5. ENVIRONMENTAL ANALYSES

5.1 Animal bone

Jennifer Thoms

The assemblage comprised 1,501 fragments of bone, weighing 1.575kg. The bones had mainly been collected from secure, numbered contexts, with the exception of 21 fragments from surface finds and similar unsecure contexts. The material was collected by hand and from sample processing.

The bone fragments were a variety of sizes, with most being very small. The bones were mainly in poor condition; this has resulted in a preponderance of large teeth in the assemblage, due to the greater resistance of tooth enamel to decay in acidic soil conditions. The assemblage, therefore, cannot be expected to reflect the original buried assemblage, or tell us much about the animals living in and around the site at the time it was occupied. In addition, the animal bone tells us very little about the possible function of the enclosure.

The bones mainly came from cattle and horse (Table 1). There were 18 horse teeth present in the assemblage and a small fragment of femur from horse as well. Bone fragments identifiable as cattle included small pieces of femur, humerus and

Table 1 The identifiable bones

Context	Fill of	Find no.	Element	Species	Condition	Stain	Taphonomy
114	115	09	max molar	cattle	fair	yes	burnt
140	138B	18	tooth mand M1	horse	good	no	
140	138B	18	tooth mand M2	horse	good	no	
140	138B	18	tooth mand M3	horse	good	yes	
140	138B	18	tooth mand I3	horse	good	no	
140	138B	18	tooth mand I2	horse	good	no	
147	115C	24	femur	cattle	fair	yes	burnt
147	115C	48	femur	cattle	poor	yes	burnt
172	115D	26	humerus	cattle	poor	yes	burnt
172	115D	26	mandibular hinge	cattle	poor	yes	burnt
172	115D	26	max incisor tooth	horse	fair	yes	burnt
172	115D	26	maxillary molars × 11	horse	fair	yes	some burnt
223	115D	35	metapodial – distal end	cattle	poor	yes	burnt
224	115D	28	mandibular 3rd molar	cattle	good	no	
224	115D	32	humerus	large mammal	poor	yes	burnt
224	115D	38	humerus	horse/cattle	fair	yes	burnt
264	174A	41	metapodial – distal end	cattle	fair	yes	? burnt
264	174A	41	mand M3	horse	good	yes	
270	060A	42	femur	horse	fair	yes	? burnt
270	060B	50	metapodial	sheep/goat	good	yes	knife mark

metapodial as well as two teeth. One fragment of metapodial from a sheep/goat was present, as well as a rib from a sheep-sized mammal. The material was in poor condition with only the teeth being classed in good condition. Some of the bones appeared to have been burnt, and one displayed a knife mark. The burning and the knife mark hint at a domestic origin for at least some of the bone, although the horse teeth rather argue against this. The number and types of horse teeth could indicate the burial of an animal within the ditch terminus (Slot 115D), if one accepts the proposition that the remainder of the bones were not preserved due to soil conditions. The horse teeth were recovered from the primary fill (C172) at the base of the southern terminus of the east-south-eastern entrance of the inner ditch.

A similar suite of horse teeth was recovered from a pit below Rampart A at Eildon Hill North, which was thought to have been the remains of the burial of a partly cremated horse (Rideout et al 1992: 50). During the excavation of the western rampart and ditch at Blewburton Hill, Berkshire, Collins discovered the remains of a horse and associated rider (Collins 1953). The remains of two additional horses were discovered just inside the entrance at Blewburton during a later excavation in 1976 (Harding 1976). Therefore, it is possible that the posited horse burial at Winchburgh was a deliberate act, whether that was ritual or symbolic in nature.

It is highly probable that the assemblage has been affected by preservation bias, with soil conditions leading to smaller bones being destroyed completely, and only larger, denser bones surviving. A summary of the indeterminate fragments is provided in Table 2.

5.2 Waterlogged wood

Mike Cressey

A single fragment of waterlogged wood, recovered from the primary fill (602) of Slot 060B during the evaluation, was subjected to formal species identification. The wood was frozen for 24 hours and then thin sectioned using a razor blade. The thin sections were then mounted on a slide and examined under a microscope at ×100 magnification. Keys listed in Schweingruber (1992) and comparisons with in-house reference slides were used to aid identification.

The wood measured 60mm long by 9.4mm wide and was 9mm thick. It was identified as *Corylus avellana* (hazel). The morphological character of the wood confirmed that it had been created by splitting a piece of branchwood longitudinally. Its surface was devoid of any toolmarks or surface trimming. The wood had no identifiable function or diagnostic traits.

5.3 Archaeobotanical analysis

Mhairi Hastie and Mike Cressey

Thirty-seven bulk soil samples (ranging in volume from 5 to 40 litres) were retained for archaeobotanical assessment. Each sample was processed through a Siraf style flotation tank. The floating debris (flot) was collected in a 250μm sieve, and once dry, scanned using a binocular microscope. Any material remaining in the sieve tank (retent) was washed through a 1mm mesh and air dried, and it was then sorted for any archaeological material.

Charcoal identifications were carried out on only the >4–2mm sized charcoal fragments. Fragments smaller than 2mm are considered below the limit of identification due to the amorphous shape of the charcoal and the problems encountered with obtaining a transverse cross-section from such small fragments.

Identifications were carried out using bi-focal microscopy at magnifications ranging between ×50 and ×400. Anatomical keys listed in Schweingruber (1992) and in-house reference collections were used to aid identifications. The results are summarised below in Tables 3 & 4. A full inventory of the identified material is provided in the site archive.

5.3.1 Results

A small amount of carbonised plant remains was recovered from the samples, including cereal grain, nutshell and charcoal (Tables 3 & 4).

5.3.1.1 Cereal grain

Three poorly preserved and abraded charred cereal grains were recovered from the fill of a possible pit, or post hole (166). Only one of the grains was sufficiently well preserved to allow identification to species, with barley (*Hordeum* sp) identified.

Table 2 Indeterminate fragments

Context	Fill of	Find no.	Notes
114	115	07	small fragments
128	021	03	tooth enamel – large mammal
128	021	04	tooth enamel – large mammal
128	021	05	tooth enamel – large mammal
140	138B	18	horse tooth fragments
140	138	18	tooth enamel, from horse
147	115B	17	some large fragments
147	115C	24	some large fragments
147	115C	48	some large fragments, some burnt
147	115	08	burnt fragments, various sizes
147	115	12	burnt, fragments of large bone
147	115	10	burnt
147	115	11	burnt
147	115	15	small fragments, most burnt
149	115	06	tooth enamel – large mammal
163	115C	47	burnt, very fragmented and crumbly remains of large bone
163	115C	46	burnt
172	115D	25	some burnt
172	115D		burnt, large fragments, bone, not tooth enamel
223	115D	39	all small
223	115D	35	probably fragments of cattle metapodial
223	115D	29	clayey texture, heavy, brick coloured
224	115D	40	all small
224	115D	38	burnt, probably humerus fragments
226	115D	36	probably burnt
226	115D	37	small fragments
264	174A	41	tooth fragments, horse or cattle
264	174A	46	burnt, tiny fragments
264	174A	46	not burnt, small fragments
270	060B	49	not burnt, small fragments
280/281	235B	52	not burnt, small fragments
	115D		chemically altered

5.3.1.2 Nutshell
One small fragment of nutshell, probably hazelnut shell, was recovered from the fill (C264) of the inner ditch (Slot 235F).

5.3.1.3 Charcoal
The bulk of the charcoal assemblage was amorphous in character and included six retent samples dominated by fragments well below the limit of identification (BLOI). Two samples were found to contain vitrified charcoal, which is the product of serious alteration of the wood's vascular structure when wood is heated to temperatures greater than 800°C. Fragmentary and much abraded wood charcoal was recovered from seven samples, primarily from the fills of the inner ditch (including ditch segments 082, 100, 105, 111, 115, 174 and 235). Generally, the amount of wood charcoal recovered from these samples was particularly small, consisting only of one or two fragments; only one sample, the fill of the possible pit/post hole (166) contained large amounts of charcoal.

Fragments of burnt heather charcoal were present in two samples, the fill of the possible pit/post hole (166) and the inner ditch. As with the wood charcoal, this debris was generally abraded and only one or two fragments were recovered from each sample.

Little can be said about this charcoal assemblage other than that it is extremely poor. Although the shrubs hazel and heather are represented along with birch and oak charcoal, their frequency does not allow any meaningful discourse on whether the charcoal identified represents fuel residues or is possibly the result of natural fires. Given the scale and size of the excavation, it is very unusual not to have recovered a larger charcoal assemblage and it is assumed on this basis that only trace amounts of charcoal were present within the inner and outer ditches. They were certainly not the recipients of domestic refuse.

5.3.2 Discussion

Overall, the condition of the carbonised plant remains recovered from Winchburgh is poor. The fragmentary and abraded nature of the debris suggests that it has undergone much movement prior to final deposition. The modest quantity of material recovered does not allow for detailed discussion.

5.4 Soil micromorphology

Clare Ellis

Eight Kubiena tin samples were taken from the fills of the inner ditch (four from Slot 235D) and the outer ditch (four from Slot 001C, Illus 11). The objective of analysis was to characterise the nature of the sampled deposits and their mode of deposition and accumulation. The summary results are given below and full descriptions are contained in the site archive.

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 assessed using a MEIJI ML9200 polarising microscope following the principles of Bullock et al (1985), Fitzpatrick (1993) and Stoops (2003). A range of magnifications (×40–×400) and constant light sources (plane polarised light – PPL, cross-polars – XPL, circular polarised light and oblique incident light – OIL) were used in the analysis.

5.4.1 Results

5.4.1.1 Summary description: inner ditch
The inner ditch fills were all apedal and comprised from the base upwards: poorly sorted silty clay; moderately sorted sandy clay; moderately sorted clay; and well sorted clay. The lowermost deposit (Context 243) has a massive microstructure with very few channels, while the overlying sampled contexts all displayed a channel microstructure, a result of the activities of soil biota including earthworms. The primary fills (C243) and (C239) contained laminations (bands of clay and silt) with some examples of a fining upwards sequence. The mineral content of the sampled contexts was dominated by sub-rounded to rounded quartz grains, with a few grains of plagioclase feldspar and rock fragments derived from a wide range of lithologies. The units all contained very few to few fragmentary biogenic

Table 3 Composition of retents (+ rare; ++ occasional; +++ common; ++++ abundant)

Context no.	Fill of	Context description	Sample no.	Pottery	Bead	Glass	Bone: Unburnt	Bone: Burnt	Nutshell	Slag/fuel ash (poss)
037	036	Terminus (basal fill)	21	Archaeologically sterile						
056/057	055	Outer ditch terminus	4	+						+
270	060B	North ditch inner enclosure	49				+			+
282	060C	North ditch inner enclosure	53							+
064	082	Ditch on outer circuit	5	Archaeologically sterile						
103	100	Inner ditch terminus	7		+ (×1)					
109		West terminus edge	10	Archaeologically sterile						
108	105	Inner ditch terminus (upper fill)	9	Archaeologically sterile						
151		Inner ditch terminus (secondary fill)	17	Archaeologically sterile						
106		Inner ditch terminus (basal fill)	8							+
152		Inner ditch terminus (basal fill?)	18	Archaeologically sterile						
112	111	Inner circuit	11	Archaeologically sterile						
112		Inner circuit	12	Archaeologically sterile						
126		Inner circuit	16	Archaeologically sterile						
147	115	Inner circuit	19	Archaeologically sterile						
114		Inner circuit (basal fill)	13	Archaeologically sterile						
114		Inner circuit (basal fill)	15	Archaeologically sterile						
159	115C	Post hole	20	Archaeologically sterile						
165	164	Possible post hole	22							+

Table 3 *cont*

Context no.	Fill of	Context description	Sample no.	Pottery	Bead	Glass	Bone		Nutshell	Slag/fuel ash (poss)
							Unburnt	Burnt		
167	166	Possible pit or post hole	23							++
264	174A	Inner ditch	46				+++	+	+ (×1)	
208	174C	Inner ditch (basal fill)	25							+
296	174C	Inner ditch	54							+
195/220	174F	Inner ditch	26	Archaeologically sterile						
249	174G	Inner ditch	30			+ (×1)				
262	174H	Inner ditch	44			+ (×1)				+
259/260		Inner ditch	45	Archaeologically sterile						
247	235A	Ditch	29	Archaeologically sterile						
278	235B	Ditch	50							+
279		Ditch	51							+
280/281		Ditch	52				+			
258	235C	Ditch	32	Archaeologically sterile						
243	235D	Ditch	27	Archaeologically sterile						
239		Ditch (basal fill)	28	Archaeologically sterile						
268	235F	Ditch	47	Archaeologically sterile						
274	235E	Ditch	48	Archaeologically sterile						

Table 4 Composition of flots (+ rare; ++ occasional; +++common ; ++++ abundant; sf = small fragments (<5mm in diam), vsf = very small fragments (<2mm in diam))

Context no.	Fill of	Context description	Sample no.	Flot vol (ml)	Cereal grain		Heather charcoal	Wood charcoal		Coal	Cinders	Shale
					Quantity	Ident		Quantity	AMS			
037	036	Terminus (basal fill)	21	<10							+ (vsf)	+
056/057	055	Outer ditch terminus	4	10				+ (vitrified: vsf)		++	+ (vsf)	++
270	060B	North ditch inner enclosure	49	10	Archaeologically sterile							
282	060C	North ditch inner enclosure	53	10	Archaeologically sterile							
064	082	Ditch on outer circuit	5	<10						++		++
103	100	Inner ditch terminus	7	<10				+ (vitrified: vsf)		++	+ (vsf)	++
109		West terminus edge	10	<10						+ (vsf)		
108	105	Inner ditch terminus (upper fill)	9	<10				+ (vsf)		+	+ (vsf)	+
151		Inner ditch terminus (secondary fill)	17	10								++
106		Inner ditch terminus (basal fill)	8	10				+ (sf)		+		++
152		Inner ditch terminus (basal fill?)	18	10								++

Table 4 *cont*

Context no.	Fill of	Context description	Sample no.	Flot vol (ml)	Cereal grain		Heather charcoal	Wood charcoal		Coal	Cinders	Shale
					Quantity	Ident		Quantity	AMS			
112	111	Inner circuit	11	<10				+ (vsf)				+
112		Inner circuit	12	10				+ (vsf)				++
126		Inner circuit	16	<10	Archaeologically sterile							
147	115	Inner circuit	19	10								++
115		Inner circuit (basal fill)	13	<10				+ (vsf)				
114		Inner circuit (basal fill)	15	<10								+
159	115C	Post hole	20	<10	Archaeologically sterile							
167	164	Possible post hole	22	10							+	++
165	166	Possible pit or post hole	23	30	+	Barley indet × 2 Cereal indet × 1	+ (vsf)	+++	Yes	+		+
264	174A	Inner ditch	46	<10	Archaeologically sterile							
208	174C	Inner ditch (basal fill)	25	10				+ (vsf)				++
296		Inner ditch	54	10	Archaeologically sterile							
195/220	174F	Inner ditch	26	10						+ (vsf)		++
249	174G	Inner ditch	30	<10			+ (sf)					+
262	174H	Inner ditch	44	<10	Archaeologically sterile							
259/260		Inner ditch	45	<10	Archaeologically sterile							
247	235A	Ditch	29	10						+ (vsf)		++

Table 4 *cont*

Context no.	Fill of	Context description	Sample no.	Flot vol (ml)	Cereal grain Quantity	Cereal grain Ident	Heather charcoal	Wood charcoal Quantity	Wood charcoal AMS	Coal	Cinders	Shale
278	235B	Ditch	50	<10	Archaeologically sterile							
279		Ditch	51	20	Archaeologically sterile							
280/281		Ditch	52	10	Archaeologically sterile							
258	235C	Ditch	32	<10								+
243	235D	Ditch	27	10				+ (vsf)				+
239		Ditch (basal fill)	28	10								++
268	235F	Ditch	47	10	Archaeologically sterile							
274	235E	Ditch	48	10	Archaeologically sterile							

silica, such as phytoliths. The charcoal content of the ditch fills was minimal and some of the charcoal was rounded. Roots had penetrated the upper contexts. The ditch fills contained, in varying amounts, iron oxide mottles, nodules and hypo-coatings, indicative of repeated episodes of wetting and drying. Similarly the presence of clay, dusty clayey and silt coatings are indicative of clay illuviation by water moving down through the soil profile.

5.4.1.2 Summary description: outer ditch

The outer ditch fills were all apedal and comprised, from the base upwards, moderately sorted sandy clay and clay loam. The lowermost deposits (C020) had massive microstructures while the middle and upper fills (Contexts 019, 018, 009) had a channel microstructure, a consequence of post-depositional bioturbation. Laminations were observed only in the basal fill. As with the inner ditch fills, the mineral content of the sampled contexts was dominated by sub-rounded to rounded quartz grains, with a few grains of plagioclase feldspar and rock fragments from a wide range of lithologies; there was a decrease in the amount of rock fragments up the profile. Fragmentary phytoliths are common-to-frequent in all but the uppermost ditch fill. The charcoal content of the ditch fills was minimal and some of the charcoal was rounded. All the contexts had been affected by the impregnation of iron oxides and all had clay and dusty clay coatings.

5.4.2 Discussion

The inner ditch fills show a general decrease in grain-size up the profile. The primary fill was eroded into the ditch under natural forces such as gravity and rain run-off. The sharp boundary between the poorly sorted lower portion of Context 243 and the overlying clay laminations is indicative of a sudden change in weather conditions, such as a series of cloud bursts resulting in increased surface run-off. The mineral component of the ditch fill reflects the content of the unconsolidated sediments of the local area. Many of the larger fragments were rounded, indicating that they had been incorporated by wind action or at least had been within the sediment for some period of time. The source of the charcoal is not known, but the quantities are too small to indicate the deliberate incorporation of hearth ashes or midden material into the ditch. The inclusion of fragmentary biogenic silica in all the ditch fills demonstrates the long-term presence of grasses (in the broadest sense); it is thought unlikely that the biogenic silica is residual hearth ash or domestic waste as there are no other indicators (micromorphological or other (see 5.3 'Archaeobotanical analysis')) that such material had been incorporated. All the inner ditch contexts have been reworked by the actions of soil biota which has largely destroyed the original sedimentary fabric. The bioturbation of the whole ditch profile suggests that the ditch filled up gradually; it does not appear to have been deliberately backfilled at any point. The whole ditch profile has been subjected to episodes of wetting and drying and these probably reflect seasonal fluctuations in the water table.

The outer ditch shows a decrease in grain-size up the profile, a consequence of it silting up under natural agencies such as gravity, wind and water. The primary fill (C020) accumulated at the base of the ditch in a series of erosional events, each capped by a thin layer of clay which settled out of suspension within a pool or puddle at the base of the ditch. Grassland immediate to the outer ditch is indicated by the relatively large content of fragmentary phytoliths. The minimal charcoal content indicates some localised burning, although the type and source of the burning is not known. In common with the inner ditch the domination of a channel microstructure in the middle and upper fills indicates that these sediments accumulated relatively slowly; unfortunately the bioturbation has destroyed the original fabric. The outer ditch has also been subject to episodes of wetting and drying.

5.4.3 Summary conclusions

The soil thin section analysis has shown that the outer and inner ditches silted up gradually and by natural means; they do not appear to have been deliberately backfilled. The fills of both of these ditches are derived from re-deposited upcast as well as eroding soil, and there are no definitive anthropic inclusions. With regard to the local environment, the relatively large proportion of phytoliths in the outer ditch fills indicates that there was grassland adjacent to the site.

5.5 Soil geo-archaeological analysis

Mike Cressey

Soil samples were retained from the same positions as the Kubiena tins processed for soil micromorphology within the inner and outer ditch fills, and were subjected to laboratory analysis to determine their remnant magnetic susceptibility (χ), percentage organic carbon, and soil pH. The work was carried out to support the soil micromorphology analysis (see 5.4 'Soil micromorphology') and to assess whether the ditch fills had received any anthropogenically derived fire residues, including ash or charcoal, that had decayed as a result of soil taphonomy.

Field sampling methodologies followed modified English Heritage (2007 and 2011) standards on sediment sampling. The soil samples were submitted to the Department of Biological & Environmental Sciences, University of Stirling for analysis. Samples for remnant magnetic susceptibility were measured using a Bartington Instruments MS2 and MS2B Dual Frequency Sensor. Soil pH was measured by a Hannah instruments laboratory bench pH meter, calibrated using pH 7 and 4 buffer solutions and normalised for room temperature. Percentage organic matter (%OM) was obtained by ignition in a muffle furnace to provide an estimate of the mineral content of the sample. Table 5 lists the results obtained from the laboratory analysis. The geological background of the site is discussed in 2.1 'Location, topography and geology' above.

5.5.1 Inner ditch fills

5.5.1.1 Magnetic susceptibility

The results of mass magnetic susceptibility on six samples provided fairly variable results ranging from between χ 10 × 10^{-3}SI units and χ 28 × 10^{-3}SI units and provided an average value of χ 19.6 × 10^{-3}SI units. The basal fills appear to be magnetically enhanced with values in the order of between 28 and 14 × 10^{-3}SI units. The higher basal values are possibly attributable to the increase in soluble magnetic iron (Fe) hydroxides that have percolated down through the ditch fill profile. The upper fills have slightly lower χ values, presumably due to a loss of Fe. One sample (Sample 3) returned a value of 573 × 10^{-3}SI units, which

Table 5 Soils analysis values for Magnetic Specific Susceptibility (Mag Sus), % LOI and soil pH (*values have not been included in the average)

Location	Sample position and context	Mag Sus (10^{-3} SI units)	% LOI	Soil pH
Inner ditch	Middle of tin C243	14.98	6.24	6.67
	S34 (C236) middle of tin	10.94	6.56	
	C241 top of tin	11.72	6.12	6.67
	C237 base of tin	11.03	6.45	
	C242 top of tin	15.28	5.15	
	C243 base of tin	28.02	6.03	
	C236 base sample			6.65
	Mean	**19.65**	**7.24**	**6.66**
Outer ditch	S1.1 base	73.79	5.23	7.1
	S1 30cm from base	20.20	5.66	
	S1 37cm from base	17.61	3.83	
	S1 46cm from base	112.00*	4.62	
	S2 4cm from base	13.37	4.39	
	S2 25cm from base	8.22	5.91	
	S2 45cm from base	28.90	5.91	
	S3 3cm from base	12.30	6.02	
	S3 12cm from base	573.30*	6.82	
	S3 21cm from base	46.61	5.68	
	S3.1 top of profile			6.73
	Mean	**14.83**	**12.57**	**6.9**

is highly anomalous and can only be explained by a very locally rich concentration of Fe. The ditch fills appear not to have been the recipient of burnt material (ash/charcoal), which would have manifested in both visible soil rubification with a coincident increase or enhancement of remnant soil magnetism values.

5.5.1.2 LOI

Loss on ignition values are all consistent with a mean of 7.2% OM, which is very low and emphasises the minerogenic nature (92%) of the fills.

5.5.1.3 pH

An average pH value of 6.6 was attained from the three samples tested. The results confirm that the soils are slightly acidic and sufficient to have led to the loss of bone. The pH value of the soil is due to the fairly high iron content of the fills.

5.5.2 Outer ditch fills

5.5.2.1 Magnetic susceptibility

The results of mass magnetic susceptibility on six samples provided fairly variable results ranging from between χ 4.6 and 176 × 10^{-3}SI units and provided an average value of χ 14.8 × 10^{-3}SI units. An anomalous value of 573.3 was obtained from Sample 3 (12cm from the base of the tin). This value is considered to be anomalous and possibly the result of high levels of Fe or super-enhancement caused by ferro-magnetic material of volcanic origin within the soil. Enhancement by ash/burning incorporated in the fill can be ruled out. In general the lower down the profile, the higher the χ values. As noted with the inner ditch fill, the outer ditch basal fills tend to have an increase in remnant magnetic susceptibility for reasons explained above. The potential for this increase may also lie in the proximity of the water table that will promote increased Fe enhancement in the REDOX zone.

5.5.2.2 LOI

The percentage LOI values (mean 12.5% OM) for the outer ditch are the same as in the inner ditch and show the fills are inorganic (87%).

5.5.2.3 pH

An average pH value of 6.9 was obtained from the two samples tested.

5.5.3 Conclusion

The results of the magnetic susceptibility confirm that there is a general trend for an increase in natural remnant magnetic susceptibility enhancement towards the base of the inner and outer ditch profiles associated with the translocation of iron hydroxides down through the relatively free-draining fills. The high water table and the increase in soil REDOX potential close to the base of the ditches is also an influencing factor on higher χ values. The loss on ignition values confirm the soils are inorganic (*c* 80–90% mineral), while the soil pH confirms the fills are acidic as a result of the high iron content within the fills and the nature of the underlying natural soil.

The results confirm the presence of weak iron oxides in the clay-rich ditch fills. Importantly, the results also confirm that both ditches have received no anthropogenic derived material such as fire residue (ash and charcoal) that would have otherwise increased the presence of highly magnetic oxides through burning (Thompson & Oldfield 1986; Gale & Hoare 1991; Crowther 2003).