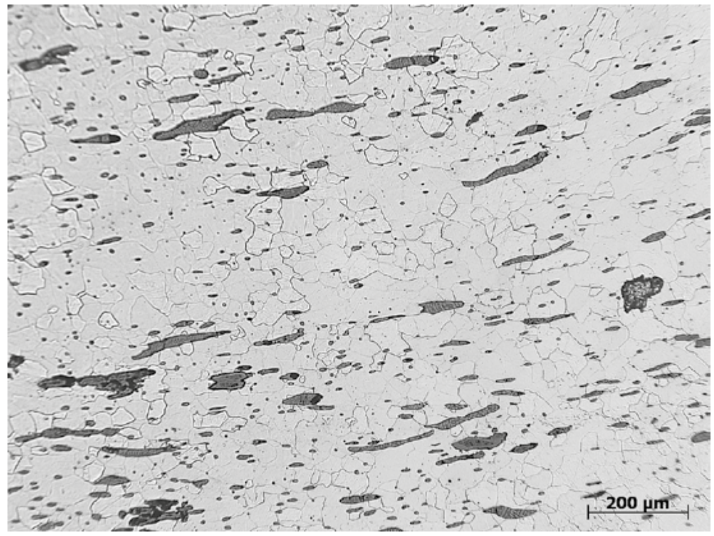


Illustration 6.42

Optical microscope image of a knife tip (Sample 2013, SF1209). The sample contains only ferrite. Note also the dark thin bands of entrapped slag (slag inclusions)

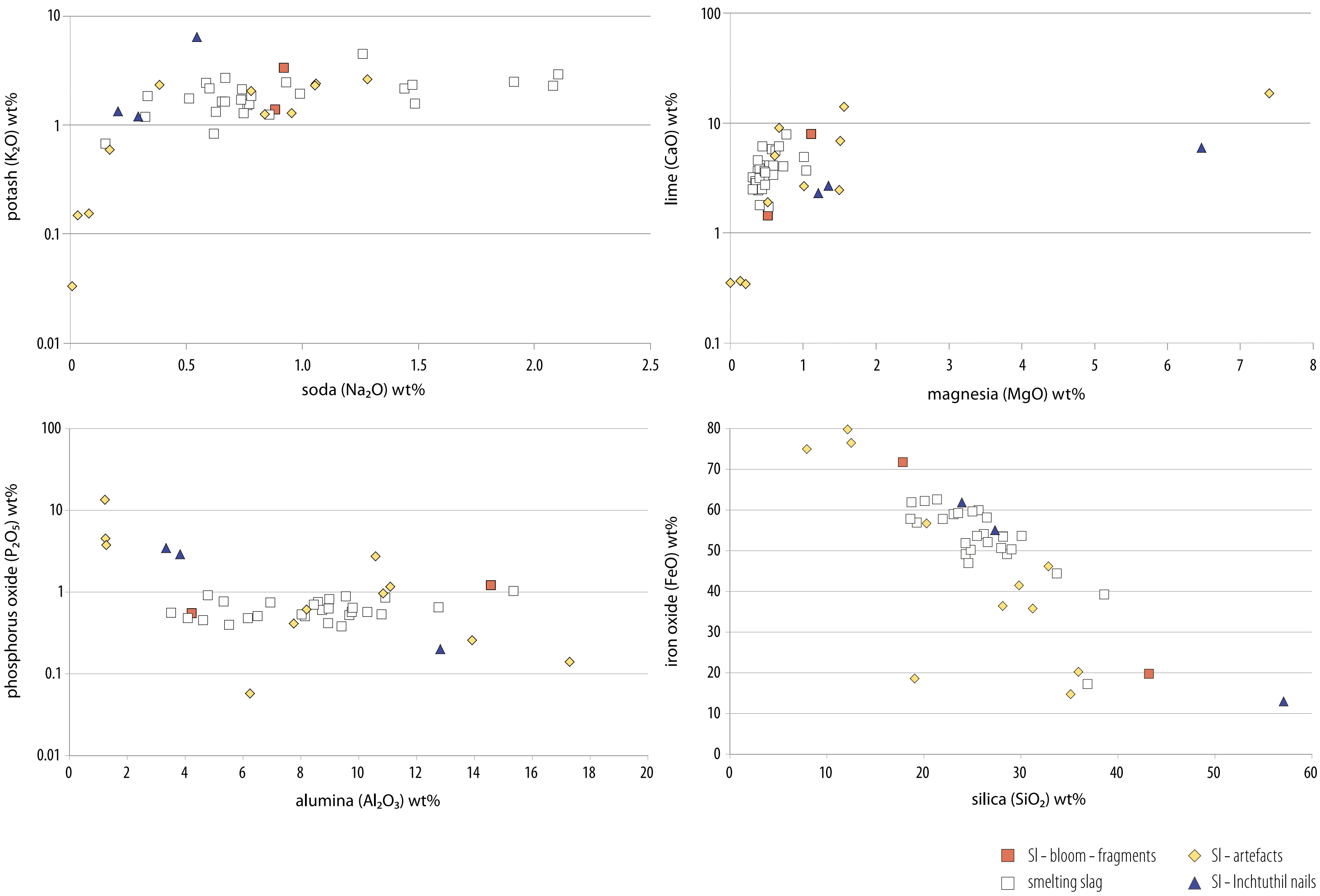


Illustration 6.43

Average chemical composition of slag inclusions compared with Culduthel slag

Table 6.14
Distribution of slag by area

Area	Mass/g
South-west corner of excavation area	2
Around cobbled surface 227	52,128
North-east corner of excavation area	1
East and south-east of House 10	251,110
Northern and north-west edge of excavation area (north of House 10)	20,859
U/S	13,390

Table 6.15
Distribution of ferrous metalworking waste by context type

Context type	Mass/g
In situ features (furnaces and hearths)	123,612
Discrete dumps	21,585
Spreads	94,473
Purposeful reuse	33,238
Residual	51,192
Unstratified	13,390
Total	**337,490**

dumps within pits; spreads or accumulations; residual scatters of waste; and purposeful reuse as metalling or built into walls (Table 6.16). The significance of each group of material will be discussed in detail below.

In situ features: furnaces and hearths

One exceptional aspect of the metalworking evidence from Culduthel is the quantity of in situ structural features, including the basal portions of smelting furnaces and stone-lined hearths. The structural components of these features, their preservation and design are discussed in further detail elsewhere. Eight smelting furnaces containing substantial quantities of smelting waste were noted, plus a possible cleared-out furnace (Table 6.17). These were associated with Workshop 2 (furnace 681), 13 (furnaces 3050 and 3790), 15 (furnaces 4147, 4262, 4355), 16 (furnace 4226) and 19 (furnace 3127). In addition to these in situ features, an earlier furnace (4790) was noted in the field directly under furnace 3790, and it was not possible to distinguish the debris from the earlier and later features. The furnace structures were sub-circular or sub-rectangular heat-affected pits, the edges lined with a horseshoe arrangement of water-worn boulders or slabs superimposed with medium- to fine-grained fired and vitrified clay. Many pieces of this furnace lining preserved wattle impressions, suggesting that a withy frame was used to build up the clay superstructure of the furnace shaft. There is a consistency in form and construction between the furnaces; all appear to be non-tapped shaft furnaces with cylindrical thick clay-walled superstructures. The soil immediately surrounding these features is frequently scorched or heat-affected. Substantial quantities (over 5kg) of smelting slag were associated with these structures, indicating that the waste from the final smelt remained in the furnace on abandonment or that debris was infilled into the base of the furnace after its final use. The presence of vitrified ceramic and slag within a pit is not sufficient to indicate an in situ metalworking feature, and could easily be a dump of secondary waste: for an in situ feature to be identified, structural evidence of the hearth or furnace is necessary.

Having said this, one feature, pit [185], may represent a cleared-out furnace. This pit lacks any structural evidence to confirm the former presence of a furnace but the morphology of the pit and the quantity of slag suggest a metalworking feature may have been present. This interpretation is bolstered by the recovery of a large horizontal run of slag which is an accidental or deliberate flow of molten waste, aligned with the main axis of the pit floor.

In contrast, pit 4273 was described in the field as the base of a collapsed clay-built metalworking feature. Although small quantities of unclassified iron slags, residues and vitrified ceramic were recovered from the pit, they were more typical of smithing waste. It is difficult, based on the quantity and range of slags present, to confirm that this was a furnace; it is more likely to be a smithing hearth.

Unlike smelting furnaces, smithing hearths do not require specifically built structures and tend to be more difficult to identify, as they are more ephemeral. Only one smithing hearth (4273) was tentatively identified, but smithing residue was recovered throughout the excavated area.

Discrete dumps

These consist of concentrations of significant quantities of waste slag (over 0.5kg) and associated vitrified material within discrete features (i.e. pits/post-holes) that lack any structural evidence to suggest the former presence of an in situ metalworking feature. Dumps differ from spreads in that they are contained within distinct and well-defined features and are not considered to be residual due to the volume of material present. These dumps generally consist of a mixture of bulk slags, fragments of vitrified ceramic and small quantities of magnetic residues, typically dominated by unclassified rake-out material (e.g. UIS), which could have derived from either a smelting furnace or smithing hearth. These dumps are usually but not exclusively located in the vicinity of an in situ metalworking feature. One, in pit 1632 within Workshop 6, is quite far removed from any recognised metalworking structures and may indicate that smelting activities continued to the north of the excavated area.

Nine discrete dumps have been identified, including seven from the area to the east and south-east of House 10 and two from around the cobbled surface 227 (Table 6.18). The contents of the pits, described here as dumps, are variable in terms of quantity and range of material present. Some, such as the possible furnace 4179 within Workshop 13, contain fairly small amounts of debris, in this case only 186g, but encompass significant quantities of

Table 6.16
Range and quantity of slag by feature category

	In situ features	Discrete dumps	Spreads	Purposeful reuse	Residual	Unstratified	Total/g
Smelting							
Plano-convex cake: furnace bottom (PCC:FB)	9,519	1,225	6,590	7,787	1,643	1,247	**28,011**
Tapped slag (TS)	2,858	—	—	—	—	—	**2,858**
Unprocessed bloom	791	310	3,714	697	1,167	571	**7,250**
Suggestive of smelting							
Runned slag (RS)	33,929	3,355	23,938	2,426	5,948	1,499	**71,095**
Charcoal-rich slag (CR)	11,358	249	1,804	—	1,374	186	**14,971**
Smithing							
Plano-convex cake: hearth bottom (PCC: PCHB)	85	1,027	4,926	3,428	7,996	367	**17,829**
Hammerscale flakes (HS)	487	314	65	97	955	36	**1,954**
Slag spheres (SS)	4	20	3	2	29	1	**59**
Smithing pan	43	—	—	—	416	—	**459**
Processed bloom	164	9	1,157	245	541	103	**2,219**
Undiagnostic of particular process							
Plano-convex cake: unclassified	825	1,222	11,378	5,337	2,926	1,658	**23,346**
Unclassified iron slag (UIS)	22,141	9,531	20,345	7,687	17,549	3,891	**81,144**
Slag amalgam (SA)	15,053	—	3,666	—	671	683	**20,073**
Atypical hammerscale flakes (HS(a))	1,894	188	84	—	—	3	**2,169**
Atypical slag spheres (SS(a))	50	—	—	—	—	—	**50**
Undiagnostic							
Vitrified ceramic (VC)	22,171	2,804	16,576	5,222	6,847	3,110	**56,730**
Fuel ash slag (FAS)	128	45	167	98	538	13	**989**
Heat-affected stone	702	—	—	41	546	—	**1,289**
Magnetic vitrified residue (MVR)	1,400	1,285	47	131	1,895	21	**4,779**
Non-magnetic vitrified residue (NMVR)	10	1	13	40	151	1	**216**
Total/g							**337,490**

Table 6.17
Range and quantity of slag present within in situ metalworking features. A = in situ smithing; B = in situ smelting; C = cleared out furnace or dump

	Workshop 2 posthole 411	Workshop 2 Furnace 681	Pit 185	Workshop 13 Furnace 3050	Workshop 13 Furnaces 3790 & 4790	Workshop 15 Furnace 4147	Workshop 15 Furnace 4355	Workshop 15 Furnace 4262	Hearth 2343 & related features	Workshop 16 Furnace 2246	Workshop 19 Furnace 3127
Smelting											
Plano-convex cake: furnace bottom (PCC:FB)	—	1,863	840	—	2,288	520	1,736	2,272	—	12,371	—
Tapped slag (TS)	—	—	2,858	—	—	—	—	—	—	—	—
Unprocessed bloom	—	85	—	26	633	24	—	—	23	—	—
Suggestive of smelting											
Runned slag (RS)	13	7,858	1,076	2,198	10,252	4,656	396	1,702	—	5,765	13
Charcoal-rich slag (CR)	—	3,445	—	4,049	3,431	34	—	399	—	—	—
Smithing											
Plano-convex cake: hearth bottom (PCC: PCHB)	85	—	—	—	—	—	—	—	157	—	—
Hammerscale flakes (HS)	19	91	97	—	—	—	13	110	2	—	—
Slag spheres (SS)	—	—	—	—	—	—	2	—	—	—	—
Smithing pan	43	—	—	—	164	—	—	—	—	—	—
Processed bloom	—	—	—	—	—	—	—	—	—	—	—
Undiagnostic of particular process											
Plano-convex cake: unclassified	—	219	216	—	152	—	238	—	—	—	—
Unclassified iron slag (UIS)	1,791	—	961	2,691	10,515	2,405	672	1,310	156	1,633	7
Slag amalgam (SA)	97	3,184	—	2,566	4,199	955	3,622	430	—	—	—
Atypical hammerscale flakes (HS(a))	—	—	—	155	1,379	167	—	—	—	193	—
Atypical slag spheres (SS(a))	—	23	2	—	15	—	—	—	—	10	—
Undiagnostic											
Vitrified ceramic (VC)	66	291	545	3,337	5,064	4,677	2,106	918	37	5,130	—
Fuel ash slag (FAS)	—	—	114	—	12	—	—	2	—	—	—
Heat-affected stone	—	171		—	531	—	—	—	—	—	—
Magnetic vitrified residue (MVR)	219	538	146	—	157	—	32	102	206	—	—
Non-magnetic vitrified residue (NMVR)	—	—	—	1	—	—	—	9	—	—	—
Interpretation	A	B	C	B	B	B	B	B	A	B	B
Total/g	**2,332**	**17,768**	**6,855**	**15,023**	**38,793**	**13,438**	**8,817**	**7,254**	**581**	**12,731**	**20**

Table 6.18
Range and quantity of slag present within discrete dumps. D = Dump; D? = Dump?; D:smi = Dump: smithing; D:sme = Dump: smelting

	Workshop 6, pit 1632	Cobbled surface 227, pit 222	House 10, pit 3750	Workshop 13, pit 4190	Workshop 15, pit 4369	Pit 2143	Context 2186	Context 2130	Smithing Hearth 4273
Smelting									
Plano-convex cake: furnace bottom (PCC:FB)	553	—	—	—	—	672	—	—	—
Tapped slag (TS)	—	—	—	—	—	—	—	—	—
Unprocessed bloom	—	—	—	—	—	—	172	102	36
Suggestive of smelting									
Runned slag (RS)	456	—	540	—	431	988	—	925	15
Charcoal-rich slag (CR)	—	—	—	—	249	—	—	—	—
Smithing									
Plano-convex cake: hearth bottom (PCC: PCHB)	—	—	—	—	—	—	156	871	—
Hammerscale flakes (HS)	15	95	120	23	—	31	—	1	29
Slag spheres (SS)	2	10	1	4	3	—	—	—	—
Smithing pan	—	—	—	—	—	—	—	—	—
Processed bloom	—	—	—	—	—	—	9	—	—
Undiagnostic of particular process									
Plano-convex cake: unclassified	—	—	—	—	—	—	—	1,222	—
Unclassified iron slag (UIS)	—	—	4,497	—	1,603	1,292	257	1,439	443
Slag amalgam (SA)	—	—	—	—	—	—	—	—	—
Atypical hammerscale flakes (HS(a))	181	7	—	—	—	—	—	—	—
Atypical slag spheres (SS(a))									
Undiagnostic									
Vitrified ceramic (VC)	86	—	528	—	630	62	517	914	67
Fuel ash slag (FAS)	—	—	—	—	—	45	—	—	—
Heat-affected stone	—	—	—	—	—	—	—	—	—
Magnetic vitrified residue (MVR)	2	866	12	159	—	—	—	—	246
Non-magnetic vitrified residue (NMVR)	—	—	—	—	1	—	—	—	—
Interpretation	D?	D:smi	D:smi	D:smi	D:sme	D?	D	D	D:smi
Total/g	**1,295**	**978**	**5,698**	**186**	**2,917**	**3,090**	**1,111**	**5,474**	**836**

Table 6.19
Range and quantity of slag present within spreads. s/s = smelting/smithing; sme = smelting; smi = smithing; u = undiagnostic
* contexts 2164, 2180, 2198, 2470, 3567

	Hearth 2166 & spreads overlying 2165, 3180	Spread 2187	Spread 1896	Spread 798	Spread 1681	Spread 1680	Spread 2102	Overdburden	Hillwash (2435, 2586, 2588, 3720, 3727)	Occupation deposits within House 10/3	Abandonment & post-abandonment	Concentration of burnt material within Workshop 11 1952	Spreads overlying Furnaces 4355/4262/4147 Workshop 15
Smelting													
Plano-convex cake: furnace bottom (PCC:FB)	2,946	—	—	2,694	950	—	—	—	—	—	—	—	—
Tapped slag (TS)	—	—	—	—	—	—	—	—	—	—	—	—	—
Unprocessed bloom	11	—	632	1,990	374	118	—	—	123	—	352	114	—
Suggestive of smelting													
Runned slag (RS)	2,694	979	1,911	5,850	2,112	1,590	—	—	3,881	184	305	4,419	13
Charcoal-rich slag (CR)	—	140	831	833	—	—	—	—	—	—	—	—	—
Smithing													
Plano-convex cake: hearth bottom (PCC: PCHB)	963	37	205	307	2,326	—	91	—	—	—	—	997	—
Hammerscale flakes (HS)	36	5	3	—	1	—	3	—	2	5	3	7	—
Slag spheres (SS)	1	—	—	—	—	—	—	—	1	1	—	—	—
Smithing pan	—	—	—	—	—	—	—	—	—	—	—	—	—
Processed bloom	53	5	152	352	113	—	4	—	89	—	193	196	—
Undiagnostic of particular process													
Plano-convex cake: unclassified	1,905	207	980	2,394	1,593	719	174	486	1,445	323	1,152	—	—
Unclassified iron slag (UIS)	3,492	65	1,098	5,110	2,524	1,506	27	330	1,574	1,090	1,386	1,489	654
Slag amalgam (SA)	651	—	532	588	549	478	193	—	—	—	675	—	—
Atypical hammerscale flakes (HS(a))	—	—	—	—	—	—	—	—	—	—	—	—	84
Atypical slag spheres (SS(a))	—	—	—	—	—	—	—	—	—	—	—	—	—
Undiagnostic													
Vitrified ceramic (VC)	3,228	164	1,391	2,557	1,925	1,219	308	654	1,488	15	31	1,988	1,334
Fuel ash slag (FAS)	—	1	—	—	—	—	—	—	69	66	—	—	—
Heat-affected stone													
Magnetic vitrified residue (MVR)	1	—	—	—	1	—	1	—	25	5	1	—	13
Non-magnetic vitrified residue (NMVR)	—	—	—	—	—	—	5	—	5	2	1	—	—
Interpretation	s/s	s/s	sme	sme	s/s	sme	u	sme	smi	u	u	s/s	u
Total/g	**15,981**	**1,603**	**7,735**	**22,675**	**12,468**	**5,630**	**806**	**1,470**	**8,702**	**1,691**	**4,404**	**9,210**	**2,098**

Table 6.20
Range and quantity of slag reused as cobbling and wall core material

			Smelting			Suggestive of smelting		Smithing					Undiagnostic of particular process					Undiagnostic					
Structure	**Context**	**Mass /g**	**PCC: FB**	**Tapped slag**	**Unprocessed bloom**	**RS**	**CR**	**PCC: PCHB**	**HS**	**SS**	**Smithing pan**	**Processed bloom**	**PCC: unclassified**	**UIS**	**SA**	**HS(a)**	**SS(a)**	**VC**	**FAS**	**Heat affected stone**	**MVR**	**NMVR**	**Interpretation**
House 4 Ring ditch	contexts 766, 767, 775, 776, 777, 805, 871, 965, 1629, 1657, 1715, 1731, 1791, 2148, 2370	2,739			342	89		944	7	1			847	183				281			44	1	Cobbling?
Cobbled surface - 227	contexts 221, 225, 227	10,765			74			1,922				20	2,127	4,842				1,612	70	41	57		Cobbling?
House 10/3	contexts 1764, 1880, 2210, 2214, 2155, 2179, 2203, 2232, 2421, 2429, 2491, 2492, 2533, 2588, 2590, 2686, 2697, 2728, 2837, 2843, 2859, 2874, 2875, 2948, 2949, 3147, 3170, 3171, 3222, 3439, 3440, 3459, 3607, 3622, 3633, 3634, 3645, 3646, 3647, 3749, 3798, 3799, 3800, 3847, 3883, 3973, 4035, 4076, 4112, 4113, 4116, 4117, 4128	2,529			179	115			55	1		4	1,029	629				437	15		26	39	Secondary as cobbling or residual
Cobbled yard 1945	context 1945	2,271	701			23		562	32			74		46				816	13		4		Secondary reuse: cobbling
Wall base Workshop 11	context 1949	7,783	6,840															943					Secondary reuse: wall
Turf wall 2477 Workshop 11	context 2477	983	246		62	252						34						389					Secondary reuse: wall
House 10/3 Collapsed wall 1682	context 1682	1,431				488								943									Secondary reuse: wall

Table 6.21

Range and quantity of slag in residual contexts. r:u = residual: undiagnostic; r:s = residual: smithing; r:s/s = residual smelting/smithing; p/h = posthole; p/hs = postholes

					Smelting		Suggestive of smelting			Smithing					Undiagnostic of particular process					Undiagnostic					
Area	**Structure**	**Feature**	**Context**	**Mass /g**	**PCC: FB**	**Tapped slag**	**Unprocessed bloom**	**RS**	**CR**	**PCC: PCHB**	**HS**	**SS**	**Smithing pan**	**Processed bloom**	**PCC: unclassified**	**UIS**	**SA**	**HS(a)**	**SS(a)**	**VC**	**FAS**	**Heat affected stone**	**MVR**	**NMVR**	**Interpretation**
A	n/a	Pit 77	78	2																			2		r:u
B	2	Various p/hs	144, 146, 394, 410, 412, 436, 437, 592, 593, 595, 596, 601, 602, 606, 607, 610, 612, 614, 632, 633, 634, 635, 636, 637, 638, 644, 645, 647, 669, 670, 671, 689, 691, 692, 697, 699, 700, 702, 788	7,561			46	1,087	706	303	###	2		17	181	3,348				761	31	478	480	1	r:s/s
B	3	Residual	832, 855, 934, 957, 959, 969, 1641, 1642, 832, 834, 853, 938, 999	56												52								4	r:u
B	4	Ring-groove	705, 707, 1628, 1656, 1659, 1721, 1784, 1787, 1789, 1798, 1800	169							13					156									r:s
B	4	p/hs	764, 765, 845, 1621, 1622, 1636, 1648, 1662, 1664, 1665, 1701, 1706, 1708, 1710, 1723, 1725, 1727, 1795, 1815, 1827, 1901, 1908, 1912, 1914, 1916, 1918, 2168, 2169, 2173, 2182, 2217, 2229, 2351, 2356, 2360, 2430)	230							45	1		37		40				77	5		21	4	r:s
B	5	p/hs	652, 656, 662, 714, 739, 820, 1699, 781, 820, 1699, 658, 660, 739, 741	27							2					23							2		r:s
B	6	p/hs	384, 385, 393, 397, 400, 456, 458, 631, 810, 1608, 1612	223							1	4				177					15		25	1	r:s
B	22	p/hs	context 868, 1611, 1640	66																65				1	r:u
B	24	p/h	context 340	1																				1	r:u
B	30	Palisade ditch	468, 533, 549	29								1				28									r:u
B	n/a	Pit 200	context 204	4												4									r:u
B	n/a	Isolated features (postholes & pits etc.)	165, 177, 193, 203, 318, 333, 350, 393, 394, 535, 557, 587, 716, 720, 748, 763, 895, 897, 1675), pits (167, 171, 189, 220, 243, 258, 321, 425, 427, 429, 622, 642, 665, 666, 826, 1616, 1637, 1652, 1684, 1687) and other deposits (296, 297, 447, 725, 1920)	1,030							12	1		74		582				336		7	17	1	r:s
C	n/a	Pit 451	Context 452	1												1									r:u
D		Cairn 4234	2671, 4288, 4289, 4301	23																20			2	1	r:u
D	10	Phase 1 features	context 2147, 2695, 2845, 2852, 3339, 3551, 3614, 3616, 4056, 4125	479	295		55				1	1				75				49			2	1	r:s/s
D	10	Phase 2 features	2691, 2849, 2995, 3135, 3605, 3716, 3781, 3782, 3784, 3789, 3844, 3876	46							1					38							2	5	r:s
D	10	p/hs and stakeholes	1883, 2507, 2513, 2540, 2555, 2563, 2567, 2581, 2598, 2599, 2605, 2611, 2613, 2635, 2639, 2641, 2643, 2647, 2649, 2655, 2661, 2702, 2703, 2704, 2705, 2721, 2723, 2740, 2744, 2752, 2760, 2765, 2769, 2861, 2862, 2866, 2884, 2888, 2890, 3012, 3016, 3018, 3020, 3028, 3042, 3044, 3132, 3144, 3145, 3223, 3287, 3288, 3462, 3471, 3627, 3630, 3636, 3743, 3804, 3902, 3904, 3961, 3964, 3986, 3992, 3994, 4060, 4062, 4098, 4110, 4127, 4130, 4185, 4186, 4193, 4198, 4199, 4213	2,187			58	494	66		62	1		8		557				563	115		245	18	r:s/s
D	10	Cobbled spread	2725, 2982	259				105								153								1	r:s
D	10	Other features	2553, 2878, 3566, 3875, 3895, 4033	402											356								4	42	r:u
D	11	Abandonment spreads	1978, 2100	6,674			251	1,460		1,751				61		1,746				1,285	120				r:s/s
D	13	p/hs	2787, 2791, 2793, 2797, 2802, 2808, 2810, 2814, 2820, 2822, 2824, 2828, 2834, 2836, 2896, 2899, 2901, 2910, 2913, 2916, 2918, 2920, 2922, 2928, 2940, 2943, 2945, 2988, 3794, 4189, 4278	2,936			18	109		661	80	1	161			1,126				406			374		r:s

Table 6.21
(continued)

Area	Structure	Feature	Context	Mass /g	Smelting		Suggestive of smelting			Smithing					Undiagnostic of particular process					Undiagnostic					
					PCC: FB	Tapped slag	Unprocessed bloom	RS	CR	PCC: PCHB	HS	SS	Smithing pan	Processed bloom	PCC: unclassified	UIS	SA	HS(a)	SS(a)	VC	FAS	Heat affected stone	MVR	NMVR	Interpretation
D	14	p/hs & ring ditch	3248, 3250, 3315, 3448, 3251, 3269, 3271, 3273, 3319, 3323, 3454, 3516, 3444	44							1	1				29							11	2	r:s
D	15	Pits	4220, 4324, 4336, 4380	1,333				137		1,126	1					45				21				3	r:s
D	15	p/hs	3491, 3493, 3495, 3513, 3559, 3944, 3968, 3972, 3983, 3996, 4132, 4187, 4188, 4268, 4295, 4297, 4299, 4300, 4304, 4311, 4312, 4349, 4351, 4354, 4364, 4372	2,106			124	116		245	68	1		35		1,466				7			40	4	r:s
D	15	Other features	4342, 4308, 4357	161							18					142								1	r:s
D	26	p/hs	3149, 3151, 3153, 3155, 3157, 3158, 3162, 3279, 3283, 3285	128												105					4		18	1	r:u
D	n/a	Pit/p/h 2777	2778	36							1					35									r:s
D	n/a	Isolated features (postholes & pits etc.)	1745, 1753, 1756, 1845, 1873, 1877, 1892, 1898, 1900, 1925, 1926, 1933, 1935, 1973, 1975, 1982, 1986, 1989, 1995, 1998, 2137, 2144, 2153, 2548, 2681, 2783, 2785, 2799, 2804, 2806, 2816, 2830, 2832, 2894, 2904, 2906, 2908, 2924, 2926, 2935, 3218, 3336, 3456, 3535, 3539, 3561, 3583, 3654, 3655, 3662, 3664, 3666, 3670, 3672, 3676, 3679, 3689, 3698, 3704, 3708, 3715, 3718, 3731, 3739, 3741, 3744, 3745, 3759, 3767, 3771, 3772, 3775, 3796, 3805, 3815, 3817, 3819, 3825, 3830, 3832, 3834, 3839, 3842, 3850, 3852, 3873, 3885, 3887, 3933, 3934, 3954, 3966, 3980, 4000, 4002, 4005, 4031, 4073, 4075, 4079, 4090, 4093, 4102, 4104, 4135, 4150, 4222, 4224, 4245, 4263, 4275, 4277, 4286, 4293, 4315, 4322, 4333, 4384, 2126, 2933, 3398, 3457, 3518, 3520, 3565, 3756, 3757, 3812, 3810, 3836, 4033, 4253, 4346, 4376, 4380	1,6871	1,348		505	2,293	602	2,002	###	9	44	249	1,210	4,472	671			2,049	200	61	631	41	r:s/s
E	7	p/hs	1779, 1829, 1831, 1833, 1835, 1837, 1839, 1841	196				10		148	10					5					22		1		r:s
E	8	p/hs	1775, 1856, 1958, 1959, 1980, 2346	374			73				4	1				296									r:s
E	9	p/hs	1746, 1747, 1762, 1861, 1967, 2106, 2116, 2126, 2129, 2152	755			36	103		329	1					84				179	20		2	1	r:s
E	12	p/hs & pits	2428, 2445, 2446, 2447, 2460, 2461, 2473, 2474, 2475, 2528, 2546, 2961, 3010, 3140, 3417 2227, 2410, 3594, 4153	3,223							3				550	2,111				551			2	6	r:s
E	12	Iron Age ground surface	2225	42							15	1				26									r:s
E	16	p/hs	2241, 2286, 2302, 2304, 2324, 2368, 2395.1751, 2237, 2286, 2324, 2326	7							1	1				3							1	1	r:s
E	17	p/hs & pits	2264, 2384, 2408, 2466, 2276, 2342, 2344, 2382, 2389, 2441, 2448, 2347	15							2					11							1	1	r:s
E	18	p/hs	3525, 3529, 3543, 3553, 2736, 3547, 3581, 3591, 3600, 3642, 3644	73							1	1				69								2	r:s
E	19	p/hs & other features	2458, 2520, 2521, 2716, 2458, 2478, 2497, 2517, 2592, 2714, 2857, 2882, 2517, 2523, 3225	3,293				34		1,431	4	1	211	40	629	449				478	6		9	1	r:s
E	28	p/hs	2337	1												1									r:u
E	n/a	Other features	2293, 2312, 2323, 2329, 2334, 2367, 2417, 2418, 2712, 2877, 3137, 3593, 3596, 3597 and other deposits (2239, 2310, 3585, 3586)	129			1				4	1		20		94							3	6	r:s
U/S				13,390	1247		571	1,499	186	367	36	1		103	1,658	3,891	683	3		3,110	13		21	1	r:s/s

micro-debris diagnostic of smithing. The number of dumps is unexpectedly small considering both the scale of metalworking taking place and the wide area over which this activity was conducted. This would imply that the metalworkers at Culduthel did not typically clear out the metalworking areas and dispose of the debris away from the main area of activity (unless outwith the excavated area) but rather let the material accumulate in the vicinity of where the work was undertaken.

Spreads

The vast bulk of the ferrous metalworking debris from the site came from a series of spreads and deposits within the main craft-working zone beside House 10 (94.4kg; Table 6.19). Thirteen spreads of debris have been identified here and each comprises significant quantities of waste material distributed among charcoal-rich material, including waste diagnostic of both smelting and smithing. The spreads appear to represent accumulations of waste material from furnaces and hearths, and tend to be dominated by fractured pieces of bulk slags. As discussed above in relation to distinct dumps, it appears as though the common practice at Culduthel was to allow the slags to build up in the vicinity of the metalworking structures rather than clearing up after each successive firing and disposing of the slag outwith the immediate area. The taphonomy of these spreads is of interest: the most significant spreads in terms of the scale of the area covered and the quantity of material present come from contexts 798 and 1681. (It should be noted that context 798 comprised a particularly extensive slag-rich spread which was sampled in the field. The mass of ferrous metalworking waste thus represents only an unquantified sample of the total.) These spreads have accumulated in a natural hollow, leading to their preservation. This leaves open the possibility that the same density may have been present across more of the site but has over time been truncated by erosion and dispersed by successive hillwash episodes.

Secondary reuse

The deliberate reuse of slags as metalling and building material has been noted in nine locations across the site (Table 6.20). This typically involves bulk slags only, with a preference towards large, fractured pieces of plano-convex cakes from smelting or smithing, and rake-out material. Bulk slags of these types are fairly robust and would have been hard-wearing underfoot. Such slags appear to have been deliberately reused alongside stones and other material to form cobbled surfaces within roundhouse structures (e.g. within House 4 and House 10/3) and outside them (cobbled surface 1945 and 1679), or as building material within walls (such as contexts 1682, 1949, 2191 and 2477). This reuse appears entirely functional. There is no evidence or patterning to suggest that this material was incorporated for any symbolic or ritual purposes.

Residual

Small background quantities of waste material, usually micro-slags and small fractured pieces of bulk slags, were observed as low-density scatters over wide areas of the site (Table 6.21). This material, deriving from nearby in situ metalworking features, dumps and spreads, infiltrates most negative features on the site through a combination of soil creep, hillwash, human action and post-depositional slumping. The presence of a background scattering of smithing waste within the post-hole features of Houses 7 and 9, and Workshops 8 and 12, is of interest as no in situ smithing hearth or dump of material has been located in this area. It suggests that the focus for smithing in this area of the site is likely to have occurred outwith the excavated area.

Comparison to Culduthel Mains (CSE) assemblage

During excavation of an adjacent field at Culduthel (Phases 7 and 8) a further small assemblage of ferrous metalworking waste was recovered (24.5kg), comprising slags diagnostic of both smelting and smithing. No evidence for in situ ironworking in this area was present. This has been discussed in a separate publication (Cruickshanks and McLaren 2011) but is worth summarising here as it forms an interesting comparison to the current assemblage. The majority of the assemblage (18.4kg) represented a dump of smelting and smithing waste which came from a single pit (pit 036) situated on the edge of the south-west corner of the site. The pit had two distinct fills, suggesting deposition in two separate events. The upper fill has been dated to AD 770–990, indicating that metalworking at Culduthel continued into the Early Historic period.

Chemical analysis of a sample of the Phases 7 and 8 slags confirmed that the plano-convex slag cakes or bottoms identified during initial classification were the product of smelting within a non-tapped furnace. Like the assemblage at CDF, significant quantities of hammerscale (both flake and sphere) were found in association with diagnostic smelting waste. Many of these flakes and spheres were noted during initial visual inspection as atypical in size and shape for smithing debris, the slag spheres being large (over 3mm diam) misshapen globules and the flakes also being larger than expected. Analysis of these large slag spheres confirmed unusually high levels of manganese and iron oxide, suggesting that, rather than being the product of blacksmithing, these spheres may have been formed either due to overheating of the bloom in the primary furnace or during bloom-refining.

The average slag compositions of the slag from each site are indistinguishable (Table 6.13) and evidence for the manufacture of natural carbon steel blooms can be found in the examination of material from both areas. It is reasonable to conclude therefore that the iron manufacture at both sites took place within a single technological tradition and employed similar techniques and raw materials despite the chronological differences.

Beyond Culduthel: local parallels

Recent excavations have revealed a range of ironworking evidence from the Moray littoral. Furnaces at Tarras and Grantown Road, Forres,[1] are not yet published in detail (B Will, pers comm; M Cook, pers comm), but work at Seafield West, Inverness, uncovered a good range of smithing debris from a blacksmithing hearth dated to 180 BC–AD 70 (Heald et al 2011). In terms of the quantity of the slag, the most comparable assemblage comes from the Iron Age settlement at Birnie, near Elgin in Moray.

1 Editor's note: The excavation report of Granton Road, Forres has since been published in Scottish Archaeological Internet Reports as volume 61.

Post-excavation work is at an early stage but an interim study of the slag assemblage has been conducted (Cruickshanks 2010). At the time of writing, a minimum of 210kg of ferrous metalworking waste and associated vitrified material has been identified representing the residues from both smelting and smithing activities (ibid). Like Culduthel, much of the slag from Birnie appears to be residual or unstratified but four smelting furnaces and at least two smithing areas (represented by distinct spreads of hammerscale) are present. Their dating is not yet clear. Two of the Birnie smelting furnaces are stone-built and display a remarkable similarity to the Culduthel examples. In contrast are two clay-built smelting furnaces, which share no parallel with the furnace forms noted at Culduthel. Radiocarbon assays for these features and chemical analysis of the associated slag will aim to clarify whether these differences in form reflect a chronological and/or technological distinction.

Discussion

Several aspects of the Culduthel slag assemblage are unique within a Scottish Iron Age context, not least the volume of ferrous metalworking waste (over 337kg) and the quantity of identified smelting furnaces and smithing hearths, summarised in Table 6.18. The scale of iron production at Culduthel overshadows other known contemporary Scottish sites; the significance of this and its place in the broader context is discussed more fully in consideration of the artefact assemblage as a whole.

Slag morphology

The slag morphologies and micromorphologies show some similarities with prehistoric iron smelting from England (e.g. Dungworth 2007; 2011). In all of these cases the limited degree of flow to the slag and the microstructural evidence for slow cooling indicate that the slag formed inside the furnace and remained there until the smelt was completed. The slag was probably only removed from the furnace once it had completely cooled. The small size of most of the slag lumps and the limited evidence for flow all suggest that relatively small quantities of slag formed. This can be explained either by suggesting that the furnaces were charged with small quantities of ore, which would yield a small bloom and little slag, or that the ore used was so rich that it would form very little slag. It is most unfortunate, therefore, that no fragments of ore were recovered from the areas excavated.

Chemical analysis of the furnace bottoms and the vast majority of the bulk slags revealed that they contain significant proportions of manganese and as such are likely to have been produced as a result of iron smelting rather than iron smithing. Considerable variation in the chemical composition of the smelting slag samples was noted. This is typical of smelting slags produced in non-tapping furnaces. There were no correlations between overall slag morphology and chemical composition, and no meaningful differences between furnaces.

The product

Analysis of bloom fragments showed that natural steel was being produced consistently in the furnaces. This is a high-quality iron, and it is unfortunate that no evidence was recovered of the ore used. The slag inclusions on some of the iron objects that were analysed match the Culduthel slags, but others do not, indicating the use of sources beyond the site.

Aspects of methodology

This assemblage has afforded the opportunity to rethink aspects of classification of ferrous metalworking debris, highlighting that our traditional interpretations of some categories of slag are no longer suitable, or at the very least require reconsideration. This is particularly true of hammerscale, which has always been seen as diagnostic of smithing. At Culduthel (CDF and CSE), small flakes and spheres were identified among slags diagnostic of smelting, sometimes in furnaces, other times in pits associated with dumps of smelting debris. Initially these were identified as hammerscale from smithing. Further examination in comparison with conventional hammerscale elsewhere on the site indicated that some of the flakes and spheres associated with smelting were identical to the other hammerscale samples, but others were atypical, consisting of large flakes and large oval globules. Clearly, these were different but the process of their formation and their relationship to smelting was not well understood. Detailed chemical analysis revealed high manganese levels indicative of smelting rather than smithing. Secondary electron SEM images also helped to demonstrate that the flakes were actually films of slag that had formed between the fuel, and that the atypical spheres were hollow spheroids produced as the result of iron burning in the furnace, similar in form to those produced during fire-welding (Dungworth and Wilkes 2009, 44–5).

Within such a large assemblage of microresidues it was possible to compare these atypical flakes and spheres with normative hammerscale samples and to conduct limited chemical analysis. But in a smaller assemblage, would it be possible to distinguish by visual examination alone the difference between hammerscale and the flakes and spheres produced in a furnace? This question cannot be answered here, but the conclusion to be drawn from this methodological problem is that the presence of flake and spherical residues cannot, on their own, be taken as indicative of smithing. Where found in quantity, and in association with other debris from smithing, the classification of flakes and spheres as hammerscale is valid. But without associated diagnostic smithing slag and/or association with a hearth, flakes and spheres in small quantities are unreliable evidence for smithing.

Context

Ironworking at Culduthel cannot be considered in isolation as this was only one process in a suite of crafts being undertaken on site. Wider aspects of craftworking, including non-ferrous metalworking and glassworking, the significance of such activities within a settlement and aspects of status and importance of ironworkers will be discussed in the overview of the finds assemblage.

Iron artefacts

Fraser Hunter with metallographic analysis by David Dungworth

The ironwork from Culduthel is one of the largest Iron Age iron assemblages from Scotland, with over 150 finds weighing *c.*2.4kg.

In conjunction with the slag and furnace evidence, it gives us an all-too-rare picture of the entire ironworking cycle, from ore to artefact. The wide range of finds casts light on a spectrum of activities at the site, and includes many that are rare or unique: the range of tools (especially for metalworking – Illus. 6.44–6.46), the weaponry (a rare find on Scottish sites – Illus. 6.46) and an unusual linchpin (Illus. 6.47) all merit special mention, while the offcuts and unfinished items give a vivid picture of the blacksmithing process. After some general remarks, this discussion will consider the key functional categories in turn (summarised in Table 6.22) before looking at issues of metal quality, distribution, deposition and broader comparisons. Dating evidence is only mentioned specifically for significant objects; Table 6.27 summarises the dates for structures, which are discussed in detail elsewhere.

A key aspect of this assemblage has been its careful treatment, from field to laboratory. Too often, ironwork is not well treated on site, with fragmentation and corrosion due to careless excavation and poor storage; this is often compounded by a lack of conservation. In the case of Culduthel, the significance of the material was realised early in the process, with metal-detecting helping to maximise recovery. The entire assemblage was X-rayed (which was critical in assessing its significance), and a large proportion was conserved. This not only ensures the long-term survival of this important assemblage but also allowed (for instance) fine tools to be spotted at an early stage, rather than being ignored as probable nails; it also allowed the identification of substantial amounts of bloom, which would have been impossible without X-rays.

Table 6.22
Summary of functional categories in Culduthel ironwork, with numbers and total mass of iron

Functional category	No. items	Mass/g	Function/identification
Tools	27	636	Blacksmithing Bronze metalworking Leather-working Textile-working Wood-working Agriculture General (range of knives, including specialist ones)
Weapons	3	233	2 daggers, spear
Transport	1	77	Linch pin
Ornaments	4	9	Projecting ring-headed pins, hooked mounts
Fixtures & fittings	9	153	—
Nails	13	57	Range of small nails and tacks
Working evidence (63; 791g)	63	791	Offcuts (471g), working debris (41g), unfinished objects (169g), stock iron (110g) (bloom fragments catalogued separately)
Unidentified	32	422	Fragmentary material
Total (152; 2,379g)	**152**	**2,378**	

Key groups

The tools are a key assemblage, providing evidence for a wide range of on-site craft activities: iron- and bronzesmithing, wood-, leather- and textile-working, and agriculture (Illus. 6.44–6.46). Tools, in particular fine tools, can be hard to identify due to the effects of corrosion and damage: once the working tip is gone, identification is impossible. Some forms were shared between different materials; small punches, for instance, are used both in leather- and bronzeworking. Study is further complicated because tools would be made for the job in hand, and need not stick to rigid typologies. Table 6.23 provides a summary of the tool assemblage; detailed discussions of attributions are in the catalogue. Both iron- and bronzeworking are represented, as other evidence from the site confirms. Some tools could be used for both, notably the files SF0512 and SF0534 (Illus. 6.45), but the two sets (SF0352 – Illus. 6.44, SF1001 – Illus. 6.46) are typical items for hot-cutting iron (as the evidence of offcuts confirms – Illus. 6.49), while fine metalworking is represented by a range of tools. Most are concerned with decoration: two plausible scribers (SF0425 – Illus. 6.45, SF1013) for laying out designs; a graver SF0372 (Illus. 6.44) for engraving them; and a possible tracer (SF0357) for chasing them. The punch SF0366a (Illus. 6.44) could have been used for decorating either leather or bronze; the snips SF0540 (Illus. 6.46), a highly unusual find, might have been used for trimming sheet copper alloy, although their fineness suggests a more delicate role, perhaps for textiles or leather. The enigmatic tool SF0509 (Illus. 6.45) might be for shaping glass beads, though its broken condition makes this uncertain.

Woodworking is suggested by an unusually small axe SF0338 (Illus. 6.44); it may be a votive model, but these are typically in bronze rather than iron (Robinson 1995), and a role in delicate woodworking is more plausible. Textile-working is only securely attested by a single needle SF0334 (Illus. 6.44), but a range of finds stem from leatherworking. Awl SF0326 (Illus. 6.44) would be used to pierce holes for stitching, and modern analogies suggest the two triple-toothed handled tools (SF0371 – Illus. 6.44, SF1002 – Illus. 6.46) could have served to make perforations for decorative stitching (with thanks to Ann Wakeling for information on modern equivalents). They are especially interesting since they foreshadow a similar socketed form typical of the early medieval period. Embossing tool SF0429 (Illus. 6.45), with its bone handle, would have been used for decorating leather, emphasising its rarely considered artistic potential.

Agriculture, that vital element of daily life, is often poorly reflected in finds assemblages, but Culduthel produced two reaping hooks or sickles (SF082 and SF0510 – Illus. 6.45). Among the other material is a range of knives, all notably fine. The unusual form of one (SF1019), with its small, curved blade and angled shank, is reminiscent of items identified as surgical knives in Denmark (Frölich 2003). Curved knives were also used for leatherworking, to avoid ripping the hide, although these tend to

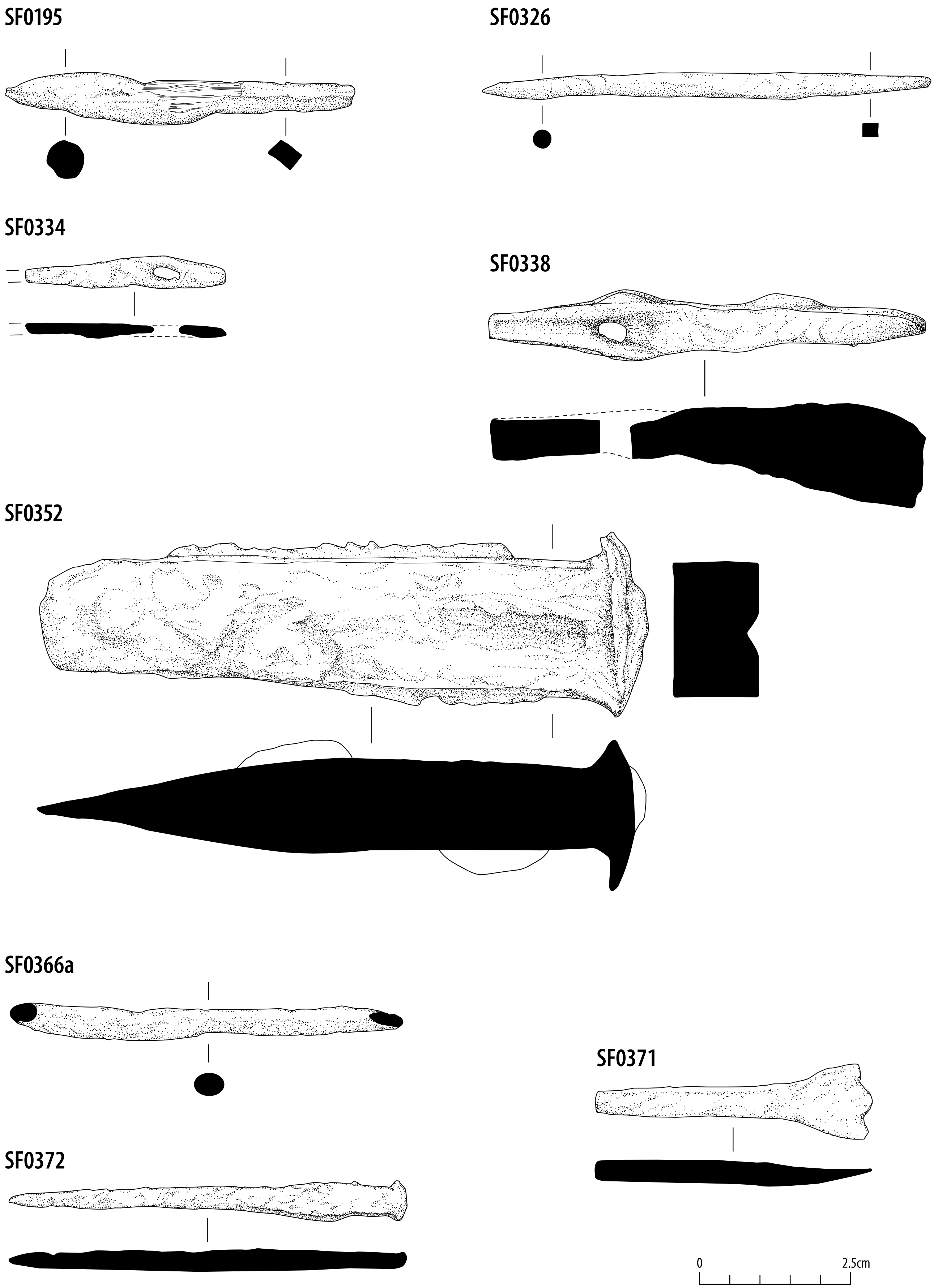


Illustration 6.44
Iron craft tools

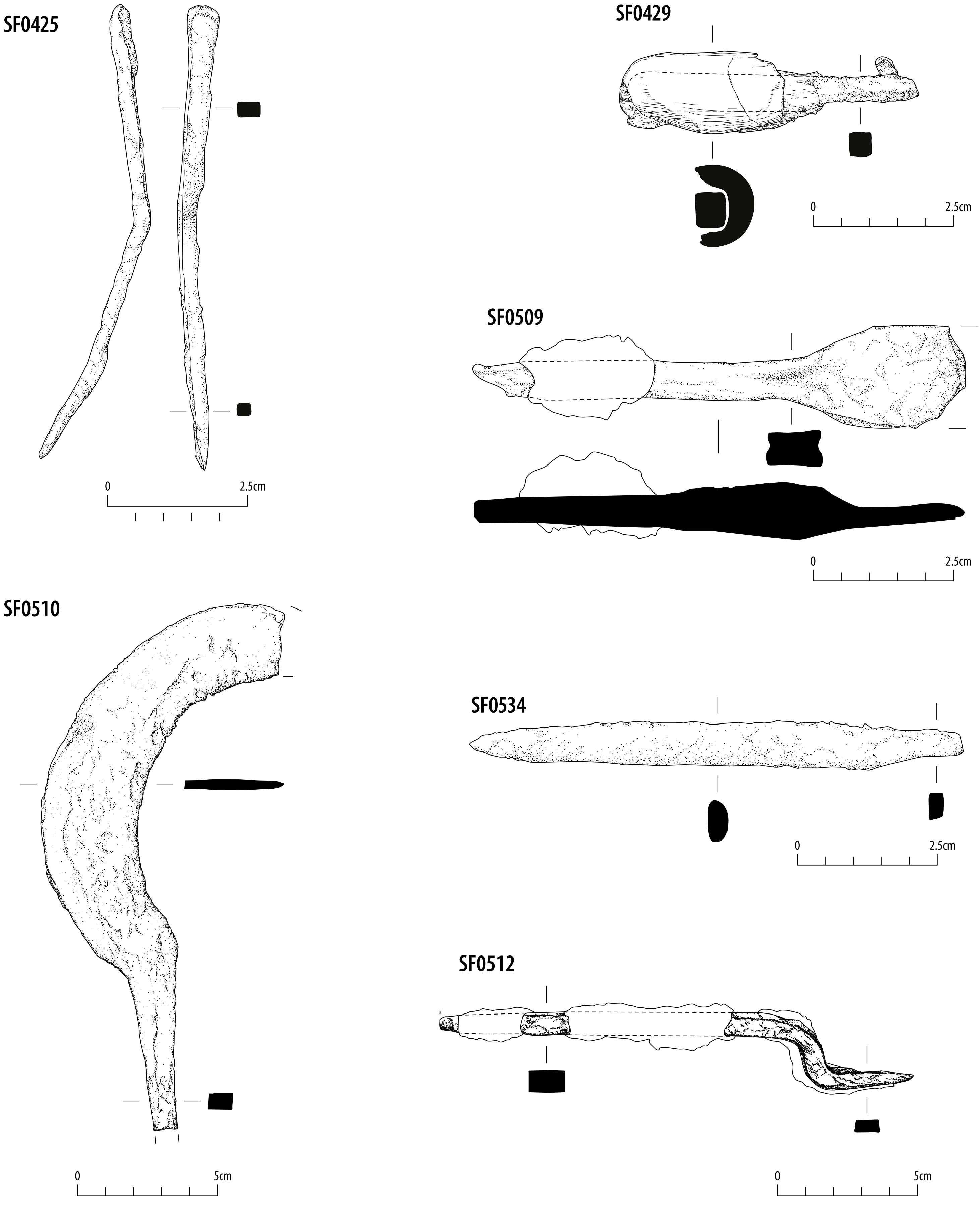


Illustration 6.45
Iron craft tools and sickle (SF0510)

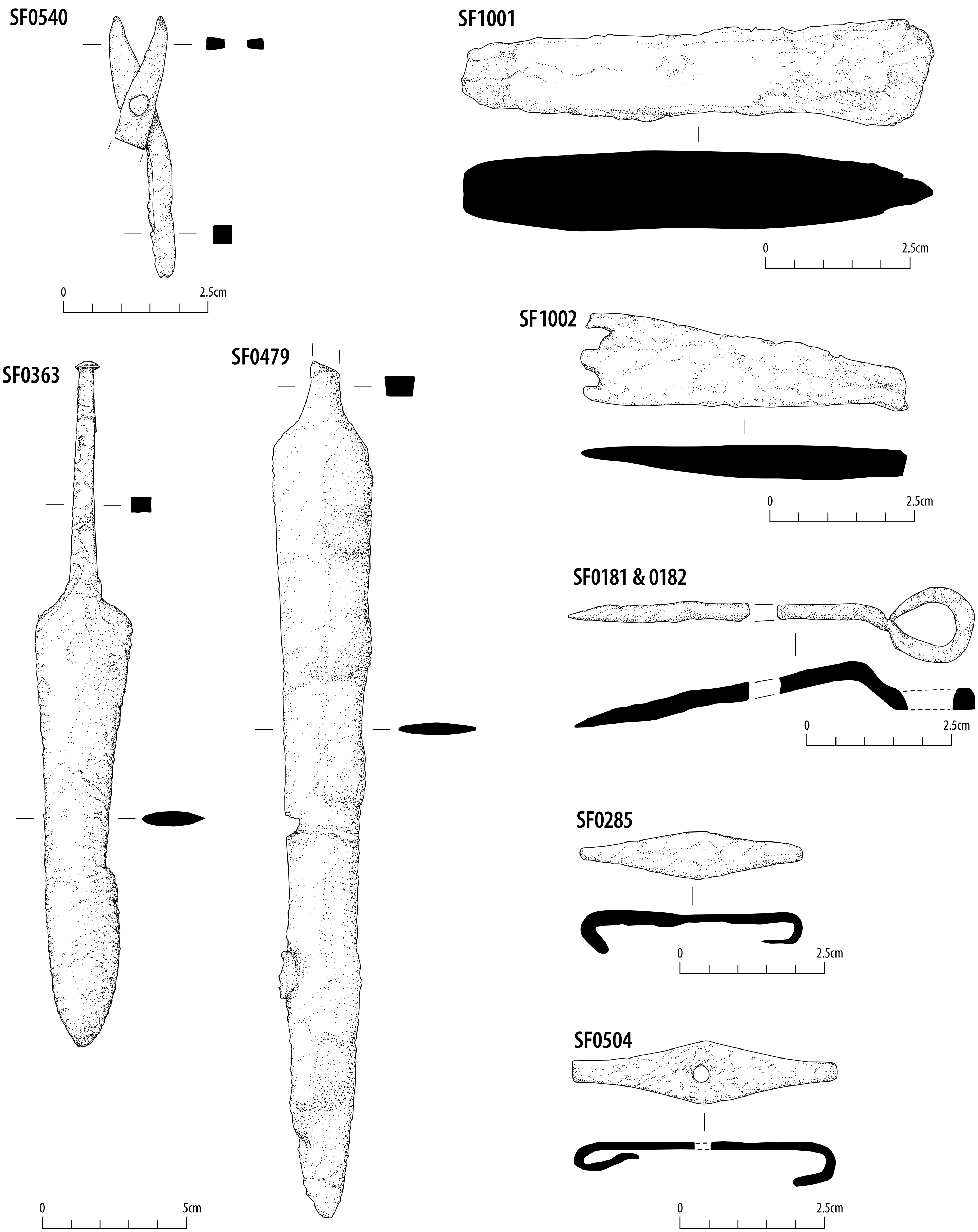


Illustration 6.46
Iron tools, daggers, pins and belt hooks

be larger (Manning 1985, 39); in technical terms, leatherworking and surgery are related, since both involve cutting skin, so similarities in tools are unsurprising. The size of this example points to a specialist task, either very fine leatherworking or medical treatment. The latter need not be far-fetched; Danish evidence points to some surgical knowledge there by the early centuries AD, and a small, curved bronze knife from Traprain could be interpreted as a lancet (Curle 1915, 188–9, fig. 37.1). Equally, ritual rather than medical practices could have a need for blood-letting.

Weaponry is represented by two daggers and a small spearhead. These are notably rare finds in a Scottish context, since there was no tradition of weapon deposition in much of Britain; thus, weaponry is generally only found as small, broken and discarded fragments (Hunter 2005b). The intact nature of these daggers strongly suggests they were deliberate, votive deposits (see below); other recent finds point to a tradition of dagger use and deposition in northern Scotland (Cruickshanks 2017). The two daggers differ markedly in size: the larger (SF0479 – Illus. 6.45), with a blade length of 277mm, falls within the size range for daggers rather than short swords (Stead 2006, 5); the smaller (SF0363; blade L 154mm – Illus. 6.45) was clearly a valued item, as considerable effort went into resharpening it after it sustained edge-damage. Their form is essentially similar, with sloping (campanulate) shoulders and straight sides tapering to a point. Such shoulders are typical of the pre-Roman Iron Age (Stead 2006, 13), and are reflected also in the copper alloy hilt guard from the site. This is confirmed by radiocarbon dates: SF0479 comes from a context dated to 160 cal BC–cal AD 60 (2σ % age probability) (GU-21923 2025 ± 35 BP), while SF0363, if associated with House 7, dates to 360–50 cal BC (2σ % age probability) (GU-21914 2140 ± 35 BP).

Table 6.23
Iron tools from Culduthel

Craft	Tools
Metalworking (iron or bronze)	Files 512, 534
Ironworking	Sets 352, 1001
Bronze-working	?Tracer 357 Graver 372 Scriber 425, ?1013
Leather-working	Awl 326 Toothed implements 371, 1002 Embossing tool 429
Textile-working	Needle 334
Wood-working	Miniature axe 338 (unusual form)
Agriculture	Reaping hook 82 Sickle 510
Knives	340a, 1019 (unusual form), 1196, 1209
Uncertain	Snips 540 (bronze, textiles or leather) Fine tool 195 (leather, bronze?) Punch 366a (leather, bronze?) Tang 1005 ?Glass-working tool 509 Unidentified fine blade fragments 1197, 1206

Daggers are most common in Britain in the late Hallstatt and early La Tène periods, overwhelmingly in south-east England (Jope 1961), yet there are later, more widely distributed but less well studied examples (e.g. Jope 1961, 339–41; Stead 1991, 71). Scottish examples come from Redcastle (Angus), Balloch Hill (Argyll), and a group from Lochlee (Ayrshire; Hunter 2005c, 85–6; Peltenburg 1982, 192, fig. 18.115; Munro 1882, 125–6); recent excavations have produced a number of other examples from Skye and Orkney (Cruickshanks 2017). Balloch Hill and Lochlee are poorly dated, but Redcastle dates from the 1st–2nd century AD. The Balloch Hill dagger has rather more angular shoulders, and the Redcastle one is broader, with a rounded tip, but one of the Lochlee ones is similar to thoses found at Culduthel, and the form finds parallels elsewhere (e.g. Rudston, East Yorks; Stead 1991, fig. 55 R 153).

The size of the small spearhead (SF1026) suggests it was a throwing weapon. There has been no systematic treatment of British Iron Age spearheads but similarly small, simple examples with rounded blades and a maximum width high on the blade are known from Iron Age contexts (e.g. East Yorkshire cemeteries, where they fall within Stead's type B2; fig. 124 no. 2, 7). SF1026 comes from Workshop 6, dated to 180 cal BC–cal AD 20 (2σ % age probability) (GU-21913 2060 ± 35 BP).

Transport is represented by a very unusual linchpin with a decorative fan-shaped head (SF0683 – Illus. 6.47), from House 10/3 (cal AD 50–240 (2σ % age probability) (GU-21933 1890 ± 35 BP)); this is paralleled only along the coast at Birnie (unpublished), and in Angus at Hurly Hawkin (Henshall 1982, fig. 7 no. 38, though not identified as such), suggesting it was a regional north-eastern type. As discussed in the catalogue, this serves as a reminder of how sparse our knowledge is of such finds outside the south of Britain. It also acts as a marker of the site's importance, as wheeled vehicles were prestige items at the time. This is reflected also in the copper alloy horse harness strap junction.

Ornamental material is sparse, comprising two pins and two mounts. Three pin fragments come from two pins, the recognisable one (SF0181 and SF0182 – Illus. 6.46) being a projecting ring-headed pin, the standard Scottish Iron Age type (there is also a copper alloy example from the site. They come from upper contexts in the dense industrial spreads to the east of House 10/3, not closely dated but probably 1st century BC–2nd century AD.

The assemblage also offers valuable insights into a previously unconsidered type of belt hook. These diamond-shaped fittings have two tangs on the reverse, one flattened to fasten the leather belt, the other forming an open hook (SF0285 and SF0504). Examples have been found elsewhere, in both iron and copper alloy (see Iron catalogue below). The hole in the centre of SF0504 probably held a decorative element. Their contexts (one from the industrial spreads, one perhaps linked to Workshop 19) would support a date of *c.*100 BC–AD 150.

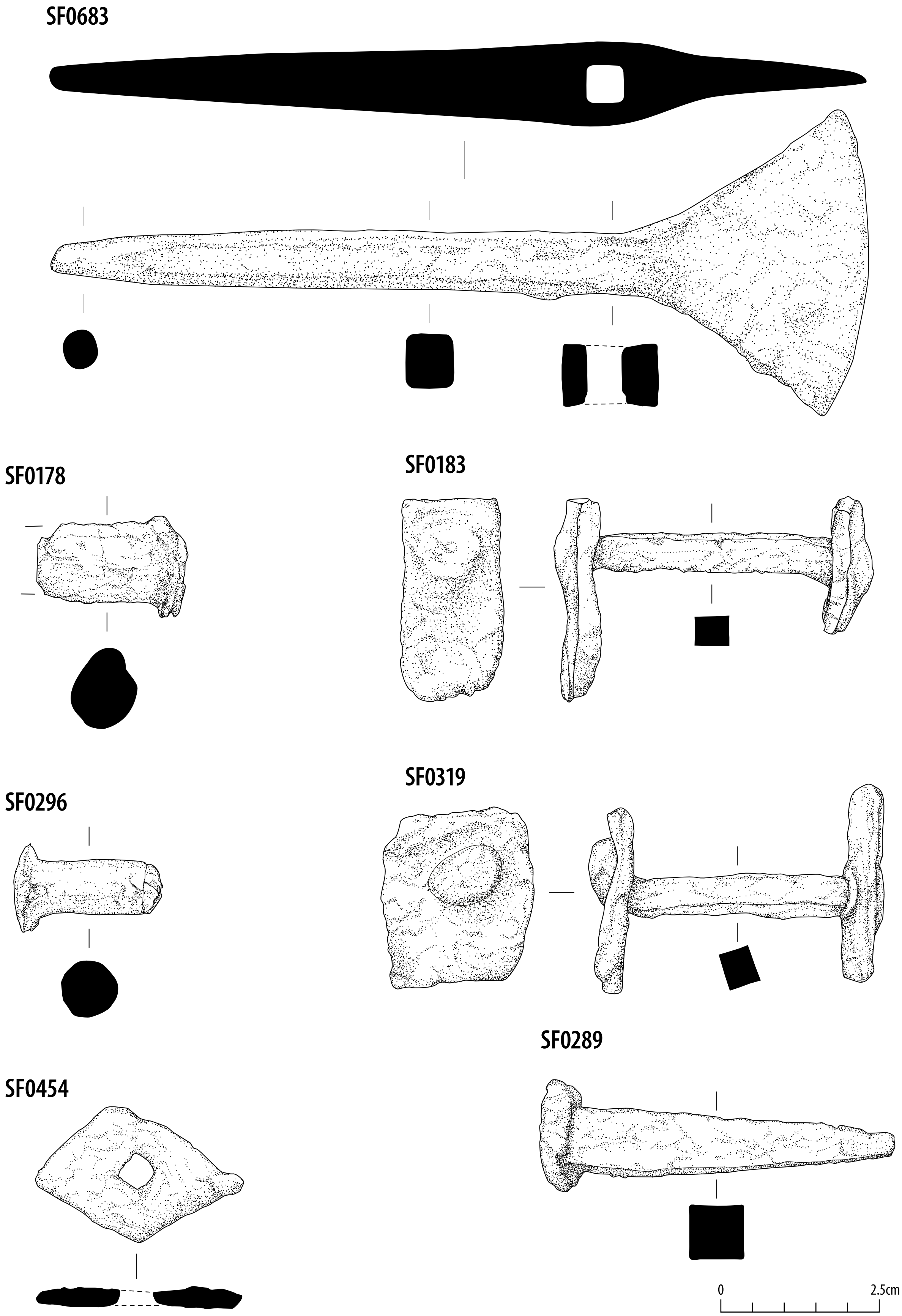


Illustration 6.47
Iron linchpin, holdfasts, bolts and a rove

Among the limited range of fixtures and fittings are a couple of holdfasts to secure timber joints 37–41mm thick (SF0183 and SF0319 – Illus. 6.47). The sparsity of nails is notable, with only 13 examples. This is a general Iron Age trend, with valuable iron being kept for more important roles, but other iron-rich sites such as Traprain Law and Fairy Knowe have larger amounts of nails (Table 6.28; Hunter 1998b, 366–7). Culduthel differs markedly from this, which suggests that the widespread use of nails depended not just on the availability of iron but also exposure to the concept of nail-based carpentry. Given that the bulk of activity at Culduthel predates Roman contact, it is tempting to see this as reflecting a lack of Roman influence in carpentry styles. The few nails and tacks present are notably fine (length varies from 20–60mm), and show considerable diversity of form: tapering, headless, narrow-headed, and tacks. This suggests an occasional and custom-made role rather than a habitual standardised use. Many are likely to come from fine furniture or other household items; the fine tacks SF1210–12 all have wood traces, indicating deposition while still within a wooden item.

The bulk of the remainder of material is concerned with ironworking (Illus. 6.48 and 6.49). Bloom fragments and offcuts are dealt with elsewhere, but the sheer quantity of offcuts is noticeable (>470g), while the bloom offcuts confirm on-site processing. The bulk of identifiable offcuts come from the ends of various forms of bars; this is unsurprising, as making a bar was a key stage in most products. Iron was also being recycled, and a number of reused items are recognisable: fragments cut from a joiner's dog, a knife, and perhaps a bolt (SF0178 – Illus. 6.47, SF0450 and SF0748). One of these, SF0450, shows the practicalities of recycling, with the end heated up and twisted with the tongs to give them a good grip while the iron was cut (cf. also SF0409 and SF1200). Another fragment, SF0434a, indicates more ambitious ornamental ironworking; it is a fine decorative branched terminal, broken and abandoned during manufacture.

Illustration 6.48
Unfinished iron. Top left: SF0287, top centre: SF0358a, top right: SF0294, bottom left: SF0435, bottom right: SF0522

The nature of the raw material

Fraser Hunter and David Dungworth

The metallographic examination, reported in detail elsewhere, has provided valuable information on the nature of the iron being produced. It is of notably high quality; analysis of bloom fragments showed these were consistently medium or hyper-eutectoid steels. Table 6.24 summarises the metallographic information on the artefacts, and the information from analysis of slag inclusions. This has interesting implications, not least that this locally made iron was not the only source being used; a number of the finished artefacts do not correlate with the local product in microstructure or slag inclusions. Indeed, one of the offcuts is a poor correlation, indicating the working of imported material or the reworking of broken items of non-site origin. It indicates we should be cautious in assuming that Culduthel was the predominant regional iron production centre; instead, it seems to have been one of several. Metallographic study was restricted to more fragmentary material, and thus covers few of the tools and weapons, although the knives that were examined showed no complex features. Unfortunately, the spearhead blade was too corroded to produce useful information. Work on other Iron Age material has shown these more specialist items did sometimes make preferential use of more carbon-rich alloys, or received more complex treatments such as tempering and/or quenching to alter their properties (Fell 1997 and1998; Lang 2006). There were no signs in the Culduthel radiographs of any complex structures or welds, but given the

Illustration 6.49
Offcuts

Table 6.24
Summary of metallographic and slag inclusion data

SF no.	Object	Metallography	Slag inclusion match to local slags
166	Offcut	Hyper-eutectoid steel	Moderate
188	Offcut	Low-carbon steel	Moderate
435	Unfinished/offcut	Low-carbon steel	Moderate
562	Offcut	Medium-carbon steel	Good
1012	Offcut	Medium-carbon steel	Poor
290	Bar	Medium-carbon steel	Moderate
1187	Bar	Hyper-eutectoid steel	No inclusions
86	Strapping	Plain iron	No match
340a	Knife	Low-carbon steel	No match
1209	Knife	Plain iron	No match
1026	Spearhead (socket)	Medium-carbon steel	Moderate
82	Reaping hook	(too corroded)	Moderate
282	Nail	(too corroded)	–

quality of the basic metal, these would be much less necessary than in regions where steel for cutting edges was scarce.

There has been little metallographic work on Scottish Iron Age iron, but the picture so far is one of diversity. Hutcheson's (1997) work comparing indigenous and Roman ironwork from southern Scotland suggested a distinction could be made between the two, with indigenous material characterised by greater numbers of slag inclusions, which tended to be more clearly aligned and more mixed; the finds also showed less indications of complex or composite construction. The results were intriguing but the data-set was relatively small, with only nine of the 15 items sampled being Iron Age. Subsequent work on the iron from Fairy Knowe, Stirlingshire, suggested a more complex picture, with the results contrasting with some of Hutcheson's findings (McDonnell 1998a). Here, the seven iron objects sampled were of good quality iron, with remarkably few slag inclusions, and included a tool of composite construction, with iron and steel welded together. The only other substantial programme of analysis comes from Pool, Sanday, Orkney; the sequence covered a large span of the Iron Age, but was predominantly of the later 1st millennium AD (McDonnell and Berg 2007). This analysis showed, among other things, the use of rather heterogeneous iron, although both steel and composite constructions were in use for blade tools. Otherwise, work has been restricted to specific items, such as the shaft-hole axe from Dun Ardtreck, which was a good-quality near-eutectoid steel (Photos-Jones 2000; contra this report, there is no reason to see the axe as Roman, since it is a well-attested Iron Age type (e.g. Vouga 1923, pl. XLIII no. 7–8)). The limited work so far thus suggests considerable regional (and probably chronological) variety, as might be expected. It also shows individual instances of complex blacksmithing procedures (the welding of different qualities of iron, and the heat-treatment of edges). The Culduthel work did not cover the kind of material that would be expected to use such techniques, but it did show the strikingly high quality of the raw material available to the smiths. It also shows the potential of extending such analyses to other sites.

Distribution

Most of the finds (around two-thirds) come from industrial spreads (mainly those located to the east and south-east of House 10/3). The remainder come from features (predominantly pits and post-holes, with only a few from ring-ditches; Table 6.25). This emphasises the importance of sites with surviving stratification as reservoirs of material culture: the buildings represented only by negative features have very few iron objects, and a high proportion of these are likely to be structured deposits rather than losses in use (below and Table 6.27). There are indications of both functional patterning and deliberate deposition in the material. Working debris is disproportionately represented in occupation layers, probably representing distance from use; it comes overwhelmingly from the area to the east and south of House 10/3 and adjacent or associated structures. The deposits seem to contain predominantly material lost or discarded in the

Table 6.25
Overall character of iron finds by context type

	Deposits	Features	Ring-ditches	Unstratified
Fragmentary/distorted	39	20	1	–
Intact	16	9	3	1
Working debris	54	5	4	–
Total	**109**	**34**	**8**	**1**

course of its use; thus there are more fixings and fastenings, while the tools are predominantly small items that could have been misplaced. There is an element of use-loss in features too, with assorted fragmentary material, but there are also other patterns. Intact objects are more common in features (including ring-ditches), tools from features are almost all larger, and they also produce more unusual items – all three items of weaponry, and a linchpin (Table 6.26). This points strongly to structured deposition, with the deliberate burial of material as foundation offerings (in post-holes) and when a building was abandoned or its use changed (for instance in ring-ditches). In some cases, these objects were in or adjacent to boundary locations such as entrances: sickle 510 at the rear end of the ring ditch in House 10/3; linchpin 683 in a post-ring post-hole near the entrance of the same house; and spearhead 1608 in an analogous situation in Workshop 6. Interestingly, the two daggers do not come from post-ring post-holes but from internal or external features (assuming they can be linked to the buildings around them); their connection to the building's life cycle is less clear. The vast majority of iron finds come from the spreads in the area to the east and south-east of House 10/3 or features under it, and must represent discards from activities in this zone. Much of it is connected with ironworking, but other crafts are also represented in this area, notably the decoration of fine metalwork (bronzework), glass and leather, confirming this was a multi-craft zone, not one solely connected with iron.

Broader comparisons

Table 6.28 provides a broad comparison with other large Iron Age assemblages from Scotland. This should be considered with caveats: it is clear, for instance, that not all the Traprain iron was retained (many nails were discarded), while in all cases, a significant amount (12–50%) could not be closely identified. There are also chronological differences: the bulk of the Traprain and all the Fairy Knowe material is Roman Iron Age (RIA), as apparently is Mine Howe, while Howe has a much broader span, with much of the assemblage being 1st millennium AD in date. There are, nonetheless, interesting similarities and differences. A key observation has been noted already; the rarity of nails from Culduthel, in contrast to those sites of Roman Iron Age or later date, suggesting markedly different practices of woodworking. It was suggested above that the use of nails is linked both to an increasing abundance of iron and to an awareness of their use from contact with Roman woodworking practice. In the case of Howe, only one nail predates the RIA, with a third being broadly RIA in date and the remainder later (Ballin Smith 1994, 216, table 6.26–6.28). The dominant feature of Culduthel, in contrast to the other sites, is the preponderance of working evidence; iron-smelting is attested at Mine Howe and Howe, and smithing at Fairy Knowe, but excavations did not locate the same scale of production as at Culduthel. Ornamental material is always rare (copper alloy was the main decorative metal), as are items of transport equipment and weaponry; only Traprain has a notable percentage of weaponry. Tools and items of domestic ironwork (fixtures, fittings and vessel parts) are the other frequent categories, although the range of tools differs. Traprain has a notably broad range, while the others, with smaller numbers, tend to be more restricted (and less representative?). In part this represents the activities in the excavated areas. Mine Howe shows a focus on fine tools for decorating metal, consistent with the discovery of many in the workshop area, while Fairy Knowe produced a range of specialist tools indicating a range of craft processes. Howe, by contrast, produced primarily knives, with few specialist tools, suggesting essentially domestic activities. It is harder as yet to present detailed regional comparanda, although the publication of the finds from Birnie, and the publication of doctoral research on the topic by Gemma Cruickshanks (2017), will assist with this in the longer term. The only other sizeable assemblage from the Moray Firth is Birnie, with over 150 objects, at the time of writing not yet studied in detail. Other published or recently excavated sites are notable for their lack of iron. There are no iron finds from Grantown Road,

Table 6.26
Material categories by context type; intact objects (left), fragmentary objects (right)

	Intact			Fragmentary		
Material category	**Deposits**	**Features**	**Ring-ditches**	**Deposits**	**Features**	**Ring-ditches**
Fixture/fitting	4	–	–	4	1	–
Nail/tack	2	3	–	5	3	–
Tool	8	1	3	8	5	1
Ornament	2	1	–	1	–	–
Weapon	–	3	–	–	–	–
Transport	–	1	–	–	–	–
Unidentified	–	–	–	21	11	–
Totals	**16**	**9**	**3**	**39**	**20**	**1**

Table 6.27

Find categories by structure. This includes, in the case of House 10/3 and Workshop 15, material from overlying deposits. Finds from features within the extent of the structures are counted with that structure, though it is not always clear that they are connected. Asterisked structures are those underneath or immediately adjacent to the industrial spreads. Spread F = features under industrial spreads. Other F = other features.

	House 4	**Workshop 6**	**House 7**	**House 9**	**House 10/3***	**Workshop 11***	**Workshop 12**	**Workshop 13***	**Workshop 15***	**Workshop 19 and Post-hole [2416]**	**Hearth 26***	**Cobbled surface 227**	**Other F**	**Spread F**	**Spreads**
Fixture/fitting	—	—	1	—	1	1	—	—	—	—	—	1	—	—	5
Nail/tack	—	—	—	1	1	1	—	—	1	—	1	—	1	—	7
Tool	2	—	—	1	3	5	—	—	—	—	1	1	2	2	9
Ornament	—	—	—	—	—	—	—	—	—	1	—	—	—	—	3
Weapon	—	1	1	—	—	—	—	—	—	1	—	—	—	—	—
Transport	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
Ironworking - offcut	1	—	—	—	7	3	—	—	1	—	—	—	2	2	30
Ironworking - debris	—	—	—	—	1	—	—	—	—	—	—	—	—	—	5
Ironworking - stock iron	—	—	—	—	1	—	—	1	—	—	—	—	—	—	4
Ironworking - unfinished	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
Unidentified	—	—	—	1	3	1	1	2	—	—	—	—	4	3	17
Total	3	1	2	3	18	11	1	3	2	2	2	2	9	7	85
Date bracket															
(95%)	AD 80–240	200 BC–AD 1	360–50 BC	360–120 BC	AD 30–230	90 BC–AD 90	110 BC–AD 70	40 BC–AD 130	40 BC–AD 120	160 BC–AD 60?	—	AD 130–340	—	—	350 BC–AD 90+

Table 6.28

Comparison of major Scottish Iron Age ironwork assemblages

	Culduthel	**Fairy Knowe**	**Mine Howe**	**Traprain**	**Howe**
Tool	27	13	11	76	2
Weapon	3	3	—	40	—
Transport	1	1	—	6	—
Ornament	4	2	1	2	5
Fixture & fitting, domestic	9	6	7	49	6
Nails	13	192+	9	'a great many'	30
Working evidence	63	—	4	—	12
Unidentified	32	30	25	68	63
Other	—	—	—	19	6
Total	**152**	***c*.250**	**57**	**260+**	**124**

Forres (despite smelting evidence from the site), Seafield West or Balloan Park, and only three fragments from Seafield West (M Cook, pers comm; Hunter 2011b; Wordsworth 1999). Similar sites further afield in the north-east are likewise sparse, with no iron from Romancamp Gate (Fochabers) or Wardend of Durris (Barclay 1993; Russell-White 1995). Even the large-scale excavations at Kintore produced no prehistoric iron finds (Hunter and Heald 2008).

This leads on to two key aspects in considering iron. One is the issue of survival. Most of the sites quoted as comparanda are plough-truncated cropmark sites. It is clear that the presence of surviving deposits is key to recovering good assemblages. Of the Culduthel ironwork, 77% came from deposits or ring-ditches and only 23% from features; even on this rich site, barely half of the roundhouses produced iron objects, and only well preserved House 10/3 produced more than three finds. As noted above, a significant number of finds from features are best seen as deliberate deposits, not accidental inclusions. They thus represent a highly partial sample of the iron in use. Coupled with the generally poor survival of iron in Scotland's acidic soils, this makes for a very limited picture of iron in the Iron Age. The rich assemblage from Culduthel is thus a highly significant assemblage. While survival is a key issue, chronology might also be important. It is notable, for instance, that the bulk of the Kintore sequence predates Culduthel (Cook and Dunbar 2008, 317–21). It seems that iron was genuinely rare (or at least restricted) for most of the Iron Age, with production only increasing in the last century or so BC. Thus, the large and sustained scale of production and use at Culduthel would represent the beginning of an iron-rich Iron Age. This is perhaps seen in the Moray Firth region by other production evidence, such as the furnaces and slag piles at Birnie, Clarkly Hill, and at two Forres sites, Grantown Road and Tarra (Will 1998b, 66; Cook 2003, 109; Cook 2008, 123; Cook 2010a, 124).

Conclusion

The Culduthel iron assemblage is of value not only for the light it casts on activities at the site, but as a fundamental reference point for future studies. This arises from the scale of the assemblage, with a variety of unusual and unique finds, and the fact that the material is well dated, with much of it late pre-Roman Iron Age in date. Clearly a wide range of crafts was practised, but the discovery of the tools themselves is all too rare. The extent of iron manufacturing evidence, from ore to artefact, is another rare opportunity, and metallographic work has shown the quality of the raw material being produced – medium-carbon or hyper-eutectoid steels. Other finds stress the status of the inhabitants, such as the daggers and linchpin; these are rare, and indicate a site of above-average importance.

Iron catalogue

Tools

SF082 Blade of a reaping hook; where it is broken the section is more rectangular, indicating it had a flat fitting (probably an open socket, the edges turned round to grip a handle) with the blade angled at *c*.45°. Slightly curved blade and edge, the latter angled a little up at the tip. A slight bend to the blade indicates it was damaged when deposited. This is a well-known Iron Age type that continued into the Roman period (Rees 1979, 450–5); something of the diversity of forms is illustrated in Rees (1979), figs. 189–171. L 99, W 23, T 5mm; 30.0g. See Table 6.24 for results of metallographic analysis. (225), deposit overlying cobbles [context 227]; context dated cal AD 130–340 (95%).

SF0195 Unidentified fine tool. Rectangular-sectioned bar, the tip broken. The tang tapers to a point with traces of a wooden handle surviving for 39mm. This suggests it was a fine handled tool such as a metal-decorating tool or an awl. L 58, section 4 × 3mm; 4.4g. (871), fill of ring ditch [context 1715], House 4. (Illus. 6.44)

SF0326 Awl. Circular-sectioned shank tapering to a fine point, the extreme tip lost; swells to retain a handle at about two-thirds of its length, above which is a rectangular-sectioned tang tapering to a rounded end. 74.5 × 4 × 4mm; 3.5g. (1681), post-abandonment deposit in area to east/south-east of House 10/3. (Illus. 6.44)

SF0334 Needle with flattened, diamond-shaped head and oval perforation (4.5 × 2.5mm); very end of tip lost, whole object slightly curved longitudinally. Its width suggests a role for textiles rather than leather. L 33, W 5.5, T 2mm; 0.6g. (1681), post-abandonment deposit in area to east/south-east of House 10/3. (Illus. 6.44)

SF0338 Miniature axe with long narrow blade expanding from the squared butt to the slightly down-turned tip. Swollen around the square perforation for the handle, slightly off-centre and countersunk on one side. Its size might suggest a toy or votive miniature, although known examples of these are in bronze. More plausibly it is a specialist tool for very fine work; its handle socket is very small, although the end of the handle may have been whittled to a peg to fit. L 73, W 16, T 10mm; 23.7g. (1671), post-abandonment/decay deposit overlying House 10/3 (thus post-AD 50–240). (Illus. 6.44)

SF0340a Tip of fine knife blade. Parallel-sided blade, the back angled to the slightly rounded tip. L 32.5, W 9.5, T 1.5mm; 1.6g. See Table 6.24 for results of metallographic analysis. (2102), spread of dark-brown silt with burnt clay, deposit in area to east/south-east of House 10/3.

SF0352 Blacksmith's set. Square-sectioned heavy shank tapering to a fine, slightly rounded chisel edge. The head is expanded and burred from striking; a channel on one side below the head is probably from manufacture. Its length indicates it was held with tongs rather than by hand, thus making it a set rather than a chisel (Manning 1985, 8–9). L 105, head 30 × 24, shank 22.5 × 14mm; 176.5g. (1896), occupation deposit in area to east/south-east of House 10/3. (Illus. 6.44)

SF0357 Fine tool – metalworking tracer? Rectangular-sectioned shank, one end (tang?) rounded, the other forming a symmetrical cutting edge affected by damage; thus its original form (and function) are unclear, although it is plausibly a tracer for chasing designs in non-ferrous metalwork (cf. Maryon 1938; 1971, 118–22; Lowery et al 1971, 173–4). 73 × 5 × 3.5mm; 3.5g.

(2100), abandonment phase associated with the industrial use of Workshop 11.

SF0366a Tool – punch? Rod with a blunt tip at one end and slight taper to the other, which is apparently rounded, although a corrosion bubble has destroyed it. Probably originally handled. L 66, D 5mm; 5.03g. (2155), main fill of ring-ditch [context 2215], House 10/3.

SF0371 Triple-toothed tanged tool, probably for creating slits in leather for stitching, based on analogy with modern tools. The rectangular-sectioned tang with a squared end expands into a broader, thinner head with three rounded teeth cut into the edge, the central one being largest; one is broken. This and SF1002 appear to be early versions of an enigmatic socketed type known in the early medieval period from Scotland, Ireland and Wales, whose function has been much discussed (Craw 1930, 117, fig. 5.7; Nicholson 1997, 425; Laing 1975, 296; Hencken 1938, 52–3; Redknap 2000, 83). Roles in textile production (in tensioning the cloth) or leather production have been suggested, inter alia. The latter seems most likely; a similar tool from the Iron Age site at Sorte Muld, Bornholm, Denmark was interpreted as a leather-decorating tool (Lund Hansen 2009, 87), and similar tools are used today for piercing leather to make regular rows of holes. The Culduthel examples suggest Scottish origins for the subsequent early medieval development of the type. L 46; shank L 34, section 5 × 4.5; head W 12.5mm; 4.6g. (2100), abandonment phase associated with the industrial use of Workshop 11 (*c*.60 BC–AD 90).

SF0372 Graver. The parallel-sided shank (a tapered rectangle in section) tapers asymmetrically in a concave curve to a strong tip, triangular in section as it survives. Below the head the shank swells, probably for a finger grip; there is then a short rectangular-sectioned length leading to a narrow mushroom-shaped head, the long axis of this upper section being perpendicular to the lower shank. The form is suited for gripping between the fingers; the form and fineness of the head indicates it is designed for striking gently, suggesting use as a graver for fine metal-working (for such tools, see Maryon 1971, 152–3; Lowery et al 1971, 172). L 66, shank 6 × 2.5 / 4.5 × 3.5, head 7 × 2.5mm; 3.5g. (2100), abandonment phase associated with the industrial use of Workshop 11.

SF0425 Fine tool, perhaps a point or scriber. Thin bent bar, one end tapering to a fine point, the other expanding to a rounded tip. The point could be seen as a tang, but the rounded tip is an unlikely working end, and it is more likely that this is a point or scriber for use on leather or fine metalwork, with the end blunted and expanded for comfort in the hand. The bends indicate it was no longer in use when deposited. L 83 (straight L 86.5), bar W 3–4, head W 5.5, T 3mm; 3.4g. (2152), fill of post-hole [context 2151], House 9. (Illus. 6.45)

SF0429 Blunt-tipped point with bone handle, probably an embossing tool. Square-sectioned bar with blunt, rounded tip, tapering to a rounded tang. Remains of a cylindrical bone handle leaves 18mm of the tip exposed. The handle implies a hand-held tool, perhaps an embossing tool for leather as it seems too short to apply the necessary pressure for use on metal. A small, curved iron bar fragment (7.5 × 2.5 × 2.5mm) is attached by corrosion, not part of the object. L 54, tool W 4.5, handle L 36.5, D 15mm; 8.7g. (2101), hillwash in area to east/south-east of House 10/3. (Illus. 6.45)

SF0509 Unidentified tool. Tang with remains of burred end to retain a handle; expands and thickens along its length, then flattens into a blade with sloping shoulders and rectangular section. The end is lost (and thus identity uncertain); it could be a fine tanged chisel, although the blade is rather thin; hints of a bevel at the broken end might indicate an asymmetrical edge, but could simply arise from damage. Another possibility is that it is a glassworking tool, used to roll heated glass beads to shape (cf. Lane and Campbell 2000, 164, illus. 4.76); again, too little survives to be certain. L 89; tang L 63, W 6, T 10; blade W 18.5, T 4mm; 25.1g. (2471), sandy deposit south west of stones [context 2456], in area to east/south-east of House 10/3. (Illus. 6.45)

SF0510 Balanced sickle, the tips of both the blade and the rectangular-sectioned tapering tang lost (the former was present upon excavation, but subsequently lost). Scattered organic traces (grass) are present across the blade. L 195; tang 57 × W 8–16 × T 5; blade W 35, T 3.5mm; 111.0g. (2232), fill of ring-ditch [2215] (2155), House 10/3 (AD 50–240). (Illus. 6.45)

SF0512 File with offset handle. The rectangular-sectioned parallel-sided blade tapers at the very end to a squared tip; no teeth survive, making it impossible to say whether it was for wood or metal, but the latter is more likely as the teeth are finer and more readily lost to corrosion. The handle (offset by 20mm) thins to a rounded tip, with vestigial traces of a bone handle; there are intermittent traces of other organics at various points. Such cranked handles are rare but not unknown in the Iron Age (Fell 1997, 90). L 176, blade L 128, W 14, T 7.5mm; 105.0g. (1715), fill of ring-ditch [context 1716], House 4 (AD 70–240). (Illus. 6.45)

SF0534 File. Short rectangular-sectioned tang with squared end, expanding gradually into a slender parallel-sided blade tapering to a pointed tip. Sub-rectangular section, sides angled, broader face rounded, narrow face flat, tip plano-convex in section. Only hints of teeth survive on the broad face (the narrow one is obscured by corrosion); teeth are also visible on the sides, slanting forward on one side and back on the other, spaced at around 12 per centimetre, which indicates use in metalworking. L 89, W 8, T 4, tang L *c*.15mm; 7.3g. (2542) fill of post-hole 2541 associated with Hearth 2434. (Illus. 6.45)

SF0540 Pair of fine snips. The two sinuous arms are held by an iron rivet; one arm lacks the handle end and is markedly thinner, with a flat section; the other is thicker with a rectangular section and rounded end. X-rays indicate a second rivet hole on this arm nearer the tip, suggesting a repair, perhaps with the thinner arm being a replacement. Such snips could be used in various crafts, from textiles or leatherworking to fine metalworking. L 46, W 10, T 6; intact arm W 5.5, T 3mm; 3.3g. (2435), sandy spread, possibly hillwash after abandonment, in area to east/south-east of House 10/3. (Illus. 6.46)

SF1001 Blacksmith's set. Square-sectioned bar, tapered slightly to a squared striking end; the expanded blade edge is slightly angled, perhaps from wear. Its shortness suggests it was held with tongs, and thus is best seen as a set rather than a chisel (Manning 1985, 8–9). L 83, shank W 13, blade W 18.5mm; 63.0g. Unstratified.

SF1002 Three-toothed tanged tool, probably for leatherworking. Rectangular-sectioned bar tapering to the broken tang tip; poorly preserved organics in the corrosion imply the former presence of a handle, the material unclear, which finished *c*.12mm short of the working edge. This is expanded, thinned and slightly convex, with two U-shaped slots defining three teeth, the outer two slightly sloping, the central one slightly rounded. See discussion under SF0371. L 58, W 16, T 5.5mm; 13.1g. (2187), silty deposit underlying hillwash (2101) and dump of fire-cracked stones (2186), in area to east/south-east of House 10/3 (context 50 BC–AD 50). (Illus. 6.46)

SF1005 Tang. Fine rectangular-sectioned bar tapering gently to a rounded tip, the other end broken. Poorly preserved organics in the corrosion stem from a bone or antler handle. 54.5 × 5.5 × 4mm; 7.0g. (2731), fill of post-hole [2730] Hearth 2434.

SF1013 Tool, square-sectioned (and thus probably not an awl), tapering to fine point. Head lost. Perhaps a scriber, for fine metalworking? 41 × 3.5 × 3.5mm; 1.7g. (798), spread of industrial waste, in area to east/south-east of House 10/3.

SF1019 Fine triangular blade with a curved cutting edge and angled, broken tang or shank. The blade is plano-convex in section. Its form suggests a specialised use. Curved blades were used for leatherworking, but this is rather small. It is reminiscent of surgical implements, known in an Iron Age context from Denmark (Frölich 2003). L 23, W 13.5, T 4; tang 4 × 4mm; 2.7g. (2187), silty deposit underlying hillwash (2101) and dump of fire-cracked stones (2186), in area to east/south-east of House 10/3 (*c*.50 BC–AD 50).

SF1196 Small knife blade, lacking tang; convex back and blade edge, rounded tip. L 52, W 16.5, T 4mm; 9.7g. (2191), possible waste deposit, Workshop 11.

SF1197 Possible blade tip with straight edge and curved back. L 25, W 17, T 3mm; 9.4g. (3741), fill of post-hole [3740], in area to east/south-east of House 10/3.

SF1206 Fine ?blade tip; near-flat lenticular section, rounded tip. 18.5 × 7 × 1mm; 0.2g. (3151), fill of post-hole [3150], Hearth 26.

SF1209 Knife tip, ?snapped/cut square. L 49, W 14, T 4.5mm; 9.2g. See Table 6.24 for results of metallographic analysis. (4286), fill of post-hole [4287].

(See also SF0450, an offcut of a knife blade.)

Weapons

SF0363 Short dagger. The square-sectioned tang with burred tip appears to hold a small square washer to retain an organic handle. It leads into a sloping-shouldered blade, originally with converging straight sides that taper more rapidly at the tip. Damage to one side has led to resharpening, creating a broad notch. Extensive brown corrosion on one side is probably from leather, suggesting it was deposited in a sheath. Any hilt guard must have been organic; no trace survives. L 236; tang L 82, W 9, T 6; washer 8 × 8 × 0.5; blade L 154, W 34.5, T 6mm; 72.0g. (1929), fill of post-hole [1898] within House 7 (360–50 BC; though not necessarily connected to this post-hole). (Illus. 6.46)

SF0479 Long dagger, much of tang lost in recent break, otherwise intact. The rectangular-sectioned tang expands gradually into the sloping shoulders of the lentoid-sectioned blade, its straight sides tapering gradually to the point. The blade has no midrib or other features. Occasional organic traces survive, rather amorphous and without any obvious regular pattern; there is no trace of any scabbard or handle. L 296; tang L 19, T 10, T 7; blade L 277, W 34, T 6.5mm; 122.1g. See Table 6.24 for results of metallographic analysis. (2416), fill of post-hole [2419] within (but not necessarily connected to) Workshop 19; placed vertically, point down, against post pipe (context dated 120 BC–AD 60). (Illus. 6.46)

SF1026 Spearhead, probably a light throwing spear. Split socket leads into a short, rounded ovoid blade with the tip and much of one side damaged; however, the curve of the intact side indicates that no more than 5mm was lost, and this would always have been a rather small stumpy spearhead. L 87; socket L 44, W 19, internal D 15; blade L 43, W 34, maximum width at *c*.44% of blade length; 39.5g. (1608), upper fill of post-hole [1607], Workshop 6 (structure dated 180 BC–AD 20).

Ornaments

Pins

SF0181 and **SF0182** Projecting ring-headed pin, in two non-joining fragments. The slightly oval head is formed from square-sectioned wire, leaving a teardrop opening; it is angled forward from the plane of the shank. Overall L 66; head H 14.5, W 13.5, T 3.5; shank D 3mm; 3.6g. (798), spread of industrial waste, in area to east/south-east of House 10/3. (Illus. 6.46)

SF0286 Pin shank fragment, circular-sectioned, broken at both ends. The narrower end preserves the beginning of a slight bend, perhaps at the tip. L 31.5, D 3mm; 1.2g. (1681), post-abandonment deposit in industrial area, in area to east/south-east of House 10/3.

Hooked mounts

The two lentoid or diamond-shaped mounts from Culduthel can now be recognised as an established type, with a broad east/north-east Scottish distribution, and a related outlier from Roman Carlisle with a rounder profile and decorative notched edge. Their form indicates they are belt-hooks, with the leather clenched in the closed hook and the open hook acting as fastener. Parallels are known from Fairy Knowe (Stirlingshire), Shanzie (Perthshire), Clarkly Hill (Moray) and Carlisle in copper alloy, Traprain Law (E Lothian) in both copper alloy and iron, and Birnie (Moray) in iron (Hunter 1998a, 339, fig. 18 no. 48a; Coleman and Hunter 2002, 90, illus. 19.5; unpublished; McCarthy 1990, fig. 112 no. 64; Curle and Cree 1916, 120, fig. 34 no. 10; Cree 1923, 194, fig. 9; unpublished). They consistently show differences between the two arms, with one being flatter than the other, or shorter. Typically one is turned against or parallel to the plate to retain the leather belt, while the other forms a hook. Finds so far indicate a broadly Roman Iron Age date; the Culduthel examples support this, but with earlier origins; SF0285 comes from a late layer in the industrial area in area to east/south-east of House 10/3. (?1st–2nd century AD), but 504 came from a pit probably connected to Workshop 19 (120 BC–AD 60?).

SF0285 Belt hook. Narrow lentoid mount, the ends narrowed to points and turned under; one is broken at a 45° angle, suggesting use as a hook. The one that clasped round an organic object such as a strap gives a thickness of 3mm for this substrate. L 39, W 8.5, H 6mm; 1.8g. (1681), post-abandonment deposit, in area to east/south-east of House 10/3. (2nd century AD?). (Illus. 6.46)

SF0504 Belt hook. Narrow lentoid-shaped object with a central cylindrical perforation (D 3mm), presumably either for a more secure fastening or a more decorative fitting. The ends taper to blunt points and are turned back on themselves, one flattened against the rear, the other forming a hook. L 46.5m W 11, T 8mm; 2.5g. (2458), fill of pit [2457], Workshop 19. (Illus. 6.46)

Transport

SF0683 Linchpin. Rectangular-sectioned shank, the edges facetted to avoid damaging the wood, tapering to a blunt tip and expanding into a fan-shaped head; a square transverse perforation (W 5mm) immediately below the head is a recurring feature of linchpins, designed to retain a securing cord (Stead 1991, 46–7). Although the identification is secure, the form of the head is unusual; it may be related to crescentic-headed linchpins, a well-known Iron Age type (Manning 1985, fig. 72), but the only parallels known to the writer are a recently excavated example from Birnie, Moray (unpublished) and a previously unrecognised example from Hurly Hawkin, Angus (Henshall 1982, fig. 7 no. 38). This reflects our poor knowledge of northern vehicle gear, in the absence of a tradition of burials and hoards; another recent linchpin find, from Phantassie in East Lothian, was also a unique specimen (Hunter 2007f). L 132; head W 48, H 33; shank section 9 × 13.5mm; 76.5g. The hole is 86mm from the tip, allowing an axle diameter of some 70mm. (3633), postpipe of post-hole [3632], House 10/3 (AD 50–240). (Illus. 6.47)

Fixtures and fittings

SF086 Strapping fragment; rectangular-section bar, end squared and slightly rounded off, with a square perforation (W 5mm) near one end, the other broken. 64 × 24 × 5mm; 25.3g. See Table 6.24 for results of metallographic analysis. (255), fill of post-hole [254].

SF0178 Bolt head; circular section with slightly expanded, flattened sub-circular head. A deliberate cut through the shank implies reuse or repair. L 25; head D 14; shank D 10–11mm; 10.0g. (798), spread of industrial waste, in area to east/south-east of House 10/3. (Illus. 6.47)

SF0183 Holdfast. The tip of the square-headed nail is burred to hold a rectangular rove. This is notably and deliberately off-centre, suggesting it was intended to project, perhaps to retain something that was slotted in. Nail L 52, head 20.5 × 17.5, shank 5.5; rove 32 × 17 × 4; timber thickness 41mm; 22.3g. (798), spread of industrial waste, in area to east/south-east of House 10/3. (Illus. 6.47)

SF0290 Broken bar terminal with rounded tip and rectangular section. L 32, W 15, T 5mm; 9.4g. See Table 6.24 for results of metallographic analysis. (1681), post-abandonment deposit in industrial area, in area to east/south-east of House 10/3.

SF0296 Short circular-sectioned bolt with a rounded tip and slightly domed, expanded sub-square head. L 24, head 14 × 12.5, shank D 8.5mm; 8.3g. (1679), cobble surface, in area to east/south-east of House 10/3. (Illus. 6.47)

SF0319 Holdfast. Sub-square-headed nail with rectangular rove held by head and the tip clenched to hold another, giving a wood thickness of 37mm. It is unusual to have a rove at the head as well as the tip. L 48.5; nail head 11.5, shank 6; roves 31.5 × 23 × 2 / 27.5 × 22 × 2.5mm; 22.3g. (1733), post-abandonment deposit, House 10/3. (Illus. 6.47)

SF0330 Strapping fragment. Flat lentoid-sectioned bar fragment, the ends broken, with a nail in situ (hexagonal head, most of shank lost). L 31, W 26, T 3.5mm; nail head W 8, shank W 4, L 6.5mm; 6.8g. (1835), fill of post-hole [1834], House 7.

SF0410 Broken ring, sub-square in section, notably flatter on one face. D 19.5, section D 4mm; 2.7g. (2100), abandonment phase associated with industrial use of Workshop 11.

SF0454 Slightly irregular diamond-shaped rove with central square hole for nail. L 33, W 22, T 3mm; 4.8g. (2130), cobbles 1945, in area to east/south-east of House 10/3. (Illus. 6.47)

SF1187 Strengthening bar? Flat rectangular-sectioned bar, ends broken, with a narrow perpendicular bar off one side and a square nail hole (W 7) at one fractured end. L 33, W 38, T 9mm; 50.2 g. (798), spread of industrial waste, in area to east/south-east of House 10/3.

(See also SF0748, offcut from a joiner's dog.)

Nails and tacks

SF0262 Headless nail, bent through 90° at a third of its length. Rectangular in section, tapering to the top and expanding gradually to the squared head end. L 43, W 4–5, T 2.5–3mm; 1.6g. (1616), upper fill of large pit [context 1615] W of House 4.

SF0282 Nail with slightly expanded thin square head, tip lost. L 26, head 8.5 × 7.5 × 1, shank 6 × 6.5mm; 3.5g. (1671), post-abandonment/decay deposit overlying House 10/3.

SF0289 Intact nail with a slightly domed sub-square head. Its excellent condition shows clear traces of the manufacturing method: the shank is parallel-sided immediately under the head from the action of the heading tool, and then tapers to a point. L 57, head 17 × 14 × 5, shank W 10mm; 23.9g. (1681), post-abandonment deposit in industrial area, in area to east/south-east of House 10/3. (Illus. 6.47)

SF0320 Nail, lacking tip; small flat square head. L 36, head W 11, shank W 8mm; 5.4g. (1777), overburden, in area to east/south-east of House 10/3.

SF0342a Small square-headed tack with circular-sectioned shank, the tip broken. L 20, head 4.5 × 5, shank D 2.5mm; 0.8g. (1861), fill of post-hole [1860], House 9.

SF0383 Rectangular-sectioned tack with slightly expanded head, the sides near-parallel with an angled tip. L 27, W 7, T 4mm; 1.9g. (2101), hillwash, in area to east/south-east of House 10/3.

SF0407 Nail, much of head spalled off, tip broken at bend. L 50, head 9, shank 5.5mm; 4.7g. (2100), abandonment deposits associated with industrial use of Workshop 11.

SF0487 Bent headless nail. 51.5 × 5 × 5mm; 4.4g. (2187), silty deposit underlying hillwash (2101) and dump of fire-cracked stones (2186), Area D.

SF0629 Fine nail, rectangular section, off-centre slightly expanded irregular rectangular head. L 31, head 4.5 × 7.5, shank 4 × 3mm; 1.3g. (3153), fill of post-hole [3152], Hearth 26.

SF0719 Bent nail fragment (shank and tip). L 34.5, W 7mm, 7.7g. (1945), cobbled surface outside House 10/3.

SF1210 Small tack with sub-square head and tapering shank; wood remains imply it was deposited still within a wooden item. L 21, head 6 × 5, shank W 3mm; 0.7g. (4108), fill of post-hole [4107].

SF1211 Small tack, lacking head; wood remains imply deposition within a wooden object. 16.5 × 4 × 3mm; 0.6g. (4108), fill of post-hole [4107].

SF1212 Broken fine bar or tack, the head lost and the tip bent, with vestigial wood remains implying deposition within a wooden item. 19 × 4.5 × 2mm; 0.3g. (4108), fill of post-hole [4107].

Ironworking debris

Unfinished items

SF0287 Irregular flat object in a sinuous W-form with a pronounced central bulge and lentoid section. Apparently complete (one end rounded, other pointed), but function unclear – probably unfinished. L 50, W 17.5, T 2mm; 3.4g. (1681), post-abandonment deposit in industrial area, in area to east/south-east of House 10/3. (Illus. 6.48)

SF0294 Unfinished object? Complete item with short square-sectioned shank (the end burred) expanding and thinning into a broad semi-circular head with a slight central stub, perhaps where it was cut from a bar. L 37.5, W 21, T 4mm; 5.4g. (1681), post-abandonment deposit in industrial area, in area to east/south-east of House 10/3.

SF0358a Bar with slightly rounded end, expanded and rounded at the other. Apparently complete, but not an obvious object type, suggesting it is an unfinished roughout. 61 × 33 × 17mm; 8.6g. (2101), hillwash, in area to east/south-east of House 10/3. (Illus. 6.48)

SF0435 Unfinished object or offcut. Part-formed ?nail with bent irregular square-sectioned shank and flat expanded head in the same plane; surface poorly consolidated. 32 × 18 × 7mm; 6.8g. See Table 6.24 for results of metallographic analysis. (2187), silty deposit underlying hillwash (2101) and dump of fire-cracked stones (2186), context 2187, in area to east/south-east of House 10/3. (Illus. 6.48)

SF0522 Unfinished fitting. Two joining fragments of an irregular lentoid-sectioned slightly tapering bar. One rounded end has an oval perforation (15 × 11mm); the other is irregularly squared. Its spongy texture implies it was bloom-smithed. One edge is quite straight but the other is irregular; this and the porosity suggest it is unfinished. Porous glassy slag is attached to one face. L 123, W 46, T 7mm; 144.8g. (2477), remains of turf wall, House 10/3. (Illus. 6.48)

Stock iron (bars etc.)

SF0340c Fine square-sectioned bar, one end squared, other slightly rounded. Stock iron? L 110, W 4.5, T 4mm; 8.7g. (2102), spread of dark-brown silt with burnt clay, in area to east/south-east of House 10/3.

SF0366b Fine bar, slightly facetted circular section, ends slightly rounded. Stock iron? L 55, D 3mm; 2.5g. (2155), main fill of ring-ditch [2215], Structure 10, Area D.

SF0385 Small bar, the section a slightly tapered rectangle; ends cut square. Probably stock iron. 45 × 10.5 × 5mm; 8.62g. (2101), hillwash, in area to east/south-east of House 10/3.

SF0531 Short rod, apparently intact, with rounded ends. Stock iron? L 22.5, D 4.5mm; 1.2g. (2495), occupation deposits, in area to east/south-east of House 10/3.

SF0728 Ingot fragment. Corner broken from a slightly spongy mass, flat on one face, edge and base irregularly curved. 44 × 41.5 × 30mm; 87.5g. (3467), ash fill of furnace [3790].

Offcuts

The catalogue covers selected pieces only; for summary details of the distribution of all offcuts, see Table 6.27. Note also SF0178 in fixtures and fittings, a bolt head that may have been cut off to reuse the body of the bolt. Bloom offcuts are considered in the section on slag.

SF0177 Offcut? Slightly irregular tapered strip, one end thinned and cut in two angled facets; a small protruding tongue is probably an artifact of the cutting. The other end is cut near-square, again in two slightly angled cuts. L 29, W 16, T 3.5mm; 3.9g. (798) spread of industrial waste, in area to east/south-east of House 10/3.

SF0188 Offcut. End of flat bar, the corners cut at an angle; cut square, with flashing in one area. 20 × 19 × 3.5mm; 3.9g. See Table 6.24 for results of metallographic analysis. (775), upper fill of ring-ditch, House 4.

SF0291 Offcut. Flat bar terminal; squared end with rounded corners and lentoid section. Slightly curving cut across its width. L 25, W 27, T 3.5mm; 6.2g. (1681), post-abandonment deposit in area to east/south-east of House 10/3.

SF0340b Offcut from end of fine rectangular-sectioned bar, slightly tapered and rounded tip. L 16.5m W 4.5, T 3mm; 1.1g.

(2102), spread of dark-brown silt with burnt clay, in area to east/south-east of House 10/3.

SF0393 Offcut. Rounded bar tip, sub-rectangular in section, cut at one end with the side irregular and flared from striking. Bar L 20, W 13, T 6; max W 29mm; 6.6g. (2101), hillwash, in area to east/south-east of House 10/3.

SF0395 Offcut? Very irregular thick, flat sub-triangular fragment; protrusion from one corner, one side with stepped cuts from a narrow chisel. Perhaps the end of a bar, the corner drawn out to hold it before cutting it off. L 53, W 42, T 9mm; 40.8g. (2101), hillwash, in area to east/south-east of House 10/3.

SF0408 Offcut from a fine square-sectioned bar, the tip drawn out and curved, perhaps from gripping it. 26 × 4 × 4mm; 1.4g. (2100), abandonment deposits associated with industrial use of Workshop 11.

SF0414 Offcut. Slightly irregular, rounded end of a fine, rectangular-sectioned strip. 21 × 4 × 2.5mm; 0.7g. Hearth 2166.

SF0430 Offcut? Short square-sectioned rod, flared and flattened at broken end, with a longitudinal slit created by cutting from each side; no sign of finishing. L 20, W 9, T 2mm; 7.3g. (2101), hillwash, in area to east/south-east of House 10/3.

SF0434a Offcut – perhaps an unsuccessful decorative terminal. Square-sectioned bar, cut at one end, the other branched with the surviving branch thinned and turned into a twist. The other branch is lost in an old break, suggesting this was a decorative terminal that was cut off and discarded after one branch broke. 16 × 13.5 × 10; bar 4 × 4.5, branch 2.5 × 1.5 (4.5 × 1.2mm at tip); 1.6g. (2187), silty deposit underlying hillwash (2101) and dump of fire-cracked stones (2186), in area to east/south-east of House 10/3.

SF0434b Cylindrical rod tapering to a lost point, other end cut square; a slight lip shows it was not struck and thus is not a punch. Perhaps a peg or bolt, or alternatively an offcut. L 25, D 6mm; 3.2g. (2187), silty deposit underlying hillwash (2101) and dump of fire-cracked stones (2186), in area to east/south-east of House 10/3.

SF0450 Offcut, probably from a bent knife blade. Asymmetrical U-shaped fragment, triangular in section; one end curves steeply to the tip, the other is cut square. The symmetry implies this is an offcut rather than a clamp or mount. The section indicates it is the end of a narrow parallel-sided knife blade; this form could arise from gripping the end in tongs and bending it for a secure grip while the remainder of the blade was cut off. L 14.5 (unbent L 31.5), H 11, T 2mm; 3.6g. (2130), deposit of stones, in area to east/south-east of House 10/3.

SF0748 Offcut, probably from a joiner's dog. L-shaped object as it survives, the longer arm tapering gradually along its length, the short stubby one tapering in section. The form suggests the long arm was inserted into ?wood (to a depth of 20mm), with the short arm part of the body of the clamp. Probably cut off to reuse the rest of the clamp. 31 × 10 × 14mm; 7.6g. (3113), occupation deposit, House 10/3.

SF1018 Offcut, cut square across the terminal of a tapering square-ended bar; flat section with tapered edges and shallow, broad hollow on one face. L 16, W 15, T 3.5mm; 2.6g. (2187), silty deposit underlying hillwash (2101) and dump of fire-cracked stones (2186), in area to east/south-east of House 10/3.

SF1200 Offcut, circular-sectioned rod bent into a triangle (probably to get a grip with the tongs) and then cut off. 19 × 11 × D 3.5mm; 1.1g. The gap in the triangle shows the tong tip was no more than 6mm wide. (2191), possible waste deposit, Workshop 11.

Working waste

SF0199 Working debris. Irregular cylinder, part-forged and consolidated, with possible tong marks on one side, the ends irregular, perhaps burnt in the forge from over-heating. 36 × 14.5 × 11mm; 14.0g. (798), spread of industrial waste, in area to east/south-east of House 10/3.

SF0203 Irregular triangular fragment, slightly curved, with sub-rectangular section. Two ?original tapered edges, the third broken. May be working waste. 18 × 16.5 × 4.5mm; 3.0g. (798), spread of industrial waste, in area to east/south-east of House 10/3.

SF0345 Irregular sub-square object, one side flat, the other slightly raised, with a protruding off-centre fine square-sectioned stub. Its form implies it was hammered against something, and it may be the debris from making fine rods. 24.5 × 19 × 6.5mm; 4.2g. (1681), post-abandonment deposit in industrial area, in area to east/south-east of House 10/3.

SF0453 Irregular pentagonal fragment, surface uneven; working debris? 24 × 19.5 × 11mm; 8.3g. (2130), deposit of stones, in area to east/south-east of House 10/3.

SF0497 Very irregular amorphous fragment, probably working debris (cf. SF0488 and SF0724). 34 × 14.5 × 13.5; 12.0g. (2232), fill of ring-ditch [2719], Structure 10, Area D

SF1191 Working debris? Rectangular-sectioned rectangular irregular fragment with a deep irregular tear on one side; probably split during working, leading to it being cut off and discarded. L 72, W 32, T 10mm. (1680), dumped deposit, in area to east/south-east of House 10/3.

Copper alloys and coins

The copper alloy finds

Fraser Hunter with Roman coins by Nick Holmes and scientific analysis by Susanna Kirk and Jim Tate

The copper alloy assemblage comprises 21 objects and 20 fragments (36.2g) of casting debris. Post-medieval material was also recovered (in archive report): three items (one of pewter) from 798 (upper spread overlying industrial area by House 10/3), and two from 225 (dark deposit over cobbles 227). Table 6.29 summarises the objects by function and findspot. The assemblage includes some highly significant items: an unfinished and unusual decorated harness strap mount, a decorated sword hilt guard (the first from the area), and a Romano-British brooch (Illus. 6.50).

Table 6.29
Summary of copper alloy assemblage by functional category and context

Functional category	Area to east and south-east of House 10/3	House 10/3 use	House 10/3 abandonment	House 4	Workshop 15	Workshop 16	House 17
Ornament (4)	—	—	278 brooch 318 strap mount 368 pin	—	—	1027 toggle	—
Weapon (1)	483 hilt	—	—	—	—	—	—
Vessel/fitting (3)	—	—	313 ring	173b vessel frag 232 ?mount	—	—	—
Sheetwork (2)	1240 rivet	—	—	241 offcut	—	—	—
Casting (21)	333 failed casting 34.1g debris	—	—	—	—	0.1g	2.0g
Roughouts etc. (3)	1246 rod offcut	—	—	173a stock metal	844 bar	—	—
Other (7)	1241	405, 503 Roman coins	311 (?intrusive)	231a strip 231b sheet	—	1236	—

The bulk of the finds consists of casting debris from the industrial area by House 10; the remainder is fragments of various fittings and fastenings, including a patch from a sheet vessel, and fragments of sheetworking debris, with two further decorated items, a toggle and a projecting ring-headed pin. Further detail is provided in the catalogue at the end of this section.

Harness strap mount

The cruciform harness strap mount SF0318 (Illus. 6.50 and 6.51) is a rare and remarkable find. It is decorated with small geometric cells intended for enamel: trumpet-related shapes and bosses, typical of British Celtic art of the first two centuries AD. Such objects, although decorated in indigenous styles, continued into the Roman period, and this is emphatically confirmed by the 2nd century AD date for this piece (it overlies a layer containing a Trajanic coin of AD 112–14). The general type is familiar, but no precise parallels are known to the writer; this is quite typical for the better-quality pieces of Celtic art, as each would be made individually, the craftworker creating the piece from their knowledge of styles and parallels. It falls into MacGregor's (1976, 33–4) category of petal- or cruciform-shaped strap junctions and mounts (mounts have only a single bar on the rear, while junctions have two). Her analysis and later work by Taylor and Brailsford (1985) remain the main published studies, although there have been many subsequent finds. The type can be split into two on decorative grounds, one with relief boss-and-trumpet ornament, the other with enamelled cells and relief trumpet-based patterns; Culduthel falls into the latter. This division reflects a more general split in the Celtic art of central Britain into two main casting traditions (MacGregor 1976, 184; Hunter 2007a, 289–93). The four-armed form shows a range from four (or even six) petals through alternating petals and rectangular arms to the cruciform style of Culduthel. Cruciforms are notably rare; only two others are known to this author, both from Traprain Law (MacGregor 1976, nos 28 and 29, the latter probably unfinished). When MacGregor was writing, the distribution lay between Tyne and Forth, with one or two outliers in East Anglia and two unprovenanced examples. Table 6.30 lists examples known to the writer, showing the expansion of the distribution in the last 25 years. The boss-and-trumpet style remains a central British phenomenon, from Humber to Forth. The enamelled examples are more widespread, from the Moray Firth to the Severn, although two of the nine known examples are unprovenanced.

What is most striking with Culduthel is that the piece is clearly unfinished; the slot for the strap on the rear has not been cleaned out after casting, and the enamelled cells are crisp but with no traces of enamel. There can be no real doubt that it was made on site. This requires a major rethink of views of Celtic art in this area. The art of the first two centuries AD in Scotland is characterised by different regional traditions: massive metalwork in the north-east, and central British metalwork (itself in different styles) from the Forth to the Humber (MacGregor 1976; Hunter 2007a, 290–2, fig. 2). Recent metal-detecting and excavation finds have revealed a thin scatter of this central British material and other apparently exotic finds in the north-east, which have been interpreted as evidence of contacts to the south (Hunter 2006a, 151–7). It now seems that some of the enamelled styles were being produced locally, alongside the more typical 'massive' tradition; there is an emerging distinction between more personal items such as jewellery, made in local styles, and other material such as horse harnesses, which marked affiliations to wider traditions (Hunter 2014a, 333).

The hilt guard

The hilt guard SF0483 (Illus. 6.50 and 6.52) is another find that shakes our preconceptions. The standard work on Iron Age swords shows nothing north of the Forth (Stead 2006, fig. 1), although Iron Age-style finds from Roman sites extend this into

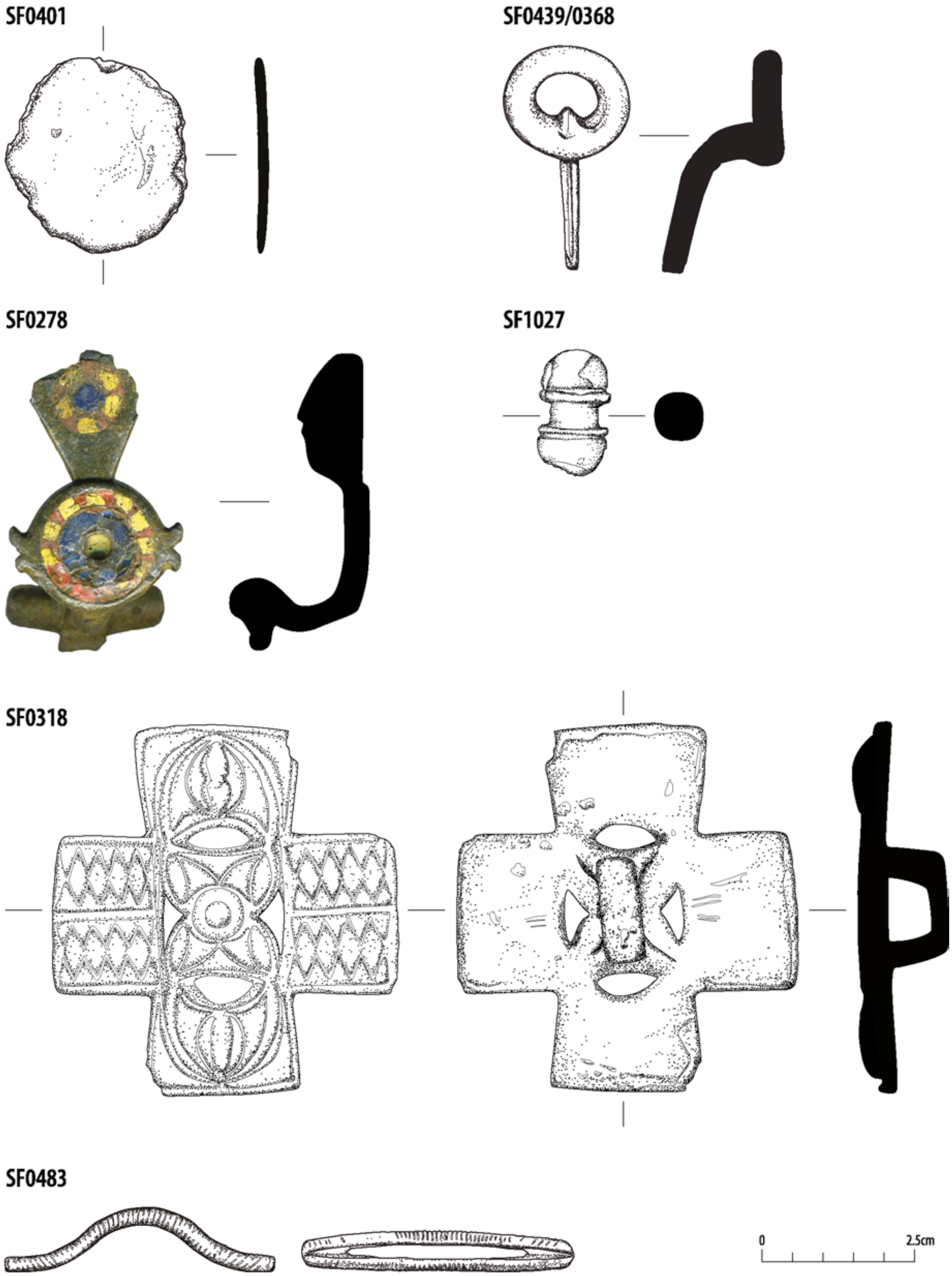


Illustration 6.50
Copper-alloy artefacts

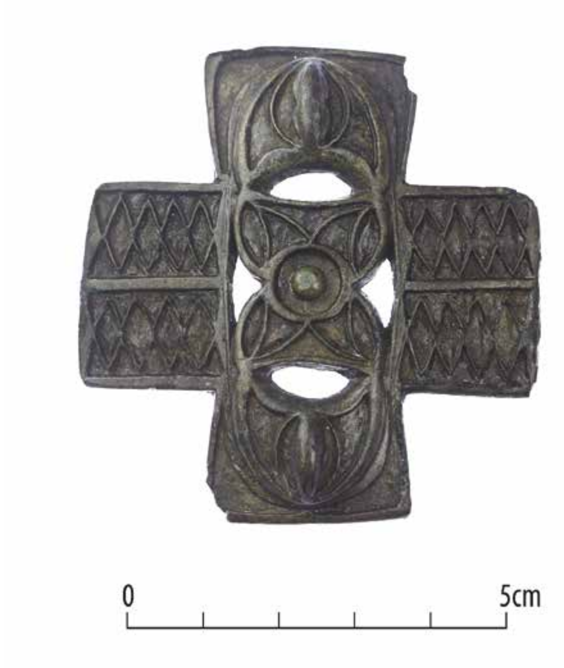


Illustration 6.51
Harness strap mount

Illustration 6.52
Sword hilt guard

Perthshire (Piggott 1950, fig. 12; Hunter 2006b, 82–3). Existing distributions are radically shifted by the two iron daggers from Culduthel, a fragmentary sword from Birnie (unpublished), a long-overlooked sword fragment from Laws of Monifieth, Angus (with campanulate shoulders; Anon 1892, 241; NMS GN 41), and this hilt guard. Its blade width (43mm) suggests it was for a sword rather than a dagger. The campanulate style is typical of the pre-Roman Iron Age (Stead's type vi; 2006, 13, 15, 17, 58–9, 68–9), and this is confirmed by the contextual date, which predates 90 cal BC–cal AD 90; given that the hilt guard was worn when deposited, it is most likely of 2nd–1st century BC date in origin. Similar campanulate hilt guards and matching scabbards are known in southern Scotland, from Bargany, Ayrshire (scabbard), Stevenston Sands, Ayrshire (iron), Ashkirkshiel, Selkirkshire (bronze), and Marshill, Alloa, Clackmannanshire (bronze; Stead 2006, nos 182, 192–3, A283; MacGregor 1976, nos 139–40; *Proc Soc Antiq Scot* 103 (1970–1), 19, fig. 1). Of these, only Ashkirkshiel is decorated (with a sinuous groove), but ornamented hilt guards are found in southern Britain (e.g. Stead 2006, figs. 64–6, 69, 92, 96 no. 191), often echoing decoration at the scabbard mouth. Hilt guards from Orton Meadows (Cambridgeshire) and Battersea (London) show notching similar to Culduthel, albeit on iron guards and on one side only (Stead 2006, fig. 57).

Although this is the first hilt guard from northern Scotland, the overall rarity of such finds makes it foolhardy to suggest this must be a southern import, especially with the cautionary tale of the unfinished strap mount in our mind; our evidence base is exceedingly sparse. It is a valuable reminder that this area was drawing on styles common across Iron Age Britain. Wear on the decoration shows it had seen extensive use; its location, as a single find in the industrial area by House 10, might suggest a weapon that had been dismantled in order to be re-hilted.

Other decorative metalwork

The other two indigenous decorative finds are both more common types. Projecting ring-headed pins were a long-lived 'type-fossil' of the Scottish Iron Age (Clarke 1971, 28–32). Cast examples are thought to start later than wire-made ones, though their currency overlaps (Stevenson 1955, 288; Campbell 1998, 168–9); the Roman-influenced alloy type of this example (SF0368/0439 – Illus. 6.50 and Illus. 6.53) and the 2nd century AD date for its context confirm this. This is reflected in its decorative qualities, unknown in the wire examples – a keel on the ring where the pin articulates evokes a trumpet design typical of Celtic art. Similar mouldings (often less clearly defined swellings) are found on other examples (e.g. Ness (Caithness); Fast Castle (Berwickshire); Smith 1925, fig. 110; Hunter 2001a). The

Illustration 6.53
Projected ring-headed pin

Table 6.30
Petal and cruciform strap mounts and junctions known to the writer

Findspot	Type	Context / date	Reference
ENAMELLED			
Culduthel, Inverness-shire	Cruciform mount; unfinished	Iron Age settlement (C2)	This chapter
Culbokie, Ross-shire	Enamelled ?cruciform mount or junction	Stray	DES 2010 (forthcoming)
Traprain Law, East Lothian	Cruciform mount (unfinished?)	Iron Age settlement	MacGregor 1976, no. 29
Glenlochar, Kirkcudbrightshire	Petal mount	Roman fort (late C1–mid C2)	Dumfries Museum 83.46.1
Middlebie, Dumfriesshire	Petal junction	Hoard of horse harness	MacGregor 1976, no. 22
Saham Toney, Norfolk	Petal junction	Hoard of horse harness	MacGregor 1976, fig. 1 Taylor & Brailsford 1985, 267, fig. 15 no. 53
South Cerney, Gloucestershire	Petal junction	Stray	*Chris Rudd List* 32, 1998, no. 30
Unprovenanced (British Museum)	Petal junction, curvilinear decoration	?	Taylor & Brailsford 1985, no. 44
Unprovenanced (Uffizi)	Petal junction	?	Kemble 1863, 194–5, pl XIX, 5
BOSS AND TRUMPET STYLE			
Traprain Law, East Lothian	Six-arm petal junction	Iron Age settlement	MacGregor 1976, no. 26
Traprain Law, East Lothian	Petal mount	Iron Age settlement	MacGregor 1976, no. 27
Traprain Law, East Lothian	Cruciform mount with openwork centre	Iron Age settlement	MacGregor 1976, no. 28
Kinneil, West Lothian	Openwork petal and rectangle junction	Roman fortlet (mid C2)	Webster 1996
Newstead, Roxburghshire	Petal and rectangle junction	Roman fort (late C1–C2)	MacGregor 1976, no. 24
Newstead, Roxburghshire	Petal junction	Roman fort (late C1–C2)	MacGregor 1976, no. 25
Ward Law, Dumfriesshire	Openwork petal junction, enamelled rings	?Roman camp	DES 2007, 60
Middlebie, Dumfriesshire	Petal and paired circle junction	Hoard of horse harness	MacGregor 1976, no. 23
Burnswark, Dumfriesshire	Petal mount	Iron Age settlement	Jobey 1978, fig. 14, 3,
Burnside, Gribton, Dumfriesshire	Quadrilobate mount with rounded arms	Stray	DES 2010 (forthcoming)
Corbridge, Northumberland	Openwork petal junction	Roman fort	MacGregor 1976, no. 21
Malton, Yorkshire	Petal and rectangle mount	Roman fort *vicus* (C2)	Lloyd-Morgan 1997, 133–4, fig. 50 no. 6
South Kesteven, Lincolnshire	Petal mount	Stray	Portable Antiquities Scheme NLM4198; Bonhams *Antiquities*, 26.10.07, Lot 260

Illustration 6.54
Dumb-bell toggle

type went on to more decorative development in the following centuries, and later examples from along the Moray coast at Covesea, Birnie and Urquhart suggest this was an innovative area (Benton 1931, fig. 16; unpublished; Treasure Trove TT 51/10).

The well modelled dumb-bell toggle (SF1027 – Illus. 6.50 and Illus. 6.54) is a type found widely in copper alloy, bone and glass, in both Iron Age and Roman contexts (MacGregor 1976, 134, fig. 18 nos 13–19); indeed, there is a glass example from the site. MacGregor suggests a Tyne-Forth distribution, but the type is more far-flung; for instance, there are local parallels in metal-detecting finds from Garguston (Muir of Ord) about 10km to the WNW, and Urquhart, some 60km E (Hunter 2009a, 126; 2014b, 109–10).

Roman finds

Three copper alloy finds show contact with the Roman world – two (perhaps three) coins (Holmes, below) and a brooch – while the evidence of alloys used in manufacturing other objects shows some further Roman influence, in the recycling of Roman objects for raw material, as discussed below. The brooch (SF0278 – Illus. 6.50) is a disc and fantail type (Hull's type 163; Bayley and Butcher 2004, 169, fig. 143). It is a substantial and striking example, decorated with three different colours of enamel. There was a preference among indigenous societies for brooches that either mirrored local tastes in metalwork (often enamelled, and with locally favoured motifs such as trumpets) or were clearly unusual and highly decorative (Hunter 2001b, 300–1). This brooch fits into the former category, its enamelled decoration and form (such as the decorative lips) fitting local tastes, and yet at the same time being a clear symbol of contacts with Rome. The type is rare in indigenous contexts; the only other examples are from a wheelhouse at Kilphedir, S Uist (Lethbridge 1952, 182–3, fig. 4 no. 1), the hillfort of Traprain Law, East Lothian (Cree 1924, 251, fig. 9.1; Burley 1956, 161, no. 49), and stray finds from Kinneswood and Kinnaird, Perth and Kinross (Hunter 2009b, 157; Hunter 2014c, 169). Roman finds from the Moray Firth area have increased greatly in recent years from excavation and metal-detecting, and it is clear there was considerable contact with the Roman world; brooches were one of the most favoured items (Hunter 2007a, Appendix 3). In the immediate environs of Culduthel, there are stray finds of an early Aucissa type (pre-Flavian) from Dores and an enamelled trumpet brooch from Torbreck, a headstud brooch from an earlier ritual site at Stoneyfield, Raigmore, and two brooches (headstud and Polden Hill) from the Iron Age site of Seafield West (Robertson 1970, 222, fig. 10, 1; Hunter 2008a, 108; Mackreth 1996; Hunter 2011b).

The Roman coins

Nick Holmes and Fraser Hunter

Two certain and one possible Roman coin all come from House 10/3 (SF0401, SF0405 and SF0503). SF0401(Illus. 6.50 and 6.55) a possible sestertius, SF0405 a Trajan sestertius (AD 112–14); SF0503 (Illus. 6.56) a As, uncertain emperor, possibly Domitian (AD 81–96). SF0401 and SF0503 are from the same deposit in different areas of the ring ditch, and SF0405 is from a later layer but spatially close (2164 is later stratigraphically but spatially close enough to be considered relatively contemporary with 2155).

The coin of Trajan, in this condition, conforms precisely to what would be expected in primary contexts on an early Antonine Roman military site, such as an Antonine Wall fort. If the *As* is indeed Domitian, this could of course indicate pre-Antonine contact between the inhabitants of the Culduthel settlement and the Roman army, but Flavian copper alloy coins have occasionally been recovered from Antonine Wall forts, so this is really entirely inconclusive. A 2nd century date of deposition is suggested by their context: both come from the final phase in House 10 (and thus constrain the range of the single C14 date of cal AD 30–230 (SUREC-30397).

Illustration 6.55
Roman coin (SF0401)

Illustration 6.56
Roman coin (SF0503)

These copper alloy Roman coins (two certain, one too worn for certain identification) are an unusual find. These were always uncommon on indigenous sites, silver ones being proportionally more common compared to Roman sites (Robertson 1975, 418). This difference from Roman practice reflects the role of the coins – these were not part of a circulating coin economy that needed small change. The higher-value metal was more sought after, as shown by the silver coin hoards from the area, best seen as a form of prestige good or special-purpose/socially useful money (Hunter 2007c). Yet the bronze coins deserve explanation. Using data from the regular roundups in the *Proceedings of the Society of Antiquaries of Scotland* (Bateson and Holmes 2006, with earlier references; Robertson 1983 summarises finds to that date), and considering only finds pre-dating the devaluation of the *denarius* in AD 238, some 36 indigenous sites in Scotland have Roman coins as single finds rather than hoards: 11 have silver only, 19 bronze only, and seven have both. With the exception only of Traprain Law (Sekulla 1982), these coins occur in very small numbers. Turning to the area north of the Forth, it is notable how many of the sites with bronze coins are those otherwise defined as higher status, notably several of the Angus and Stirling brochs (Leckie, Hurly Hawkin, Fairy Knowe), and on the north-east littoral, sites like Birnie as well as Culduthel. This supports the view that richer sites had access to a wider range of Roman material culture, only some of which was passed on to other sites (Hunter 2001b, 297).

It is unclear what use was made of these bronze coins. They may simply have been valued as a source of raw material (as was probably the case with the hoard from Longhorsley, Northumberland, found with a casting sprue; Abdy 2003), but they might have had rather more social significance. It is noteworthy that the three coins from Culduthel were found close together, at the rear

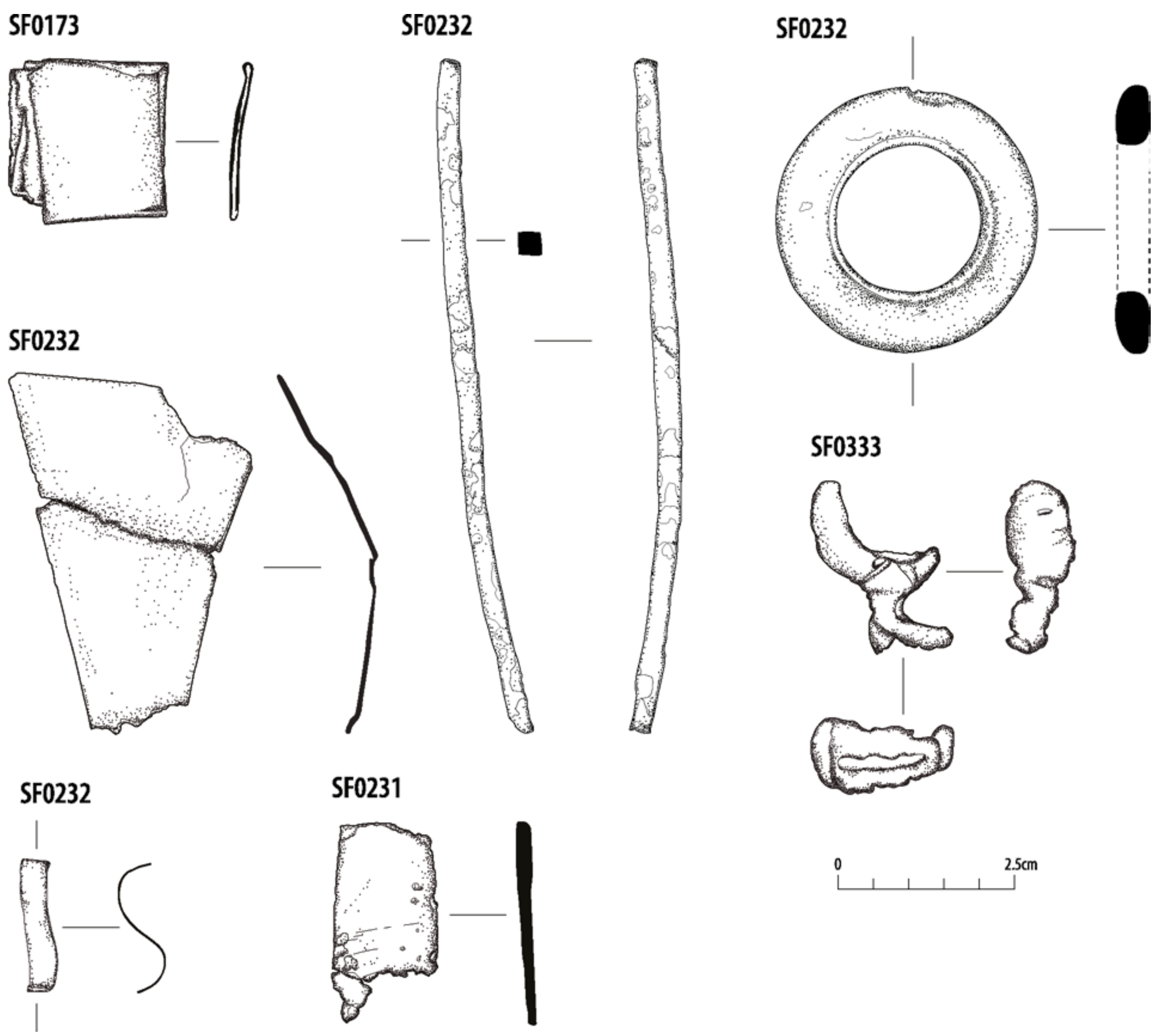


Illustration 6.57
Copper-alloy artefacts

entry of the ring-ditch in House 10/3 in its last phase; they could be seen as deliberate deposits in the building upon abandonment, perhaps even a small scattered hoard. This indicates they were perceived as having a social value. Likewise, the settlement site at Clarkly Hill, near Burghead, produced a hoard of bronze coins of Antonine date as well as a late 2nd century *denarius* hoard (Chapman et al 2009, 225); there was clearly a perceived value to Roman bronze coins, at least among some people. Future work might usefully compare and contrast the evidence of denominations and dates, but for the moment, the Culduthel coins remain locally unusual.

Other finds and manufacturing evidence

The other finds are mostly rather fragmentary, and thus hard to identify, but include pieces of a sheet copper alloy vessel (SF0173b – Illus. 6.57) and an enigmatic ring fitting (SF0313), its role unclear. There is also a notable quantity of casting debris, with one larger failed casting (SF0333 – Illus. 6.57) and 20 small fragments (36g) of casting waste, mostly droplets or nodules spilled from moulds. This is all from the industrial area by House 10, apart from two single fragments that are best seen as secondary dispersals from the core production area (analogous to the single crucible fragments found elsewhere). A bar (SF0844) from adjacent Workshop 15 may point to some non-ferrous metalworking in this structure too. The industrial area by House 10 has no certain evidence of sheetworking; there is only a single, used rivet. The certain sheetworking evidence all comes from the ring-ditch of House 4; indeed, all the items from this building could be interpreted as the residue of sheetworking, but it is a tight concentration rather than a spread, suggesting a scientific analysis rather than the dispersal of working debris.

The alloys

Susanna Kirk, Jim Tate and Fraser Hunter

Virtually all of the copper alloy objects were analysed non-destructively using X-ray fluorescence (XRF) in order to ascertain the alloy types used (full details are available in the archive). The objects were analysed on the flattest possible area of their surface, with at least two spots analysed except where size (<10mm) or fragility precluded this. Any existing breaks were analysed to try and see beneath the corrosion layer, and for the larger objects multiple analyses were taken to check for consistency; very little variation was found. Alloy types can be defined by looking at the ratios of different alloying elements to one another or the absolute quantities of alloying elements within the metal (Bayley and Butcher 2004, 14). For example, Bayley and Butcher (2004, 14) define brass as being either a metal with the level of zinc being more than four times that of tin or a metal with more than 8% zinc. Within their study bronze is defined as having more than 3% tin and gunmetal as a bronze with significant zinc; leaded alloys are defined strictly as being those with more than 8% lead. However, definitions do vary. For example, Dungworth (1997) defines bronze as containing at least 5% tin, brass as containing at least 15% zinc, and gunmetal as containing more than 5% tin and 5–15% zinc; leaded alloys are those containing more than 1% lead, it being argued that at this level the presence of lead affects the properties of the metal. For this study, alloy type was based on the presence of a distinct peak for the major elements of interest, copper, zinc, lead and tin. A 'trace' of an element was defined as being a peak just visible above the background. The attribution of alloy types from surface analyses is always somewhat speculative since, due to the presence of surface corrosion, the analyses may not be representative of the bulk metal. However, in the present study some of the casting debris was subsequently sampled, abraded and analysed quantitatively to act as a control on the surface results (Table 6.33); the agreement in alloy attributions between the two methods was good. Catalogue entries include the alloy type for each object.

Table 6.31 summarises the correlation between alloy type and manufacturing technology. Looking first at the objects, the dominant alloy was bronze or leaded bronze, consistent with the predominantly pre-Roman dating of the site. Zinc-containing alloys (brass and leaded gunmetal) are found only in imported Roman items or in finds from late (Roman Iron Age) phases in House 10 (the harness mount and ring-headed pin). The relatively few sheet fragments used only bronze or leaded bronze, predominantly the former, while cast objects were more often leaded, the lead making the casting process easier. It is unwise to place too much weight on indications of minor elements, as they are often near the instrument's detection limits, but there are hints of patterns (Table 6.32). Traces of silver and/or antimony were found in just over half of the cast objects and casting waste, but in none of the wrought items. This suggests a clear and careful separation in metal source for casting and sheetworking alloys. The sample size is too small to see any clear correlations between minor elements and alloy types. The casting debris is overwhelmingly of leaded bronze; this was clearly the main casting alloy used on the site. It

Table 6.31
Alloy types (from surface X-ray fluorescence) correlated with manufacturing technology

Technology	Leaded copper	Bronze	Leaded bronze	Leaded gunmetal	Brass	Totals
Sheet	–	3	2	–	–	5
Cast	–	2	5	4	2	13
Casting waste	2	2	15	2	–	21
Totals	**2**	**7**	**22**	**6**	**2**	**39**

Table 6.32
Occurrence of minor elements by technology and alloy type

Minor elements	As	Sb	Ag	n
Technology				
Sheet	–	–	–	5
Cast	2	4	8	13
Casting waste	2	14	13	21
Alloy type				
Leaded bronze/copper	3	14	14	24
Leaded gunmetal	–	1	4	6
Bronze	1	3	3	7
Brass	–	–	–	2

was not, however, the only one. The unfinished strap mount was of gunmetal, and a number of crucibles and moulds showed significant zinc traces, suggesting that gunmetals did come into use on the site in the Roman Iron Age. However, only two fragments of casting debris contained zinc. One, from 2677, is likely to be intrusive in this context (which is pre-Roman), presumably from higher deposits in the industrial area. The other, from a post-hole near Workshop 16, is one of the stray fragments distant from the main area.

Deposition

The fragments of casting debris are best seen as use-losses, and this is likely to be true generally for much of the material in the craft area. Fragmentary material from elsewhere may fall into the same category, but there are signs of other depositional processes at work too. As noted, the fragments from House 4 concentrate in one area and may be a deliberate cache. A number of the other items could be seen as deliberate deposits, linked perhaps with rituals connected to the abandonment of particular buildings. This is most convincing with House 10/3, with its striking finds: the two Roman coins in the entrance to the ring ditch, the Roman brooch in an abandonment layer directly in the entrance way, and the perfect but unfinished strap mount in the same layer, just inside the doorway. Such suggestions of patterned deposition are a warning against any simple correlation of finds to building function or status.

Catalogue

Alloy types were determined by surface X-ray fluorescence by Susanna Kirk and Jim Tate; see archive report for method.

Table 6.33
Results of quantitative analysis of six fragments of casting debris, compared with the results from (semi-quantitative) surface analysis and (italicised in the final column) the alloy type from surface analysis

Find	Analysis	Fe	Ni	Cu	Zn	As	Pb	Ag	Sn	Sb	Alloy
288	abraded	0.1	0.1	89.1	0.1	0	2	0	8.6	0.1	leaded bronze
	surface	*1.9*	*0.1*	*54.0*	*0.7*	*0*	*6.5*	*0.2*	*36.5*	*0.2*	*leaded bronze*
321	abraded	2.3	0	85.4	6.8	0.1	0.4	0.1	4.6	0.3	gunmetal
	surface	*9.1*	*0*	*72.5*	*2.9*	*0.4*	*1.1*	*0.9*	*12.3*	*0.8*	*bronze/ gunmetal*
424	abraded	0.1	0	94.3	0	0	2.7	0.9	0.2	1.7	leaded copper
	surface	*7.7*	*0*	*62.7*	*0.1*	*0.2*	*17.5*	*2.1*	*0.4*	*9.3*	*leaded copper*
490	abraded	0.9	0.1	74.6	0	0	8.8	0.4	13.7	1.2	leaded bronze
	surface	*4.6*	*0*	*45.1*	*0.2*	*0*	*15.6*	*0.8*	*30.6*	*3*	*leaded bronze*
696	abraded	0.4	0.1	68.3	0	0.3	0.2	0.2	30.3	0.3	bronze
	surface	*1.3*	*0.1*	*52.6*	*0.5*	*0.1*	*0.6*	*0.6*	*43.3*	*0.7*	*bronze*
1242	abraded	0.2	0	63.9	0.3	0	6.3	0.2	29	0.2	leaded bronze
	surface	*2*	*0*	*37.5*	*0.9*	*0*	*9.8*	*0.3*	*49.2*	*0.3*	*leaded bronze*

The Roman coins

Nick Holmes

SF0401 Coin, worn almost to the point of being unrecognisable; original edges lost; traces of a bust right. Could be a sestertius or a very worn George III penny. Alloy: brass (trace lead). 32 × 30 × 2.7mm; 8.32g. 2155 (House 10/3, main fill of ring-ditch 2215). (Illus. 6.55)

SF0405 Trajan (AD 98–117): *sestertius* (AD 112–14)

Obv.: [IMP CAES NERVAE] TRAIANO AVG GER DAC P M TR P COS VI P P; bust laureate right, with drapery on left shoulder.

Rev.: [FELICITAS AVGVST]; S C to left and right in field; Felicitas standing left, holding caduceus and cornucopiae.

30.0mm, 19.92g, die axis 165°; damaged and encrusted green patina; moderate wear.

RIC 625; BMC 964–5 variant (bust type). Alloy: leaded gunmetal.

Context 2164 (House 10/3, fill of ring ditch 2215).

SF0503 Uncertain emperor, possibly Domitian (AD 81–96): *As*.

Legends illegible and reverse design unidentifiable; bust on obverse may be of Domitian.

29.0mm, 9.23 g; highly corroded, and degree of wear therefore uncertain. Alloy: brass.

Context 2155 (House 10/3, main fill of ring-ditch 2215). (Illus. 6.56)

Ornaments

SF0278 Romano-British enamelled plate and fantail brooch (Hull's type 163; Bayley and Butcher 2004, 169, fig. 143); the hinged pin, integral headloop and parts of the fantail are lost (the latter being recent damage). The cylindrical head has a solid copper alloy axis (D 2mm) to hold the pin. The central circular plate on the bow has diametrically opposed projecting pairs of lips on the edges and three concentric enamelled fields (maximum D 18mm) defined by solid walls. These comprise a central opaque yellow dot (mostly lost); a mid-blue translucent ring; and an outer ring of alternating opaque yellow and red blocks, with no cell divisions. The regular shape of the yellow blocks indicates they were inserted as blocks; where they are lost, it can be seen that red underlay them, implying the red was applied first and slices of yellow blocks pushed into it while it was still malleable. Lethbridge (1952, 182) notes the same phenomenon on the Kilphedir brooch. Overlapping of the red into the blue ring indicates the red was applied before the blue. The fantail bears a ring and dot motif (D 11mm); the central blue dot is surrounded by a ring of yellow and red blocks, the form again indicating that the yellow was applied as blocks. On the underside of the disc is a central dot, its role unclear; perhaps for centring the brooch while the enamel was applied? Alloy: leaded gunmetal (minor silver). The blue enamel is probably coloured with cobalt and opacified with calcium antominate; the yellow is coloured by lead (unusually, there is no trace of tin or antimony, lead stannate and lead antimonite being common colorants in yellow plain enamels); the red is probably coloured by copper. L 51.5, H 19.5; head L 28, D 8; disc D 29mm; 21.8 g. Context 1671 (House 10/3, post-abandonment deposit, directly over entrance). (Illus. 6.50)

SF0318 Unfinished enamelled cruciform harness strap mount with a single loop on the rear (the description takes this to be vertical). The central panel is a saltire formed of four trumpets (each with two cells, body and 'mouth', to take enamel), springing from a central three-dimensional boss with a surrounding recessed ring. Concave-sided enamelled triangular panels lie vertically between the trumpet pairs; there are openwork gaps between the central panel and the wings (lentoid at top and bottom, concave-triangles to the sides). The side wings, in lower relief, each have pairs of horizontal enamelled panels (16 × 11mm), with a central row of four conjoined lozenges flanked by triangles above and below. The edge adjacent to the central panel has a slightly raised lip. The slightly flared top and bottom wings are dominated by a pair of vertically set conjoined high-relief ovals flanked to either side by a lower pelta and trumpet. Overall this forms a crescentic motif with a marginal lower-relief flange; two curved enamelled cells fill the gap between this and the corners of the wing. There is no evidence of enamel ever having been applied, although the bases of the cells are grooved for keying. The front surface is very well finished; the rear is less carefully finished, with fine file-marks in places. The single rectangular loop on the rear (L 19, H 10.5, T 7mm) is unfinished; it has a recess (11 × 7.5mm) to take a strap that has been perforated by a drilled hole (probably present in the model; D 7.5mm), but this has not been expanded to remove the rest of the metal, and the item was thus unusable. One or two horizontal nicks on one side of the arms probably come from post-casting working. There are hints of a casting seam on the loop edges; this must have been a lost-wax or multi-piece casting. Alloy: leaded gunmetal (trace silver). L 61, W 58, T 17.5mm; 56.4g. Context 1671 (House 10/3, post-abandonment deposit). (Illus. 6.50 and 6.51)

SF0368 and **SF0439** Two joining fragments of a cast projecting ring-headed pin, lacking the tip. The tapering lentoid-sectioned shank bends into a slightly oval circular-sectioned head with a low transverse decorative keel continuing the line of the shank's edges across the ring; this evokes a conjoined trumpet design. Alloy: leaded gunmetal (trace silver). L 38; shank L 26 × 5 × 3.5; head externally 20.5 × 19, internally 10 × 8, T 5mm; 7.6g. Context 1671 (House 10/3, post-abandonment deposit) and unstratified. (Illus. 6.50 and 6.53)

SF1027 Dumb-bell toggle; domed ends, with collars at their bases flanking a relatively deep rectangular-sectioned channel. Alloy: leaded bronze. L 20.5, D 11.5mm; shank D 7.5, L 4mm; 8.3g. Context 2252 (post-hole 2251, beside Workshop 16 post-ring). (Illus. 6.50 and 6.54)

Weaponry

SF0483 Decorated sword hilt guard of low campanulate form; parallel-sided with a slight taper to the rounded ends. The upper and lower faces are flat; the rounded edges bear an incised design of transverse V-sectioned grooves. This decoration is rubbed off the middle of the edge on both sides, the point of highest relief, indicating extensive use. It is more marked on one side, suggesting a preference to how it was worn. A lentoid V-sectioned slot is cut into the underside for the blade (L 43, T 2.5mm) and shoulders (W 30.5 as they emerge). The very clean edges indicate it was cut rather than cast; on the upper side, three central diagonal incisions on one side of the slot may be marking out lines for the perforation. The rounded edges suggest the piece was cast and then perforated, hammered to its final shape if required, and decorated. Alloy: bronze (minor silver, trace antimony). L 44.5, W 6.5, T 2.5, H 10.5mm; 2.5g. Context 2130, stone deposit (yard surface in industrial spread by House 10/3; predates 90 cal BC–cal AD 90). (Illus. 6.50 and 6.54)

Vessels and fittings

SF0173b Two fragmentary sheets, riveted together with three (surviving) rivets set in a triangle. No original edges survive, but it is likely this was a patch for a copper alloy vessel. Solid rivets (head D 3, burred shank D 2mm). The larger sheet has file-marks on the surface; little survives of the smaller sheet. Alloy of one sheet: bronze. 25 × 21 × 1.2mm; sheet T *c.*0.3mm; 0.7g. Context 775 (House 4, upper floor deposit in ring-ditch 1810). (Illus. 6.57)

SF0232 Mount? Sheet cut into an isosceles triangle, with two tips broken and a diagonal bend; edges cut square, with slight lip from cutting on one side. No trace of attachment system but likely to be a decorative mount. Alloy: leaded bronze. L 43, W 31, T 0.5mm; 3.8g. Context 775 (House 4, upper floor deposit in ring-ditch 1810). (Illus. 6.57)

SF0313 Ring, one face flat, the other gently rounded; broad perforation (D 21mm) with slightly rounded edge and raised lip on the upper face. Probably a decorative collar; no trace of fastening, such as solder. The lip is slightly uneven, probably from manufacture rather than wear. Alloy: leaded bronze. D 37.5, T 4mm; 14.0g. Context 1671 (House 10/3, post-abandonment deposit)

Sheetworking debris

SF0241 Sheetworking offcut. S-shaped strip, ends squared, one edge slightly tapered (with file-marks from shaping), the other cut; bending probably post-dates cutting. Alloy: leaded bronze. 18.5 × 4.3 × 0.6–1.0mm; 0.4 g. Context 775 (House 4, upper floor deposit in ring-ditch 1810)

SF1240 Cast fine rivet (in two joining fragments), tip lost; low-domed head and circular shank, filed to shape; bent (and thus probably used). Alloy: leaded bronze (minor silver, antimony and arsenic). L 7, head D 3, shank D 1mm; 0.1g. Context 2550 (pit 2549, associated with Hearth 2434)

Roughouts, stock metal etc.

SF0173a Folded and flattened strip, producing six layers of metal; probably a package intended for reuse. Broken at one end. Alloy: bronze. L 23.5, W 18, T 2.5mm (sheet T *c.*0.3–0.4mm); 4.9g. Context 775 (House 4, upper floor deposit in ring-ditch 1810). (Illus. 6.57)

SF0844 Slightly bent square-sectioned bar, one end square, the other slightly irregular from casting. Probably stock metal for

Table 6.34
Summary of casting debris by context

Context	Context description	No. items	Mass/g	Alloys	Type
1681	Post-abandon-ment deposit, by House 10/3	1	4.2	Leaded bronze	Nodular casting waste
1682	Collapsed wall/ bank material – adjacent to House 10.3	1	2.9	Leaded gunmetal	Nodular casting waste
2101	Hillwash	2	4.4	Leaded copper; leaded bronze	One linear droplet
2165	Spread of waste over Hearth 2166 & 2434	2	7.1	Leaded bronze	One flat spill
2187	Spread of waste over Hearth 2166 & 2434	2	3.5	Leaded bronze	Nodular casting waste
2252	Posthole 2251, beside Workshop 16 post-ring	1	0.1	Leaded gunmetal	Nodular casting waste
2433	House 17, posthole 2420	1	2.0	Leaded bronze	Nodular casting waste
2435	Spread of waste over Hearth 2434	1	6.0	Leaded bronze	Nodular casting waste
2677	Charcoal spread associated with hearth 2434	4	0.6	Leaded bronze, leaded gunmetal, leaded copper	One droplet
2836	Posthole 2835 adjacent to Workshop 13	1	0.1	Bronze	Nodule
3022	Charcoal spread associated with hearth 2434	1	3.1	Leaded bronze	Nodular casting waste
3038	Heat-affected natural – hearth 2434	1	0.7	Leaded bronze	Nodular casting waste
3159	Hearth.26, posthole 3158	1	1.1	Leaded bronze	Flattened, amorphous
3467	Ash fill of furnace 3401	1	0.4	Bronze	ID not certain; amorphous, corroded
Total		**20**	**36.2**		

working up. Alloy: bronze (minor silver and antimony). 96 × 3.5 × 4mm; 6.8g. Area D context 4340 (Workshop 15, fill of pit 4341).

SF01246 ?Offcut from tip of circular-sectioned rod; cut square; end slightly angled. L 4, D 3.5mm. Context 2677.

Casting debris

SF0333 Failed casting. Tapered curved object, lentoid in section with rounded terminals and a ridge on the concave side, indicating a two-piece mould. Sprue and irregular header attached to convex surface. It looks like the casting only partly filled the mould (perhaps for a ring?). Alloy: leaded bronze. L 28 (object L 19.5), W 10, object T 3.5mm; 4.3 g. Context 1681 (post-abandonment deposit by House 10/3). (Illus. 6.57)

(See Table 6.34 for a summary of the less diagnostic material.)

Unidentified

SF0231a Slightly tapered sheet strip fragment, one end broken, the other cut square with one part folded under; transverse file-marks. Does not join SF0173. Alloy: bronze (trace lead). L 22.5, W 14.5, T 0.6mm; 1.0 g. Context 775 (House 4, upper floor deposit in ring-ditch 1810). (Illus. 6.57)

SF0231b Two non-joining sheet fragments, lacking original edges. 10 × 7 × 0.2mm and 7 × 5 × 0.2mm; 0.1 g. Context 775 (House 4, upper floor deposit in ring-ditch 1810). (Illus. 6.57)

SF0311 Unidentified flat cast fragment, one side slightly convex; part of one straight, slightly lipped edge survives, but the others are lost. Alloy: brass (minor silver and arsenic; trace lead and tin). 22.5 × 20.5 × 3mm; 3.1 g. Context 1671 (House 10/3, post-abandonment deposit) Possibly a more recent intrusive piece.

SF1236 Rounded corner fragment from an object with flat faces. Alloy: leaded bronze. 4 × 2 × 2mm; 0.1 g. Context 2252 (post-hole 2251, beside Workshop 16 post-ring).

SF1241 Six non-joining fragments of a flat cast object, the surviving edge straight and square. Alloy: leaded bronze (minor silver and antimony). 0.1g; largest fragment 8.5 × 5 × 1mm. Context 2548 (post-hole 2547, associated with Hearth 2434).

Lead

Fraser Hunter

Nine lead items were recovered from Culduthel, predominantly small strips coiled into cylinders, triangles or cuboids, all of similar weight. There was also a solid ovoid item, perhaps a weight, and a part-worked bar with extensive tool traces, along with an unidentified fragment. All the coiled strips (SF0280, SF0281 – Illus. 6.58, SF0354a/b – Illus. 6.58, SF0386 and SF0403), the ovoid possible weight (SF0511) and the part-worked sheet (SF1000) are from artefact rich layer sealing House 10/3 and post-date its abandonment (*c*.1671). Only one of the finds is securely Iron Age, a sub-cylindrical fragment (SF1624) from a post-hole of House 10/3, but a Roman Iron Age is feasible for the remainder as *c*.1671 included a wide range of Roman and Roman Iron Age finds.

The six strips, slightly plano-convex in section, were coiled into various hollow forms, the ends overlapped to differing degrees. There is a broad consistency in dimensions, but not so close as to suggest a weight standard, suggesting use as a weight for holding or retaining something rather than measuring (Table 6.35).

Illustration 6.58
Lead artefacts

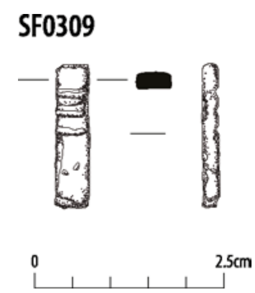


Illustration 6.59
Pewter artefact

Table 6.35
Catalogue of coiled strips. *c*.1671 is a post-abandonment context which represented the interface between the feature fills in House 10/3 and the base of the ploughsoil; it is not securely Iron Age

Find no.	Form	L (mm)	W (mm)	m (g)	Context
280	Cylinder	15	13-15	10.66	1671
281	Cylinder	13	14-15.5	11.22	1671
354a	Triangular	15	15-17	18.26	1671
354b	Cylinder	17	14-16	15.02	1671
386	Cuboid	15	13-14	12.52	1671
403	Triangle	14.5	16	14.60	1671

Both the presence and working of lead are a rarity in the Iron Age. Fragment SF1624 is securely contexted and shows some access to lead on the site. The bulk of the finds from post-abandonment layer *c.*1671 are Roman Iron Age in date, and there is little evidence of later intrusion. This would fit with wider pictures of lead use in Iron Age Scotland (for a review, see Hunter 2007e). Lead is extremely rare (though not unknown) until the Roman period, when it is found especially on sites showing evidence of Roman contact. This makes it likely that the ultimate source was recycled Roman lead. It is likely this was valued primarily as a raw material for recycling; there is no typologically distinctive Roman material, but a wide range of expedient use as found at Culduthel. The sheet with hammer-marks provides confirmatory evidence for on-site working.

The lead isotope analysis (below) is consistent with a southern Scottish source, but there is overlap between Scottish and English ore sources (e.g. the North Pennines) in isotope ratios (Rohl 1996), and a more southerly source cannot be ruled out. Our knowledge of the Roman exploitation of Scottish sources is too incomplete to support further speculation on this topic at present.

Lead isotope analysis

Rob Ellam

Isotope analysis of nine lead objects recovered during excavation at Culduthel was undertaken. The lead isotope ratios measured (Table 6.36) provide a fairly consistent suite of values. Comparison of the Culduthel isotope ratios to other published British and Irish lead sources suggest that the lead derived from a south-eastern Scottish source rather than exploiting more local sources. In Rohl's (1996) compilation of British and Irish lead ores, she recognised the following Scottish localities: Midland Valley (West Linton and East Calder), Southern Grampians (Tyndrum), Southern Uplands (Carphairn, Wanlockhead and Leadhills) and Southern Highlands (Strontian). Unfortunately, lead isotopes do not distinguish the Southern Uplands from the single East Calder sample analysed. The Culduthel lead samples fall comfortably within the Southern Uplands – East Calder field (Illus. 6.60). This is potentially highly significant as it indicates that the two closest sources to the site, Strontian and Tyndrum, were not exploited and that the lead used here was from a far more distant south-eastern source such as Wanlockhead or Leadhills.

Table 6.36
Lead isotope ratios

SF no.	206Pb/204Pb	%SE	2 SE	207Pb/204Pb	%SE	2 SE	208Pb/204Pb	%SE	2 SE	208Pb/206Pb	%SE	2 SE	207Pb/206Pb	%SE	2 SE	208Pb/206Pb
280	18.224	0.0054	0.002	15.566	0.0075	0.002	38.153	0.0076	0.006	2.09383	0.0035	0.00015	0.85423	0.0027	0.00005	2.09383
281	18.216	0.0063	0.002	15.560	0.0085	0.003	38.139	0.0081	0.006	2.09378	0.0033	0.00014	0.85423	0.0034	0.00006	2.09378
354a	18.236	0.0105	0.004	15.562	0.0138	0.004	38.158	0.0114	0.009	2.09230	0.0046	0.00019	0.85342	0.0045	0.00008	2.09230
354b	18.274	0.0057	0.002	15.574	0.0072	0.002	38.210	0.0074	0.006	2.09098	0.0025	0.00010	0.85229	0.0023	0.00004	2.09098
386	18.270	0.0059	0.002	15.571	0.0080	0.002	38.197	0.0079	0.006	2.09077	0.0041	0.00017	0.85226	0.0028	0.00005	2.09077
403	18.241	0.0079	0.003	15.568	0.0101	0.003	38.171	0.0091	0.007	2.09253	0.0047	0.00020	0.85347	0.0031	0.00005	2.09253
511	18.208	0.0060	0.002	15.551	0.0084	0.003	38.116	0.0092	0.007	2.09350	0.0039	0.00016	0.85415	0.0030	0.00005	2.09350
1624	18.197	0.0167	0.006	15.539	0.0240	0.007	38.083	0.0139	0.011	2.09269	0.0055	0.00023	0.85403	0.0091	0.00016	2.09269
1000	18.243	0.0054	0.002	15.567	0.0070	0.002	38.169	0.0070	0.005	2.09211	0.0031	0.00013	0.85324	0.0022	0.00004	2.09211
Standards																
NIST981	16.923	0.0087	0.003	15.480	0.0092	0.003	36.666	0.0096	0.007	2.16683	0.0062	0.00027	0.91483	0.0042	0.00008	
NIST981	16.919	0.0127	0.004	15.482	0.0136	0.004	36.675	0.0143	0.010	2.16755	0.0056	0.00024	0.91500	0.0043	0.00008	
NIST981	16.926	0.0064	0.002	15.486	0.0081	0.003	36.684	0.0083	0.006	2.16715	0.0037	0.00016	0.91492	0.0029	0.00005	
Mean	16.923			15.483			36.675			2.16718			0.91491			
2 SD	0.007			0.006			0.018			0.00072			0.00017			
"True"	16.9405			15.4963			36.7219			2.16771			0.91475			

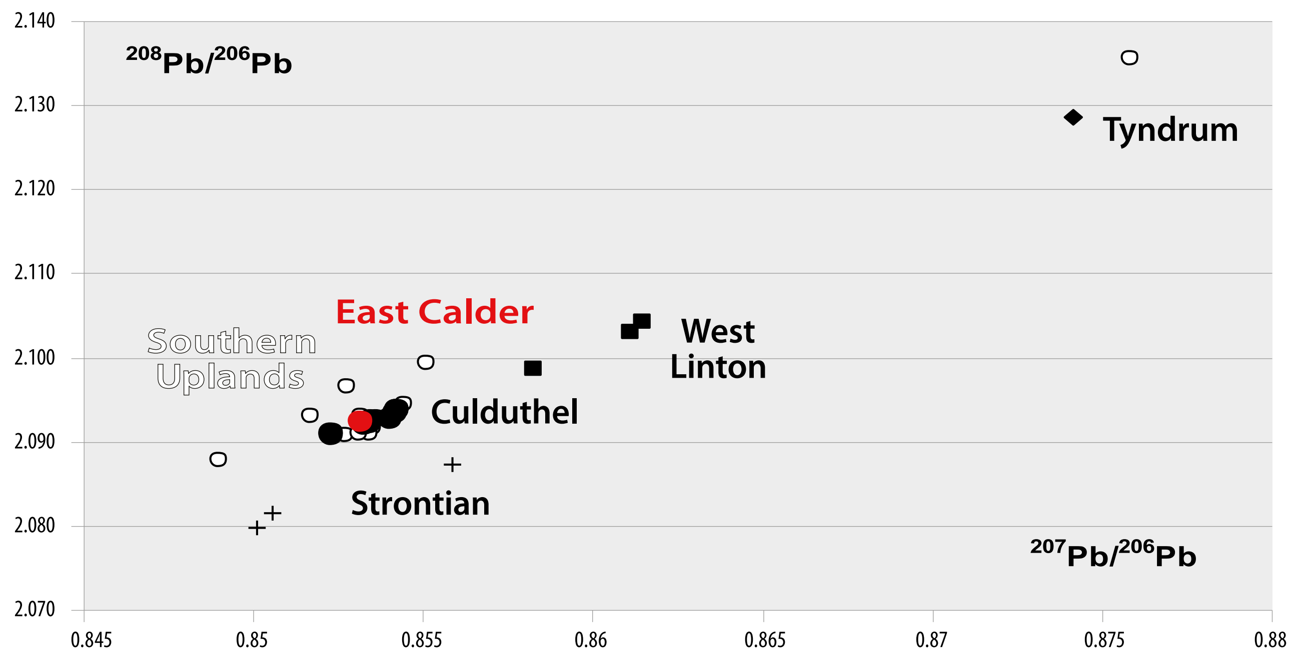


Illustration 6.60
Culduthel lead isotope values plotted against those from other published Scottish lead sources

Catalogue

SF0511 Well-rounded solid ovoid ?weight, formed from folding a strip in half and hammering to shape. End slightly damaged, overall form slightly irregular. L 18.5, D 14–15mm, mass 13.10 g. *c*.1671.

SF1000 Extended D-shaped sheet folded in half to form a tapered rectangle rounded at one end, the ends hammered closed and the surfaces with extensive toolmarks from flattening. On one side there are small oval facets, the best-preserved *c*.13mm × 4mm; at the broad end the hammer has caught it at an angle, giving sharp linear marks from the tool's edge. The other side has two deep, broad facets, one nearly triangular, the other slightly crescentic; it is likely these come from different areas of the anvil used while hammering. Probably prepared as raw material. L 92, W 36, T 14mm; mass 229.25g. *c*.1671.

SF1624 Sub-cylindrical fragment; unidentified. L 11, D 7mm, mass 2.00g. Context 2492.

Part D

Glass

The glass artefacts and glassworking debris from Culduthel: typology, discussion and catalogue

Fraser Hunter

Culduthel has produced a nationally important glass assemblage, since it includes evidence for the working of glass, both opaque red for metalwork inlay, and yellow, blue and clear glass for jewellery, primarily beads (Illus. 6.61 and 6.62). It is one of only a handful of sites in Britain with such evidence. It has also produced a notably wide range of beads, many of which are local products. Several come from dated contexts; this is a great asset, as depressingly few beads are closely dated. The number of small beads recovered from sieving (60% of the total of 22) emphasises the vital need to sample and sieve in order to recover a representative selection of such finds. Sampling also emphasised the ability of modern finds to get into ancient layers, with small fragments of modern glass (as well as plastic and post-medieval glassy blast furnace slag) coming from over 20 layers or features. This report should be read in conjunction with the analytical report (Davis and Freestone, Chapter 6, Analysis of the glass objects cross-reference here), which provided evidence critical for the interpretation of the assemblage.

Working debris

The remarkable evidence of working debris is mostly in the form of small flakes, droplets or fragments of rods or bars recovered in wet-sieving. They are predominantly opaque red (21 fragments, mostly flakes and blobs), with single items of opaque yellow (a small sphere), translucent blue (blob) and clear (flattened blob) glass (Illus. 6.62). Additionally, four more complex pieces of working debris show the combination of different colours. The debris is overwhelmingly linked to Hearth 2434 in the area to the south-east of House 10, which was also the focus of the non-ferrous metalworking evidence; only two fragments come from elsewhere in the area, plus a single piece from later levels in House 10/3, and two pieces from close to the palisade. These latter hint at a secondary working area, as they are rather different in character (see below). The evidence suggests the material represents both inlays in metal (the red) and glass jewellery (the other colours). Associated radiocarbon dates put this phase of production in the period *c.*200 BC–AD 20. Two dates are associated with glass production: a single AMS date from an oval pit beneath the hearth [2166] (pit [2777]), which contained sherds from crucibles, yielded a date of 200 cal BC–cal AD 1 (SUREC-30388); and a single AMS date from charcoal retrieved from hearth [2434] (2677) which yielded a date of 170 cal BC–cal AD 20 (SUREC-30386).

Red is extremely unusual for Iron Age glass jewellery, although opaque red beads are known from Iron Age contexts in Scotland, for instance, from Dun Ardtreck and High Pasture Cave, Skye, Dun Vulan, South Uist, and Airrieolland, Wigtownshire, while a red-coated yellow bead is claimed from Dun Bharabhat, Lewis (MacKie 2000, 387, no. 51, illus. 24 and 28; Hunter [forthcoming b]; Parker Pearson and Sharples 1999, 39; Maxwell 1889, fig. 50; Harding and Dixon 2000, 28–9, fig. 12.6). It is much more likely to have been intended as inlay in metalwork; this is consistent with the fragments that have been drawn into rods or bars (SF1268 – Illus. 6.63). The process is attested in the unfinished strap mount from the site (SF0318 – Illus. 6.50), its cells prepared for inlay, while the local 'massive' metalwork tradition of north-east Scotland used opaque red and yellow glass inlays on armlets and finger rings (MacGregor 1976, nos 239, 242–3, 260). From this, it follows that the opaque yellow could also have been used for inlay, but it could equally have been for jewellery, either yellow annular beads or as trails on class 13 beads (see below). The analytical results show that the yellow trails and many of the yellow beads are closely similar, suggesting both these types were being manufactured on site. Blue inlays are exceedingly rare in the massive tradition (attested only as tiny dots in the eyes of the Culbin bracelet; MacGregor 1976, no. 214); thus, it is much more likely that the blue blob comes from jewellery manufacture, as blue glass beads are a typical Iron Age type; it comes from an area far away from the main concentration of working debris. As Davis and Freestone note (Chapter 6, Analysis of the glass objects cross-reference here), working debris for clear glass is rare, but the cluster of analytical data suggests that the clear glass was being worked on site for the manufacture of class 13 beads.

There are a few intriguing pieces of working debris that combine two or more colours. SF1286 is a clear triangular blob with a yellow blob at one corner. The colour combination is common in class 13 beads and, although this seems too small to be a roughout, it is probably working debris from such a bead. More complex and puzzling is SF1289 (Illus. 6.64), a broken opaque red block, rather bubbly, with a series of trails set into it. The trails are themselves interesting, as one of them is a yellow strand twisted with a clear one. This may have been to eke out

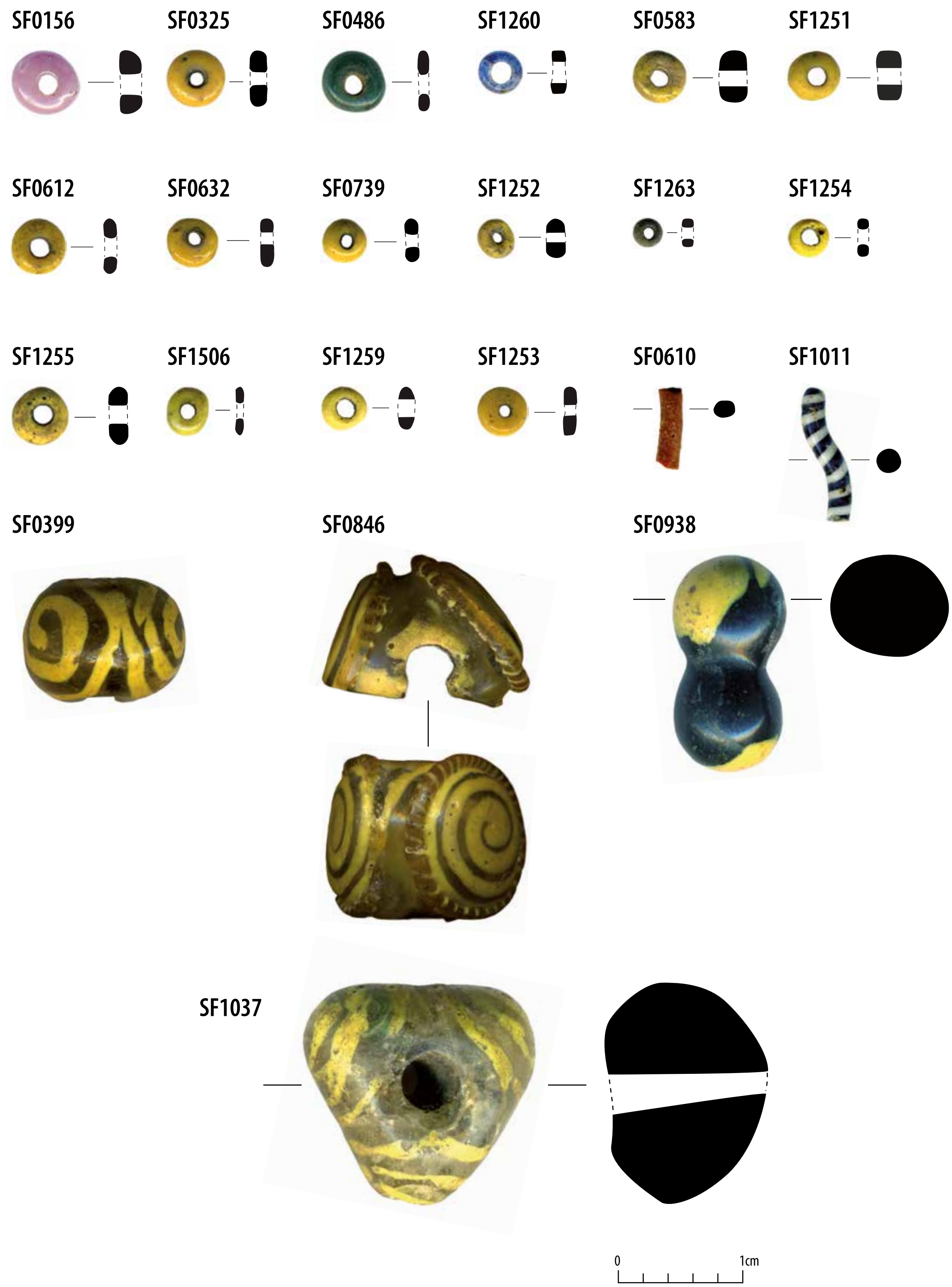


Illustration 6.61
Glass artefacts

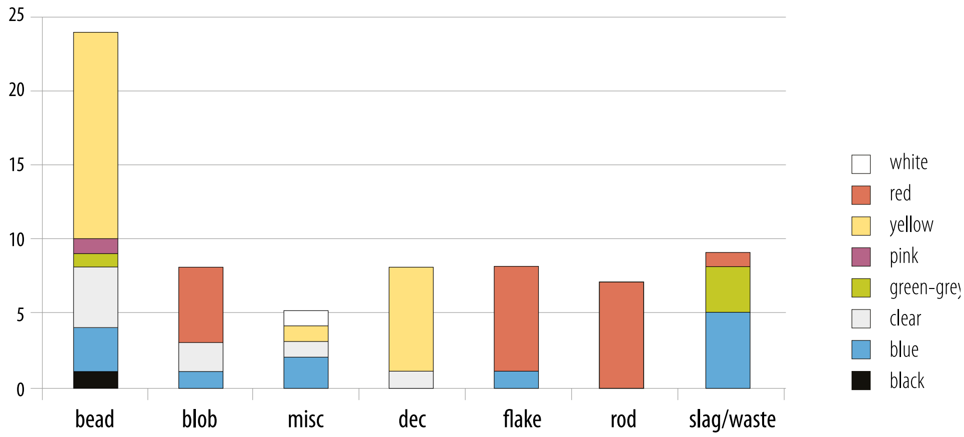


Illustration 6.62
Glass – colours and types of object

yellow glass, although the number of yellow glass beads suggests it was not particularly rare, or it might have decolourised due to overheating (cf. Henderson 1987a, 173). The red has collapsed over two of the trails, and this must be seen as a discarded item, but what was it? It could be a complex inlay for metalwork, but this is otherwise unknown in the massive tradition; yet, as noted, red beads are also exceedingly rare, inlaid ones are unknown, and there are no other obvious and plausible forms of jewellery. Although class 1 glass bangles used red trails in their coatings, distributional evidence strongly suggests they were not local products (Stevenson 1976), while a series of small glass balls, perhaps gaming pieces, only used red in fine inset eyes, much smaller than this (e.g. Ralston and Inglis 1984, 41). The other possibility is the much more human one of a mistake in the workshop, with different glass strands accidentally becoming mixed; they would then be essentially unusable, as they could not be easily separated.

There is one high-quality cable or trail from the site, an opaque blue and white one SF1011. This must have been intended for inlay in beads; the more ornate examples of both class 13 and 14 beads can have cable trails (e.g. SF0846 – Illus. 6.65), and although blue and white is not found in class 13s, there are parallels in class 14 (e.g. Guido 1978, pl. IIId; she refers to them rather disparagingly as 'ladder patterns which are in effect imitation cables' (p.87), but they clearly are inlaid cables). Intriguingly, the analytical data indicates this was rather separate from the other glass on the site, and its composition is more typical of Roman glass. This is a remarkable observation, indicating the import of pre-formed specialist components from the Roman world.

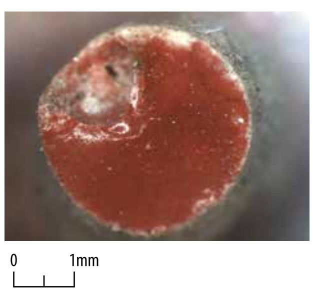


Illustration 6.63
Cross-section of opaque red rod (SF1268)

Jewellery

The beads themselves cover a notably wide range, including typical north-east types such as Guido class 8 and 13 (respectively yellow annular (14 examples) and triangular with yellow spirals (three examples)), three versions of the ubiquitous blue beads, and two more unusual ones, a 'black' bead and a two-tone green bead. Pink bead SF0156 (Illus. 6.61) is problematic, as although from an apparently secure context, it is interpreted here as intrusive because it does not have an ancient glass composition,

Illustration 6.64
Broken opaque red block showing the trail of a yellow strand twisted with a clear strand (SF1289)

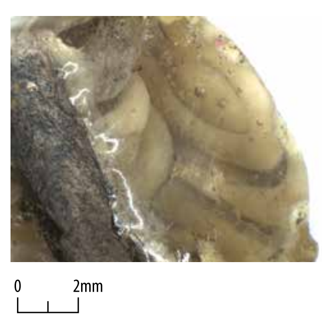


Illustration 6.65
Opaque yellow decoration on bead seen through broken clear glass (SF0846)

is a colour otherwise unattested in the Iron Age, and appears remarkably fresh; small items of glass can be quite mobile in deposits, as the quantities of modern glass sherds recovered by wet-sieving demonstrate. There is also a single dumb-bell toggle. The analytical data suggests that much of this glass jewellery was made on site: many of the yellow annular beads form a tight analytical cluster, as do the class 13s. This is supported by the evidence for iron scale on the interior of the perforations from their manufacture, which has not been worn away by use.

The yellow glass beads are a common type in the Scottish Iron Age. Guido's discussion and map (1978, 73–6, fig. 25) are now over 30 years old, and her distribution shows a concentration in the Culbin Sands (close to Culduthel), which was a production centre for glass jewellery, but gives no other north-east examples. This can now be redressed by examples from Culduthel, Brackla (Harden and Bone 1990, 24), Birnie and Clarkly Hill (unpublished). The yellow glassworking debris from Culduthel indicates there were several centres of production; implications of this are discussed below. Guido's dating (late 1st century BC–2nd century AD) was rather conservative, as she was constrained by the diffusionist framework of the period. Campbell (1991, 162) argued that associations supported her dates, but at that time there were few associated radiocarbon dates. At Culduthel, dates from contexts or associated structures producing these class 8 beads demonstrate a 2nd century BC–2nd century AD floruit, and indeed SF1251 comes from a structure with a 4th–1st century BC dating bracket. This agrees with a recently obtained date from excavations at Dun Glashan, Argyll, where such a bead came from a layer dated to 350–50 BC (Henderson 2005, 166).

Guido's class 13 (1978, 85–7, fig. 34), triangular beads with inlaid yellow spirals, is a typical product of north-east Scotland north of the Mounth, as her distribution map shows. Recent finds strengthen rather than change this, although they have produced a few more outliers. This includes one from a dated context, at Dun Bharabhat, Lewis (Harding and Dixon 2000, 28): dates for this phase (2100±50 bp, 2010±50 BP) can be combined to give a two-sigma range of 170 BC–AD 30. An example from Thainstone (Aberdeenshire) was associated with 1st–2nd century AD radiocarbon dates. Examples from Culduthel are linked to dates of *c*.110 BC–AD 70, 50 BC–AD 130 and AD 20–230, confirming a floruit of the later 2nd century BC to the 2nd century AD. The variation in quality among the class 13s is notable, with SF1037 (Illus. 6.61) having a rather incompetently applied spiral while SF0846 (Illus. 6.61 and 6.65) has a complex design applied with considerable care, including applied cordons round the spirals. Indeed, it is the most complex yet known; no other published examples have such applied cables. All three Culduthel examples are of clear glass, in contrast to Guido's comment that this is not found in class 13 beads (1978, 85–6). (See now Bertini et al's technological examinations of the type; 2011; 2014.)

Blue glass beads are a common and long-lived type, their currency extending well past the Iron Age. These three examples are notably varied in form and colour, and this variety is seen also in their analysis. SF1260 (Illus. 6.66), a mid-blue annular bead (group 6(iv b); Guido 1978, 66–8) comes from a structure dated to 360–50 cal BC (2σ) (GU- 21914 2140 ± 35 BP). SF1261 (Illus. 6.67), a barrel-shaped form (group 7(iv); Guido 1978, 70), is later, *c*.90 BC–AD 90, while the markedly darker blue globular example (SF1263 – Illus. 6.61; also group 7(iv)) potentially dates to *c*.160 BC–AD 60.

Illustration 6.66
Small blue annular bead (SF1260)

Illustration 6.67
Small blue barrel-shaped bead (SF1261)

There are two more unusual beads. SF1264 appears black, though under strong transmitted light it is actually a very dark blue. Truly black glass is unknown in prehistory, though it is found in the Roman period (Van der Linden et al 2009). The context of this one indicates a pre-Roman date, and there are local parallels for black glass: a number of class 13 beads are described as 'very dark opaque' (Guido 1978, 194–5), suggesting that black glass was available to bead manufacturers in the north-east (this has been confirmed by Bertini et al 2011).

The other unusual bead, SF0486 (Illus. 6.68), is mid-blue-green with an opaque green trail. The blue-green colour can be paralleled in the Iron Age; green is much less common, although green ring beads are known (e.g. Dun Ardtreck, Skye and Dun Mor Vaul, Tiree; MacKie 2000, 398–9; MacKie 1974, 148 no. 1). The idea of applying trails to a bead is a common Iron Age habit, so this may well be an Iron Age bead of unusual type.

The dumb-bell toggle (SF0938 – Illus. 6.69) is a type well attested in glass, copper alloy and bone; indeed, there is a copper alloy version from the site. Clickhimin (Shetland) has produced a similar two-tone one, in this case clear with a yellow stripe (Hamilton 1968, 144, fig. 64.1), while an example from Howe (Orkney) was monochrome turquoise green (Henderson 1994). Henderson (1994, 236) notes a further example from Leckie (Stirlingshire), and gives Irish parallels that indicate the type runs into the Early Historic period.

Illustration 6.68
Dark green/blue bead (SF0486)

Illustration 6.69
Blue toggle with yellow decoration (SF0938)

Glassworking in the Scottish Iron Age

The Culduthel evidence for glassworking is exceptional. It is one of only a handful of Iron Age sites in Britain to produce such debris, otherwise securely attested only at Culbin Sands (Moray), Dunagoil (Bute), Meare (Somerset) and Hengistbury Head (Dorset), with more circumstantial evidence from Luce Sands (Wigtownshire; Henderson 1989a; unpublished, Bute Museum; Hunter et al 2018). From around the Iron Age/Roman transition there is also evidence of the manufacture of blue wave-trail beads at Parc Bryn Cegin, near Bangor, north Wales (Cool 2008). Culbin, just 40km north-east of Culduthel, has long dominated discussions of north-east Scottish glassworking (Henderson 1989a, 69–71 reviews the convincing evidence), but Culduthel changes the picture. Henderson argued there was glassmaking at Culbin, but the Culduthel evidence points to the reworking of glass ingots, and this seems a more likely explanation for Culbin as well. Guido's discussion of production was framed in terms of 'factories' producing beads, but this seems rather anachronistic (1978, 32–7), and the current find, so close to Culbin, suggests a rather less centralised situation. It also emphasises that much glassworking was for metal inlays ('enamel') as well as for glass jewellery. The spatial co-occurrence of the opaque red glass and the non-ferrous casting debris suggests either they were the work of the same person or two specialists worked closely together.

The analytical data suggests that the class 8s, class 13s and blue beads were all being made on site, although the scatter of some yellow and blue beads beyond the core cluster shows that beads from other sources also arrived on site. Other finds support a multi-centre view of jewellery production, relying on imported glass ingots (as Davis and Freestone's work suggests) but well-equipped with the pyrotechnological skills to work it. From Dunagoil (Bute) comes an unpublished ingot of opaque yellow glass, while Castlehill (Ayrshire) produced bead-making debris in yellow, blue and white glass, although this is probably Early Historic in date (Smith 1919, 128). The distributional evidence of glass bangles also suggests various production centres in southern Scotland and northern England (Kilbride-Jones 1938; Stevenson 1976), though this remains a complex and poorly understood type. Analytical evidence has added to this evidence of multiple centres: Henderson's (1987b) analysis of typologically similar beads from Meare (Somerset) and near Donaghadee (County Down) showed that they had different origins.

The difficulty in pinning down glassworking sites is unsurprising, when the Culduthel evidence shows how vestigial such evidence can be. It came from a very small area of a very large site, and was almost all recovered from samples rather than in the field. We must surely envisage a larger number of production sites for glass jewellery, working imported ingots, rather than a centralised picture of a few 'factories'. The Culduthel evidence also highlights the interlinking of glass- and metalworking, with jewellery manufacture, bronze-casting and glass inlay-work being done around the same hearth.

Catalogue

Jewellery

Yellow glass beads (Guido class 8; Guido 1978, 73-6). All are opaque yellow; unless stated they are annular and D-sectioned with flat faces. Almost all have a thin dark layer coating the perforation, identified under the SEM as iron scale; this suggests an iron rod was used to form the beads around. Perforation to nearest 0.5mm.

Class 8 beads; annular

SF0612 Antimony-coloured bead. (Illus. 6.70)

Illustration 6.70
Antimony-coloured bead (SF0612)

Illustration 6.71
Tin-coloured bead (SF1254)

SF1254 Tin-coloured bead. (Illus. 6.71)

SF1251 Globular D-section, edges smooth, dark layer in perforation (deep red as well as deep blue). D 4.0 × 4.2, H 2.4, perforation D 1.5mm. Context 1888 (fill of post-hole [1887, House 9). (Illus. 6.61)

SF325 Ends smooth. Dark layer in perforation. Glossy surface with worn faces suggesting use-wear. D 4.5, H 2.4, perforation D 1mm. Context 1896 (occupation deposit around Workshop 11 and the three hearths [2166], [2434] and [26]). (Illus. 6.61)

SF583 Surfaces rather eroded. D 4.2, H 1.8, perforation D 1mm. Context 2225 (occupation deposit within Workshop 12). (Illus. 6.61)

SF612 Rounded edges merge into flat faces; ends smoothed. Wear on faces. Dark layer in perforation. D 4.4, H 1.9, perforation D 1.5mm. Context 2225 (occupation deposit within Workshop 12) (Illus. 6.70 and Illus. 6.61)

SF632 Slightly mis-shapen with one edge slightly squashed and perforation off-centre; one face slightly dished. One end smoothed, the other with a slight collar from manufacture. Very thin dark layer within perforation, flaked in parts, merging with yellow. D 3.8 × 4, H 1.8, perforation D 1mm. Context 2225 (occupation deposit within Workshop 12). (Illus. 6.61)

SF1252 Irregular doughnut, perhaps a pierced blob; circular-sectioned, rather eroded and vesicular. Dark layer within perforation. D 2.8 × 3.1, H 1.6, perforation D 1mm. Context 2285 (post-hole [2284] of Workshop 16). (Illus. 6.61)

SF1253 Well-rounded edge merges into face. Notably glassy surface. End of perforation irregular where glass broken off. Dark vertical streaks on perforation interior. D 3.8, H 1.7, perforation D 1mm. Context 1853 (stone wall base House 10/3). (Illus. 6.61)

SF1254 Globular D-section with well-defined worn narrow faces. Dark layer in perforation. D 3.1, H 1.9, perforation D 1.5mm. Context 3218 (Fill of metalworking pit [3217] adjacent to Workshop 13. (Illus. 6.71)

SF1255 Annular D-section merging with faces, ends smoother. Rather eroded; dark layer in perforation. D 4.5, H 2.0, perforation D 1.5mm. Context 3458 (fill of space between furnace stones and edge of cut of Furnace [3050] Workshop 13. (Illus. 6.61)

SF1469a One face flat with smooth perforation edge, the other slightly convex with perforation edge extended and broken off. A dark material coats the interior of the perforation. D 3.8, H 1.8, perforation D 1.5mm. Context 3467 (basal fill of Furnace 3790 Workshop 13; 90 cal BC–cal AD 80 (SUERC-30391).

SF1469b Broken flanges at both ends. Dark skin in perforation and in places on surface – a deep blue-gray, perhaps an oxidation state of the glass. Rather eroded. D 4.0 , H 2.4, perforation D 1.5mm. Context 3467 (basal fill of Furnace 3790 Workshop 13; 90 cal BC–cal AD 80 (SUERC-30391).

SF1506 Rounded edges merge into rather rounded faces; rather irregular, with traces of slight collar at ends. Dark layer in perforation. D 3.3 × 3.9, H 1.8, perforation D 1.5mm. Context 3467 (basal fill of Furnace 3790 Workshop 13; 90 cal BC–cal AD 80 (SUERC-30391). (Illus. 6.61)

SF739 Globular D-section, glossy surface, ends smoothed; dark layer in perforation. D 3.5 × 4, H 2.1, perforation D 1mm. Context 3961 (fill of Pit [3959] located within the interior of House 10/3. (Illus. 6.61)

SF1259 Slightly irregular, the perforation with rounded edges and remains of a dark layer. Slight use-wear on faces. D 3.5, H 1.6, perforation D 1.5mm. Context (fill of post-hole [3492] Workshop 15. (Illus. 6.61)

(Guido 1978, 73–6.)

Class 13 beads; triangular with inlaid spirals

SF0399 Half of a rounded triangular bead (class 13); bead; clear body with few bubbles and flush inlaid opaque yellow clockwise spirals; two (?of three) survive, one a single trail that overlaps the second, which is composed of two trails that touch but do not join perfectly. Wear at ends. Thin dark layer in perforation and some white or blue-green lenses within the body, apparently at the interface of folds within the glass body. D 13.2, H 9.8, perforation D 2.5mm. Context 2156 (=1853) (stony surface E of House 10/3 ring-ditch; *c.*AD 30–230). (Illus. 6.72)

Illustration 6.72
Colourless glass bead with yellow decoration (SF0399)

SF0846 Half of a triangular bead (class 13), of complex design and high quality. The base glass is clear with some bubbles. The two surviving flattened bosses (of three originally) have inlaid anti-clockwise opaque yellow spirals, with one spiral springing off the next. This creates a slightly blobby yellow pattern at the ends, as parts of the spiral have been folded into the body of the bead and are visible around the perforation. Each boss is bordered by an applied cordon in pale translucent yellow-brown glass with an S-twist fine opaque yellow cord; on the more complete one the two ends are butted in a subtle join. The outer surfaces of the cables are worn away at the ends, indicating the bead saw heavy use. Thin dark coating within perforation, with longitudinal striations. D 16, H 13.2, perforation D 3–3.8, cable D 1.3mm. Context 4342 (occupation deposit, Workshop 15; *c.*40 BC–AD 130). (Illus. 6.61)

SF1037 Triangular bead (class 13), one face flattened, the other rounded. Clear body, made less translucent by the swirls within it from manufacturing; some faint opaque trails. On each point is an inlaid spiral, rather incompetently applied – irregular and composed of several trails, with bits of the spiral merging or branching off; one ends up as a circle surrounding a spiral. Wear and damage at ends. Side L 19.0, H 12.5, perforation D 3–4.3mm. Context 1096 (F1095. Workshop 12; 110 cal BC–cal AD 70 (2σ) (GU-21924 2015 ± 35 BP). (Illus. 6.61)

(Guido 1978, 85–7.)

Blue beads

SF1260 Translucent mid-blue annular bead, D-sectioned with rounded faces. Guido (1978, 68) group 6(iv b). D 3.5, H 1.4, tapering perforation D 1.5mm. Context 1779 (F1778. House 7; 360–50 cal BC (2σ) (GU-21914 2140 ± 35 BP). (Illus. 6.66)

SF1261 Translucent mid-blue barrel-shaped bead, the ends slightly rounded and slightly worn. Guido (1978, 70) group 7(iv), although the colour is not as deep as cobalt blue. D 3.5, H 3.0, perforation D 1mm. Context 2471 (sandy deposit SW of stones 2456, Workshop 11; *c.*90 BC–AD 90). (Illus. 6.67)

SF1263 Globular D-sectioned dark blue translucent bead (near opaque), slightly rounded ends. Guido (1978, 70) group 7 (iv). D 2.2, H 1.5, perforation D 1mm. Context 2877 (F2876 pit within Workshop 19). (Illus. 6.61)

Other beads

SF0156 Opaque pink irregular globular bead with one face slightly flattened; rounded remains of a slight protuberance, probably where detached. No wear; very fresh, and analysis shows it is a potash glass; thus it is an intrusive, modern item. D 5.3, H 3.5, perforation D 1.5mm. Context 595 (F597, Workshop 2). (Illus. 6.61)

SF0486 Annular two-tone blue-green bead with well-rounded D-section. The main body of the bead is a translucent mid-blue-green with an opaque bright green trail inlaid at one end. Some wear on ends. Spiral trails from manufacturing visible. D 4.9, H 2.3, perforation D 1.5mm. Unstratified, from section cleaning; probably pit 2416. (Illus. 6.68)

SF1262 Bead fragment? Clear body with two closely spaced opaque yellow trails inlaid. Too small to determine form; surface worn. 2.5 × 2.5 × 1mm. Context 2548 (F2547, linked to Hearth 2434; *c.*170 BC–AD 20). (Illus. 6.73)

SF1264 Annular 'black' bead, D-sectioned with narrow flat faces. The colour is not strictly black (which is almost unknown in prehistory) but a very deep ?blue which appears black. Guido (1978, 68) group 6(ix). D 3.2, H 1.4, perforation D 2mm. Context 3467 (fill of Furnace 3790; 90 BC–AD 80).

Illustration 6.73
Pale glass fragments (SF1262)

Other glass jewellery

SF0938 Dumb-bell toggle, appearing black and yellow (the black actually a deep translucent slightly greenish blue within which trails, probably from production, can be seen). Each end is decorated with a large blob and a small stripe of opaque yellow. The surface is slightly corroded in one area. At the junction of the two lobes is a slight indent, probably from a tool such as tongs. L 17.5, D 9mm. Context 4380 (4379, Workshop 15, 40 BC–AD 120). (Illus. 6.69)

Working debris

These are listed by context and associated structure where applicable to give an idea of distribution.

Pits adjacent to Workshop 22

Context 1074 (F.1077) SF1007 Rounded sub-triangular mid-blue translucent blob. 7.0 × 4.7 × 1.7mm.

Context 1075 (F.1076) SF1011 Cable prepared for inlay (opaque white and translucent mid-blue), slightly sinuous, one end rounded, other broken. Seven twists/cm. L 11, D 2mm. (Illus. 6.74)

Context 2548 (F.2547), linked to Hearth 2434

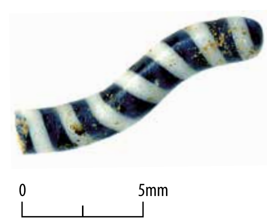


Illustration 6.74
Blue and white spiral (SF1011)

Opaque red

SF1268 Rod; bubbly, ends broken. L 16.5, D 1.8mm. (Illus. 6.63)

SF0610 Bar fragment, rectangular-sectioned with rounded corners; one end cut, the other ?deliberately snapped, with subsequent flaking. Some striations on surface from drawing. 8.5 × 3.3 × 2.4mm.

SF1271 Broken tapered droplet, slightly bubbly. 2.5 × 1 × 1mm.

SF1272 Longitudinal drip with irregular bubbly surface, broken along one side and both ends. L 4.5, D 1.5mm.

SF1273 Fragmentary (non-joining) longitudinal drip with irregular bubbly surface, broken along one side and both ends; vestigial dark layer on fracture surface. L 5.8, D 2mm.

SF1278 Broken edge of irregular rounded flat droplet. 4.5 × 1 × 0.5mm.

SF1277 Angular fragment with rounded surface. 6 × 3 × 0.5mm.

SF1269, SF1270, SF1274, SF1275, SF1276, SF1279 (×3) Eight small angular flakes.

Other glass types

SF1266 Opaque blue slightly curved fragment with opaque yellow trail; the other side, apparently original, is slightly bubbly, with a further yellow trail, suggesting it is probably working debris rather than a broken object. 2.3 × 2.0 × 0.7mm. (Illus. 6.75)

Illustration 6.75
Antimony-rich blue flake (SF1266)

SF1267 Broken flattened clear glass blob. 5 × 2.5 × 1.5mm.

Context 2550, 2549, linked to Hearth 2434
SF1280 Curved strip of opaque red glass, rounded rectangle in section with edge damaged on one side, suggesting it was prepared for manufacture or use as an inlay. Remains of dark strip on interior (cf. similar dark layers on beads). Broken at both ends. 7 × 2.5 × 1mm. Sample 989 context 2550.

Context 2677, charcoal spread linked to Hearth 2434 (150 BC–AD 30)
SF1281, SF1282, SF1283 Three opaque dull red angular flakes, one from a rounded blob

Context 3022, spread linked to Hearth 2434
SF1286 Translucent blob folded into a triangle, a dot of opaque yellow inlaid into one end. Too small to be a waster; probably working debris, the colour combination suggesting perhaps a class 13 bead. Around half of the outer edge abraded. 6.5 × 5 × 4.5mm.

SF1287 Linear nodular dribble of opaque red glass. 10.5 × 5mm, D 1–2mm.

SF1288 Angular flake of opaque red glass, the irregular outer surface suggesting it is a waste or droplet; layer of opaque yellow in centre. Accidental mixture? 6.5 × 4 × 1.5mm.

SF1289 Accidental mixture? Bubbly opaque red block, the ends broken, with a series of trails set into it: a yellow trail with two clear threads Z-twisted into the surface; an adjacent translucent green trail with yellow set in it (perhaps two trails), which is visible in the section, although covered on the surface by red; and on another face a rather collapsed and bubbly ?yellow trail with ?carbonised flecks within it. Its irregular and inconsistent form, and the mixture of colours, suggests it was an accident that was discarded. 8.5 × 6 × 3.5mm. (Illus. 6.64)

Context 3402 Furnace 3790 (90 BC–AD 80)
SF1294 Near-perfectly spherical droplet of slightly bubbly opaque yellow glass, probably an accidental droplet of working debris. D 2.5mm. (Illus. 6.76.)

Illustration 6.76
Opaque yellow ball (SF1294)

Context 2100, abandonment deposit, Workshop 11 (90 BC–AD 90)
SF0355 Linear drip of opaque red glass, circular-sectioned with flowed appearance; one end rounded, other broken. Slight facet on one side, possibly from tongs or from touching something. L 17, D 3mm. (Illus. 6.77)

Illustration 6.77
Glass 'rod' with discoloured outer surface (SF0355)

Context 3440 F.3439, House 10/3 (AD 30–230)
SF1295 Bubbly opaque red rounded broken glass lump. Small white crystal growth in surface layer. The bubbles suggest it was a discarded lump rather than raw glass. 14 × 16 × 13.5mm.

Analysis of the glass objects

Mary Davis and Ian Freestone

The glass from Culduthel offers an excellent opportunity to determine the composition of glass being used to manufacture small items in the Later Middle Iron Age. While a significant number of Iron Age glass objects have been analysed from Britain, the published data are still limited, and material from production sites is rare. The assemblage consists predominantly of beads, plus a number of 'blobs' and working residues such as rods and flakes. The majority of the objects are yellow, red and blue, though black, green and decorated clear beads were also present (Illus. 6.62). Whereas the yellow glass is present predominantly in the form of beads, the red glass, most of which was from a single context, comprises flakes, working pieces and waste.

Analytical methods

Analysis was carried out using a CamScan Maxim 2040 scanning electron microscope (SEM) fitted with an Oxford Instruments energy dispersive X-ray detector and ISIS spectrometer (EDS). Operating conditions employed a 30° take-off angle, a 20kV accelerating voltage, and the samples were analysed for 100 seconds livetime with a beam current that yielded a count rate of *c*.4,000 counts per second when on a metallic cobalt standard. The spectrometer was calibrated using pure elements, oxides and minerals; for lead, a leaded glass standard was used where high concentrations of PbO were present. Corning A-D (Brill 1999) and a range of commercial glass standards were used to evaluate accuracy and precision. Results on flat polished samples are believed to be better than 2% relative for SiO_2, 5% relative for minor components present in concentrations greater than 2%, and 10% for components around 1%, with uncertainties increasing towards the detection limits

Forty samples of glass were selected for analysis; most of the objects were sampled once, though when decorated and consisting of more than one colour, additional samples were taken (Table 6.37). Eleven out of 20 red fragments were sampled, mounted and polished (many pieces had the same context and arrived in the same bag). It emerged that these included a piece of red slag, and a modern fragment of plastic material. The compositional analyses (scatter diagrams) below exclude the latter two pieces. Two methods of sampling were employed. The red glass was sampled in the conventional way: approximately $1mm^3$ pieces were removed and embedded in polyester resin, which were then polished down using silicon carbide and alumina polishing agents. To avoid unnecessary damage, the other objects, mostly beads plus some fragments, were sampled using the method devised by Bronk and Freestone (2001). This uses a diamond-coated file to score across a small section of the surface of the object to produce fine glass flakes (Illus. 6.63). The procedure was originally assessed to be suitable for the classification of glass types and to allow useful conclusions to be drawn about raw materials, provenance and date, although not as accurately and precisely as for mounted and polished samples (Bronk and Freestone 2001). Fragments for analysis were selected using a close examination of both secondary (SEI) and back scattered electron images (BSEI) in the SEM (Illus. 6.78 and 6.79). The two images when viewed in tandem allowed the selection of a flat, clean surface, not shadowed by other pieces (SEI image) with a consistent atomic number and lack of surface abnormalities or corrosion (BSE image). As expected, using the flake method the overall percentage totals departed from 100% due to the variable geometry. Sometimes considerable time was needed to locate the most appropriate flakes or areas of flakes to achieve the best analytical total. As observed by Bronk and Freestone (op cit) the standard deviation for the flakes was slightly greater than that for polished samples; also as with the polished samples, the largest standard deviations were for sodium, possibly due to its volatility in the electron beam, and lead, antimony and tin (plus copper in red glass), probably due to uneven dispersal of these metal compounds within the glass matrix, especially when used as opacifiers. Analyses were normalised to totals of 100% so they could be compared to one another and to other analyses. Overall, the flake method proved a useful and effective way to obtain analyses of objects that would otherwise have been difficult to sample. However, the user must be aware of potential problems and limitations, and it should be noted that it is a slow and laborious (hence expensive) procedure. Furthermore, as will be seen below, with certain types of glass there may be unpredictable sources of error that were not anticipated in the original evaluation.

Analytical results are presented in Table 6.37 and in greater detail within the archive report. Excluding a fragment of copper corrosion product, 12 samples, mainly categorised as waste or 'cullet' are clearly modern and/or non-glass waste, and unrelated to the focus of this report. These are separated from the remaining soda-lime-silica glasses in the archive report. Each possesses a number of characteristics that are inconsistent with the great majority of glass pre-dating the 15th century, notably high

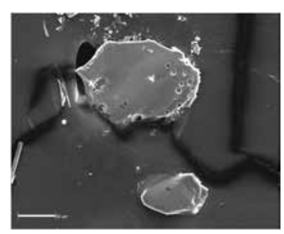


Illustration 6.78
SEI yellow and clear glass (scale bar = 50μm); surface undulation in the flake (SF1286)

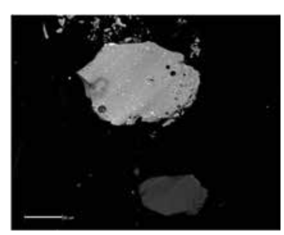


Illustration 6.79
BSEI yellow and clear glass (scale bar = 50μm); fine particles (SF1286)

Table 6.37
Analytical results

		Content	SF No.	Na2O	MgO	Al2O3	SiO2	P2O5	Cl	K2O	CaO	TiO2	MnO	FeO	CuO	SnO2	Sb2O3	PbO		original total		
opaque red																						
flake, cut broken	red	2548	1269	11.18	0.51	1.57	41.56	0.37	0.64	0.65	4.71	0.12	0.46	0.51	10.63	b.d.	0.98	26.07	100.00	99.56	LIA	
flake, cut 'heated'	red	2548	1274	11.54	0.56	1.69	42.37	0.34	0.65	0.84	5.13	0.08	0.43	0.46	8.65	b.d.	0.61	26.63	100.00	99.52	LIA	
rod, burned organic on surface	red	2550	1280	10.65	0.43	1.83	41.15	0.40	0.65	0.61	4.90	0.10	0.40	0.58	9.64	b.d.	0.85	27.81	100.00	99.05	LIA	
rod	red	2548	1268	10.16	0.39	1.66	42.03	0.34	0.65	0.58	4.70	0.03	0.47	0.53	11.03	b.d.	1.14	26.28	100.00	99.55	LIA	
flake	red	2548	1275	10.65	0.46	1.93	42.57	0.43	0.64	0.77	5.27	0.11	0.40	0.63	9.35	b.d.	0.83	25.90	100.00	100.3	LIA	
fragment, heated elongated	red	3022	1287	11.22	0.55	2.00	42.59	0.35	0.63	0.80	5.26	0.14	0.42	0.60	8.82	b.d.	0.79	25.73	100.00	101.8	LIA	
object/lump	red/yellow/ clear	3022	1289	11.18	0.42	1.77	42.28	0.30	0.67	0.56	4.66	0.14	0.38	0.55	9.90	b.d.	1.01	26.16	100.00	101.9	LIA	
rod, darkened outer surface	red	2100	355	10.97	0.33	1.44	43.82	0.41	0.76	0.46	4.54	0.08	0.29	0.32	6.67	b.d.	1.21	28.64	100.00	100.1	LIA	
rod, 'squared'	red	2548	610	11.04	0.35	1.46	43.09	0.33	0.76	0.52	4.36	0.04	0.34	0.37	7.76	b.d.	1.09	28.45	100.00	100.1	LIA	
rod, 'squared'	red	2548	610	11.21	0.44	1.71	42.27	0.34	0.62	0.58	4.70	0.08	0.36	0.50	10.56	b.d.	1.07	25.53	100.00	100.1	LIA	
flake	red	2677	1281	11.13	0.40	1.59	42.68	0.34	0.69	0.55	4.53	0.06	0.35	0.44	9.16	b.d.	1.08	26.99	100.00	100.1	LIA	
flake, burned	red	2677	1282	11.13	0.54	1.89	41.84	0.29	0.60	0.81	5.36	0.19	0.44	0.59	9.97	b.d.	0.87	25.45	100.00	100	LIA	
Blue																						
flake	blue	2548	1266	18.43	0.66	2.42	59.40	0.18	0.30	0.93	8.68	0.10	0.35	2.01	<0.5	b.d.	4.89	1.00	100.00		Roman	
bead	blue	1779	1260	22.14	0.56	1.55	63.51	0.11	1.12	0.49	7.38	0.15	0.05	1.13	<0.5	b.d.	0.51	0.78	100.00			
part toggle	blue/yellow	4380	938	19.51	0.54	2.52	62.51	0.07	0.99	1.21	8.10	0.08	0.55	0.84	<0.5	b.d.	b.d.	0.80	100.00			
blue spiral	blue/white	1075	1011	17.02	0.72	2.72	59.08	0.23	0.96	6.63	8.52	0.07	1.73	1.59	<0.5	b.d.	b.d.	0.08	100.00		Roman	
bead	blue	2471	1261	15.78	1.11	0.89	67.35	0.40	1.10	5.16	6.73	0.05	0.18	0.47	<0.5	b.d.	b.d.	0.10	100.00		ODD composition	
bead	blue	2877	1263	25.40	1.27	1.78	54.57	0.14	1.29	1.39	4.90	0.12	6.67	0.93	<0.5	b.d.	b.d.	0.98	100.00		ODD composition	
opaque yellow																						
bead	yellow	1869	325	10.87	0.41	2.19	55.85	0.27	1.05	0.69	6.20	0.05	0.13	1.77	<0.5	b.d.	0.80	19.08	100.00		LIA	
bead	yellow	3961	739	12.88	0.46	2.12	54.55	0.27	0.76	0.69	7.16	0.09	0.50	0.95	1.21	b.d.	1.41	16.83	100.00		LIA	
ball	yellow	3402	1294	11.52	0.73	1.85	42.78	0.62	0.51	2.05	3.99	0.10	0.72	1.60	<0.5	b.d.	3.74	29.15	100.00		LIA	
bead	yellow	2725	1253	16.18	0.47	2.00	46.48	0.31	0.70	0.49	5.39	0.07	0.08	1.37	1.41	b.d.	2.26	22.75	100.00		LIA	
bead	yellow	3458	1255	15.86	0.50	2.27	53.89	0.29	0.77	1.20	6.15	0.04	0.52	0.77	1.30	b.d.	1.23	15.18	100.00		LIA	
bead	yellow	3467	1469A	13.89	0.85	1.93	46.90	0.65	0.66	1.46	4.83	0.10	0.73	1.32	0.88	b.d.	2.42	23.27	100.00		LIA	
bead	yellow	3467	1469B	10.45	0.84	1.64	42.55	0.62	0.54	1.17	3.93	0.08	0.44	1.34	1.20	b.d.	1.97	33.23	100.00		LIA	

alumina, high lime and high manganese contents. They fall into a number of categories; a group are early modern manganese-rich blast-furnace slag, a pink bead is potash-lead-silica glass post-dating 1700, a blue 'lump' has a modern composition with low levels of several minor elements, especially chlorine, and the remainder appear to be various metallurgical waste products or fuel ash slag. Some of this waste material may relate to the Iron Age industrial activity on the site (fuel, slagged structural material) but does not represent glass product. No high medieval glass appears to be present.

The majority of the remaining glasses are of the soda-lime-silica type, all with magnesia contents at around or below 1.5%. They are therefore categorised as natron-type glass, which is the major glass type in use in the Later Middle Iron Age and Roman

Table 6.37
(continued)

		Content	SF No.	Na2O	MgO	Al2O3	SiO2	P2O5	Cl	K2O	CaO	TiO2	MnO	FeO	CuO	SnO2	Sb2O3	PbO		original total		
bead	yellow	1888	1251	13.07	0.46	2.29	56.75	0.23	0.95	4.28	5.43	0.04	0.04	0.79	<0.5	b.d.	0.68	14.42	100.00		LIA	
bead	yellow	2223	612	14.06	0.43	2.15	52.47	0.26	0.98	0.79	5.17	0.09	0.00	1.13	<0.5	b.d.	0.32	21.44	100.00		LIA	
bead	yellow	2223	632	13.76	0.43	2.12	53.30	0.28	0.90	0.68	5.65	0.07	0.11	0.88	0.76	b.d.	0.79	20.23	100.00		LIA	
bead	yellow	2285	1252	14.04	0.49	2.13	51.23	0.35	0.81	1.25	6.25	0.06	0.55	0.86	<0.5	b.d.	0.93	19.93	100.00		LIA	
bead	yellow	3467	1506	11.31	0.46	2.14	51.47	0.50	0.58	1.32	6.30	0.08	0.29	1.61	<0.5	b.d.	1.41	22.00	100.00		LIA	
bead	yellow	3996	1259	14.41	0.42	2.15	56.70	0.21	1.07	0.59	5.91	0.08	0.05	0.76	0.96	b.d.	0.83	15.78	100.00		LIA	
part object	yellow/red/ clear	3022	1288	14.56	0.53	2.16	54.27	0.23	0.79	0.65	6.57	0.10	0.46	0.82	<0.5	b.d.	0.99	17.39	100.00		LIA	
part bead	yellow/clear	1096	1037	14.10	0.40	1.87	48.66	0.39	0.78	0.86	6.05	0.05	0.15	1.17	1.03	b.d.	0.93	23.47	100.00		LIA	
part bead	yellow/clear	2156	399	13.47	0.60	2.51	56.65	0.27	0.62	1.08	7.29	0.05	0.59	0.80	<0.5	b.d.	1.08	14.55	100.00		LIA	
part bead	yellow/ trans/clear	4342	846	14.17	0.37	1.92	49.81	0.28	0.71	0.80	6.41	0.06	0.20	1.25	0.96	b.d.	0.60	22.34	100.00		LIA	
part toggle	yellow/blue	4380	938	13.32	0.44	1.93	47.69	0.34	0.88	0.88	5.63	0.06	0.07	0.98	1.15	b.d.	0.68	25.90	100.00		LIA	
part blob	yellow/clear	3022	1286	14.60	0.54	2.23	54.01	0.22	0.73	1.54	6.58	0.08	0.55	0.75	<0.5	b.d.	0.92	16.51	100.00		LIA	
bead	yellow	2223	583	10.37	0.47	1.82	33.73	0.51	0.55	0.53	4.48	0.09	0.59	0.59	<0.5	3.43	b.d.	42.13	100.00		LIA or 4th C or later	
bead	yellow	3218	1254	9.57	0.37	1.75	34.31	0.50	0.77	0.34	3.73	0.02	0.61	0.77	<0.5	2.00	b.d.	44.71	100.00		LIA or 4th C or later	
translucent yellow-brown																						
part bead	trans/ yellow/clear	4342	846	17.47	0.45	1.91	68.95	0.20	1.10	1.57	6.99	0.04	0.01	0.32	0.94	b.d.	b.d.	b.d.	100.00		LIA	
clear																						
part bead	clear/red/ yellow	3022	1289	19.57	0.70	2.43	64.68	0.19	1.11	1.04	6.94	0.06	0.31	0.30	<0.5	b.d.	2.04	b.d.	100.00		Roman	1-4th
part bead	clear/yellow	1096	1037	19.36	0.61	2.50	64.18	0.12	1.14	1.54	7.98	0.06	1.18	0.29	<0.5	b.d.	b.d.	b.d.	100.00		Roman	1-4th
part bead	clear/ yellow/trans	4342	846	19.04	0.57	2.59	64.59	0.16	1.01	1.30	8.08	0.06	1.16	0.29	0.81	b.d.	b.d.	b.d.	100.00		Roman	1-4th
part bead	clear/yellow	2156	399	19.20	0.72	2.86	64.13	0.10	0.92	1.58	8.08	0.08	1.10	0.50	<0.5	b.d.	b.d.	b.d.	100.00		Roman	1-4th
blob	clear/yellow	3022	1286	18.73	0.57	1.45	67.90	0.06	0.60	1.37	8.12	0.03	0.54	0.44	<0.5	b.d.	b.d.	b.d.	100.00		Roman	1-4th
misc																						
bead	black	3467	1264	17.97	0.51	1.31	57.87	0.09	0.89	0.78	7.95	0.10	0.03	10.39	<0.5	b.d.	0.56	0.90	100.00		Roman	
spiral	white/blue	1075	1011	17.61	0.55	2.53	59.80	0.18	0.44	2.61	7.30	0.03	0.85	0.37	<0.5	b.d.	7.15	b.d.	100.00		Roman	
lump	pale	2548	1267	15.31	1.52	3.39	64.90	0.11	0.70	1.75	9.05	0.15	1.39	0.84	0.86	b.d.	b.d	b.d.	100.00		Roman/ Byzantine	
bead	green-blue	2416	486	17.42	0.62	2.62	63.76	0.13	0.89	2.19	7.90	0.06	1.18	0.46	2.24	b.d.	b.d	0.50	100.00		Roman	

periods, in Britain, Western Europe and the Mediterranean. The glasses contain variable quantities of copper, lead, antimony and tin, which were added as colourants and opacifiers. To assess the relationships between the glasses it is useful to exclude these additions (Brill 1999; Brill and Cahill 1988, 19), so that the underlying composition of the base glasses can be compared. For this purpose, the data are presented in some diagrams as reduced or recast data, where the analyses were recalculated after the removal of elements with a higher atomic weight than iron as all were used as colourants and/or opacifiers in at least some of the objects. The remaining analysed elements were normalised so their totals equalled 100%. Asterisked components in the graphs signify that they represent these reduced compositions (e.g. *% CaO).

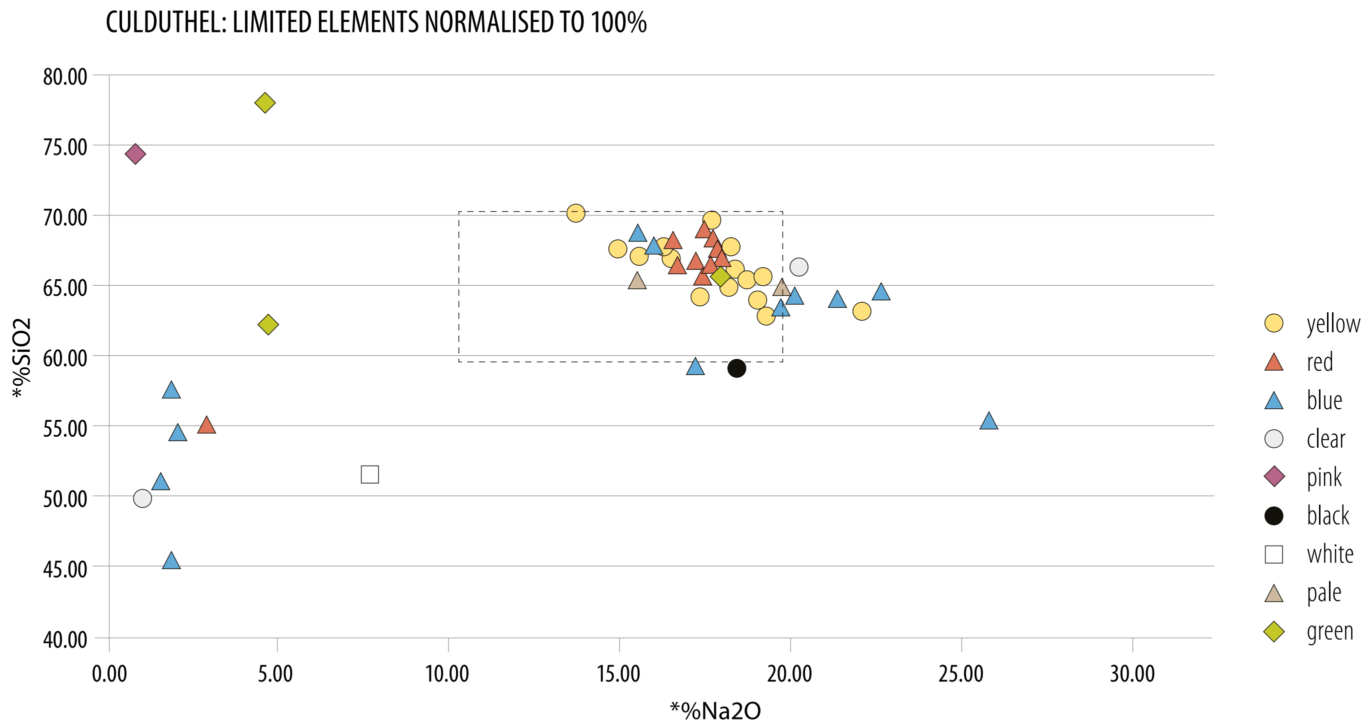


Illustration 6.80
Soda/silica composition of the glass; the box illustrates the normal composition for soda-lime-silica glass from the LIA/Roman period, and differentiates outliers with low soda values

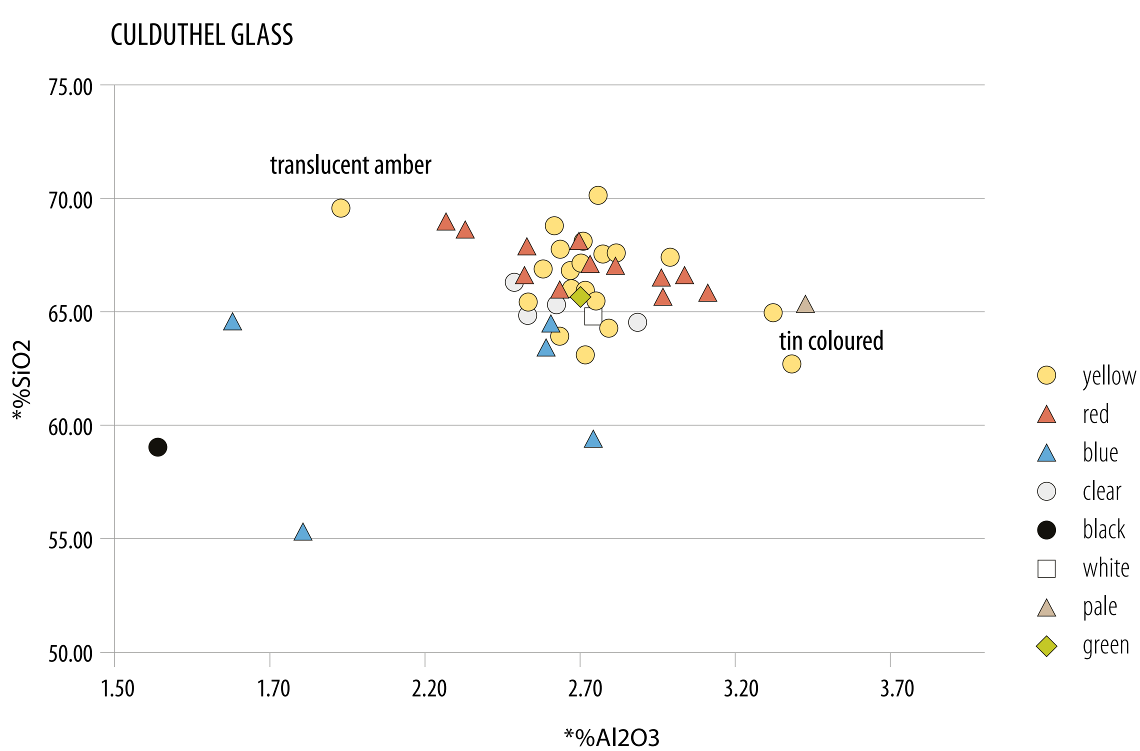


Illustration 6.81
Scatter diagram of alumina versus silica illustrating some of the glass outliers

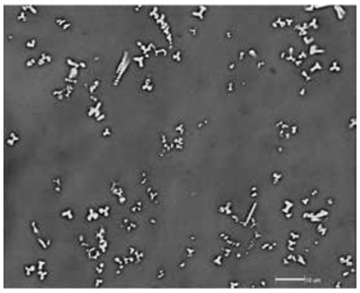


Illustration 6.82
BEI of cuprite dendrites within red glass (scale bar = 10 μm) (SF1269)

Illus. 6.80 shows the samples in terms of their reduced soda and silica contents. The 'box' indicates the usual compositional range for uncoloured soda-lime-silica glasses in the Later Middle Iron Age (LIA) and Roman period (approx. 60–70% silica and 14–20% soda). The majority of the glass from Culduthel lies within this range, with the modern and waste samples appearing as outliers. The status of one blue glass bead (SF1263) with exceptionally high Na_2O is unclear. Most of these soda-lime-silica glasses have low magnesia (MgO) and potash (K_2O) contents.

Alumina is likely to have been incorporated into the glass with the silica as a naturally occurring impurity; its concentration therefore reflects the raw material and may be used to provide an initial impression of production-related groupings. Illus. 6.81 shows that the majority of the yellow and red glass samples form a fairly compact group, while the blue is much more dispersed, as is the ?Roman-style black glass bead. Interestingly, neither of the two blue objects that do fall within the main group of glass are the small annular beads; one is the toggle decorated with yellow glass (Illus. 6.69) and the other is a flake – suggesting that blue glass may have been worked on site. The two yellow beads with high alumina are both coloured with tin rather than antimony; and the yellow in the top left-hand corner is the one example of yellow/amber translucent glass used as decoration on one of the clear beads.

Roman and Later Middle Iron Age soda-lime-silica glasses were typically made using natron, a mineral source of soda, and these 'natron glasses' are generally found to have less than 1.5% each of MgO and K_2O, and typically less than one per cent. The analyses of the Culduthel glasses have low MgO, but in some cases the K_2O contents are higher than is typical for glass of the period. Potash contents greater than 1.0% are frequent in the yellow, blue and colourless glasses, and in several cases exceed four per cent (Table 6.37). Given that these compositions resemble Later Middle Iron Age/Roman glass in other respects, along with their contexts and typologies, it must be assumed that they are of Later Middle Iron Age/Roman date, but have been contaminated with potash by some process. Recent examination of the glass products from an experimental replication of a wood-fired Roman glass furnace has shown that potash contamination may occur due to the vapour from the wood fuel (Paynter 2008). We therefore assume that the elevated potash contents encountered in the Culduthel beads were a product of the bead-making procedures adopted. One possibility is that the flake sampling procedure we have adopted removed samples from much closer to the surfaces of the objects than those usually analysed, and the surfaces of the beads had been contaminated by potassium in the manufacturing process (perhaps during annealing).

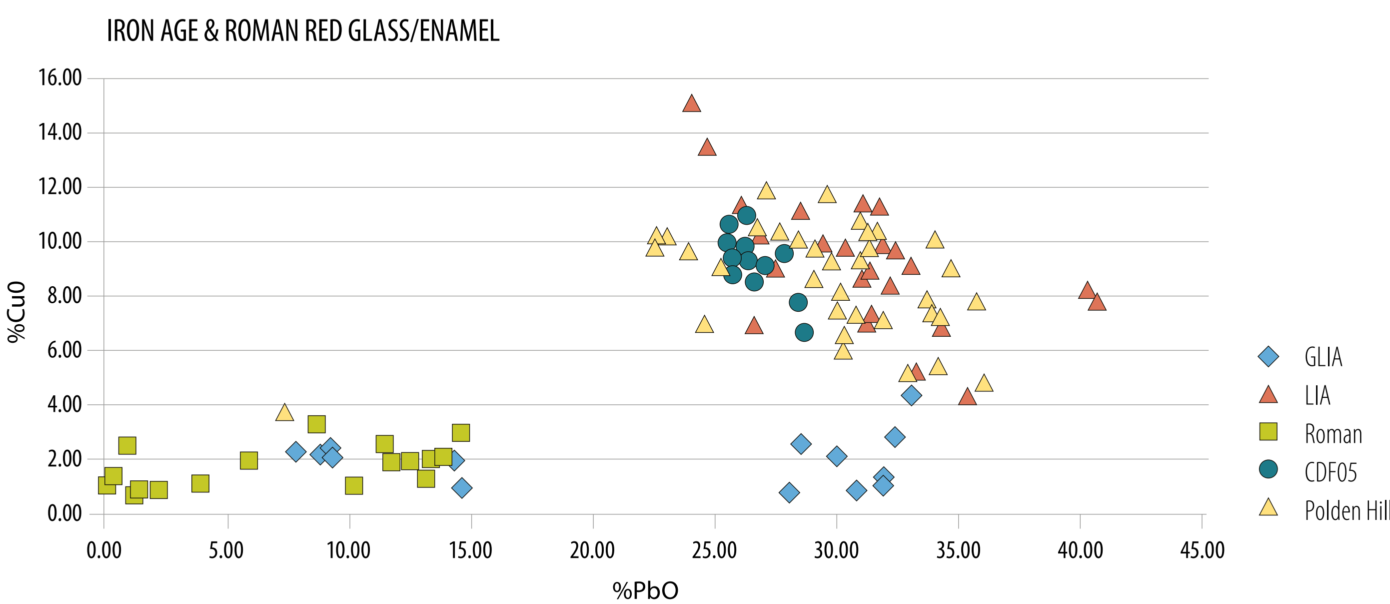


Illustration 6.83
This scatter diagram of the two main additional elements (copper oxide and lead oxide) added to LIA opaque red glass illustrates how the Culduthel glass sits as a discrete group among other similar Late Iron Age red glass, and away from Roman red glass

Opaque red glass

The red glass from Culduthel is a soda-lime-silica glass with large additional quantities of both lead and copper (averaging 26.64% lead oxide and 9.35% copper oxide). Like other examples of Later Middle Iron Age opaque red, the copper occurs in the form of dendritic (branching) crystals of cuprite (cuprous oxide, Cu_2O) within the glass matrix, which give the glass its intense colour and opacity (Illus. 6.82). It is highly likely that this glass was traded as ingots or blocks of glass; several examples of these have been found (e.g. Tara Hill, Ireland (Freestone et al 2002); Fish Street, London (Stapleton et al 1999)). The original clear glass, before the colourants were added, as with the majority of Iron Age and Roman glass is likely to have been derived from the Eastern Mediterranean (e.g. Nenna et al 1997; Degryse and Schneider 2008). Where and by whom the glass was coloured has not been determined, but this type of red glass was used for decorating La Tène metalwork in northern, rather than Mediterranean Europe. However, similar compositions of glass do occur very occasionally on the walls of nymphaea in the 1st century AD (Arletti et al 2006; Boschetti et al 2007) and in Roman orange tessera (Brun 1991, Appendix 1). The composition of all the red glass from Culduthel corresponds well to other Iron Age opaque red glasses from Britain in terms of its copper and lead oxide contents (Hughes 1972; Henderson 1989b) (Illus. 6.83). Also shown are red Roman glass tesserae from Italy (Freestone and Stege, unpublished data), which typically have lower copper and lead oxide contents, while red glass from 'geometric' Later Middle Iron Age enamelled objects differs in its copper oxide content. Although geometric Later Middle Iron Age material probably dates from the same or an overlapping period as the Culduthel, Polden Hill and other Later Middle Iron Age samples, the decoration on these artefacts is different stylistically, and often incorporates polychrome enamel, rather than inlaid red (and occasionally yellow) glass (Davis and Gwilt 2008, 154–58). A feature that is well illustrated in this figure is the relatively limited compositional range of the Culduthel reds relative to the other groupings.

Illus. 6.84 shows that the levels of manganese oxide within the Culduthel red glass vary from 0.29–0.47%. Levels of MnO above 0.1% are likely to indicate its deliberate addition as a decolourant (Freestone 2006); the levels here imply that the base glass used to produce the opaque red had been decoloured using manganese. The use of MnO as a decolourant appears to have been introduced in the 2nd century BC. The Culduthel reds once again appear to form a discrete group despite their varied shape and use. Some appear to have more of a burnt/melted appearance; these particular fragments tend to show a slightly higher than normal potassium oxide content at around 0.8% rather than 0.5% K_2O (Table 6.37), which is likely to represent contamination during glassworking. Ash from charcoal, used to maintain a reducing atmosphere to preserve the cuprite colourant in the glass, may have become incorporated into the glass (see Paynter 2008).

One further important observation on the elemental composition of the red glass from Culduthel is the strong linear correlation noted between the alumina and iron oxide values (Illus. 6.85). The lead oxide and silica contents of these glasses are relatively constant, so this is not a dilution effect due to increased content of lead. Alumina was not available for use as an independent additive, and the increase with iron oxide strongly suggests that a clay component was being incorporated into the glass matrix. The most likely cause of this would be from the use of a clay crucible at high temperatures. The high lead content of the molten red glass would have been very corrosive at high temperatures, as noted by Heck et al (2003) in their work on a Merovingian crucible fragment that had reacted with lead-rich yellow glass colourant. If the Culduthel red-coloured glass was also being prepared in a crucible, it could be assumed that the high lead content would have a similar affect on this glass. This would account for trend seen in Illus. 6.70, which is also present to some extent with other components in the Culduthel glass such as magnesia, potash and silica. This in turn has implications for the processes of manufacture and exchange (see discussion below).

Many of the red pieces of glass occur as small fragments, rods or elongated 'dribbles', and the latter, in particular, often show a discoloured/oxidised surface round the outside (e.g. SF0355 – Illus. 6.77). Inlaying into metal was the most common use for 'sealing wax' red glass in the Later Middle Iron Age, where it was also occasionally used in conjunction with yellow glass, for example on the massive armlet from Castle Newe in north-east Scotland (MacGregor 1976 no. 239). However, the size of some of the rods from Culduthel could indicate that drawn 'threads' are being made for decorative purposes (as with the yellow spirals on the larger beads), though there are no surviving red artefacts to confirm this. There is no indication that the Culduthel red glass was being used for the manufacture of beads or discrete glass objects; Later Middle Iron Age beads of red glass are virtually unknown in Britain (see Hunter's report here for Scottish examples).

There are two unusual pieces of red glass from Culduthel where a very fine, predominantly yellow glass rod or trail has been fused to a red lump (SF1289 – Illus. 6.64). The yellow glass looks as if it has been finely twisted with clear glass as part of cane making – in a manner often used for manufacturing mosaic glass, though on a much smaller scale here. The fineness of the twisted rod suggests the yellow and clear glass might have been mixed to make a scarce yellow glass go further; a more obvious example of this can be seen in 'yellow' glass arm rings from the vicinity of Berne (Müller 2009, 35), where yellow glass is applied only to the inner surface of the plain glass ring (see Hunter's glass report here for further discussion).

Opaque yellow glass

The most numerous type of glass artefact from the site is the small opaque annular yellow bead. There are 14 of these, plus one small yellow ball (SF1294 – Illus. 6.76), which may have been made in preparation to be converted into a bead. Yellow glass has also been used to decorate other objects; mainly larger colourless beads, but also a blue toggle (SF0938 – Illus. 6.69). There is one blob of colourless/pale-green glass with a small amount of yellow on one side (SF1286), plus the yellow/clear rod with the red lump discussed above, and a translucent yellow/brown with opaque yellow spiral attached to one of the large decorated beads (SF0846 – Illus. 6.61 and 6.65).

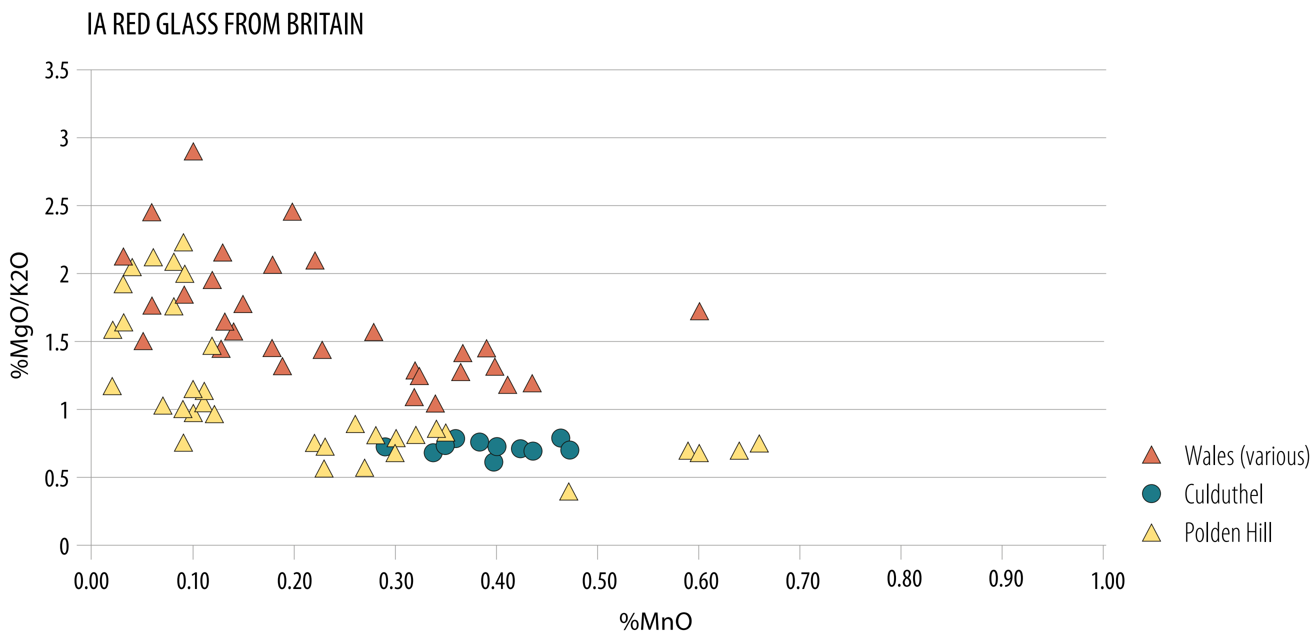


Illustration 6.84
Scatter diagram of manganese oxide versus magnesia and potash, showing grouping of red glass from Culduthel

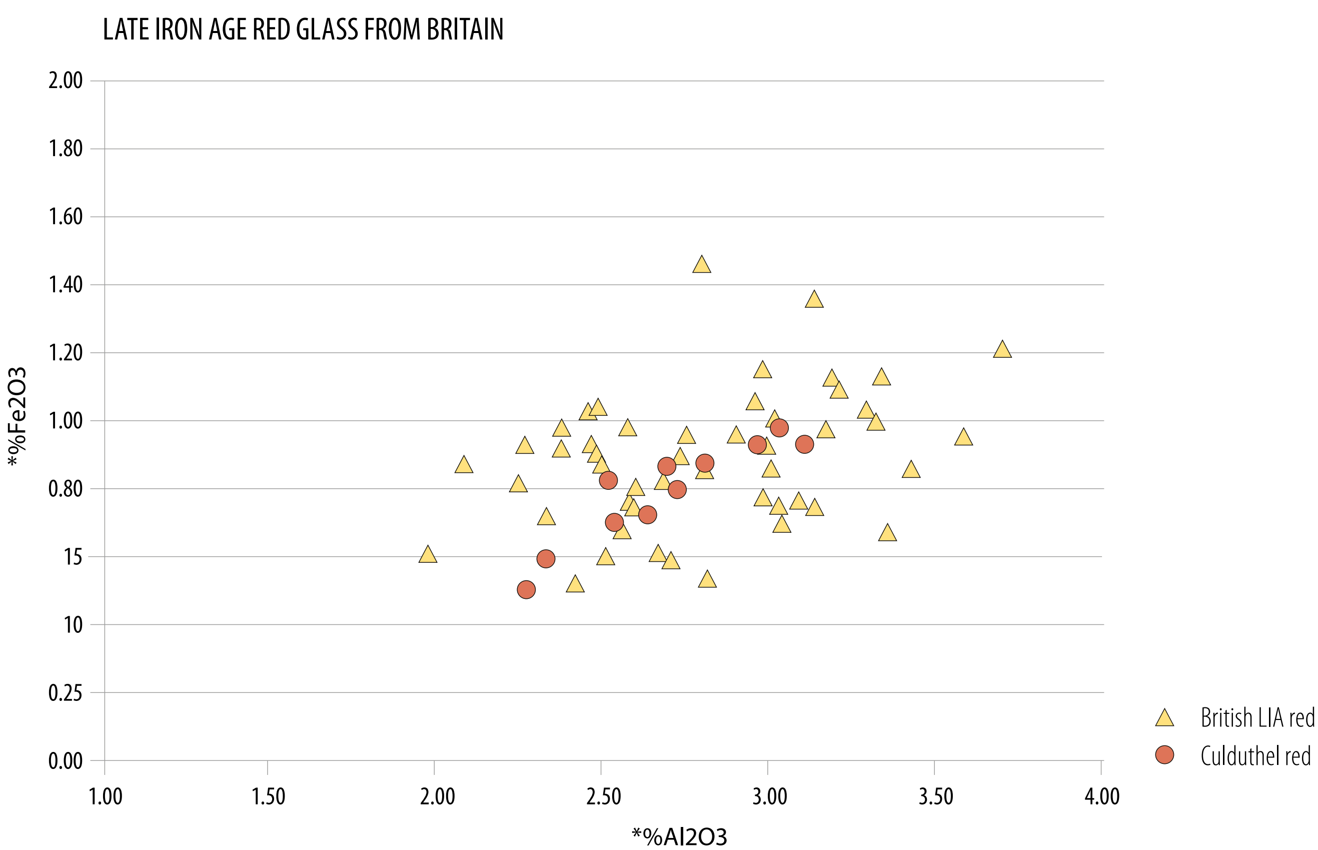


Illustration 6.85
Scatter diagram showing a clear linear correlation between alumina and iron oxide on red glass from Culduthel

Illustration 6.86
Lead and antimony levels in the yellow glass. The two tin-coloured beads are in the top left-hand corner

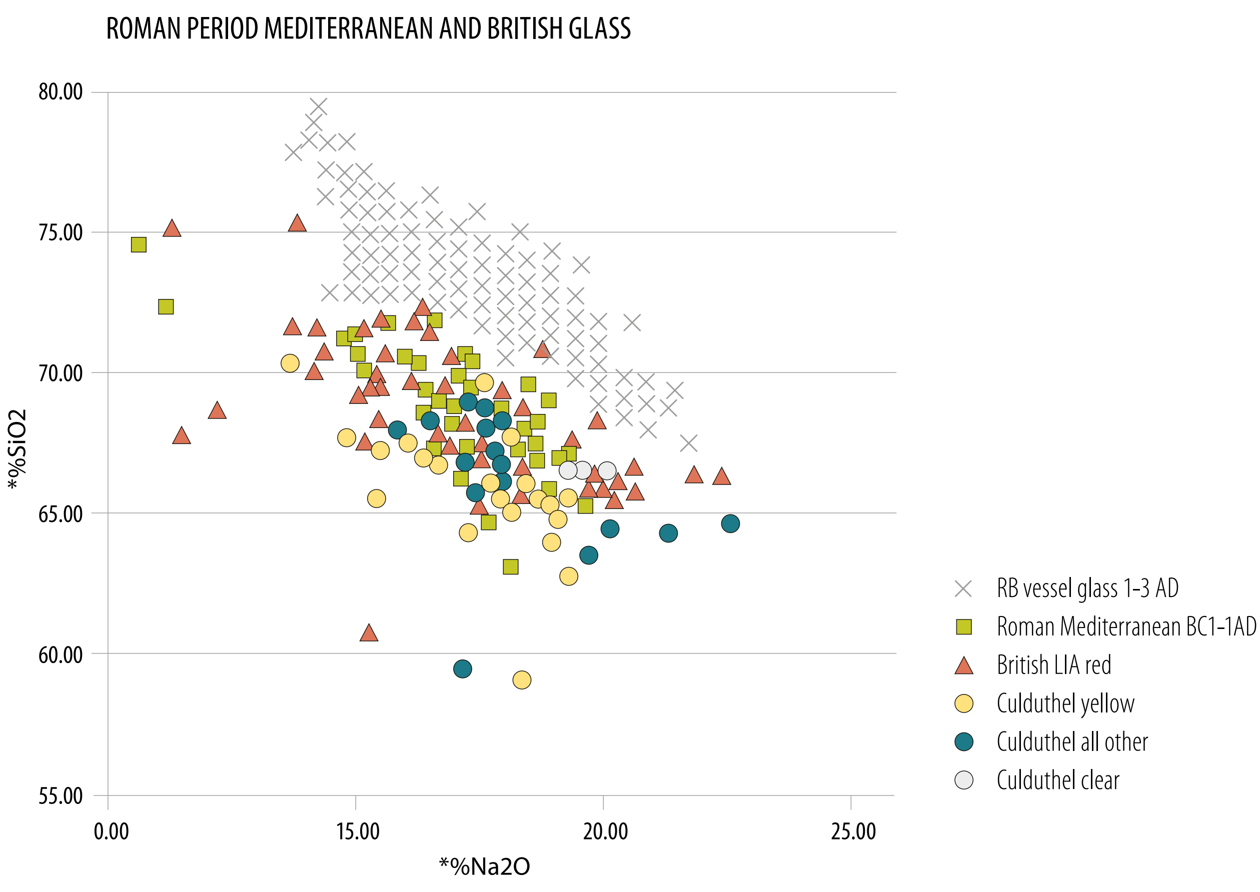


Illustration 6.87
Scatter diagram showing the similarity of the yellow glass from Culduthel to other British IA glass and Roman Mediterranean coloured glass dating from 1st century BC to 1st century AD (Freestone Roman mosaic vessel glass, Jerusalem glass ref). There is a noticeable difference from British vessel glass from Binchester (Paynter 2006); Colchester, York, Leicester, Mancetter (Jackson 2005) and Lincoln

All but two of the analyses of the opaque yellow glass showed that this was coloured by lead antimonate, by far the most common colourant used in the Iron Age and Roman period for yellow glass (Illus. 6.86). Like the sealing wax red glass, the original 'clear' glass was probably manufactured in the eastern Mediterranean and coloured in secondary workshops, from where it would have been distributed as yellow blocks or ingots (Tite et al 2007). This scenario would make sense for the yellow beads here; although they are generally similar to each other, their composition is more variable than the red fragments (although it should be borne in mind that they were analysed using the less precise 'flake' sampling technique). For example, the yellow used for applied trail decoration on other glass from Culduthel, including the yellow and clear spiral on the red fragment, seems to form a distinct group, close to several of the annular beads, but not all of them. There were possibly two or three different ingots worked on the site, probably within overlapping timeframes, considering the similarity of the artefacts and decorative styles.

Two of the yellow annular beads, virtually indistinguishable in appearance from the antimony-coloured beads (SF0612 – Illus. 6.70), were coloured using lead stannate (SF1254 – Illus. 6.71). This is a relatively rare colourant in the Iron Age; however, Henderson and Warren (1982) have analysed a number of Iron Age tin-opacified yellow artefacts (mainly beads) from Britain and Ireland ranging in date from the 3rd century BC to the 3rd century AD. Other notable instances of the use of tin-opacified yellow glass are for armlets from Hengistbury Head (Henderson 1987c), the trail decoration on one bead from Glastonbury (Henderson 1995) and on the hilt of the Thorpe sword (Freestone unpublished analysis). It is difficult to determine on the basis of composition alone whether these tin-opacified beads date from the Later Middle Iron Age, or from a second influx of tin-coloured beads in the 4th century AD, or even into the early medieval period. Tite et al (2007) have a higher average tin content for analysed tin-yellow beads from the Iron Age based upon their review of published analyses by other authors, and their conclusions would have the Culduthel beads sitting more comfortably with Late Roman or continental early medieval yellow glass (Tite et al 2007, 77). However, available analyses for the Thorpe sword (Stead 2006; Freestone, unpublished data) and Hengistbury Head armlets (Henderson 1987c) are not dissimilar to Culduthel (Illus. 6.86), and given their similarity in style to the antimony-opacified beads, and their contexts, it seems probable that they are indeed Later Middle Iron Age. It is unlikely that the small amount of tin-opacified yellow glass from Culduthel was made on site; there is evidence for making objects, but not for modifying the glass colours. The tin-coloured glass was probably also imported either as a block from a different source, or as finished beads.

One further indication for a Later Middle Iron Age date for the yellow beads, along with most of the Culduthel glass assemblage, is the overall levels of soda and silica compared to 1st–3rd century AD Romano-British vessel glass (e.g. Paynter 2006; Jackson 2005). It can be seen (Illus. 6.87) that the base composition of the yellow glass corresponds with the distinctive Later Middle Iron Age red glass, and with clear and coloured Mediterranean glass from Italy and Jerusalem (1st century BC to 1st century AD) but not with the Romano-British colourless glass. Coloured glass tesserae from the 1st to 3rd centuries overlap both areas on the diagram (Freestone, unpublished work). The absence of Culduthel data from the colourless glass field strongly suggests that glass made after the middle of the 1st century AD is absent.

Blue glass

Blue is another colour of glass commonly used in the Iron Age and Roman periods. The blue glass from Culduthel consists of three small, individually distinctive annular beads (SF1260 – Illus. 6.66, SF1261 – Illus. 6.67 and SF1263), one flake (SF1266 – Illus. 6.75), a toggle decorated with yellow glass (SF0938 – Illus. 6.69) and a twisted spiral of blue and white glass (SF1011 – Illus. 6.74). There are also five pieces of post-medieval waste/slag (Table 6.38). The slag was all of a mid-blue-grey colour and some pieces were deformed with attached concretions or prominent air bubbles. All had a composition and appearance that suggest these were fragments of slag from an iron blast furnace, and therefore post-medieval contaminants (Tylecote 1992, 126). Lump SF10007 is likely to be post-medieval, in the light of its very low chlorine content.

The majority of the blue glass artefacts had compositions consistent with Roman glass (Illus. 6.88); the flake had a large amount of calcium antimonate present. One bead SF1262 was close in form and appearance to the yellow annular beads, and the toggle (SF0938 – Illus. 6.69), which was decorated with yellow glass, is best seen as Iron Age in style. The yellow glass used for the decoration of the toggle fits well with the composition for other decorative yellow glass from the site (Illus. 6.86). As noted in Illus. 6.81, the flake and toggle, which might be associated with glassworking on the site, both show alumina and silica levels similar to the red working debris plus the yellow and clear glass beads. The variability of the blue objects from Culduthel might suggest a much larger number of sources, possibly being supplied over a longer period of time. Alternatively blue glass material for glassworking may have been obtained from a range of sources on an opportunistic basis, and may have consisted of tesserae, vessel fragments and old beads. Blue glass annular beads were present in the MIA in particular (for example those from Rudston and Glastonbury; Henderson 1991a; 1995); however, the Culduthel ones are all small and all different from each other in both shape and colour. In Illus. 6.84, it can be seen that the soda/silica levels for the blue glass are relatively variable in their quantities; but that one of the beads (SF1261) is quite close to the plotted Roman and Romano-British blue glass. It seems likely that blue glass objects were being made at Culduthel, but that the exchange and availability of this glass was different to that of the traded red and yellow glass. This could in part be due to the relative scarcity of blue-coloured glass in both the Roman Late Republican era and the British Later Middle Iron Age.

Clear glass

There is relatively little extant colourless glass at Culduthel. There are three very small colourless fragments (SF1262 – Illus. 6.73 and SF1267), and the rest of the colourless glass consists of components of three polychrome beads and a small thread twisted with yellow glass and attached to a red lump. Colourless glass would have been available as cullet, and was probably easier

Table 6.38
Modern and slag analytical results

		Content	SF	Na2O	MgO	Al2O3	SiO2	P2O5	Cl	K2O	CaO	TiO2	MnO	FeO	CuO	ZnO	SnO2	Sb2O3	PbO		Original total
waste/slag	blue	3204		1.92	1.27	7.06	54.38	0.03	0.00	6.52	15.64	1.42	10.17	1.17	bd	0.08	0.01	0.02	0.03	100	post-med
waste/slag	blue	2877	1138	1.79	1.39	6.69	45.26	0.09	0.02	4.68	18.84	0.56	15.08	4.79	bd	0.02	0.00	0.17	0.02	100	post-med
waste/slag	blue	3064	1222	1.53	2.03	5.90	50.94	0.21	0.03	5.01	16.15	0.99	11.72	5.10	bd	0.02	0.00	0.00	0.03	100	post-med
cullet	blue	Cullet		1.75	3.87	6.96	56.48	0.15	0.42	1.88	23.13	0.39	0.05	2.56	bd	0.05	1.76	0.07	0.06	100	metallurgical waste?
lump	blue	1074	10007	15.40	0.54	1.00	68.42	0.15	0.17	0.67	12.46	0.18	0.13	0.25	bd	0.02	0.00	0.08	0.28	100	late
clear ball	clear	3467	1469	1.01	2.55	15.68	49.48	0.12	0.03	3.34	22.61	0.79	3.38	0.45	bd	0.02	0.00	0.14	0.07	100	
waste/slag		2101	416	3.08	2.71	6.87	59.67	3.41	0.00	7.43	8.60	0.50	0.34	7.30	bd	0.02	0.00	0.00	0	100	fuel ash slag
waste/slag		2821	1108	3.09	2.10	4.05	67.67	2.63	0.00	11.91	4.71	0.51	0.37	2.84	bd	0.00	0.00	0.00	0	100	fuel ash slag
slag	red	3440		2.75	1.66	16.88	53.05	0.34	0.00	9.76	5.73	0.89	0.24	4.81	3.81	0.08	0.00	0.00	0.00	100	metallurgical waste?
waste/slag		4256	1697	3.68	1.61	15.16	63.69	0.25	0.00	4.78	4.40	0.85	0.14	5.32	bd	0.06	0.00	0.00	0	100	
lump	green-grey	3144	1231	4.66	0.54	7.41	62.00	0.46	0.03	15.64	2.06	0.69	0.23	5.82	bd	0.03	0.00	0.04	0.04	100	
lump	green	2778	1085	4.23	0.74	3.04	73.59	0.21	0.83	1.22	8.56	0.08	0.65	1.20	4.24	0.02	0.00	0.00	1.38	100	metallurgical slag?
lump	green	2677	1037	4.44	3.30	0.56	3.45	8.86	0.09	0.01	0.22	0.03	0.03	1.93	18.43	0.10	56.15	0.05	2.36	100	corrosion
bead	pink	595	156	0.50	0.04	0.24	47.30	0.38	0.26	14.73	0.00	0.05	0.04	0.05	0.70	0.05	0.00	0.06	35.57	100	post-Med
Batch 2		**Batch 2**																			
waste/slag		2101	416	3.08	2.71	6.87	59.67	3.41	0.00	7.43	8.60	0.50	0.34	7.30	0.09	0.02	0.00	0.00	0	100	
waste/slag		4256	1697	3.68	1.61	15.16	63.69	0.25	0.00	4.78	4.40	0.85	0.14	5.32	0.08	0.06	0.00	0.00	0	100	
waste/slag		2821	1108	3.09	2.10	4.05	67.67	2.63	0.00	11.91	4.71	0.51	0.37	2.84	0.11	0.00	0.00	0.00	0	100	

to obtain than specially coloured glass. It would also have been easy to remelt/soften and reuse without compromising its colour, which could be one explanation for the lack of waste glass found.

The colourless glass used for the polychrome beads has a relatively consistent composition; a very tight group of three objects is present (Illus. 6.81 and 6.89), which along with the use of consistent compositions of added yellow decoration, implies that these were made in a single campaign of glassmaking, perhaps in a single batch.

Other natron-type glass

There are a number of other objects; a small greenish blue annular bead with a Roman/natron-type composition coloured by copper, and a blue and white spiral fragment (SF0486 – Illus. 6.68 and SF1011 – Illus. 6.74). There are no comparative compositions to either the blue or the white glass in this piece, and no working debris in these colours, which could imply a pre-worked imported cable; although other spiral rods, the amber and clear glass on bead SF0846 (Illus. 6.65) and the clear and yellow spiral on SF1289 (Illus. 6.64) imply cables might have been manufactured on the site.

There is also a small black bead, coloured by iron, again with a composition consistent with other Roman black glass (Bateson and Hedges 1975), Van der Linden et al's recent study of 'black' Roman glass suggests this bead was probably manufactured after AD 150 (Van der Linden et al 2009, 828, 837), based on high iron content correlating with relatively high antimony, plus calcium oxide levels of 7–9%. However, a further paper includes analyses of Iron Age black glass from France and Switzerland, dating into the 2nd century BC. This glass has similar iron, alumina and potassium oxide levels to the Culduthel glass but with slightly lower calcium oxide levels. However, a full set of data is not available for more detailed comparison (Gratuze 2009).

Discussion

In conclusion, it is difficult to be precise about the date of the assemblage from the analytical work alone; there is both Later Middle Iron Age and Roman-type glass present, which probably dates the material from the 1st to the 4th centuries AD, the Later Middle Iron Age or perhaps a little earlier. Red, yellow and dark blue are colours commonly used for glass in the Iron Age, and these stand slightly apart from the black, pale-blue, white and green colours that are characteristically Roman in their composition,

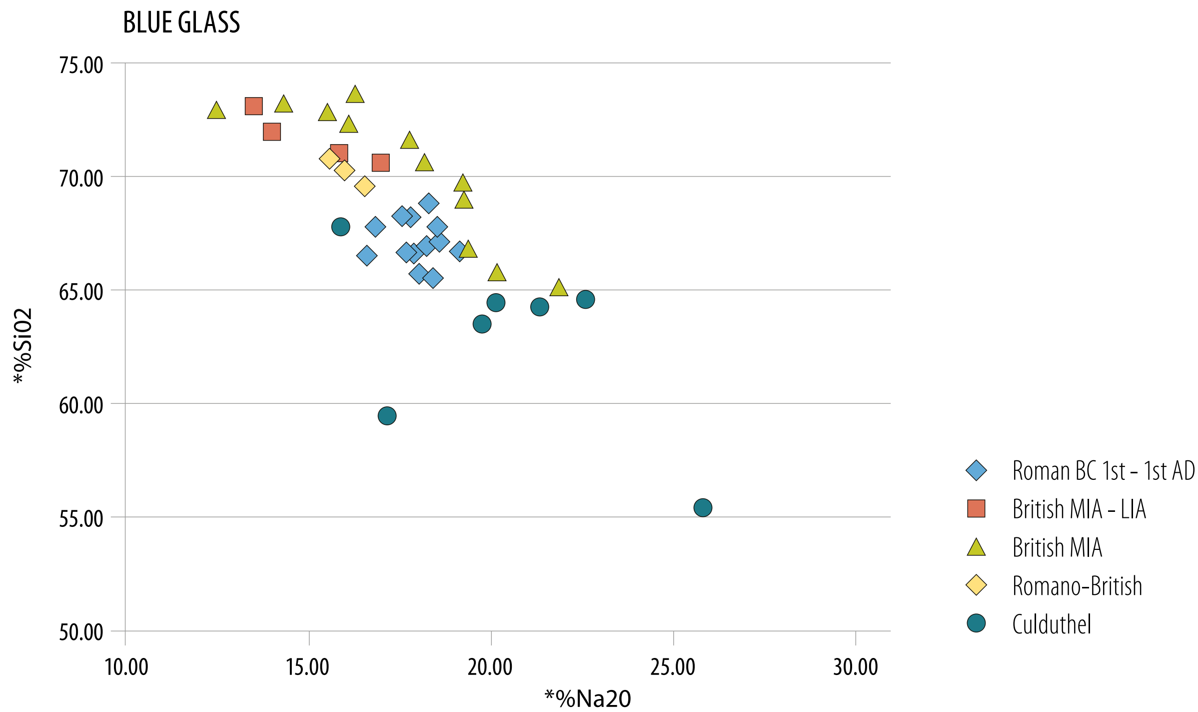


Illustration 6.88
Various IA and RB blue glasses showing a diversity of colourless glasses used before the addition of colourants. (Henderson 1995; 1987c; 1987b; MacDonald & Davis 2002)

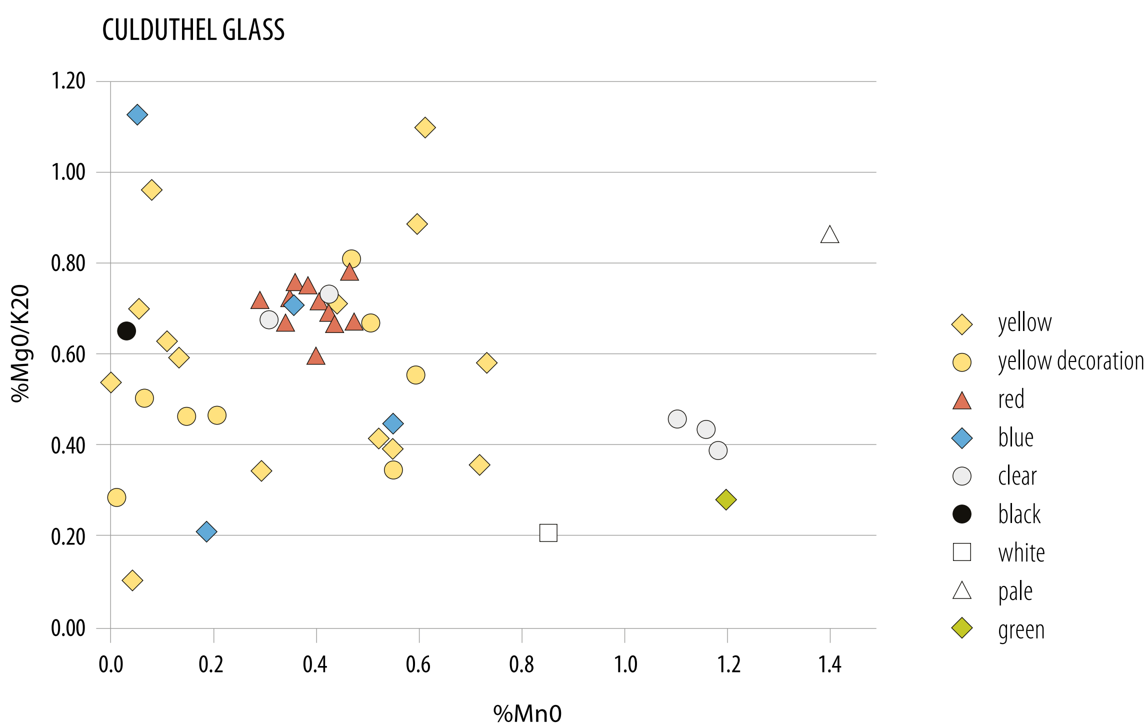


Illustration 6.89
Scatter diagram showing how the colourless glass is distributed; the three decorated beads are on the right-hand side

but quite possibly contemporary in date. No red glass objects are extant; this is possibly because red glass would only have been used for inlaying into metal. The yellow glass beads are all minute, and probably represent accidental loss; there are no unworked yellow lumps, which implies little waste. The presence of tin-coloured as well as antimony-coloured yellow glass could testify to the scarcity of yellow glass (Tite et al 2007), which was used as sparingly as possible, either as trail decoration on other glass objects, inlaid into metal, or for very small artefacts. The only sizeable glass artefacts are the polychrome beads, of which two out of three are broken. There is very little scrap clear glass, suggesting this could have been reworked. It appears that the majority of the glass was native in style and manufacture, but that some single glass items of Romano-British material and style were being acquired. It is possible that Roman blue glass was also being reworked at Culduthel, for example the blue flake (SF1266). The fact that the compositions of the blue glass objects and fragments from the site are so variable could imply pieces were being acquired when and if the chance occurred, possibly via 'Roman' routes rather than more established 'Celtic' trade links. No lumps/ingots of blue glass have been discovered in Britain from this period, unlike red and purple glass. There are several levels at which glass could have been worked on the site. It seems increasingly likely that the later prehistoric and Early Historic soda-lime-silica glasses in Europe were being manufactured in the Eastern Mediterranean (Freestone 2005 and 2006; Nenna et al 1997; Degryse and Schneider 2008). By the 1st century AD, the manufacture of artefacts by glass-blowing would have been established, and glass production would increasingly be carried out on an industrial scale.

Examination of sealing-wax red glass used for La Tène artefacts in particular, has shown some variation through time and also geographically, for example differences between Middle and Later Middle Iron Age glass on both mainland Europe and Britain (Brun and Pernot 1992; Henderson and Freestone 1991). The discovery of coloured ingots (those mentioned from Tara Hill and Fish Street, but also examples such as the purple ingot from Hengistbury Head (Henderson 1987c)) suggests that certain coloured glasses were traded in lumps. Although the composition of such lumps can be similar, variations might suggest a number of different centres were colouring the glass before trading it on. The occurrence of the sealing-wax red glass within Continental La Tène Europe and Britain suggests a number of specialist sites may have been colouring the glass away from its original Mediterranean source of manufacture, specifically for use on Celtic Iron Age artefacts. Brun and Pernot (1992) have pointed out that the amount of red glass in circulation for the decoration of artefacts was probably relatively small, as examples such as the lump from Tara Hill would have provided enough glass to decorate hundreds of objects. They also feel that the technical sophistication required to produce opaque red glass would probably only have been achieved in a few workshops (Brun and Pernot 1992, 236–7). Other analyses of opaque red glass, e.g. from Polden Hill, have shown that although chemically similar, differences within red glass compositions can be distinguished by certain element content, e.g. magnesium, potassium and manganese (Illus. 6.89).

In order to colour the glass, it would need to be heated to high temperatures to incorporate the colour evenly, and the use of fine particles of colourant materials would help obtain an even dispersal in the glass-melt and so produce a homogeneous glass colour. In the case of red glass, specific ingredients and heat treatments would also be needed to produce the very bright and intense colour. Although soda-lime-silica glass will melt at approximately 1100°C, so obviously requires a relatively high level of pyrotechnic sophistication, it is possible to reshape, decorate and anneal glass at much lower temperatures, when the glass is not liquid but has become ductile. Leaded glasses, in particular, will readily soften at lower temperatures, which would have been the case for both the red and yellow glass from Culduthel. Extra heat would increase the glass flow, and could be varied depending on the need of the glassworker. This level of technology would allow red glass to be softened enough to press into metal recesses, allow cullet to be reshaped into beads, and allow yellow glass to be shaped into artefacts or used for trailing decoration. While there is evidence for such relatively low-temperature activity at Culduthel, there is no evidence in the production area for the high temperatures needed for colouration, and it is pertinent that no crucibles for glass were recovered.

Analytical work by Heck et al (2003) on a Merovingian crucible fragment containing yellow glass, and tin-opacified beads from the same area of Schleitheim in Switzerland, show that the concentration of the tin and lead within the crucible is far higher than in the manufactured beads. This work led to the conclusion that the yellow colourant was produced independently, and later added to clear soda-lime-silica glass during a separate part of the manufacturing process. A similar colouration process could have been undertaken for the red glass from Culduthel, implied by the elevated correlating levels of alumina and iron oxide discussed above (Illus. 6.84). Both this, and Heck et al's work add weight to the argument that coloured glass blocks were imported to the site at Culduthel, rather than manufactured or coloured at the site. Indeed, the very tight correlation compared to other British Later Middle Iron Age red glasses also adds evidence to the theory that the red glass from Culduthel was from a single batch. Further evidence for the manufacture of the objects at Culduthel (other than the glass waste itself), is the remains of iron scale in the holes of many of the beads (Illus. 6.90 and 6.91), suggesting these were worked on an iron mandrel. It is possible that the iron rods were pre-heated to develop a scale which would adhere to the heated glass and was removed as part of the bead; removing glass directly from iron rods without some form of release agent is very difficult. Beads can easily be rounded, and trail decoration incorporated by rotating heated glass on a mandrel.

Conclusion

The majority of the red, yellow and clear glass is Iron Age in date and style; this would conventionally be seen as 1st–2nd century AD in date, although the evidence is poor, and the slightly earlier range suggested by the Culduthel radiocarbon dates (*c*.170 BC–AD 20) is entirely consistent with the analytical information. Many of the 'single' items such as the blue, black and green beads, and the blue and white spiral are characteristically Roman, and could be roughly contemporary or slightly later in date, but appear to

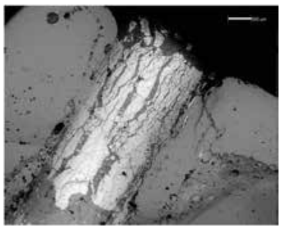


Illustration 6.90
BSEI of bead perforation, showing iron scale lining the inside of the hole. (Scale bar = 500 µm) (SF0399)

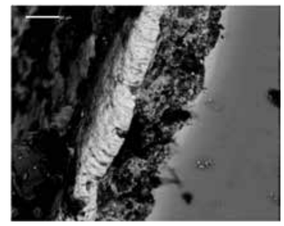


Illustration 6.91
BSEI of bead perforation, showing cross-section of iron scale lining the hole. (Scale bar = 30 µm) (SF0399)

come from a different tradition of glass making, though used at Culduthel in a similar manner.

There is no evidence for primary glass manufacture or colouring of glass on site, though many of the objects could have been formed there, and the shape and nature of many of the red fragments imply this was happening. The strap union (SF0318) with empty recesses is a typical example of metalwork that would have been inlaid. The iron scale within the majority of the beads could also imply local manufacture, as it suggests relatively little use-wear. Its presence in the yellow and polychrome beads (both antimony and tin coloured) is in contrast to the blue, and black beads (which appear Roman in composition and style), where there is no iron scale in the holes.

Vessel glass

HILLARY E M COOL

Vessel glass was found in two contexts. Nos 1 and 2 came from the fill of a post-hole of roundhouse House 10/3, and no. 3 came from a deposit sealing it. All are in very poor condition, with nos 2 and 3 reduced in the main to the texture and size of granulated sugar and the body fragments no. 1 having unusual clouded surfaces. The soil conditions at Culduthel are presumably to blame for this, as it is most unusual for a soda glass (as the fragments appear to be), to be reduced to this state.

Their condition poses problems for identification as even the original colour is difficult to be sure of. Given their contexts, they may be assumed to be ancient rather than modern. They appear to be naturally coloured and no. 3 retains the typical blue/green colour of the 1st to 3rd century AD. No. 1 clearly comes from a blown vessel that was not a bottle, and such evidence as there is from no. 2 suggests that it too was not a bottle. No. 3 retains larger granules, some of which are thick enough to have come from a bottle, though equally they might have come from the thicker elements such as bases of other types. The most that can be said of these remains is that they show features that would be consistent with them coming from later 1st to 3rd century AD vessels. This is consistent with their context. An earlier date would not be possible as vessel glass generally appears in most areas of Britain at the same time as a Roman presence can be seen, in the form of the army. Shades of blue/green glass were also favoured in the mid- to late Saxon period but glass vessels of that date are much rarer than they were during the Roman period. In the light of the presence of Roman coinage and a Romano-British brooch from this structural phase, a Roman date seems more likely.

In addition to this evidence for blue/green vessels, two small flakes of deliberately coloured glass were found from context 2550, the fill of a post-hole surrounding Hearth 2434. It is always difficult to tell the colour of flakes of translucent glass but the intensity of the colour remaining rules out the possibility that they came from blue/green vessels and a shade such as peacock is most likely. This was a rare colour within the output of the Roman glass industries and not particularly common either among beads of Iron Age or Roman date. Within vessels the colour was probably commonest among the cast vessels of the early 1st century AD (Grose 1989, 254) and this identification cannot be ruled out. The colour was also very occasionally used for blown vessels of the mid-1st century and even more rarely on some luxury vessels of the late 2nd to 3rd centuries (Cool et al 1995, 1569–71, fig. 739). It might be thought unlikely that luxury vessel glass was to be expected on a site so far to the north, but it is worth pointing out that it might fit a pattern that has previously been noted. Roman vessel glass is rarely found in the Highlands and Islands but when it does occur there is a disproportionate number of unusual forms compared with the general contemporary pattern further south in the province of Britannia (Cool 2003, 142). Alternatively, these flakes could be part of the glassworking industry attested at the site. Certainly their colour would be appropriate for decorative items though, as noted, it is rarely encountered in beads. The glassworking debris does not appear to have produced glass of this colour.

Catalogue of vessel glass

SF0533 Two pale-blue/green to light-green body fragments, not from a bottle. Surfaces clouded and edges starting to strain crack. Context 2540 (fill of post-hole 2539, House 10/3).

SF1301 Strain-cracked granules from a probably pale-blue/green vessel. The one fragment retaining both surfaces indicates that the granules did not come from a bottle. Context 2540 (fill of post-hole 2539, House 10/3).

SF0528 Strain-cracked blue/green granules from a vessel. The thickness of some of them would allow the original fragment to have come from a bottle. Context 2198 (occupation deposit overlying post-hole 2539, House 10/3).

SF1302 Two chips from separate samples. Deliberately coloured glass, most probably peacock (green/blue). Context 2550 (fill of post-hole 2549, associated with Hearth 2434).

Chapter 7

CRAFT AND SETTLEMENT IN LATER IRON AGE NORTH-EAST SCOTLAND

Introduction

Culduthel is an exceptionally rare site in Scotland, both in the range and quality of the material culture recovered and the archaeological features identified. The circumstances that allowed for the excellent preservation of the site, the large quantities of waste debris from the various industries and successive layers of hillwash, created the optimum conditions to seal and protect parts of the site. The intact stone bases of the smelting furnaces contained their final firings, and stone walls, paving and yards survived. Blacksmithing tools, glass rods, crucibles and moulds were found where they had been discarded or lost and deliberately deposited artefacts were located where they had been originally placed. For a site situated in a heavily ploughed field this evidence is remarkable.

The quality of this record has allowed for a detailed examination of many aspects of the occupation of the land, from the Neolithic to the early 1st millennium AD (Chapters 3 to 5) and especially for the period of intense industrial activity in the Middle Iron Age. The depth and complexity of the archaeological evidence for this period has allowed for rare insights into the processes undertaken to manufacture iron, bronze and glass items and the workshops and furnaces where these activities took place. The detailed exploration of these remarkable findings is within Chapters 4 to 6 and will not be repeated here. This final chapter will instead explore what can be understood about the community that worked and lived there by looking at the social context of the settlement; at how labour might have been organised, for expressions of identity of the craftworkers and the community, the social significance of metal- and glassworking and the rituals woven into their production and into daily life. Here there will also be an opportunity to look at evidence for the scales of production and the community's networks of contact, exchange and mobility. We will then turn to look at the community's neighbours along the Moray Firth coastal plain to help place Culduthel within a broadly contemporary settlement landscape and explore its wider social and cultural networks.

Living and working at Culduthel

Although overshadowed by the establishment of the Iron Age craftworking centre, there is good evidence for Early and Late Neolithic activity and Early Iron Age occupations. Clusters of pits filled with discarded pottery defines the Neolithic activity, potentially representing seasonal visitations over many generations. Similar activity can be seen right across the terrace in earlier prehistory, perhaps linked to periodic visits to the rectilinear enclosure 200m to the north-east.

The land was first permanently settled in the Early Iron Age by farming communities growing crops and keeping livestock. The palisade was a significant investment in the land and, alongside the ambitious design of the buildings (one very large roundhouse and a technically complex ring-groove), a picture emerges of affluent communities living on the fertile terrace. At neighbouring Early Iron Age settlements (e.g. Balloan Park – Carter and Russell-White 1993; Wordsworth 1999) and those across the low-lying coastal plains of southern edge of the Moray Firth similar groups of unenclosed roundhouses, some with palisades close by, have been identified. A data set that suggests that this was a typical site type in the region in this period.

Once this occupation was over the land was not settled again for least a century. The craftworking settlement was established in earnest with the construction of a series of purpose-built workshops, many containing iron smelting furnaces, and four post-built roundhouses. The settlement seems to have been active at some point between the 2nd century BC and the early to mid-2nd century AD with most production taking place prior to the late 1st/early 2nd centuries AD. It was primarily an iron production site, manufacturing and repairing iron tools, weapons, fixings and fastenings. Other pyrotechnical industries were also ongoing, including secondary glassworking, the casting of bronze and the production of metalworking ceramics. Iron tools recovered from site show that organic crafts including leather-, wood- and textile-working could have produced goods in tandem with the metal and glass objects.

The layout of the craftworking settlement gives the impression that the majority of the workshops could have co-existed as a contemporary group. This arrangement, alongside their uniform design and identical furnaces, potentially indicates that the entire enterprise was established following a pre-determined scheme. Does this evidence then suggest that the site was built and controlled by a chief or head craftworker or under the patronage of a local elite? Or does it reflect that the site had been relocated from an established craft-working centre or an industrial quarter of a domestic setting they had outgrown, perhaps by an egalitarian community of craftworkers (cf. Giles 2007, 397)? The answers here remain unclear but we can at least surmise, with so little domestic and agricultural evidence identified during the excavation, that the site was built primarily as a place of industry.

Furnaces were extant within five of the workshops and it is likely that they were present in at least another two. These smelting furnaces were each located close to the entrances of the workshop with their openings facing the doorway, a configuration that would have maximised the daylight and ventilation. The smoke and fumes emitted by a furnace in use would have rendered the interior of a roofed building unbearable for the ironworkers and the walls of the workshops may have been wholly or partially made from removable wattle panels to increase the airflow when required. Whatever the design of the workshops the risk of fire would have been constant, and it is surely a testament of the skills of the ironworkers that none appear to have burnt down.

While the furnaces were almost identical in design, the workshops did vary in size and entrance orientation. Ethnographic evidence recognises that ironmaking was frequently a collective endeavour by extended family units (Pleiner 2000, 104). The subtle differences in workshop design may reflect that each building was constructed by a semi-autonomous team of craftworkers who were adapting a blueprint for their individual requirements.

Other metalworking activities may have also taken place around the smelting furnaces. The long-lived Middle Iron Age workshop identified at Mine Howe in Orkney was undertaking various craft processes including smelting, smithing and bronze-working. Its interior contained small smithing hearths and anvils made of stone, wood and whalebone beside the large central hearth, with raw materials (such as charcoal, ore and clay) stored in recesses in the walls (Harrison 2005, 12). This evidence demonstrates that the entire iron production process at Culduthel could have taken place under one roof. If this was the case could each workshop have worked semi-independently and specialised in the manufacture of a specific range of iron products?

The archaeological record for the ferrous metalwork at Culduthel demonstrates that this was a dynamic and adaptable group of workers, constantly remodelling, repairing and rebuilding their buildings and furnaces over time. It was obviously a highly proficient group, who created a diverse range of goods in iron and high-quality natural steel with periods of intense manufacture. The labour force required to supply the raw materials, run the furnaces and produce finished items must have been sizable and well-organised to achieve the quality and quantity of the products seen.

In a dedicated area of the site, glass and copper alloy objects were being manufactured. This was also specialist work, which was clearly undertaken by a confident and well-resourced team with a wide range of skills. These crafts required non-local raw materials and it is perhaps through the exchange networks first established by the iron producers that copper, lead and glass became accessible to the site. The success of the iron manufacture may have led other craftworkers to the site or the community may have invited them in to increase the range of products and exploit new markets. The glass and bronze objects found on site shows that these makers were skilled artisans with extensive knowledge of indigenous styles over a wide geographical area. If Culduthel was a renowned craftworking centre, these bronze- and glassworkers could have travelled great distances to join this successful enterprise.

The evidence for domestic occupation of the site is limited. The four post-ring roundhouses seen in Period 3a had no obvious links to the industries seen on site and three (located on the north-west edge of the site) potentially predate the establishment of the craftworking site. The roundhouse House 10 stands out here. Three successive buildings were constructed on this plot and this location must have held considerable significance to the entire community. The cumulation of these buildings in the early centuries AD was monumental in size, embellished in stone and surrounded by a cobbled yard. Clearly a house of visible status built in a place with deep ancestral heritage.

This building, along with a similar and likely contemporary roundhouse to its north-east (House 4), could have housed extended family groups of up to 50 people (Armit and McKenzie 2013, 501), and in a domestic Iron Age setting this interpretation would seem entirely appropriate. The assemblages of discarded, lost or structurally deposited artefacts however show that these buildings were intrinsically linked to the craft-working community throughout their existence, from construction to abandonment and collapse. The interiors of both houses were dominated by ring-ditches, potentially functioning as a series of subterranean 'workshop' compartments to undertake specific manufacturing tasks and to store finished objects, rare raw materials and traded or gifted goods. This evidence suggests that these buildings were multi-functional spaces, to securely store goods; to polish, assemble display and trade objects in a dry charcoal free space and a place to create fine leather and wooden goods, potentially under the control of an elder craftworker or community leader.

Status, society and trade

Houses and workshops

The craftworking site could have been the industrial quarter of a domestic settlement located across the northern side of the terrace or a separate enterprise connected to one or several groups living in the local area. The architecture of the workshops and roundhouses of the earliest phases of the site tell us little about the prosperity or identity of the community who worked here, or who, if anyone, ultimately controlled it. These were each fairly modest buildings and practically designed to serve their purpose. Equally, the fact that the settlement was unenclosed gives no indication of the community's wealth or social organisation, as this was a typical arrangement for settlements in the north-east in this period, when elaborate defences were seemingly neither a necessary statement nor an indication of status.

More can be surmised in the later phases of the settlement, with the construction of two large-scale roundhouses in early 1st millennium AD. Now we see the medium of architecture beginning to play a role in the community's, or individuals', expressions of identity. These houses would have been monumental structures that dominated the modest workshops on their doorsteps and would have been prominent landscape features from a considerable distance. These complex and elaborate buildings would have been a huge community investment of labour and resources and a significant event in the life of the settlement. The stimulus for their construction is unknown but it is possible that they were built to respond to internal competition within the community or the rise of individual prosperity and power of one craftworker. This move away from the communal household towards individual status is a broader cultural shift in the 1st millennium AD and the creation of large houses at this time may have been one avenue to gaining status within a community (Armit 2006, 255; Armit and McKenzie 2013). There are hints that the plot for House 10 was held by a single familial group for a significant length of time and could have been passed down through the generations, with each new cohort renewing the structure to herald their ownership and reaffirm the ancestral seat (Armit 2005).

One of the objectives in building these monumental houses must have been to externally display the social identity, status and stability of certain individuals of developing status within the community, or of the wider community to outsiders. The ring-groove roundhouse is increasingly common in the north-east in the first few centuries of the 1st millennium AD, often seen at a large scale and built in key locations within settlements (e.g. at Seafield West in Inverness and Birnie and Clarkly Hill in Moray). Were these new buildings at Culduthel adhering to this wider regional trend? The increasingly felt proximity of the Roman world may also have been a factor in the adoption of this architecture. Contact with the Roman world, or its material, is believed to have played a role in the development of the 'massive' metalwork in the north-east in the 1st century AD (Hunter 2007d, 289). Was the perceived threat of Rome also the catalyst for conspicuous displays of identity and tenure through the construction of increasingly big houses?

It is within these houses that we also get a glimpse of some of the ritual practices of the community undertaken to mark important stages in the lives of the buildings and those who dwelled within them (Webley 2007). The two separate ceremonies to decommission the grandest building on site (House 10/3) are the most striking here but in both buildings the structured deposition of objects were clearly well-planned, complex events with rare and precious items carefully selected and grouped together as offerings to reflect significant events in the life of the house, its occupants and the wider community. Alongside the prestige Roman and indigenous objects were deposits of metalworking debris such as iron fragments, coiled lead objects, copper alloy strips and manufacturing tools, including a miniature iron axe, placed close to the entrances or within the ring-ditches. Similar deposition of metalworking debris or hoards of objects associated with manufacture (such as currency bars) have been observed in these 'liminal' locations, such as ditches and doorways, at other Iron Age settlement sites (Hingley 1990, 1997, 2006), which has led to the suggestion that these transitional zones' locations were deliberately chosen for deposition to reinforce and reflect the magical and dangerous act of metalworking manufacture (Hingley 1997).

Imports and exports

The material culture recovered from site offers us a clearer picture of both the lifestyle and the affluence of the community. The range of iron objects shows that the site's primary products were utilitarian items, mainly agricultural and craftworking tools, fixtures and fittings, presumably manufactured for use within the community and for wider trade and exchange. Prestige iron items, such as the chariot linchpin and weapons, were also being made and repaired. The daggers are rare finds in Scotland and their intact nature and deliberate deposition indicates that these were important objects within the community. The ability to make and repair fine weapons could have been the apex for a community that specialised in ironworking and must have guaranteed notoriety in the region and beyond. Chariot fittings are also incredibly rare finds in the Scottish Iron Age. The linchpin alongside the range of woodworking tools found on site suggests that the Culduthel craftworkers could have built chariots. This undertaking would have been a substantial investment in labour and resources, with up to an estimated 100 man-hours needed just to cut and shape the wood (Carter et al 2010, 61) and up to 36kg of iron required for the chariot's fittings (Halkon 2011, 153, 160). Given the time, raw materials and ability it took to make a chariot, it must have been a highly visible expression of elevated status in this period (Piggott 1986; Halkon 2011). It is notable therefore that the community at Culduthel does not appear to have been alone in its chariot ownership in the region at this time, with chariot fittings and a range of horse gear also found at the Middle Iron Age settlement at Birnie in Moray (Hunter 2005d, 28).

The material associated with manufacture also suggests that the community at Culduthel was actively trading in sustained markets of exchange over considerable distances. Glass, copper alloys and iron were all being brought to the site. The limited amount of imported iron coming into the site is likely to have arrived through exchange or trade in the region but the glass had a longer journey, coming via the Eastern Mediterranean as clear blocks or ingots and perhaps being coloured at a secondary site before coming to Culduthel (Freestone and Davis, Chapter 6). The Roman glass was also supplied ready-made, with pre-formed blue and white cable or trail intended for inlay in beads imported onto site as a specialist component. The source of the copper is unknown but the majority of the lead was coming from south-west Scotland, presumably via another series of trading networks.

Other Roman goods were also coming onto site. The majority of this material, the glass beads, the brooch and the glass vessel, conform to the type of luxury Roman material seen on many Scottish Iron Age sites in this period and relate to feasting and personal adornment (Hunter 2007a, 15). These imports may have been highly symbolic. For example, wearing the disc and fantail enamelled brooch, an item that is similar to the local style but clearly of Roman manufacture, must have given considerable social value to the wearer. As this preference for indigenous styles of Roman brooches was widespread in the region at this time, ownership of this brooch would be in harmony with local trends (Hunter 2014a, 335). The glass vessel buried within a pit inside House 10 may also hint that some within the community were turning their backs on communal feasting and wished to individually demonstrate their wealth (ibid, 16). The Roman coins would also have been rare and exotic items in the region in the 2nd century AD. In a non-monetary society these coins may have been a portable way to own and store valuable raw materials. Equally, they could have been used for particular transactions within the settlement's networks (Hunter 2001a, 20) or as powerful ritual items which held the memories of contact and exchange.

This access to Roman goods is reflected right across the Moray Firth in the 1st and 2nd centuries AD, with availability of this material beginning in earnest after *c.*AD 80 (Hunter 2007a, 18–22). The corpus and distribution of this material has increased substantially over the last two decades with commercial and research excavations now complementing the picture previously formed by antiquarian investigations, metal-detecting and stray finds. Many settlements active in the region in the first few centuries AD do have Roman items, with those located along the southern coast containing greater quantities and higher quality finds including coin hoards, brooches and toilet instruments (e.g. the settlement sites of Birnie (Hunter 1999–2000, 2002–2005c, 2006c, 2007b, 2008–2010), Seafield Road West (Cressey and Anderson 2011), Clarkly Hill (Hunter 2011a; 2012) and the ritual site of Sculptor's Cave, Covesea (Armit et al 2011)). Hunter (2007a) suggests that this distribution across the rich arable lands on the south side of the Moray Firth reflects the ability of the local elites to access this material through trade, diplomacy or tribute, directly with the Romans or indirectly via tribes to the south. This pattern of access is also seen in southern Scotland where early Roman material of the 1st and 2nd century AD was centred at prominent sites (e.g. at brochs, crannogs and hillforts). Here Macinnes (1984, 242) has suggested that these wealthier settlements were acting as hubs of access and redistribution for this material.

The ability of select communities to access Roman goods, whether as diplomatic gifts through direct contact with Roman emissaries (i.e. as possibly seen with a series of coin hoards at Birnie) or through exchange within local networks, suggests there was a 'hierarchy of access' to this material (Hunter 2007a, 18). The Roman assemblages from Culduthel and other wealthy local settlements along the Moray Firth coastal plain suggest that these sites may have been deliberately targeted by the Romans or other communities with access to this material in the first few centuries AD. Whether these objects were gifts, bribes or traded, relationships seem to have been purposefully established using this material.

And what of the status of the craftworkers themselves? The act of creating iron objects from bog ore may have been considered a restricted magical act, highly prized, with strong symbolic and social connotations within Iron Age society (cf. Hingley 1997; McDonnell 1998b; McDonnell and Dockrill 2005; Giles 2007). Early Celtic and Norse literature demonstrates the significant role the smith had within communities and the special status and mobility of some craftworkers (e.g. Gillies 1981; Scott 1986; Kelly 1988), while ethnographic and anthropological studies of metalworkers show that they could be regarded as powerful but liminal figures on the outskirts of normal society (Helms 1993; Herbert 1993; Hingley 1997).

Where identified in the archaeological record, smelting appears to be a task that was kept separate on other production sites (e.g. at Wakerley in Northhamptonshire – Jackson and Ambrose 1978, and at Brooklands, Surrey – Cleere 1977). This was presumably due to the dangerous nature of the activity to the surrounding community, but perhaps it was kept at a distance in response to its transformative nature. Burials show that both the craftspeople and their tools were highly regarded in society. A cache of well-made blacksmithing tools identified within a pit at the Iron Age site of Garton Slack in East Yorkshire, with a basket of carbonised grain placed over them, suggests a deliberate act of burial to link the ironworking to the agricultural cycle (Giles 2007, 396). The burial of a young male at the Iron Age cemetery at Rudston in East Yorkshire appears to be a rare example of a craftsperson's internment. It contained blacksmiths' tongs and a hammer alongside spears and a short sword (Stead 1991), which may represent a blacksmith buried with his tools and his finest products (Halkon 2011, 158).

The smelter and smith may therefore have been slightly separated from society, highly regarded but detached from normal social relations, associated with rituals and magic, and seen as skilful individuals with 'a privileged understanding of the way that the world worked' (Giles 2007, 400). Their ability to manufacture weapons for combat or protection and tools for cultivation and food production may also have deemed them as having supernatural powers that meant they were able to make, repair or break objects that greatly impacted on daily life; the ability to maim or kill, eat, create life and assist in death (ibid, 400–5). In addition, the highly skilled nature of their work, the physical power and mental stamina required, and their ability to source raw material to achieve this, suggests that they were powerful and influential individuals with the ability to create prosperity for the wider community (ibid, 407).

The social standing of the glass- and bronzeworkers in Iron Age society may have been similar to the ironworkers. As these were highly complex items made from rare and valuable imported raw materials, bronze- and glassworking is likely to have been a highly restricted activity and these craftworkers may have been elevated above the ironworkers on site (Henderson 1991b, 119). As their products were mainly for personal adornment and feasting, with some of the techniques used (such as enamelling) only seen on prestige objects in this period, their ability to make items of outstanding beauty and value must have been highly regarded. If, as outlined below, bronze- and glassworkers were a mobile group who were not part of the permanent community at Culduthel, their special status may have been redefined by the very fact that they were strangers in the midst of the community.

Scales of production and networks of exchange

Iron

Iron production was the dominant industry on site. The wide range of high-quality steel objects, including specialists craft tools, weapons, fixture and fittings, must have been manufactured for the workers on site, for the local domestic settlements and for wider trade and exchange. Calculating the scale of iron production at Culduthel is problematic as clearly only a part of the site was excavated. Excavators of the Iron Age iron production site at Crawcwellt in Wales used the estimated total weight of the slag dumps to calculate the number of ironworking cycles and the amount of fully refined bar iron produced (Crew 1998, 30). As Crawcwellt was an upland site, undisturbed by the plough, Crew's inferences seem fairly accurate but, as slag was only preserved in certain places at Culduthel and was only partially sampled during the excavation, calculations for the amount of iron produced at Culduthel will have to be fairly ambiguous.

Using Crew's calculations (1998, 31), if Culduthel produced one tonne of slag (a low estimate given that over a third of a tonne was recovered through the sample excavation of the waste debris), 180 ironworking cycles (smelting and refining) would have taken place and up to *c*.70kg of refined iron could have been produced. As the 150 iron finds recovered from site weighed *c*.2.4kg, 70kg of refined iron could have produced well over 1000 items.

Evidence from southern England and Wales shows thriving and extensive trade networks in iron currency bars and other bulk items in the late pre-Roman Iron Age (Crew 1994; 1995; 1998). Much work will need to be done to meet this level of understanding of the iron industry in Iron Age Scotland and, as many older excavations routinely threw away slag, there will be a heavy reliance on recent work to create a model for this industry (Hunter et al 2006). At the time of writing there are no regional models in mainland Scotland for Iron Age ironworking but the publication of Birnie in Moray (the only other sizable assemblage of iron in the region in this period) and Gemma Cruickshank's 2017 doctoral research on Scottish production will certainly help develop this picture.

If we stay with our calculation of 70kg of iron, more than a tonne of bog ore and 10 tonnes of charcoal would have been required to produce this amount and these resources must have been close to site. The management of timber, coppicing and harvesting hectares of woodland, making charcoal and transporting it would have required a considerable amount of labour and time. As these tasks were seasonal, with the timber requiring to be dried for several months before the charcoal was burned over the summer (DeRoche 1997, 22), supply must have been well-organised and programmed. Collecting the clay and stone for furnace construction and the bog ore would have also been incredibly labour-intensive and time-consuming, with considerable local knowledge and skill required.

Bronze

Non-ferrous metalworking evidence has been identified on only a handful of sites of Middle/Late Iron Age date in Scotland and production in this period may have been both an infrequent activity and a technology restricted to certain groups or individuals (Hunter 2014a, 330; 2015; Heald 2005). While the complete range of bronze products made at Culduthel is unknown, it is clear that bronze-casting and sheet working was carried out and prestige metalwork was being made, some of which was enamelled. Although the markets for these goods is not known, the circulation of a regional group of massive metalwork along the coastal plains of the Moray Firth (Hunter 2014a, fig. 35.1) indicates that there was vigorous trade and exchange networks in prestige bronze objects in the north-east in the first few centuries AD.

The best evidence for sheet production is the fine bar ingot and the reused quern with its moulds for a bar ingot, a roughout for sheetworking, perhaps for feasting vessels such as cups and caldrons. As the skills required for sheetwork are distinct from casting, this work may well have been undertaken by specialist sheetworkers (Hunter 2015, 235). For the casting, the harness strap mount is the best example from the site as it was certainly made on site by highly skilled bronzeworkers who had an awareness of styles from beyond the region. As its style reflects wider traditions of British Celtic art of central Britain in the first two centuries AD and not the local 'massive metalwork' tradition that flourished in the 1st/2nd century AD in this region (Hunter 2014a, 333), it can be presumed that these bronzeworkers had influences from beyond the region. The recovery of similar horse equipment on other sites in the north-east in this period also shows that the community at Culduthel was tuning into a general trend of showing affiliation with central Britain through these objects (ibid).

Other elements of the bronzeworking taking place on site can be surmised. The worn copper alloy hilt guard appears to have been brought onto site for repair, perhaps travelling over a considerable distance to be fixed. Seen alongside the iron daggers and spearhead, it may be suggested that Culduthel had a considerable trade in the production and repair of weapons.

The assemblage of copper alloy objects, crucibles and moulds does not inform us of the level of bronzeworking taking place on site. It can be surmised that the bronzeworkers were highly skilled and had access to a range of raw materials, technologies and influences from beyond the local area. It is also probable that the bronzeworking at Culduthel was intimately linked to the production of glass, notably through the enamel used to inlay metal objects but also through the shared technology and the requirement for highly skilled artisans. The archaeological evidence suggests that bronze- and glassworking were undertaken together in a designated workshop; notably a turf and not a timber structure, which must have had an air of impermanence about it when surrounded by the workshops for ironworking. Does all this evidence suggest that the bronze- and glassworking at Culduthel was a short-lived or periodic set-up? Were groups of mobile specialist bronze (and glass) workers intermittently visiting the site and working for a time before moving onto another production site in the region or beyond?

Glass

The glass production at Culduthel gives us perhaps the clearest insight into the site's networks of trade and exchange but little can be defined about the level of production. Two identifiable styles of glass beads were made on site – the Guido's Class 8 and Class 13 beads (Guido 1978). Their production at Culduthel confirms previous held theories that these beads were being manufactured in north-east Scotland at some point between the 2nd century BC and the 2nd century AD (Henderson 1989a). Culduthel appears to have been part of a wider regional glass manufacturing tradition based in the north-east and may have been one of a network of glass production centres in the region.

One other known glass production site has been identified in the region at Culbin Sands, a long strip of dunes located between the mouths of the rivers Nairn and Findhorn on the southern shore of the Moray Firth, *c*.16 nautical miles from Culduthel. More than 250 beads (including Guido's Class 8, 13 and 14 beads) and glassworking waste have been identified across the bay but as yet no evidence of hearths or workshop has been found (Henderson 1989a, 69–71). The wealth of earlier prehistoric material from Culbin associated with production (especially barbed and tanged arrowheads, bronze axes and faience beads – cf. Bradley et al 2016) and the site's potential to be a sheltered inlet for people travelling along the coast, allowing access inland via the rivers, has led to the suggestion that this place had a long-standing specialist role in production and exchange and may have been the location of a well-established beach market (Carver 1999, 57; Bradley et al 2016).

The proximity of Culduthel to Culbin Sands and the production of identical beads in both locations implies that, if these sites were operating contemporarily, they worked together to receive and distribute imported raw materials and to make and supply glass objects. The consistency of bead styles, the complex technologies used to create them and the skill levels required to make beads and inlay metalwork also suggests that specialist glassworkers could have been a mobile and cohesive workforce, which may have moved frequently between production sites over a sizable region (cf. Hunter 2015, 237). Given the evidence from Culduthel, it is a possibility that these glassworkers moved alongside a group of bronzeworkers, or that these specialist workers were in fact one and the same.

This concept of a group of glassworking specialists working within a defined area is further validated by the concentrated and geographically restricted distribution of Class 13 and 14 beads in the north-east between the Dee and the Moray Firth (Guido 1978, fig. 34, 86 and fig. 36, 88). These beads, along with Class 8 and blue beads, have been recovered from a variety of sites in the region, including those considered to be settlements of the local elite (i.e. Birnie in Moray and Clarkly Hill), reflecting both the increased use of ornamental items throughout society from the 2nd/1st centuries BC and the uptake of certain items within this cultural package. These beads also travelled great distances and have been found as far afield as Skye, the Orkneys and Western Isles and south-west Scotland (Henderson 1991b, fig. 5). These objects were highly portable and could have arrived on sites from many different sources but to some extent this distribution must reflect the far-flung exchange networks that bead producers (including those working in the north-east) were tapped into, either directly through the exchange of goods or through their notoriety and the desirability of communities to obtain their products.

Neighbours across the north-east

To gain a better picture of the later prehistoric landscape in which Culduthel was situated, an area along the coast of the Moray Firth has been looked at in detail (Illus. 7.1). This area of study covers

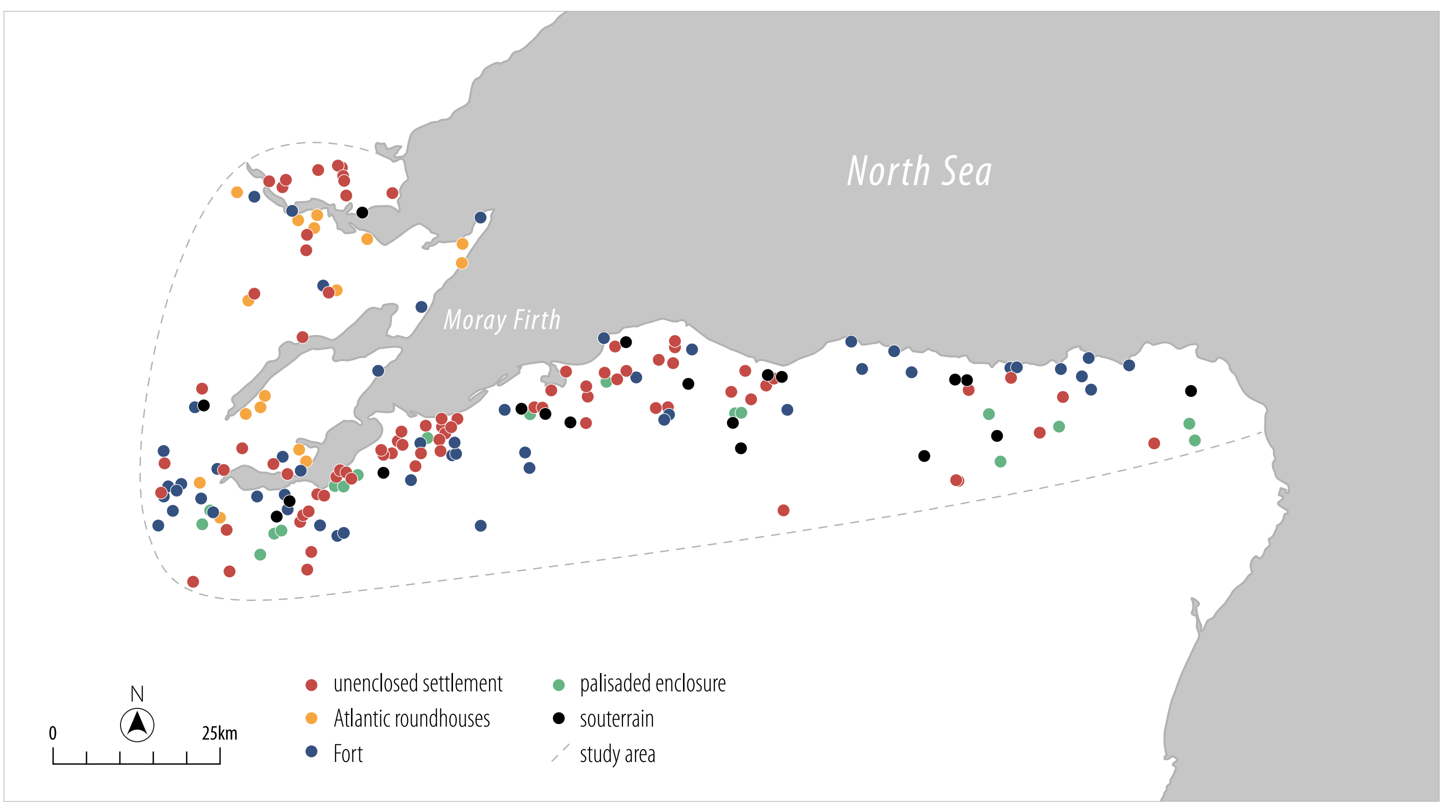


Illustration 7.1
The later prehistoric sites within the study area

the entire length of the southern coastline (the coast of Nairnshire, Morayshire, Banffshire and Aberdeenshire), extending approximately 15 miles inland to encompass the low-lying coastal plain. Broadly characterising the settlement landscape of this area through an analysis of distributions of particular settlement forms will help define local and regional settlement morphologies and how Culduthel may have fitted within these. The study area has also been extended northwards to include the Inner Moray Firth (the Beauly, Cromarty and Dornoch Firths) and the southern coast of Sutherland to look for differences and similarities either side of the firth.

The ability to characterise the later prehistoric settlement within the study area has considerably improved in the last two decades, due to a sharp increase in development-led and research excavations across the region. At the forefront of this has been the archaeological work in and around the city of Inverness (detailed in Chapter 1) and across Morayshire and Nairnshire, and research excavations led by Fraser Hunter of the National Museum of Scotland that have targeting two settlement sites that had previously produced a range of Roman finds through metal-detecting (Birnie and Clarkly Hill in Moray). Data has also been gathered for this study from the National Monuments Record of Scotland (NMRS, now the NRHE) and the lists of archaeological sites and monuments produced by the Royal Commission for the Ancient and Historical Monuments of Scotland (RCAHMS, now HES) for Nairn district in 1978 and North-east Inverness in 1979 (RCAHMS 1978; 1979). An overview and brief synthesis of the later prehistoric archaeological record for the Moray Coast is also included within the monograph *In the Shadow of Bennachie* (RCAHMS 2007). Another major source of data is the cropmark record. Coverage by aerial photography is variable across the study area but was improved across the Moray coast with the 'The Moray Aerial Survey' undertaken in the late 1980s by Barri Jones (Jones et al 1993). This survey included selected areas along the coastal plain and, although biased towards finding Roman archaeology, did identify sites of a range of periods.

The archaeological record

The archaeological record along the southern edge of the Moray Firth is dominated by unenclosed settlements visible as crop marks located along the low-lying coastal plain (Illus. 7.1; Halliday 1999, 57; Jones et al 1993, fig. 3.8, 59). Enclosed cropmark settlement sites defined by a palisade enclosure are also here, but in fewer numbers. None have been excavated but some, such as Aldourie Farm near Inverness (NH63NW 34) and Blackhill in Inverness-shire (NH74NW 32), are circular palisades of *c.*30m in diameter containing single roundhouses. The large oval double palisaded enclosure at Balblair in Nairnshire (NH85NE 46) is also defined by an external ditch. The interior contains at least one roundhouse which is surrounded by further settlement. Souterrains are also scattered across the area, seemingly a denser distribution than to the north but investigations are needed to confirm their chronology and form or relationship to settlement.

Larger enclosed or defended sites form a diverse group across the region but not to the scale or numbers seen further south in Perthshire or East Lothian. Smaller forts, some with evidence of vitrified walls, are spread eastward and inland, such as Dun Davie, Dun Garbhlaich, Dun Fhamhair and Caisteal Rollach in Inverness-shire, Castle Finlay in Nairnshire and the Doune of Regulas in Morayshire. Their function as enclosed farms or outlook posts may be valid given the small size of the enclosures (all less than 0.15 ha) but the fort at Dun Mor, located to the west of Inverness, may have a different function with its modest summit citadel and large lower bailey enclosed in a single scheme (Feachem 1966). Smaller still are a group of oval enclosures defined by a single drystone wall located in Inverness-shire (Cnoc a' Chinn, Dun a' Chliabhain, Dun Mor II, Dun Fionn and Aigas). In Argyll these would be 'dun' enclosures with occupation perhaps extending to the mid-1st millennium AD (Mackie 1974; Nieke 1990) but work is clearly needed here to understand these sites in the north-east.

Promontory forts along the Moray coast are markedly larger than those further north with timber and stone ramparts, or earthen banks and ditches, bounding large internal areas. The triple ditched cropmark site of Gilchrist to the west of the Beauly Firth is the only inland site of this type and encloses a tongue of land surrounded by marsh. Along the Moray Coast the fort at Cullykan was settled, probably discontinuously, from the later Bronze Age and developing into fortified settlement by the mid-1st millennium AD (Greig 1971; 1972) while investigations at the fort at Portknockie indicated it was a small defended domestic settlement from the early 1st millennium BC, potentially emerging as an important site in the mid-1st millennium AD (Ralston 1980; 1987). Further east, the promontory occupied at Dundarg Castle in Aberdeenshire is likely to have prehistoric origins prior to its development as a medieval stronghold (Fojut and Love 1983). The most exceptional promontory fort in Scotland is at Burghead, located on a headland on the south Morayshire coast. It is the largest fort of its type in Scotland, enclosing an area of 3 ha divided into an upper citadel and lower annexe, each enclosed by large walls. A corpus of Pictish stone plaques with bull symbols and an elaborate rock-cut well within its interior suggest that Burghead was a high-status centre in the early medieval period. Radiocarbon dating through piecemeal excavation work has shown that the upper citadel wall was built around the middle of the 1st millennium AD (Edwards and Ralston 1978, 206) and recent work by the University of Aberdeen has identified buildings of this date surviving within the interior of the fort (Noble and Sveinbjarnarson 2016).

Regionally distinct are the oblong forts enclosed by a single massive thick timber-laced wall. They may well date to Middle Iron Age (Cook 2010b) but have also been shown to represent one phase of enclosure within multi-phase sites (Feachem 1966, 68; Dunwell and Ralston 2008, 88; RCAHMS 2007, 101). Their distribution is closely paralleled centuries later by the massive metalwork distribution along the southern side of the Moray Firth (Hunter 2014a, 325–6 and fig. 35.1) and, along with the distribution of glass beads across the area (Guido 1978, figs. 34 and 36), suggest that a distinct region with strong identities was in place for many centuries in the north-east.

Two sites within the study area are defined as ritual sites. Deskford is the location of the Deskford Carnyx, the head of an Iron Age trumpet made of sheet bronze and brass that is likely to have been constructed between AD 80 and 250 (Hunter 2001c). It was discovered in Banffshire in the bottom of a peat moss in the

19th century and subsequent excavations around the findspot have shown that the carnyx was likely to have been placed into this wet location as part of a series of votive offerings (ibid). The Covesea caves are a series of caves located on the south shore of the Moray Firth. The Sculptor's Cave is the best known for its Pictish carvings along its entrance walls, but excavations within the interior of the cave have recovered significant assemblages of Late Bronze Age metalwork, Roman Iron Age artefacts and distinct burial rites of multiple decapitated individuals from both periods (Armit et al 2011). Recent excavations of a second cave to the west of Sculptor's Cave (Cave 2) have identified Iron Age metalworking overlying concentrations of disarticulated human bone of Late Bronze Age date (Büster and Armit 2014; 2015), and it is now recognised that these caves may have been part of a Late Bronze Age and Iron Age mortuary complex.

Unenclosed settlements

The unenclosed sites are mostly modest sized roundhouses, predominantly within small-scale settlements (e.g. south of Inverness at East Beechwood Farm – Engl 2011; Lower Slackbuie and Balloan – Wordsworth 1999; and along the Moray Coast at Grantown in Forres – Cook 2003; 2008; 2010a, and Coul Braes in Moray – Suddaby 2008) but the substantial ring-groove house at Seafield West in Inverness suggests that bigger houses were also constructed in the region (Cressey and Anderson 2011) (Illus. 7.2). The 2nd century AD bronze brooch found within the house perhaps suggests that these larger buildings were built and in use well into the 1st millennium AD, similar to the evidence seen further north at the substantial house at Bellfield Farm in North Kessock (Murray 2011). Where radiocarbon dating evidence is available it does show some large houses were built in the late 1st millennium BC and evidence of the long-term use of single plots of land both before this period and after is frequent. At Romancamp Gate in Fochabers in Moray, four large unenclosed roundhouses were built and occupied in the late 1st millennium BC, three of which overlapped and superseded one other after the previous structure had burnt down (Barclay 1993, illus. 3, 258). Further east at Tulloch Wood in Moray, eight hut-circles were identified within a landscape of banks, lynchets and field clearance cairns (Carter 1993). Three single-walled hut-circles and a bank had been built later in the 1st millennium BC, while a further hut-circle and field wall show the land was settled much earlier, at least by the late 2nd millennium BC (ibid).

Many of these sites have identified small-scale ironwork, usually located in the heart of a settlement seemingly producing tools and objects for everyday life in the communities. At East Beechwood the settlement of roundhouses and palisade had a possible furnace and dumps of slag that included smelting and smithing waste (Engl 2011). Slag from settlements at Milton of Leys (Halliday 2000) and Slackbuie (Site F on Illus. 1.8 – Fyles 2007; Dutton 2007) also show that ironworking was modest and

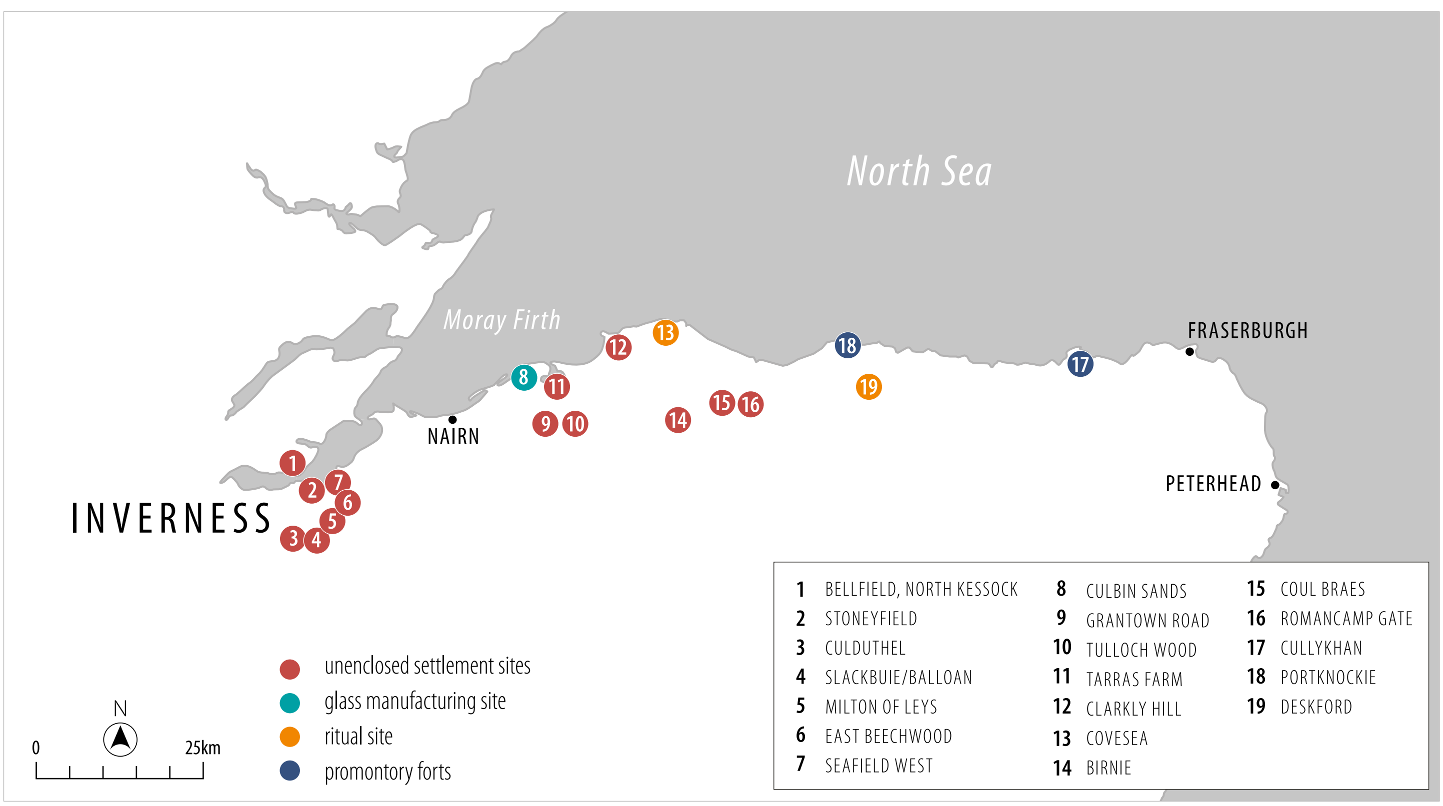


Illustration 7.2
Excavated unenclosed settlement sites within the study area. The locations of promontory forts, ritual sites and glass manufacturing sites are also shown.

related to the community's needs. Two sites in Forres also show evidence of small-scale iron production. At Tarras Farm several stone-built iron-smelting furnaces and hearths and large quantities of iron slag and furnace bottoms were of probable Iron Age date (Will 1998b), while at Grantown Road two furnaces, charcoal rich spreads and slag were identified within a settlement of roundhouses (Cook 2008, 123).

Two sites in the region have produced evidence of ironworking taking place within buildings. The later Iron Age settlement at Seafield West in Inverness, a potential contemporary of Culduthel, is one of the few sites in the region where an Iron Age smithing hearth has been identified within a building (Cressey and Anderson 2011). Occupied between the 1st century BC and the 3rd century AD the excavations identified eight roundhouses including one large ring-groove building (Structure A), a possible double-ring roundhouse within a palisade (Structure B) and a roundhouse with a ring-ditch (Structure C). One of the roundhouses (Structure H) contained a centrally located pit edged with stone slabs and filled with in situ ironworking debris including hearth bottoms. The charcoal within the hearth was dated to 180 BC and AD 70 (ibid, 23). Two Roman copper-alloy brooches were recovered suggesting that the inhabitants were of some status.

At another Iron Age settlement occupied through the Middle Iron Age at Bellfield Farm in North Kessock a small circular roundhouse (*c*.4m diameter) contained the remains of an iron-smelting furnace (Structure 3 in Area 2a, Murray 2011). The building was similar in design to the workshops at Culduthel, with a south-facing porch. The furnace was a large circular pit that contained 3.1kg of ferrous metalworking waste, the majority of which was unclassified iron slag/runned slag and furnace bottoms. A 4th to 2nd century BC date was obtained from charcoal recovered from the lower fill (ibid). Surrounding the building and to the south-west (Area 3) and east (Area 1) were pits containing a range of ironworking debris. The majority has been interpreted as residual, but some seems to have been deliberately and sequentially deposited. One pit contained fragments of saddle querns at its base and plano-convex hearth bases in the upper fill. Given the depth of the pit (*c*.1m), and the numerous deposits between the lower and upper fill, it may have been returned to repeatedly in order to deposit specific artefacts.

Illustration 7.3
Aerial shot of excavations at Birnie, Moray in 2008. © Aberdeenshire Council Archaeology Service AAS-08-4 DG CT_0326

The two sites excavated within Moray by Fraser Hunter (Birnie and Clarkly Hill) stand out within the region. These were wealthy and prosperous settlements of considerable status and their assemblages of prestigious goods suggests that both were local power centres in the region, comparable to, or, in the case of Birnie, beyond the status of Culduthel.

The discovery of the Iron Age settlement of Birnie was prompted by the discovery of a scattered hoard of Roman denarii of Severan date (AD 193–211) within a field containing cropmarks of a settlement (Hunter 1999–2000, 2002–2005c, 2006c, 2007b, 2008–2010). Investigations identified an unenclosed settlement of at least 25 roundhouses that had been occupied in the 1st millennium BC and AD (Illus. 7.3). A period of intensive settlement in the Roman Iron Age was defined by ring-groove and post-built houses, some of which appeared to have been deliberately burnt down. During this period the site was producing iron, with evidence of smelting, blacksmithing, bronze casting and sheetworking alongside other crafts. This industry was at a smaller scale than seen at Culduthel, but a sizeable iron assemblage suggests production was still considerable (Hunter, Chapter 6, Iron Artefacts).

The site was clearly well-connected, with a wide range of objects imported including bronze chariot gear and exotic jewellery of amber and gold. Contact with the Roman world was confirmed by a range of Roman finds including a further Roman coin hoard of more than 300 denarii ending in Septimius Severus (AD 196–7), samian ware, a range of brooches including a enamelled plate brooch likely made in the Rhineland or northern France (Hunter 2000, 16), an enamelled bird-headed pin, fragments of a glass bowl and Black Burnished Ware pottery. This assemblage suggests long-term sustained contact between the settlement and the Roman world in the first few centuries AD.

Indigenous finds confirm the importance of the site and considerable status of the occupants. Within a substantial roundhouse built in the early 1st millennium AD a wide range of luxury goods was deposited prior to abandonment, including the terminal of a gold ribbon torc, an amber bead, glass bangles and a spiral finger ring, all of which suggest that individual wealth was demonstrated through jewellery in the settlement. A range of glass beads found across site (including Class 8 and 13) show contact with regional networks of glass production, while the range of rare horse gear (including copper alloy horse harness and bridle bit), a copper alloy terret and a fan-headed linchpin, confirms the presence of chariots and horses.

At Clarkly Hill, another scattered hoard of denarii indicated the presence of an Iron Age settlement, later confirmed as an extensive unenclosed settlement of at least eight roundhouses by a geophysical survey (Hunter 2012, Fig. 5). Two sessions of work in 2011 and 2012 identified two roundhouses and iron- and bronzeworking in the early centuries AD. One roundhouse was large, *c.*18m in diameter, and finds from the interior included Roman glass, a bronze strap fitting and a Class 13 glass bead. The second roundhouse had a range of prestige finds including a Romano-British trumpet brooch and a Roman Iron Age massive openwork finger ring. A collection of local finds (an intact iron sickle, steatite lamp and iron dagger) were found deliberately placed on a large flat slab (a possible hearth) in the centre of the house. After abandonment a series of standing stones were erected marking the location of the house and within one of their stone holes a human skull, a sherd of samian ware and a silver finger ring were found (Hunter 2012). Hunter (ibid) has suggested that the stones were a deliberate act to turn the building to a ritual site.

To the north of the settlement a trench was opened to target a highly magnetic anomaly seen in the geophysics. This trench was full of ironworking slag and bog ore. Fragments of crucibles indicated bronzeworking had also taken place. A dismantled iron smelting furnace and two hearths indicated that this area was likely to have been the metalworking centre of the settlement. Another trench targeting the location of the scattered hoard identified more than 60 denarii (the latest *c.*190 AD) and a few bronze coins of an earlier date (ibid).

The Roman finds alongside a high-quality local assemblage of weapons, glass beads and bronze suggest that Clarkly Hill was able to access Roman and indigenous luxury goods and was likely a site of considerable status. Evidence from the initial investigations of the industrial area to the north of the settlement shows that the community was also engaged in craftworking, including iron-smelting and smithing and bronzeworking. The Class 8 bead (from the plough soil) and the Class 13 beads prove contact was made with the region's glass manufacturing sites.

Discussion

This brief overview shows that Culduthel was part of a thriving later prehistoric landscape. From excavation work on the most common site type, the unenclosed sites, a wide range of settlements appeared to have co-existed in the Iron Age. These range from the modest roundhouses in small groups (e.g. East Beechwood Farm, Lower Slackbuie and Balloan in Inverness-shire and Balnaferry and Grantstown along the Moray Coast) to more substantial and higher status settlements at Culduthel and Birnie. The function, status and chronology of the wide range of enclosed sites is, however, still unclear. Our knowledge of the wider landscape in which these settlements existed is also fairly limited and further work has been done to begin to understand different site types in the region. Investigation of the promontory forts of Cullykan and Portknockie show that they were both settled in the later prehistoric period and have long, albeit discontinuous, occupation that extends well into the 1st millennium AD. As many of the larger hill-top sites are small in scale with few visible internal features it is possible that they were not permanently settled, and functioned as communal places for seasonal gatherings. There are strong indications that these settlements sit within an active ritual landscape, from the work undertaken at Covesea Caves and the land surrounding the findspot of the Deskford carnyx.

A model for north-east Scotland in the Iron Age postulates that the region was dominated by smaller groups or individual settlements, with unenclosed settlements of roundhouses and smaller enclosed hamlets or households, and society was organised at a local level (Hunter 2007a, 48). With no evidence for large-scale centralised power centres across the Moray Firthlands and a considerable corpus of small settlements or individual households it seems likely that this model is fairly accurate. Hierarchy between these unenclosed settlement sites is potentially visible through the ability of more affluent settlements to access some Roman goods and build large ring-groove houses.

Higher status settlements can be identified at Culduthel, Birnie and Clarkly Hill in the first centuries AD. Each had the ability to access luxury Roman goods and high-quality local products and were engaged in the specialist manufacture of ferrous and non-ferrous objects. Their shared styles and forms of material culture implies that they were each tuning into a distinctive shared regional cultural package to assert their local inter-group identities. This package included the making and wearing of prestigious metalwork and other personal ornaments, the procurement of Roman goods, the chariot and horse gear with bronze bridle bits and harness straps (many in exotic non-local styles) and the construction of large-scale houses. The need for these communities to define and curate their identities in a unified way may have come in part through the growing proximity of the Roman world at this time and the perceived threat that society and life was about to change (Hunter 2007d, 289).

Conclusions

The excavation of Culduthel has shown that an affluent and well-connected craftworking centre was located in north-east Scotland in the Middle Iron Age. This settlement shares many cultural affiliations with other high-status contemporary settlements in the region at this time, which were manufacturing ferrous and non-ferrous objects and had access to wide networks of exchange and trade with local, regional and larger-scale affiliations. It is the sheer scale and organisation of the iron production, the manufacture of glass beads and prestigious enamelled metalwork that separates Culduthel as distinct and unique. Here we see a purpose-built, highly specialist craftworking centre, established and run as a production site by an ambitious, experimental and creative community.

Culduthel may well have been one of a network of production sites located along the fertile and well-connected southern coast of the Moray Firth. The evidence from Clarkly Hill and Birnie to the east demonstrates that both sites were likely producing iron beyond their community's requirements and could have been manufacturing for exchange and trade. The motivations behind a shift to larger-scale manufacture of iron on these domestic settlement sites is unclear but at Culduthel the construction of a new separate craftworking site suggests that the demand for iron objects in the region was significant, the control of this production was desirable and the raw materials accessible. The bronze casting and sheetwork seen at Culduthel was also underway at Birnie, evidence that demonstrates that the skills and raw materials for production of copper alloy were also available to other sites of status in the region at this time. If Birnie and Culduthel were in contemporary use, can it therefore be assumed that some level of contact, through exchange or meeting, for the sharing of skills, itinerate craftworkers, technology and resources was in play to develop this regional manufacturing tradition (cf. Hunter 2015, 237)? If skilled bronzeworkers were moving frequently to set up temporary workshops at different production sites across the southern coast of the Moray Firth, knowledge, skills and access to materials would have travelled with them. The current corpus of bronzeworking evidence in the region alludes to it being restricted to higher status sites and access to this craft, and the mobility of the craftworkers may have been controlled by individuals or communities.

Culduthel is so far the only site in north-east Scotland identified to have been making glass beads and enamels in this period. The level of glass production here is not clear but from the range of imported glass found on site, the assemblage of native Iron Age beads found across the north-east and the evidence from the Culbin Sands, it appears that Culduthel may have been one of a number of production sites in the region. Similar to bronzeworking, and technologically connected to it, glassworking (through access to raw materials or the mobility of craftworkers) may have been equally restricted to certain communities in the region. The distribution of glass beads in the north-east in the Iron Age shows that personal ornaments were an important part of the local and regional identities in this period and participation in these networks and in the production of glass jewellery and enamelled metalworking may have been a key motivation to develop this technology at Culduthel. By controlling the distribution of these desirable products the community would have garnered an exceptional level of notoriety and status.

Complex social dynamics were also underway within the community itself. Control or central leadership during the establishment of the craftworking centre is certainly implied through the layout and organisation of the site while higher status individuals or groups are visibly emerging on site from the early part of the 1st century AD. These people are able for the first time to build larger houses and increasingly have access to the Roman material and prestigious goods that were desired across the region at this time (Hunter 2007d, 293). A hierarchy of specialist artisans may also have existed on site, determined perhaps by the prestige of their output, the rarity of materials used and their level of specialist skills. The glass- and bronzeworkers may have been occasional visitors to the site and afforded a separate special status within the community.

The craftworking centre appears to have been abandoned at some point between the mid-2nd and early 3rd century AD. This is a period of wider social change seen across the north-east of Scotland and beyond. Many sites with long histories of occupation are abandoned during this time, large-scale domestic architecture disappears, the circulation of indigenous material vanishes, and newly established settlements of this date remain stubbornly elusive to archaeologists. Settlements may have been abandoned due to a myriad of social, political and economic factors including broader changes in the structure of society and ideas of community and the individual. Why the community left Culduthel is unknown. In and around the workshops the final firings of the furnaces were in place as well as piles of waste debris containing many usable or recyclable items, evidence that suggests this was a hurried and unplanned exit. Within the large roundhouses, however, a very different, planned and drawn-out exit can be observed in the carefully curated closing rituals of the large buildings.

The proximity of the Roman world could have played a key role in disrupting the political and social landscapes of the north-east at this time. Hunter (2007a, 48) points out that the break in the settlement record in the north-east coincides with a drop in Roman imports in the region. It is not clear, however, if this lack of imports was a deliberate policy by the Romans or a change of preferences by the local elites (ibid, 51–2). On leaving the settlement at Culduthel the community left behind many Roman objects, seemingly parting gifts for the houses but potentially also symbols of a rejection of Roman culture.

The settlement of Culduthel was clearly a thriving Iron Age enterprise, a purpose-built centre producing a range of utilitarian and prestige items for use within the settlement and for trade and exchange. It was able to attract or train highly skilled workers who had an awareness of the demands of the local and regional marketplace and could import raw materials from a wide range of sources. The Roman material coming onto site may have been the result of trade, diplomacy or tribute, directly between an emerging elite at Culduthel and the Romans, or indirectly via tribes to the south. That the community was able to participate in these social and economic networks by the early part of the 1st millennium AD demonstrates that it had become a significant settlement in the landscape of Iron Age north-east Scotland.

The discovery of Culduthel from a single cropmark of an isolated palisade of little consequence should be seen as a salutary warning to archaeologists not to dismiss seemingly inconsequential sites. Unenclosed settlements and palisade enclosures dominate the landscape of the north-east and, to further understand the social and political geography of the region, work will be required on both the seemingly prestigious enclosed sites and those that appear on the surface to be far less remarkable.

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Abbreviations

BAR	British Archaeological Reports
CBA	Council for British Archaeology
NMAS	National Museum of Antiquities of Scotland (now National Museums Scotland)
Proc Soc Antiq Scot	*Proceedings of the Society of Antiquaries of Scotland*
RCAHMS	Royal Commission on the Ancient & Historical Monuments of Scotland (now Historic Environment Scotland)

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