6 ENVIRONMENTAL EVIDENCE

6.1 *Archaeobotanical and charcoal analysis, by Mhairi Hastie*

6.1.1 Introduction

Two hundred and seventy-five bulk soil samples were taken during the excavation, ranging in volume from 0.5 to 70 litres, and retained for palaeoenvironmental analysis. This report concentrates on the cereal grains, wood charcoal and other plant remains recovered from the samples.

6.1.2 Methodology

A system of flotation and wet sieving was used to separate the archaeological material from the soil samples. Initially, the flotation debris was collected in a 250µm and, once dry, scanned using a low-powered microscope (magnification ×10–×200) to identify the archaeological material. Material remaining in the flotation tank was wet-sieved through a 1mm mesh and air-dried before being sorted to identify any remaining significant material.

Identifications of cereal remains and other plant material were made with reference to CFA Archaeology's modern comparative reference collection and seed atlases. Samples that contained large concentrations of charred cereal remains were subdivided using a riffle box and a proportion of the sample sorted. The number of grain/wild taxa present in the sorted fraction was then multiplied to give a representative number for each species within the whole of the sample. The cereal remains recovered from the same feature number were amalgamated and the results are summarised in archive.

The wood charcoal from 90 randomly selected samples (approx. 70% of the samples containing charcoal) was sorted and identified. Identifications were carried out on charcoal fragments at or greater than 4mm in diameter using a binocular microscope at magnifications ranging between ×10 and ×200. Charcoal fragments measuring less than 4mm in diameter were considered to be below the level of identification (BLOI) and these are summarised in archive. Anatomical keys listed in Schweingruber (1992), Gale & Cutler (2000) and CFA Archaeology's reference charcoal were used to aid identifications. Where samples contained a large quantity of wood charcoal, the sample was subdivided using a riffle box and a proportion of the charcoal identified. Results are summarised in archive.

6.1.3 Results

Out of the total 27 bulk samples processed, 60 samples contained cereal grains. The majority of these samples contained only small quantities of poorly preserved/abraded grain and wild taxa, although an extremely large concentration of grains was recovered from the fill of a pit (F116). Barley rachis fragments (cereal chaff), which are rarely recovered from Scottish archaeological sites, were present in a sample taken from the ring-ditch (F100).

Wood charcoal was present in 134 samples. Preservation of the charcoal varied with both well-preserved large roundwood and small vitrified fragments of charcoal being recovered. In most cases the vitrified charcoal fragments were extremely poorly preserved, with little or no micromorphology remaining and identification of the wood species was not possible.

The diversity of the plant remains recovered was generally poor. By far the most abundant element was cereal grain, a low spread of grains being uncovered across the whole of the excavated area and throughout many different features. Both barley (*Hordeum* sp.) and oat (*Avena* sp.) grains were identified. In most cases the number of barley grains exceeded the number of oat grains, and this suggests that barley was the main cultivated crop. The bulk of the cereal grains were much abraded, although occasional barley grain still had hulls attached, indicating the presence of the hulled variety.

An almost pure sample of cereal grain was recovered from the fill of the medieval Pit F116, with over 45,000 grains being identified. The grains were extremely well preserved compared with plant material recovered from the rest of the excavated area. The assemblage from the pit was dominated by grains of oat, which made up 72% of the identifiable grains, with lesser quantities of barley. Large quantities of the grain were extremely fragmentary and could not be identified to species level.

Many of the oat grains still had lemma and palea fragments attached and six grains were sufficiently preserved to identify the cultivated black oat (*Avena strigosa*). A large percentage of the barley grains identified still had hulls attached and the presence of both twisted and straight grains indicates the presence of six-row barley (*Hordeum vulgare*). A small proportion of the grain, both oat and barley, had elongated embryos indicating that some of the grain had started to germinate prior to being burnt.

The wild taxa, as represented by the seeds (used here in general terms to include items which are strictly fruits etc) were relatively sparse. However, taxa from a number of different habitats were present:

- minor residual elements from crop cleaning including charlock (*Raphanis raphanistrum*), fat hen (*Chenopodium* sp.), persicaria/pale persicaria (*Polygonum persicaria/lapathifolium*) and grass (Gramineae indet);
- taxa indicative of waste places such as wood rush (*Luzula* sp.) and goosegrass (*Galium aparine*);
- sedge (*Carex* sp.) indicative of more heathland and wet areas; and
- woodland elements represented by hazelnut shell.

Fragments of burnt humified peat and occasional charred rhizomes (underground stem fragments) were recovered from features associated with the enclosure ditch, the ditch itself F171, an adjacent Pit F208 and an internal feature F216.

As with the cereal grain, the largest concentration of wild taxa was recovered from the fill of Pit F116, comprising charred rhizome fragments and the seedpods (siliqua) of wild radish. No wild radish seeds or seedpod fragments were recovered from any other samples.

Small fragments of burnt hazelnut shell were recovered from only one sample, the fill of circular Pit F208 associated with the enclosure ditch.

Charcoal was recovered from many different features and structures across the excavation area. Birch (*Betula* sp.) was the most abundant material identified, followed by hazel (*Corylus* sp.) and alder (*Alnus* sp.). Cherry/blackthorn type (*Pomodiaceae* indet.) and hawthorn/rowan type (*Prunus* sp.) are also present, and willow is represented by a single charcoal fragment recovered from the entrance to Roundhouse 1 (F5). In terms of the overall weights, birch and hazel provided the largest volume of charcoal.

The largest quantity of charcoal was recovered from a ring-ditch (F100). Further high concentrations of charcoal were present in Roundhouse 1 post-hole F11, Roundhouse 2 post-hole F110, Pit F116 and Beaker pits F134, F168. Well-preserved round wood fragments of charcoal were recovered from these samples; the composition and size of the round wood being similar for each sample. Birch round wood measured generally *c* 20–40mm in diameter, while hazel round wood fragments were principally *c* 20mm in diameter. Small twigs of hazel, approximately *c* 10mm in diameter, were also present. Results are summarised in archive.

6.1.4 Discussion

Prehistoric features

Beaker pottery and radiocarbon dating indicated an Early Bronze Age date for pits F168 and F134. A large concentration of charcoal was recovered from Pit F168, the wood charcoal being dominated by birch and hazel. Pit F134 contained several sherds of Beaker pottery but only small amounts of charcoal, all of which was identified as alder. No cereal grains were recovered from features dated to the Early Bronze Age.

A general spread of cereal grains was present throughout the ring-ditch F100 of Roundhouse 2 and associated features. Cereal grains were dominated by hulled barley, with occasional oat grains. None of the oat grains were sufficiently well-preserved to identify the wild or cultivated species. Low numbers of weed seeds were present in five of the samples from this structure, principally indicative of arable fields and wet areas. Low quantities of wood charcoal were recovered from many deposits associated with the ring-ditch structure. The charcoal assemblage was dominated by birch with lesser quantities of alder and hazel. Small fragments of both rowan/hawthorn type and cherry/blackthorn type were also uncovered. A very high concentration of charcoal was recovered from the ditch fill F100**,** consisting primarily of large round wood fragments of birch.

Occasional fragments of barley rachis (chaff fragments) were encountered from the fill of ring-ditch F100. The rachis make up the central axis of the ear and such remains are only rarely recovered from Scottish sites. They are less dense than the grains and as such are more likely to be reduced to ash when coming in contact with fire. Ethnographic sources (Fenton 1999) record that the ear of the barley was scorched over the fire to assist the threshing process. The recovery of small quantities of barley rachis with charred cereal grain may suggest that the grain was indeed being dried as whole ears.

Evidence from both ethnographic and archaeological sources indicates that the grain was most probably processed only in small quantities when required and that small-scale crop processing, including parching of the grain, removal of the hulls and grinding of the grain was carried out on a day-to-day basis close to the domestic hearth. Accidental burning of crop remains during this everyday processing would produce low quantities of burnt crop and other debris which over time would become spread throughout many different areas of the settlement along with hearth ash and other domestic rubbish.

Of note is the apparent lack of cereal remains in features associated with Roundhouse 1 in the southern half of the excavation area. Only one carbonised rhizome fragment was recovered from the fill of the entrance (F5) and one barley grain was present in the fill of a nearby pit (F47). The retrieval of at least small amounts of charred cereal grains is a common characteristic of previously excavated roundhouse structures (for example Birnie, Hastie 2005; Kintore, Holden et al 2008) and these assemblages are typically interpreted as corn accidentally burnt during food processing. The lack of such debris within features associated with the post-built structure may suggest that this structure was used for non-domestic activities. Roundhouse 1 also produced low quantities of wood charcoal including alder, birch, hazel, rowan/hawthorn type, cherry/blackthorn type and willow, recovered from the majority of features associated with the post-built structure.

Seeds of wild taxa including persicaria, fat hen and grass were recovered along with the grain. These are commonly retrieved with cereal assemblages from Scottish prehistoric sites and would have been a frequent element of the corn crop. All would grow to the same height as the corn and would have been gathered by reaping high on the ear (Jones 1987).

The wood charcoal assemblage was dominated by native trees particularly alder, birch and hazel, all of which are native to western Scotland and would have been available locally. Similar charcoal assemblages have been recovered from other prehistoric sites on Skye (for instance High Pasture Cave: Cressey 2005). Alder would have been exploited from streams and wetland areas, while hazel and birch would have thrived on the local acidic soils (ibid).

The charcoal consisted principally of roundwood fragments; no timber fragments were noted. As with the cereal grain the bulk of the charcoal would probably have originated from the hearth being spread over time through many unrelated deposits and features.

Some of the birch roundwood fragments were large, with a diameter of *c* 40mm indicating that mature branch wood was being exploited. The roundwood fragments were all very uniform in diameter and it appears that the site occupants were deliberately collecting wood of a specific size. Straight hazel rods of young growth were also present, these may have been collected as a starter fuel, and reflect the growth pattern of stems commonly found in coppiced wood. Alder, birch and hazel can all be coppiced in order to provide a long-term source of wood, although hazel and alder do self-coppice as part of their natural regeneration cycle. The regular size of the round wood present at Kiltaraglen does however suggest that coppicing techniques were used and indicates a degree of woodland management being carried out by the occupants of the site.

Very small quantities of cereal grains and other plant remains were recovered from the enclosure ditch F171. The majority of the cereal grain and charcoal was recovered from internal features associated with the ditch (some of which have been dated to the medieval period). Barley grains dominated the samples; occasional grains still had hulls attached, suggesting that the bulk of the grains were the hulled variety. Small quantities of weed seeds were present in the fill of the ditch and in four internal features. These principally comprise species indicative of arable fields and wet areas. Only very small, poorly preserved and vitrified charcoal fragments were recovered from features associated with the enclosure ditch; a mixture of alder, birch, hazel, rowan/hawthorn type and cherry/blackthorn type were present.

Only small quantities of poorly preserved oat grain and charcoal were recovered from the fill of miniature souterrain F163. AMS dates gained from two fragments of charcoal suggest that at least some of the material from this feature is medieval in date and the presence of oat within these deposits would not be unusual for this period. No other plant remains were recovered from the feature.

Fragments of humified peat and charred rhizomes were recovered from features associated with enclosure ditch F171 (Pit F208 and internal feature F216), indicating that peat turves were also being used as a fuel in addition to wood. This is confirmed by the soil micromorphology which identified two distinct dumps of peat ash within the ditch fill and suggest that the peat ash originated from a domestic hearth. It is also possible that peat was being collected for specific activities such as smoking of meat or fish.

Charcoal recovered from three features (pits F208/F211 and the miniature souterrain F163) produced medieval dates. The quantity of carbonised material recovered was generally low; apart from the wood charcoal, only a small quantity of oat grains was recovered from F163 and the quantity and quality of the plant remains recovered does not allow for detailed discussion. The presence of such material does, however, suggest that possibly crop processing or some domestic activity was being carried out on the site during this period.

Very small quantities of poorly preserved cereal grain and charcoal were recovered from the possible pit alignment and other isolated features.

Medieval cereal grain – Pit F116

A large quantity of almost pure charred grain was recovered from Pit F116, together with metalworking debris and a high concentration of alder charcoal. No other large quantities of plant remains were uncovered from the excavated area.

The cereal assemblage was dominated by grains of black oat with lesser quantities of barley, with over 20,000 grains being present. AMS dates from cereal grains present in the pit (Section 6.5) indicate a medieval date for the plant assemblage. A small proportion of the grain showed signs of sprouting (elongated embryos), indicating that some had started to germinate prior to being burnt.

Ferrous slag and fragments of what may be a hearth or furnace base (McLaren above) were recovered from the upper fill of the pit together with the large quantity of grains. McLaren notes that the pit lacks any micro-debris, and suggests that the deposit was a secondary dump of waste rather than in situ metalworking. The mixed nature of the assemblage, with metalworking debris and large quantities of cereal grain, would concur with this.

There was no direct evidence from the archaeological record for the original source of the burnt grain and there are several possible sources for this material, all of which would result in large quantities of burnt grain:

- *Grain burnt during corn drying*
  In northern-temperate climates where wet harvests are commonplace it was necessary to dry the harvested crop. This not only assisted the removal of the outer hulls from the grain but also hardened the grains for grinding. During the Prehistoric period drying was carried out over the hearth when required. Later in the Roman and medieval periods, when larger quantities of grain were cultivated, the corn was dried in corn-drying kilns. Even today it is necessary to dry the grain following very wet summers, and grains can begin to germinate in the fields when particularly wet weather delays the harvest. Drying of the corn was a hazardous job, any grain that fell through the drying floor would become charred and kilns frequently caught fire during use, destroying both the kiln and the crop being dried. Several kilns, along with large quantities of charred grain, have been uncovered from Scottish medieval sites. Good examples were uncovered during the excavation at the medieval monastic settlement at Hoddom, Dumfries and Galloway (Holden 2006), where several of the kilns were found to have been rebuilt a number of times after being destroyed by fire.
- *Grain accidentally burnt during the malting process*
  The grain may have been deliberately germinated as part of the process to produce beer. As the purity of water could not be guaranteed during the medieval period, beer was the most common drink during this period. It was consumed on a daily basis by all social classes in the northern and eastern parts of Europe, where grape cultivation was difficult, and beer made from oats was common in the medieval period. The grain would have been soaked in water then spread onto a malting floor where the sprouting grains would have been allowed to grow for several days. The sprouted grains would then have been dried probably in a kiln to kill the acrospires (sprout at the end of a seed when it begins to germinate). Too great a heat would toast the grain and destroy the necessary enzymes required for brewing.
- *Conflagration of stored grain*
  The extremely large quantity of almost pure grain recovered from the pit fill could be the remnants of stored corn. Partially cleaned grain could have been stored in either sacks or baskets (Fenton 1999) and could easily have been destroyed if the structure they were stored in went up in flames.

Neither direct evidence for any large conflagration events nor the presence of a corn-drying kiln was identified during the excavation. Nevertheless, later ploughing in the area may have removed much of the evidence and it is difficult to ascertain the exact origin of the burnt grain.

Occasional seed pods (siliqua) of charlock were recovered from the pit fill with the cereal grains. This species is very invasive and spreads rapidly in areas where the ground has been disturbed. It was a widespread weed of cultivated fields during the medieval period, especially of non-calcareous soils (Clapham et al 1962). It was once considered to be the most troublesome weed of arable land in Britain (Long 1938) and only became less abundant following the introduction of hormone weed killers. The seed pods are indehiscent and break up into segments containing a single seed which are similar in size to cereal grain. As a consequence they would be hard to separate from the grains by such processes as winnowing or fine-sieving and would require to be removed principally by hand sorting.

6.2 Calcined and cremated bone, by Sue Anderson

Pieces of calcined bone (total 646 fragments, 218.61g) were recovered from 32 features, the majority from palaeoenvironmental samples. Most features produced very small quantities, weighing between 0.1g and 19.0g, and the fragments were generally heavily abraded. The largest group was recovered from the fills of the circular enclosure ditch, F171 (314 fragments, 149.4g), of which the majority was a cremation burial from amongst the stones (Unit 4) in Slot 3.

Ten fragments (1.5g) were collected from two features related to Roundhouse 1, the entrance (F5), possible central hearth pit (F40) and one nearby pit feature (F3). All pieces were tiny and unidentifiable, except one fragment from F3 which was from a large mammal.

Roundhouse 2 and the ring-ditch structure produced a larger assemblage, 149 fragments (24.5g), which was spread across several post-holes and the fill of the ring-ditch itself. Again the majority of these fragments were small and unidentifiable, although most were probably medium to large mammals. Fragments of possible antler were found in Roundhouse 2 post-hole F76 and ring-ditch post-hole F95, which may indicate that working of this material was being carried out on the site.

Features around and within the enclosure F171 contained a total of 183 fragments (57.91g). The largest part of this assemblage was concentrated in features close to, within or cutting the fills of F171. Four features to the south of F171 accounted for only eleven fragments (3.5g); one fragment from possible souterrain F163 was a complete sheep/goat proximal phalange. The largest groups were collected from medieval Pit F208 (48 pieces, 30.1g) and the Early Iron Age Pit F216 (25 pieces, 3.7g), but again fragments were generally not identifiable to species. The groups from features cutting the fills of the enclosure ditch included some possible human fragments, most notably a piece of tibia from F229,

Table 13 Cremation burial quantification

Sample	Skull		Axial		Upper limb		Lower limb		Unidentified	
	No.	Wt	No.	Wt	No.	Wt	No.	Wt	No.	Wt
237	25	16.8	4	2.3	9	10.1	19	25.5	120	31.9
275	16	4.7	3	3.3	2	2.0	5	4.7	55	16.8
–	2	0.7	–	–	–	–	10	4.9	6	0.4
Totals	**43**	**22.2**	**7**	**5.6**	**11**	**12.1**	**34**	**35.1**	**181**	**49.1**

which may represent disturbance of the cremated bone assemblage in F171 (see below). Some of these features, particularly F238 and F245, contained a few pieces of unburnt tooth enamel; the tooth fragments were not human.

The large quantity of bone from F171 was mostly found in the west side of the ditch, in Slots 3 and 4, but one fragment was from Slot 10. As noted above, a large proportion of this material was from a single Unit 4 deposit (171/303) which was the remains of a human cremation burial, represented by 276 fragments (124.1g). Table 13 shows the quantities of bone from the four main areas of the body. The context also contained at least six fragments of animal bone (3.2g), and some of the unidentified material could also be non-human.

Very little axial material had survived in this assemblage. Most of the unidentified pieces were certainly long bones, but the fragments were too small and abraded to be assigned to a limb. Axial fragments are frequently the least calcined part of the skeleton, and it is possible that they had been lost to the acidic soils. The assemblage did not include any sex or age indicators and the individual can only be classed as 'adult' based on the size of the long bones.

A few other fragments of probably human skull and long bone were collected from 171/102 (1 fragment, 5.8g) and 171/305 (total 28 fragments, 12.5g), but this material was more mixed and appeared to contain a higher proportion of animal bone. Fragments from 171/405 and 409 in the adjacent slot were also noted as possibly human, and may represent disturbance of the main group.

In summary, the fragments of bone recovered from the post-built structures, the ring-ditch structure and the features around the enclosure probably represent the charred remnants of domestic waste. The preservation of unburnt bone in an acidic soil such as this is always poor and it is unsurprising that none of the large quantities of bone which would have been discarded by the occupants of the site has survived. Only one definite concentration of human bone was identified, and this was buried within the fill of the enclosure ditch. The abraded nature of the bone, together with its early date, suggests that it was probably an accidental incorporation in the ditch fill, representing a disturbed cremation burial from a nearby interment, which may explain why such a small proportion of the body is present.

6.3 *Phosphate analysis, by Mike Cressey and Bob McCulloch*

6.3.1 Introduction

Total soil phosphate (P) analysis was undertaken on thirty-eight soil samples taken from five features suspected of containing elevated levels of P and a sample of natural subsoil (Table 14). Samples were selected in an attempt to answer questions posed by the excavations, in particular: were Pit F168 and the short linear features (F232, F245) graves; and were the fills of features associated with Roundhouse 2 enhanced to levels commensurate with domestic activity?

Soil P levels are normally increased in archaeological soils, especially in the presence of human and animal bone. Other organic residues accumulating from occupation of the site will also lead to local P enhancement (Craddock et al 1986; Dockrill & Simpson 1994). Phosphates are effectively fixed in soils as a result of cation-exchange capacity and firmly bound to both the inorganic and organic component within the soil and are not readily lost to leaching or re-mobilisation.

6.3.2 Laboratory methods

Samples are analysed following the procedures of Smith & Bain (1982). Samples were dried and sieved to 90μm. Sub-samples of 2g were treated with 25ml 0.5 molar hydrochloric acid solution to eliminate any calcareous content and rinsed with distilled water to remove any excess acid. A further sub-sample of 0.1g of the treated soil was heated singularly with 1g sodium hydroxide (pellet form) until a colourless liquid is formed. The samples were left to cool and 25ml of distilled water added. After approximately 12 hours the sample solution is made up to 50ml and centrifuged. The supernatant was transferred into a sealed container prior to colorimetric analysis. Reagent solutions are prepared; 20ml 1.2% ammonium molybdate, 5ml 1.5% ascorbic acid and between 0.5 and 5ml of the prepared bottled sample,

Table 14 Soil phosphate distribution values within five features

Context	Feature	Max mg/kg P	Min mg/kg P	Mean mg/kg P
F168	Upper middle fill of Beaker pit	456	353	382
F168	Lower middle fill of Beaker pit	417	440	428
F168	Primary fill of Beaker pit	104	98	101
F232	Upper fill of pit	671	337	504
F232	Lower fill of pit	715	537	624
F245	Upper fill of pit	963	963	963
F245	Middle fill of pit	1253	1253	1253
F245	Lower fill of pit	930	731	827
F99	Roundhouse 2, Pit fill	370	317	335
F100	Ring-ditch, Upper fill	348	338	343
F100	Ring-ditch, Lower fill	407	335	423
003	Control (natural subsoil)			37

depending on the concentration. The solutions are placed in a spectrophotometer at 880nm to measure the absorbance. Values are each expressed as mg/kg of soil P.

6.3.3 Results

The results are shown in Table 14 and include P maximum and minimum values along with the mean P sample obtained from the P values for each feature. Here the mean P value has been used to assess the relative degree of soil enrichment in contrast to the local subsoil which has undergone no P enhancement. The control sample attained a P value of 37mg/kg, which is negligible.

- *F168, pit containing Beaker pottery*
  The upper and middle fills attained mean P values of 382 and 428mg/kg respectively, three times higher than the primary fill, which attained a mean value of 101mg/kg. It is possible that these values reflect the absence of organic matter towards the base of the fill. Some phosphate enhancement is present within the fills.
- *F232, elongated pit cut into upper fills of the enclosure ditch F171*
  The upper and lower fills have attained mean phosphate values of 504 and 624mg/kg showing phosphate enhancement.
- *F245, elongated pit cut into upper fills of the enclosure ditch F171*
  The upper fill of this feature attained a mean phosphate value of 963mg/kg. The middle fill where animal bone was recorded produced a mean value of 1253mg/kg, which is exceptionally high but not unexpected. The lower fill phosphate value is also elevated, at 827mg/kg.
- *F99, primary fill of pit associated with Roundhouse 2*
  The fill of the pit's primary fill produced a mean phosphate value of 335mg/kg, showing that this feature's fill has been enriched with phosphate derived from organic material.
- *F100, primary and secondary fills of ring-ditch*
  The ring-ditch upper fills have attained a mean phosphate value of 343mg/kg whilst the lower fill attained a mean of 423mg/kg.

6.3.4 Discussion

The results confirm that all the features examined display phosphate enrichment derived from anthropogenic activity at the site. F245 has produced the highest value at 1253mg/kg which, in contrast to the background value, is extremely enhanced. Analysis of soils obtained from a Bronze Age plank-built log coffin at Seafield West, near Inverness (Cressey & Sheridan 2003) provided clear evidence for the former presence of a body. The results from the deposit containing Beaker sherds and from the basal fills below confirm that enrichment is present but the values are not overly high and are commensurate with residual material discarded into a pit.

Fills obtained from Pit F232, Pit F99 within Roundhouse 2 and ring-ditch F100 all display P enrichment in contrast to the control sample values. These values, although not overly high, reflect the general background P levels that would be expected in the presence of human- and animal-derived P. Similar P values have been obtained from other studies (Cameron et al 2007) where a series of pits and other negative features were associated with later prehistoric settlement. Local P highspots are not uncommon where the sample has been enriched by organic material rich in phosphate (eg excrement/ food waste/ashes).

The P values obtained from the range of archaeological features sampled at Kiltaraglen all display levels of P enrichment contrasting to the control sample. These enriched values are the result of varied human activities carried out at the site.

6.4 Micromorphological thin section analysis, by Claire Ellis

6.4.1 Methods

Field sampling

Five Kubiena samples were taken from a variety of features and were subject to full micromorphological analysis. The first sample, Sample 27, was taken through the lower fills of a possible post-hole or hearth feature (F40) in Roundhouse 1. The second and third, Samples 80 and 130, were taken through the fills of a post-hole forming Roundhouse 2 (F81) and the internal ring-ditch (F100). The fourth, Sample 344, was taken through the fills of a circular enclosure ditch (F171) and finally a fifth, Sample 298, through the fills of a pit within the area defined by F171. The summary results are given below. Full descriptions are contained in the archive report.

Thin section manufacture and description

The samples were prepared for thin section analysis by G. McLeod at the Department of Environmental Science, University of Stirling, using the methods of Murphy (1986). Water was removed and replaced by acetone exchange and then impregnated under vacuum using polyester crystic resin and a catalyst. The blocks were cured for up to four weeks, sliced and bonded to glass and precision lapped to 30µm with a cover slip. The samples were described using a MEIJI ML9200 polarising microscope following the descriptive terminology and methodology of Bullock et al (1985) and Fitzpatrick (1993). A range of magnifications (40×–400×) and constant light sources (plane polarised light –PPL, cross-polars – XPL, circular polarised light – CPL and oblique incident light – OIL) were used in the descriptions.

6.4.2 Objectives

A series of broad research questions have been formulated regarding the nature of the occupation on the site, the type of structures present and the function of these. Specifically the objectives were to:

- determine the nature and function of the sampled feature (F40, Sample 27); the formation hypothesis is that this feature is a post-hole or hearth associated with a post-hole defined roundhouse;
- determine whether the post rotted in situ, was replaced or even supplemented by an additional post (F81, Sample 80);
- determine the nature and mode of deposition of the ditch fills (F100, Sample 130); the formation hypothesis is that this is a ring-ditch in which a wall has collapsed and upon which ash has been dumped;
- determine the nature and mode of deposition of the internal feature fills (F209, Sample 298);
- determine the nature and mode of deposition of the enclosure ditch fills (F171, Sample 344); the formation hypothesis is that the ditch backfilled soon after its construction but occurred as two separate phases.

6.4.3 Results and discussion

The sampled contexts comprise poor to well sorted calcareous silt. The mineral component of all the sampled contexts is dominated by micrite (microcrystalline calcite); although this is largely masked by sequioxides due to the dominance of ash in Sample 298 and 130. The natural comprises calcareous silt; the micrite and sparite content is presumably derived from the inferior or lower oolite while the 10–15% rock fragments are largely derived from olivine basalts. All the contexts have been severely reworked by soil biota (earthworms and enchytraeid) resulting in welded crumb/welded granular microstructures and channels (Dawod & FitzPatrick 1992). Nearly all the contexts comprise juxtaposed rounded clasts, many of which are the by-products of bioturbation. The natural is dominated by uncarbonised, dark brown to grey calcareous silts, yellow brown calcareous silts and packing voids and channels which are infilled with pale yellow calcareous silt. All but Sample 298 contain rounded clasts of the natural. Samples 27, 298 and 130 contain varying quantities of charcoal, mixed wood and peat ash, silty peat ash and clasts of carbonised peat (Simpson et al 2003). In contrast Sample 344 contains minimal anthropic indicators.

- *Sample 27: F40 post-hole or hearth? (illus 13c)*
  This sample was taken through the natural and lowermost fill (40/3) of the feature. The boundary between the bioturbated natural and lower fill is generally diffuse, although in places it is sharp and marked by a decrease in grain size of the micritic silt and an increase in silt-sized charcoal fragments. The lower fill has very abundant silt-sized charcoal fragments and very abundant large charcoal fragments; the latter dip around 45° toward the base of the feature. Although wood ash dominates there are very frequent clusters of granular silty peat clasts, this demonstrates a mixed fuel source. The survival of discrete clasts of wood ash, silt peat ash as well as large charcoal fragments indicates that the bulk of the bioturbation probably took place prior to its deposition within the ditch; the act of moving and dumping the material resulted in the juxtaposition of the different ashes. Furthermore, the natural shows no indication of in situ burning and together with the distinct dip of the charcoal it seems that the deposit is not in situ but may well have been

dumped or utilised as packing material around a large post. There is no micromorphological evidence to indicate whether the feature once contained a post-hole.

- *Sample 80: F81 post-hole (illus 17d)*
  This sample was taken through the basal fills of a post-hole associated with Roundhouse 2. The natural 003 into which the post-hole was cut is a moderately to poorly sorted silt. This natural has been subject to bioturbation and has possibly been locally redeposited; subsequently calcareous silt was in-washed into the packing voids. Therefore, it seems likely that once the post-hole was dug it remained open to the elements for some period of time. The base of the post-hole 'cut' is sharp, a clear indication of a sediment hiatus; the wavy nature of the boundary is due to the later activities of soil biota. The lowermost sampled fill (81/4) is a moderately compact, well-sorted silt in which coalesced fecal pellets are common. Pale yellow amorphous and moderately to strongly decomposed woody organic matter dominates (81/5). Around 5% of the organic matter appears charred and is associated with sequioxides. This charred organic matter may be derived from a post that had been burnt or scorched prior to its burial to protect it from decay. The dominant woody organic matter is likely to be the rotted remnants of a wooden post much disturbed by the post-depositional activities of soil biota. The overlying sediment (81/3) is a moderately sorted calcareous silt with frequent amorphous organic matter. The presence of rounded clasts of mixed wood/silty peat ash and rounded clasts of redeposited natural indicates that this unit may have been produced as a wooden post rotted, the wood being replaced by overlying and adjacent material brought into the profile by the action of soil biota and gravity.
- *Sample 130: F100 ring-ditch (illus 18b)*
  The surviving ash components within Sample 130 indicate that silty peat turves and wood were both utilised as fuel but carbonised peat was also recorded (Carter 1998; Simpson et al 2003). The survival of considerable quantities of charcoal, biogenic silica and red (rubified) fine mineral material suggests that the fires were of a relatively low temperature (around 400°C) and typical of a domestic hearth in which combustion was incomplete due to a deficiency in oxygen (Courty et al 1989; Simpson et al 2003); this may have been caused by the use of naturally damp fuel and/or the deliberate dampening of the fires to create an environment suitable for the smoking of meats or fish.

Similarly, although no natural was sampled, the presence of rounded clasts of natural unaffected by heat indicates that the burning probably occurred elsewhere prior to the ash-rich deposit being dumped within the ring-ditch. In common with Sample 298 the juxtaposition of rounded clasts of different ash types indicates that these ashes were produced by discrete burning events fuelled mainly by one sort of fuel. Such a mixed deposit may have been formed from the redeposition of composted midden material upon which numerous hearth cleanings had been dumped and partially mixed through the activities of soil biota. At least two phases of discrete dumping are evident within the ditch, with the lower deposit containing an abundance of wood ash and silty peat ash while the upper contains slightly less wood ash. Similarly the lower ring-ditch fill comprises a mixed peat, silty peat and wood ash while the overlying fill is dominated by wood ash with less silty peat ash.

The mechanics of ring-ditch formation remain open to debate, but one suggestion is that some ring-ditches are the by-product of erosion caused by cattle over-wintered in stalls located around the perimeter of a roundhouse. The use of ashes to soak up urine is well attested (Adderley et al 2006) and coupled with the relatively low porosity of the units it is possible that the ring-ditch deposits are the remnants of winter floor levels. The presence of rare goethite-rich clay coatings demonstrates that these units have also been subject to limited illuviation which occurred after the post-deposition bioturbation and other physical disturbance. One explanation is that these coatings were produced by the puddling and trampling effect of stall stock (Courty et al 1989: 130), although alternatively these could have been the product of the post-depositional weathering of ash rich in potassium, the latter encourages local clay movement (ibid: 113).

- *Sample 344: F171 enclosure ditch (illus 5b)*
  The fills of the enclosure ditch (F171, Units 2–3) essentially comprise bioturbated, redeposited rounded clasts of natural set within a fine silt-sized micritic matrix and in the upper sampled fill very rare clasts of ashy silt stained by goethite. It is probable that at least some of the bioturbation took place while the sediment formed part of an enclosing bank(s). The boundary between the two fills is clear and abrupt, and coupled with the difference in compaction between the two contexts the micromorphological evidence is indicative of a hiatus in sedimentation. There is no visible preferred orientation of the coarse mineral content or rock fragments; this may indicate that the ditch was deliberately backfilled, rather than a gradual accumulation through natural erosion processes such as episodic runoff and slumping. Goethite crystals with voids are frequent in the upper ditch fill and attest to post-depositional wetting and drying of the deposit, perhaps on a seasonal basis.
- *Sample 298: F216 fill of pit within enclosure ditch (illus 11c)*
  The surviving ash components within Sample 298 indicate that silty peat turves and wood were both utilised as fuel. The survival of considerable quantities of charcoal, biogenic silica and red

(rubified) fine mineral material suggests that the fires were of a relatively low temperature (around 400°C), and typical of a domestic hearth in which combustion was incomplete due to a deficiency in oxygen.

It appears unlikely that the burning of the constituents of Sample 298 (F216, illus 11c) took place within the feature as the natural appears to be unaffected by heat. The juxtaposition of rounded clasts of different ash types indicates that these ashes were produced by discrete burning events fuelled mainly by one sort of fuel. Such a mixed deposit may have been formed from the redeposition of composted midden material upon which numerous hearth cleanings had been dumped and partially mixed through the activities of soil biota. At least two phases of discrete dumping are evident within the pit, with the lower deposit containing an abundance of wood ash and silty peat ash while the upper contains slightly less wood ash.

6.4.4 Summary conclusions

1. Sample 27. The sampled fill (40/3) comprises dumped mixed ash of mainly wood but with some silty peat and is characteristic of low temperature fires, typically domestic. There is no micromorphological evidence to indicate the function of F40.
2. Sample 80. The post-hole F81 appears to have been left open to the elements prior to the setting of the post. The post within F81 rotted in situ. The post may have been charred prior to its setting within the post-hole.
3. Sample 130. The fills of the ring-ditch F100 comprise mixed ash, the lower fill containing peat, wood and silty peat ash while the overlying fill is dominated by wood ash with a minor silty peat component. Again, the ashes are typical of low-temperature fires. The ash fills are not in situ.
4. Sample 298. The fills of Pit F216 within the enclosure also comprise mixed ash typical of low-temperature fires. The lower fill comprises the remnants of silty peat ash and frequent wood ash with very large fragments of charcoal while the upper fill has no large charcoal fragments and slightly less wood ash. The ash fills are not in situ but were dumped into the ditch on at least two separate occasions.
5. Sample 344. The enclosure ditch fills comprising Units 2 and 3 of F171 are dominated by redeposited natural that has been subject to bioturbation when it was presumably incorporated into the enclosing bank(s) as well as some post-depositional disturbance. The fills were probably deliberately dumped into the ditch, although there was a break in the backfilling of the ditch between the dumping of the lower (Unit 2) and upper (Unit 3) sampled fills.

6.5 *Radiocarbon dating*

Thirty-nine samples were sent for AMS dating at the Scottish Universities Environmental Research Centre (SUERC). These dates were derived from carbonised cereal seeds or charcoal recovered from bulk or charcoal samples collected during the excavation. The aim of the radiocarbon dating programme was to ascertain the date of features that could not be dated by other means and to refine the currently accepted dating of the artefacts that were recovered.

Charcoal samples recovered on site for identification and radiocarbon dating were securely wrapped in aluminium foil, and then kept in a temperature-controlled environment during storage. Bulk samples were recovered on a judgemental basis (Jones 1991) before being wet-sieved (Kenward et al 1980), with other charcoal and carbonised seed samples being extracted from the products. These were found in both the flot and residue as a result of waterlogging.

No in situ organic structural deposits were identified during the excavation and the dated feature fills are, where this is identifiable, contemporary with, or later than, the abandonment of the feature. This is not to suggest that all of the organic components of these fills are contemporary with their deposition and the issue of residuality in the organic assemblage is a complicating factor in the results.

Given the redeposited nature of the dated fills, paired radiocarbon samples were used, utilising carbonised cereal seeds as a priority and, where charcoal from the same context was used, different species where possible. In three instances (GU-17454–5, GU-17463), the carbonised barley broke up during treatment and substitute samples (GU-17857–9) were submitted. The results of the AMS dating are shown in Table 15.

Prior to analysing these dates, an understanding of the taphonomy is essential. There was little evidence for burrowing in the excavated deposits and there were no rabbit burrows or molehills in the field. The products of soil biota are acknowledged in the mircomorphological report but the subsoil was compact, with lenses of iron deposits and worms being rarely encountered. The inclusion, deliberate or otherwise, of earlier charcoal into constructional contexts is a complicating factor and one that could not be recognised during the excavation. In overview, the radiocarbon evidence indicates two main phases of activity, an extended period covering the Later Bronze Age, the Early Iron Age and the transition between them (1300–400 cal BC) and a shorter period in medieval times (1000–1400 cal AD). Episodes of pit-digging took place in the Early Bronze Age, as did the cremation of at least one individual.

Chi-squared tests were used to analyse statistically the radiocarbon dates and dated contexts. The dates from F134 failed the test and despite both being of alder, the charcoal samples were not burnt in the same event. Those from hazel and birch in F168

Table 15 AMS C14 Radiocarbon dates from the sites at Kiltaraglen

Context	Sample	Lab Code	Date BP	Material	Delta 13C	Calibrated 1σ	Calibrated 2σ
Beaker pits							
134/2	67A	GU–17468	3945±30	Alder	–25.6‰	2550–2340BC	2570–2340BC
134/2	67B	GU–17469	3845±30	Alder	–26.1‰	2400–2200BC	2460–2200BC
168/4	156A	GU–17926	3910±40	Hazel	–27.2‰	2470–2340BC	2550–2230BC
168/4	156B	GU–17927	3905±40	Birch	–26.1‰	2470–2340BC	2490–2230BC
Enclosure ditch							
171/303	237A	GU–17480	3670±30	Bone	–21.1‰	2140–1970BC	2140–1950BC
171/303	237B	GU–17481	3610±30	Bone	–23.3‰	2025–1925BC	2040–1880BC
171/1020	357A	GU–17472	2960±30	Hazel	–25.6‰	1260–1120BC	1300–1050BC
171/1020	357B	GU–17473	2960±30	Hazel	–25.8‰	1260–1120BC	1300–1050BC
171/609	242A	GU–17503	2930±30	Hazel	–25.7‰	1210–1050BC	1260–1020BC
171/609	242B	GU–17504	2965±30	Hazel	–25.2‰	1260–1120BC	1310–1050BC
Feature cut into enclosure ditch fill							
245/3	350A	GU–17478	2445±30	Alder	–25.6‰	740–410BC	760–400BC
245/3	350B	GU–17479	2430±30	Alder	–26.1‰	720–410BC	750–400BC
Pit within enclosure							
216/2	248A	GU–17462	2445±30	Barley	–22.3‰	740–410BC	760–400BC
216/2	267A	GU–17859	2465±30	Barley	–22.8‰	760–510BC	760–410BC
Pits outside enclosure							
208/7	188A	GU–17476	905±30	Birch	–25.2‰	1040–1180AD	1030–1210AD
208/7	188B	GU–17477	925±30	Birch	–27.9‰	1040–1160AD	1020–1180AD
211/2	189A	GU–17474	980±30	Birch	–26‰	1010–1150AD	990–1160AD
211/2	189B	GU–17475	955±30	Hazel	–26‰	1020–1160AD	1020–1160AD
211/3	190A	GU–17506	910±30	Birch	–26.1‰	1040–1170AD	1030–1210AD
211/3	190B	GU–17507	920±30	Hazel	–26.8‰	1040–1160AD	1020–1190AD
Roundhouse 1							
40/3	38A	GU–17464	2970±30	Birch	–26.6‰	1260–1120BC	1310–1050BC
40/3	38B	GU–17465	2970±30	Willow	–27.8‰	1260–1120BC	1310–1050BC
Roundhouse 2							
81/3	81A	GU–17466	2925±30	Birch	–24.3‰	1200–1050BC	1260–1010BC
81/3	81B	GU–17467	2850±30	Alder	–26.5‰	1060–930BC	1120–920BC
99/4	109A	GU–17452	2875±30	Barley	–23.1‰	1120–1000BC	1190–930BC
99/4	109B	GU–17453	2360±30	Barley	–24.9‰	510–380BC	530–380BC
Ring-ditch							
100/104	120A	GU–17858	2820±30	Birch	–24.8‰	1010–925BC	1070–890BC
100/22	144	GU–17505	2825±30	Birch	–25.9‰	980–840BC	1000–830BC
100/53	106A	GU–17857	2875±30	Hazel	–25.4‰	1120–1000BC	1190–930BC
100/82	105A	GU–17456	2775±30	Barley	–22.1‰	980–850BC	1000–840BC
100/82	105B	GU–17457	2820±30	Barley	–24.6‰	1010–925BC	1070–890BC
Micro-souterrain							
163/52	161A	GU–17470	885±30	Birch	–26.5‰	1050–1220AD	1040–1220AD
163/52	161B	GU–17471	835±30	Alder	–25.4‰	1175–1255AD	1150–1270AD
Pit							
116/2	65A	GU–17460	600±30	Oat	–24.9‰	1305–1400AD	1290–1410AD
116/2	65B	GU–17461	655±30	Barley	–23.6‰	1280–1390AD	1270–1400AD
116/4	66A	GU–17458	585±30	Barley	–24.3‰	1315–1405AD	1290–1420AD
116/4	66B	GU–17459	645±30	Oat	N/A	1285–1390AD	1280–1400AD

passed. The charcoal dates from the enclosure ditch passed and those from the human cremation in the ditch allow the assumption that a single individual is represented. The dates from features cut into the ditch are virtually identical to those from the single dated internal feature. Roundhouse 1 is earlier than Roundhouse 2 and within the dates from the latter, those from F100 are statistically different from F81/F99. Even between F81 and F99 (discounting GU-17453 as being intrusive), the remaining three dates fail the test. The samples from the intercutting pits F208/F211 pass the test as do those from F163 and F116. Significantly perhaps, the charcoal dates from the enclosure ditch and from Roundhouse 1 pass the test and could relate to the same event. Both may stem from contemporary events surrounding the conclusion of activity at these locations but there is no good evidence for their contemporary use. When combined with GU-17466 from F81 in Roundhouse 2, the same enclosure dates pass the test and could again derive from the same event, but add the second date from F81 and the test fails.

Few of the contexts could be described as 'charcoal-rich'. Exceptions to this include F40 in Roundhouse 1, Beaker Pit F168 and the lenses of charcoal in ditch F171, Slot 10. Otherwise reliance was placed on charcoal which was often a minor constituent of the overall context. Further, these contexts were often formed at the end of, or after, the use of the feature in which they were found.

The medieval dates from pits F208/211 were something of a surprise. Although they do not contradict the stratigraphy, they are at variance with the dating suggested by both the artefacts and the spatial distribution of the features in that area. Despite appearances, it may be that F211 was non-archaeological and therefore all the samples from it and F208 represent natural medieval intrusions into a prehistoric feature. Neither seeds nor artefacts were recovered from it. Against this, both birch and hazel were represented and it is more likely that such a scenario would involve a single species.

In the field, it seemed clear that Pit F208 cut Pit F211, with charcoal from the latter then eroding onto the base of the former. A line drawn through the axis of symmetry within Pit F209/216 inside the enclosure F171 runs through the centre of Pit F208 forming a clear spatial (mirror-image) alignment. This, and the similar scale of the features, is strong evidence for a relationship between these pits, one that is not supported by the C14 dates. Although the upper fill of F208 overlay the fill at the edge of the ditch, the ditch clearly bent slightly (illus 7) to avoid the pit, and illus 10 demonstrates the degree of care used in cutting the edge of the ditch around the edge of the pit. Although secure, the stratigraphy is not an insurmountable problem here, as, for unknown reasons, the ditch may have been infilled before the pit. Overall, the degree of doubt is sufficient to arouse suspicions over the dates from this feature. Suspicion may also be cast over the dates from F209/216. Although very similar to those from F245, a pit cut into the fill of the enclosure F171, the spatial relationship between F209/216 with F208 is a concern. Overall, the dating and sequence of features 171, 209/216, 208 and 211 as suggested by the radiocarbon dates, the stratigraphy, the artefacts and their spatial layout within the site cannot be easily reconciled.

Suspicions may also be attached to the dates from F163, as the pottery belongs in the 1st millennium BC and if this feature is accepted as being akin to a souterrain, dates after the 4th century AD are rare (Dunwell & Ralston 2008).

Date GU-17453 from F99, within the otherwise well-dated Roundhouse 2 is hard to interpret. This well sealed context had no apparent contamination but contained barley dating broadly to the period when activity was centred to the south, on features within the enclosure and cut into its ditch.