Rural Life, Roman Ways? Examination of Late Iron Age to Late Romano-British Burial Practice and Mobility at Dog Hole Cave, Cumbria

By HANNAH J. O'REGAN, KEITH BLAND, JANE EVANS, MATILDA HOLMES, KIRSTY MCLEOD, ROBERT PHILPOTT, IAN SMITH, JOHN THORP and DAVID M. WILKINSON

Supplementary material

This supplementary information file provides further detail on the excavation, small finds, zooarchaeology, human osteology, taphonomy and palaeoenvironment of Dog Hole cave, including individual finds descriptions (Philpott), osteological methodologies and analyses (Holmes, McLeod, O'Regan), isotope methodology (Evans) and trace element analysis (Chenery). All authors contributed to the interpretation and writing of the main paper.

Where figures or tables in the main text are referred to, they are denoted MT, and those in the supplementary information are prefixed S.

The following authors were responsible for analyses and reports:
Small finds. Analysis and report: Philpott
Zooarchaeology. Main chamber analysis: O'Regan and Holmes. 2010-11 excavation analysis: Holmes. Report: Holmes
Human osteology. Main chamber analysis: O'Regan and McLeod. 2010-11 excavation analysis: McLeod. Report: O'Regan and McLeod

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1. General information on the site and excavation

The name 'Dog Hole' for the site is relatively recent, as Jackson notes that the site was called 'The Fairy Hole',[1] while Benson and Bland[2] state that it had been known as the 'The Dog Hole' since Jackson's excavations. Jackson identified a large number of dog remains from his excavation, which may have led to the name 'Dog Hole' being applied.[3] Interestingly, Benson and Bland found the complete skeleton of a dog in a limestone gryke near the cave during their excavations in the 1950s, perhaps suggesting some local memory of the shaft being used to deposit dogs, or that the recent name change had inspired someone to bury their dog nearby.

Dog Hole has been excavated at least three times, by J. Wilfrid Jackson in 1912,[4] by Benson, Bland and colleagues in the late 1950s[5] and by the current authors in 2010-11. A full description of the excavations up until 2010 can be found in Wilkinson *et al*.[6] These excavations removed different parts of the deposit, with Jackson excavating the shaft, Benson and Bland excavating the main chamber, and O'Regan *et al*. excavating the north shaft (Fig. 2MT, Fig. S1). Each of these has provided slightly different evidence for the usage of the site in different periods. We have described the evidence for these in the main paper, so here we discuss aspects of our excavation of the north shaft, including descriptions of the sediments, with photographs as appropriate.

The top of the north shaft at the beginning of the excavation was filled with branches, leaves and rubbish that had been washed or dropped in from above. Despite having a protective grill across the entrance, items as large as a fence post and car tyre had been deposited in it. The grill was added in the early 1980s, but it had been cut through on at least one subsequent occasion[7]. The topmost layers were termed 'modern debris' and were removed and checked for archaeology on the surface before disposal (Fig. S2). Below these were further unconsolidated layers which were termed 'context 1' and 'context 2'. These were also checked on the surface before disposal. Once we were down at the level of the shoring that was being replaced, the site datum was placed, and the site divided into three sections (A, B and C as shown in Fig. 3MT). The wet, plastic and highly clastic sediment was difficult to trowel. Therefore, while large items were identified and excavated in situ, all clasts and sediment was taken to the surface and washed or wet sieved through ~1mm kitchen sieves on the surface to facilitate recovery. This process, while extremely time-

[1] Jackson 1913, 262.

[2] Benson and Bland 1963, 61.

[3] Benson and Bland 1963.

[4] Jackson 1913.

[5] Benson and Bland 1963.

[6] Wilkinson *et al.* 2011.

[7] Wilkinson *et al.* 2011.

consuming (especially picking residues), allowed the recovery of very small items, e.g. one of the largest bead assemblages from a cave in Britain. The excavation proceeded in approximately 20cm spits from this point.

Layers 1 and 2 were behind the original cavers' shoring which we replaced. Layer 1 (i.e. A1, B1, C1) largely contained small fragmented pieces of bone and recent debris such as crisp packets and buttons from clothing. Below this was a layer of very large clasts (Layer 2 (i.e. A2, B2, C2)) to a depth of approximately 70cm. These two layers together were interpreted as the spoil of the previous cave diggers who had excavated the north shaft, having put up the shoring, they then infilled behind it with the debris as they excavated it. Below Layer 2 appeared to be more *in-situ* archaeology, containing quantities of larger bones including human remains (e.g. see Fig. 6MT).

In Layers 3 and 4 a void appeared in column A and little was recorded from A3 and A4. Otherwise Layers 3, 4 and 5 were all similar with a mixture of larger and smaller bones interspersed between clasts. The only piece of identifiable Roman pottery, a piece of black burnished ware, came from C5. A change was noted at the base of Layer 5 (i.e. A5, B5, C5) with an increasing quantity of charcoal and calcined bone in the deposit, making it appear black. This thin layer was termed the Charcoal Rich Layer (CRL, also known as Context 4) and spread across the excavation area. It was excavated and kept separate, before Layer 6 was excavated below. At the same time, a step was cut into the lower sediments, some 60cm from the shoring, to prevent trampling damage to the archaeology below. The step was cut to 50cm deep and the material taken out in ~20cm spits, and labelled Step 1, Step 2 and Step 3. The material recovered from these steps was a mixture of Romano-British artefacts, bones and modern debris, suggesting that some was *in situ*, and some had been washed down the shaft after it had been excavated by the original cavers. The excavation in 2010 ended with the excavation of Layer 6.

Layers 7 to 10 were excavated in 2011. Column C petered out at the base of Layer 6, as the shaft widened to the east and narrowed to the west. The area where it widened was designated column AA, which began in Layer 7. Column B petered out in Layer 7, leaving the excavation (and concentrating the archaeology) into columns AA and A for Layers 8 to 10. A further 'step' was cut in Layers 9 and 10 to allow excavation to proceed comfortably, and three copper-alloy artefacts were found (see Small finds catalogue below). At the base of the site the partial articulated horse was recovered, with a fragment of human neonatal cranium lying beneath it, and another adhering to the vertebrae. The site was closed after excavation of this layer. The material collected at the base was labelled as 'clean-up of passage', as it led into the small dead-end chamber that was identified in 2010. This chamber is entered by a 'squeeze' and our limited exploration suggested that the only archaeology was late 20th-century bottles and cans left by previous cavers.[8]

It is important to note that despite three excavations, only part of the sediment in Dog Hole has been excavated. It is very likely that more archaeology is present, particularly behind the shoring, but also potentially below Layer 10. Note also that although we describe our excavation as the north shaft it is not obvious if this would still be a shaft if the cave was emptied of fill, or if it would just be a continuation of the large main chamber.

[8] see Wilkinson *et al.* 2011 for more details.

Section S1 Figures

Fig S1. Views within Dog Hole. A) view up the main shaft from directly below the entrance. B) View into the main cave, taken from the same position as A. C) view down the north shaft, showing shoring and excavation of the lower levels.

Fig S2. Modern debris at the top of the north shaft, including a recent pheasant bone, branches and leaves.

2.0 Small finds description and catalogue

Report by Robert Philpott

2.1 Introduction

As detailed in the main paper, the majority of the finds assemblage is Roman in date and falls into a narrow range of categories: personal ornaments (beads, bracelets, an ear-ring and a finger-ring), footwear (hobnails) and pottery (small fragments only). See the finds catalogue (Table S1) for a full description of the items, along with their precise location within the cave.

2.2. Roman Finds

2.2.1 Personal Ornaments

2.2.1.1. Beads

There are up to 193 complete or fragmentary beads, the uncertainty arising from the fact that some broken bead fragments may belong together. The beads fall into nine types, of which eight are glass and the ninth jet or shale.

Type 1. Translucent wound glass beads of identical mid-blue colour, varying only slightly in size (most are from 4.0-5.0mm in diameter, and 3.0-4.0mm in height) and in precise form. Most have a slightly tapering form, effectively creating a rounded conical shape, though a few are a little more irregular; a few are squatter (e.g. SF51, SF95), and annular in shape (e.g. SF160) and there is one broader and eccentric example (SF53). Many have very fine spiral striations on the surface, typical of the core-wound manufacturing technique (e.g. SF39). They belong to Guido's Group 7iv, consisting of 'medium and small blue translucent and opaque globular beads'. Guido defines the class of globular beads as those whose height is more than half their diameter[9]. The Dog Hole Cave examples show some variety of shape and size in detail, but appear to form part of a single batch, and are likely to have formed part of the same necklace. Unlike Type 3 beads, or light green examples, these beads are in very good condition with no pitting on the surface. There are 87 examples in total (SF2-5, 7-17, 19, 21, 22, 24, 25, 39, 43-45, 49-58, 60, 61, 63, 64, 68-70, 75, 76, 83, 84, 94, 95, 99, 100, 103, 105, 114-116, 135, 139, 154-156, 160-162, 166, 167, 171, 172, 174-182, 184-187, 72).

[9] Guido 1978, 69.

Guido observes this is a common and very long-lived form, appearing before the Roman conquest and continuing into the post-Roman period.[10] There are numerous parallels for these beads, with examples recorded in the North West at Brougham, where despite a slightly flattened profile, they are called 'spherical',[11] and in Wales from Coygan Camp[12], where they are slightly irregular in thickness.

2. Very small pale green glass wound bead of globular/spherical form, often in poor condition with pitted and decayed surfaces, e.g. SF20, SF 66, SF67, SF82 and SF163. Examples such as SF82 and SF163 have a slightly ribbed surface. The size ranges from 1.0-2.5mm in diameter, and most measure about 3.0 mm in height. They belong to Guido's Group 7ii, defined as 'medium and small globular beads in natural greenish translucent glass' and the related Group 6iib of 'small annular beads' of similar glass. Guido considered that the great majority of beads of this type are of Roman date and they were made throughout the Roman period.[13]

3. Thin-walled beads in mid to dark blue translucent glass, spherical but ranging in size from tiny to very small. Examples where the central hole is large (due to the small size of the beads) appear more annular than globular (e.g. SF31, 106-109). They belong to Guido's Group 7. The slightly larger examples have thicker walls. For example, SF69 and SF68 are very small dark blue spherical examples measuring in diameter up to about 3mm and 2mm in height (e.g. SF37, SF59). Very small annular examples include SF105-109, SF77-81, SF85-93, SF96, SF101, SF104, SF106-112, SF117-121, SF123-134, SF136-138, SF143-149, SF153, SF159, SF164, SF169, SF170, SF189-195.

4. Elongated drawn cylindrical beads in pale green slightly translucent glass, with clear longitudinal striations caused by the drawing process. Guido remarks that these beads appear throughout the Roman period in Britain and into post-Roman period, but they reach their maximum popularity in Britain after the third century A.D.[14] There are two examples (SF65 and SF142), the latter being the only complete example at 7.5mm long and 3.5mm in diameter. The prominent surface striations may be due to differential etching of the surface through decay.

5. 'Gold-in-glass' beads consisting of two conjoined elongated ovoid segments in clear glass with gold leaf interior (SF30, SF113). An example from the 1957 excavations had the same

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[10] Guido 1978, 70.

[11] Cool 2004, 206, fig. 4., 206, 8.

[12] Charlesworth 1967, 187, fig. 49, 12.

[13] Guido 1978, 66, 69.

[14] Guido., 1978, 95.

elongated double ovoid form.[15] The unusual form of the latter type led Boon to consider that it might be post-Roman in date.[16]

6. Clear yellowish tinged glass beads with a globular body, roughly broken off collars, and distinct ribbing on the surface. There are three examples of the standard globular type (SF158, 157, 188);[17] there are slight surviving traces of gold-coloured metal in SF157.

Together types 5 and 6 show that there are five examples of gold-in-glass beads from Dog Hole Cave, of two different types. Gold-in-glass beads have been extensively discussed.[18] See main text for discussion of these types.

7. A very small cylindrical bead, in dark amber glass, translucent, wound (SF150) measuring 2mm in height and 2mm in diameter. A single example is present. Guido[19] notes that short cylindrical glass beads in colours other than blue or green are rare in Roman Britain.

8. Small cylindrical segmented beads, in opaque black highly polished jet or shale, with a consistent diameter of about 6mm, and of Romano-British date. Of the 13 examples, one has a single segment (SF98), 10 have two (SF40, SF42, SF62, SF71, SF72, SF74, SF151, SF152, SF173, SF183), and there are two examples with three segments (SF97, SF168). For similar examples in glass, see Guido.[20] The end of the beads are often concave with a matte finish, and in one or two cases the other end may be polished, demonstrating the end of the longer jet cylinder before lathe turning to add the segmental grooves. In SF42, the ends have fine parallel saw or file marks. It is not possible to distinguish between jet and shale without scientific analysis, as some types of shale take a high polish like jet.[21]

Eight and a half 'jet' beads were recovered from excavations in 1957,[22] of which 6½ examples were of the same simple segmented type present in the 2010-11 excavations.

Bead discussion

[15] Benson and Bland 1963, no XIV, fig 11.

[16] Boon 1977, 199.

[17] Illustrated by Boon 1977, fig. 1.1; Guido 1978, 93-94, fig. 37, no 3.

[18] Boon 1977; Guido 1979; Cool 2004; Cool 2010; Eckardt 2014, 45-50, fig. 2.7.

[19] Guido 1978, 96.

[20] Guido 1978, 91-93.

[21] Allason-Jones and Miket 1984, 302; Eckardt 2014, 109.

[22] Benson and Bland 1963, 66.

The excavations in 2010-11 recovered up to 193 beads of glass and jet or shale, to which should be added at least another 40 examples found in 1957.[23] Most of the beads recovered were types current in the Roman period (Table 7MT). In Roman Britain beads were commonly strung as necklaces or bracelets on leather, fibre thread or copper-alloy wire. Necklaces as a type of personal ornament become more popular in the later Roman period.[24] The practice of depositing necklaces as grave furniture with female or adolescent burials in Roman Britain provides a means of assessing their composition, including the type of beads present and their numbers. One of the largest groups was recorded at the Lankhills cemetery, Winchester, where of the 24 accompanying fourth-century inhumation burials, some individual necklaces were strung with upwards of 100 beads. Necklace 85, for example, has about 165 small beads of six main types. A few burials at Lankhills had multiple necklaces; Grave 336 had four sets of beads, three at the neck, and one at the feet.[25] At another large late Roman cemetery, Poundbury, Dorchester five women and adolescent females were buried with necklaces, including 'jet' cylindrical transverse grooved beads identical to those from Dog Hole Cave, though a little narrower in diameter at *c.* 5mm on average.[26]

Hilary Cool's discussion of the deposition of bead necklaces with cremations and inhumation in Roman Britain shows that of the numerous later second- and third-century cremations known in southern Britain, few have beads. In most of these cases, the beads were not pyre goods but placed in the graves unburnt. In northern Britain, there are few burials containing beads that are contemporary with Brougham in the third century.[27] A single burnt glass bead was found in a burial at Trentholme Drive, York and one or two beads were found at Low Borrow Bridge in two infant cremation burials,[28] while beads are absent from cemeteries at Lanchester or Petty Knowes. As a result Cool suggests that the habit of dressing women for burial, which was frequent at Brougham, appears to be an unusual occurrence overall in third-century Britain.[29]

The late Roman practice of wearing individual necklaces strung with several types of bead as evidenced in cemeteries suggests that the assemblage of nearly 200 beads from Dog Hole Cave may represent at a minimum no more than the contents of two necklaces, with these very small beads dispersed through the cave deposits through post-deposition disturbance.

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[23] Benson and Bland 1963, 65-66.

[24] Cool 1983, 297.

[25] Guido 1979.

[26] Guido and Mills 1993, 102, fig. 71, nos 13-16.

[27] Cool 2004, 18.

[28] Cool 2004, 390.

[29] Cool 2004, 390.

2.2.1.2 Metal Jewellery
See main text for description and discussion of bracelets, finger-rings and the earring.

2.2.1.3. Footwear
See main text for discussion of hobnails.

2.2.1.4 Other Iron Objects
Besides hobnails, there is a small quantity of other iron objects. Identification is not always certain due to corrosion and breakage. Several objects take the form of circular-sectioned wire (SF196, 203, 204, 205, 208, 209, 223, 237, 255), and may be fragments of pins or needles. One object (SF203) with a pointed end and shank that curves gently towards an irregularly swelling head suggesting that it is a pin. Another probable needle or pin is SF204/205, which also has a pointed end and narrow circular shank. However, the absence of ends in most cases makes it difficult to be certain and some of these items may be modern. One uncertain item (SF258) is a curved iron object, of possible D-shaped section. It could be the curved bow of a brooch or an iron bracelet fragment, but again the lack of diagnostic terminals makes it impossible to be certain.

2.2.1.5. Pottery
See main text for description and discussion.

2.2.2. Context of deposition
A number of finds recovered by Benson and Bland[30] closely parallel, either in general type or in precise form, those recovered subsequently, including a gold-in-glass bead, 'jet' (or shale) beads, blue glass beads, bracelets, and hobnails. The finds from the 1957 excavation are considered here along with the finds from the 2010-11 investigations.

Due to later disturbance, the original context of deposition of both the Romano-British artefacts and of the large group of human remains is uncertain. It is not possible to determine with certainty whether the skeletal remains were interments buried in graves within the cave or were casual deposits. However, some of the classes of artefact present were frequently used as grave furniture to accompany the dead in the later Roman period, raising the possibility that some, if not all, were formal burials. The close association of some Roman finds and the human and animal remains was explicitly recorded by Benson and Bland,[31] who noted that 'four bronze bracelets … were found in the northern part of the cave, intermingled with both animal and human skeletal material. Also associated with these were a whetstone and a blue-glass bead. Sometime later, an iron penannular brooch

[30] Benson and Bland 1963.

[31] Benson and Bland 1963, 62.

and an iron axe-head were found similarly associated with the skeletal material'.[32] The nature of some of the finds, notably personal ornaments and hobnailed footwear, is consistent with burial items frequently deposited in graves. Furthermore, the datable bracelets can be assigned to the late third–fourth century, broadly contemporary with the adult human remains as determined by radiocarbon dating, two in the mid third to fourth century and one in the later third to fourth century.

A detailed examination of Romano-British burial practice suggests that some of the items found by Benson and Bland in the late 1950s are unlikely to represent grave furniture. Axe heads and whetstones are rarely found as grave goods in Roman burials, although occasional examples have been found[33], and a connection with craft activities within the cave may provide a context. The presence of possible needle or pin shafts in iron wire from the 2010-11 excavations, although not certainly Roman in date, has parallels in north-western burials. At Brougham two needles appear to have been heat-affected so had presumably passed through the pyre.[34] The two small pottery fragments found in 2010-11 do not appear to come from intact or near-complete vessels, the usual state in which pottery vessels were deposited with the dead in formal burial contexts.

The skeletal remains of at least 28 individuals were found at Dog Hole Cave. By the fourth century across Roman Britain, many inhumations were buried without grave furniture. It is conceivable that at a minimal interpretation the objects may represent no more than one female burial, the body having been buried wearing hobnailed shoes, multiple bracelets, perhaps a finger-ring, earrings and one or more necklaces. However, the number of bones showing evidence of staining suggests that items were deposited with more than one of the bodies, although the majority of the 28 burials were presumably unfurnished.

Little is known of Romano-British rural burial practice in north Lancashire-south Cumbria, as few burials have been excavated. The Roman cemeteries further north at Carlisle in the later Roman period have produced few graves which have been subject to adequate recording and investigation. One skeleton was furnished with 11 blue cylindrical glass beads on a gold wire.[35] Closer to Dog Hole Cave, a contracted inhumation burial under a mound at Heaves Fell, Beathwaite Green, Cumbria[36] had a blue bead, a brooch and ring in the grave[37], while a

[32] Benson and Bland 1963, 62.

[33] Philpott 1991, 186-187.

[34] Cool 2004, 393.

[35] Taylor and Collingwood 1926, 219.

[36] Hughes 1912, 400-401; Faull 1977, 27.

[37] Philpott 1991, 347.

finger-ring was found in an early Roman-period cist inhumation at Crosby Garrett, Cumbria[38].

2.3. Modern (20th-century) Finds

Modern finds from Dog Hole Cave include a Morse code tapper with a resin or plastic knob and base, found in B5 (SF269), a penknife with mother of pearl handle from C2 (SF270), and five metal rivets with split shafts (SF265, 268, 271-273), of a type which usually decorated clothing, several retaining a small portion of a thick fibrous textile (not analysed) preserved in the ground by contact with the metal. The Conservation report suggested that the metal of rivet SF265 'may be made from an aluminium alloy, judging by the white granular corrosion products present over a darker grey surface'.[39] A copper-alloy cylindrical band (SF262) also appears to be a modern object.

Other material is likely to be modern but there are no diagnostic characteristics, particularly in the case of the iron, which is both fragmentary and heavily corroded. Several broken sections of iron 'wire' may be Roman pin or needle shafts, but a later date is possible, and the thin iron sheet may also be modern. The context information is crucial in the absence of other diagnostic criteria for dating, and the presence of other late material will raise the probability of this material being recent.

Section 2: Table

SF no	Context	Description	Dimensions (mm)	Material	Type
	Dog Hole 2011 – A7 1.40m below datum	Three tiny thin flakes of iron, of indeterminate function, undiagnostic		Iron	
1	C4/C6	Type 1 bead. Pale-mid blue glass bead, truncated conical form, fragment, wound manufacture D of hole 1.5mm,	H 3.5 D 6+, T2.5+	Glass	Bead
2	Dog Hole 2011 A9B -1.50—1.60m a)	Type 1 bead. pale-mid blue glass bead , truncated conical form, wound manufacture	H 3.0 D 4.5 D of hole 2.0mm	Glass	Bead
3	Dog Hole 2011 A9B -1.50—1.60m b)	Type 1 bead. pale-mid blue glass, truncated conical form, wound manufacture,	H 4.0 D 4.5 D of hole 1.0mm	Glass	Bead
4	Dog Hole AA8 21/07/2011	Type 1 bead, pale-mid blue glass, rounded cylindrical form	H 4.0 D 4.5 D of hole 2.0mm	Glass	Bead
5	Dog Hole AA8 20.07.11	Type 1 bead. pale-mid blue, wound bead, rounded conical form hole	H 4.0 D 4.5 D 2.5mm	Glass	Bead

[38] Whimster 1981, 169.

[39] S. Newman, unpub.

6	Dog Hole AA8 20.07.11	Small disc [this is of uncertain material; it could just be a small copy of a coin (a minim) but there is no obvious visible design, and it is more likely a small natural pebble]	T 1.5 D 5.0	Uncertain	Uncertain
7	Dog Hole 2011 AA8 [3 beads]	Type 1 Bead of pale-mid blue colour, wound, with trace of molten glass adhering to top.	H 4.0 D 4.5 D hole 2.5	Glass	Bead
8	Dog Hole 2011 AA8 [3 beads]	Type 1 bead of pale-mid blue colour, wound, cylindrical with rounded top	H 4.0 D 4.5 D hole 2.0	Glass	Bead
9	Dog Hole 2011 AA8	Type 1 bead of pale-mid blue colour, wound, cylindrical with rounded top	H 4.0 D 4.5 D hole 2.5	Glass	Bead
10	Dog Hole 2011 A8	Type 1, pale-mid blue colour, wound; disc form, slight taper towards top	H 3.0 D 5.0 D hole 2.0	Glass	Bead
11	Dog Hole 2011 A8	Type 1, pale-mid blue colour, wound; rounded conical form, tapering toward top	H 3 D 4.5	Glass	Bead
12	Dog Hole 2011 A8	Type 1, pale-mid blue colour, wound; rounded conical form, tapering toward top	H 3.5 D 4.5	Glass	Bead
13	Dog Hole 2011 A8	Type 1, pale-mid blue colour, wound; rounded conical form, tapering toward top	H 3.5 D 4.5	Glass	Bead
14	Dog Hole 2011 A8	Type 1, pale-mid blue colour, wound; rounded conical form, tapering toward top	H 3.5 D 4.5	Glass	Bead
15	Dog Hole 2011 A8	Type 1, pale-mid blue colour, wound; rounded conical form, tapering toward top	H 3.0 D 4.0 D of hole 1.5	Glass	Bead
16	Dog Hole 2011 A8	Type 1, pale-mid blue colour, wound; rounded conical form, tapering toward top	H 4.0 D 4.5	Glass	Bead
17	Dog Hole 2011 A8	Type 1, pale-mid blue colour, wound; rounded conical form, tapering toward top	H 4.0 D 5.0	Glass	Bead
18	Dog Hole 2011 AA7 -120 to -135	Type 3 very small globular dark blue glass bead, wound, pitted surface	H 2.5 D 3.0 D of hole 1.5	Glass	Bead
19	Dog Hole 20/10 C4	Type 1 bead. pale-mid blue colour, wound; rounded conical form, tapering toward top, flaw in body in moulding	H 3.0 D 4.5 D hole 2.0	Glass	Bead
20	Dog Hole 2011 AA8 21.7.11	Type 2 bead. Very small fine bead, in pale green translucent glass, with traces of ribbed due to decay, surface pitted	H 2.5 D 3.0 D of hole 2.0	Glass	Bead
21	Dog Hole 2011 AA8 21.7.11	Type 1 Small glass bead pale-mid blue colour, wound; rounded conical form, tapering toward top, broken in two parts	H 3.0 D 5.0 D of hole 2.0	Glass	Bead
22	Dog Hole 2011 A9b -1.75m 80-90cm ENE, 40-50cm NNW	Type 1 small mid blue glass bead,	H 3.0 D 4.5 D hole 2.0	Glass	Bead
23	Dog Hole 2011 A9b -1.55 – 1.60m	Type 3 Very small translucent mid blue bead, spherical/globular, wound	H 2.0 D 3.0, D hole 0.5	Glass	Bead

24	Dog Hole 2011 A7 -1.35m 18/07/2011	Type 1	H 3.5 D 5.0, D hole 2.0	Glass	Bead
25	Dog Hole 2011 A7 -1.35m 18/07/2011	Type 1	H 3.5 D 4.5, hole 1.0	Glass	Bead
26	Dog Hole 2011 A7 -1.35m 18/07/2011	Type 3 – more annular than globular, but pale-mid blue glass, pitted	H 2.0 D 3.0, hole 1.5	Glass	Bead
27	Dog Hole 2011 A7 -1.35m 18/07/2011	Type 3 – more annular than globular, but pale-mid blue glass, pitted	H 2.0 D 3.0, hole 1.5	Glass	Bead
28	Dog Hole 2011 A7 -1.35m 18/07/2011	Type 3 – more annular than globular, but pale-mid blue glass, pitted	H 2.0 D 3.0, hole 1.5	Glass	Bead
29	Dog Hole 2011 A7 -1.35m 18/07/2011	Type 3 – as above	H 2.0 D 3.0, hole 1.5	Glass	Bead
30	Dog Hole 2011 A7 -1.35m 18/07/2011	Type 5. Very fragmentary remains of clear glass bead – with traces of gold – one element is an elongated ovoid, with ribbing in the glass	H - D -	Glass	Bead
31	Dog Hole 2011 A9c 1.60m	Type 3 Annular version, mid blue, pitted surface	H 2.0 D 3.0, hole 1.5	Glass	Bead
32	Dog Hole 2011 A9c 1.55-1.60m BOD	Type 2, pale green translucent, bead, glob/annular, broken	H 1.0	Glass	Bead
33	Dog Hole 2011 A9c/A10c	?Type 2. tiny fragment of pale green translucent bead, broken	H 1.0 D -	Glass	Bead
34	Dog Hole 2011 A9b 10cm ENE 70cm NNW 1.67B.O.D.	Type 3. Very small pale blue bead, decayed and pitted surface, probably annular/spherical	H 1.5 D 3.0, hole 1.5	Glass	Bead
35	Dog Hole 2011 A9c -1.65m B.O.D.	Type 3. pitted surface, decayed annular/globular bead, pale blue translucent	H 2.0 D 3.0, hole 2.0	Glass	Bead
36	Dog Hole 2010 A6	Type 3. Very small mid blue spherical – slightly flattened base	H 2.0 D 3.0, hole 1.0	Glass	Bead
37	Dog Hole 2010 C3	Type 3. Very small dark blue opaque glass bead	H 2.0 D 3.0, hole 1.5	Glass	Bead
38	Dog Hole 2010 C3	Very small flake of buff ceramic with several prominent 1mm black subrounded mineral inclusions; this could be mortarium fabric? Wt 0.3g	L 12+ W 9 + T 3+	Ceramic	Pottery
39	Dog Hole C5	Type 1. Small wound mid blue glass bead, slightly tapering form, wound. This clearly shows the final spiral marks on surface of manufacture, demonstrating wound technique	H 4.0 D 4.5, hole 2.5	Glass	Bead
40	Dog Hole 2011 AA7 -1.20m to -1.35m 18.07.2011	Type 8. Small two-segmented cylindrical bead, opaque black jet	L 6.5 D 5.5, hole 2.5	Jet	Bead
41	Dog Hole 2011 AA7 -1.20m to -	Two small lumps of pale pinkish material – this appears to be mortar or plaster, larger very abraded and		Mortar?	Mortar

	1.35m 18.07.2011	rounded fragment has several small black subrounded mineral inclusions, other looks like calcareous non-anthropogenic ?lime deposit?			
42	Dog Hole 2011 AA10 -1.70 to -1.80m, 90cm-1.20m ENE; 0-70cm NNW	Type 8. Small two-segmented cylindrical bead, opaque black jet/shale	L 8.0 D 6.0, hole 3.0	Jet	Bead
43	Dog Hole 2011 AA10 -1.70 to -1.80m, 90cm-1.20m ENE; 0-70cm NNW	Type 1 mid blue	H 3.0 D 5.0, hole 2.0	Glass	Bead
44	Dog Hole 2011 AA10 -1.70 to -1.80m, 90cm-1.20m ENE; 0-70cm NNW	Type 1 mid blue	H 3.0 D 5.0, hole 2.0	Glass	Bead
45	Dog Hole 2011 AA10 -1.70 to -1.80m, 90cm-1.20m ENE; 0-70cm NNW	Type 1 mid blue	H 3.0 D 5.0, hole 2.0	Glass	Bead
46	Dog Hole 2011 AA10 -1.70 to -1.80m, 90cm-1.20m ENE; 0-70cm NNW	Type 3. Mid blue, translucent glass, very small bead	H 2.0 D 3.0, hole 1.5	Glass	Bead
47	Dog Hole 2011 AA10 -1.70 to -1.80m, 90cm-1.20m ENE; 0-70cm NNW	Type 3. Mid blue, translucent glass, As previous (no 46) but smaller	H 2.0 D 3.0, hole 1.5	Glass	Bead
48	Dog Hole 2011 AA10 -1.70 to -1.80m, 90cm-1.20m ENE; 0-70cm NNW	Type 2. pale green translucent, spherical, broken in half	H 3.0 D 5.0, hole 2.0	Glass	Bead
49	Dog Hole 2011 A9.b ‘step’ 1.65-1.70 B.O.D. 30-70cm ENE, 65-75cm NNW	Type 1. blue glass bead broken in half, tapering form	H 4.0 D -	Glass	Bead
50	Dog Hole 2011 AA10 90cm-120cm ENE 0-70cm NNW, -1.70-1.80m	Type 1. blue glass bead clear evidence of wound manufacture, irregular form;	H 4.0 D 4.5, hole 1.0	Glass	Bead
51	Dog Hole 2011 AA10 90cm-120cm ENE 0-70cm NNW, -1.70-1.80m	Type 1. blue glass bead squat/flattish example	H 2.5 D 4.5, hole 2.0	Glass	Bead

52	Dog Hole 2011 A7 -1.40	Type 1. near-spherical blue glass bead	H 3.0 D 5.0, hole 1.0	Glass	Bead
53	Dog Hole 2011 A7 -1.35m	Type 1 bead. off-centre hole, broad, flat example	H 3.0 D 5.0, hole 1.0	Glass	Bead
54	Dog Hole 2011 A7 -1.35m	Type 1 bead.	H 4.0 D 5.0, hole 1.0	Glass	Bead
55	Dog Hole 2011 A7 -1.35m	Type 1 bead.	H 3.0 D 5.0, hole 1.5	Glass	Bead
56	Dog Hole 2011 A7 -1.35m	Type 1 bead.	H 3.0 D 4.5, hole 2.0	Glass	Bead
57	Dog Hole 2011 A7 -1.35m	Type 1 bead.	H 3.0 D 4.5, hole 2.0	Glass	Bead
58	Dog Hole 2010 B3	Type 1. broken in half	H 2.0 D -	Glass	Bead
59	Dog Hole 2010 B3	Type 3 Dark blue, very small globular, with three areas of decay on surface, pitted surface, slightly translucent	H 3.0 D 3.5, hole 1.0	Glass	Bead
60	Dog Hole 2010 B2	Type 1 bead. Half of broken bead, conical form	H 4.0 D -	Glass	Bead
61	Dog Hole 2010 B1	Type 1 bead. tall cylindrical with rounded top and small projection of glass	H 3.5 D 5.0, hole 1.5	Glass	Bead
62	Dog Hole 2010 B4	Type 8. Small 2-segmented bead in black opaque jet; polished externally. Shallow U-shaped groove	H 7.0 D 5.0, hole 2.5	Jet	Bead
63	Dog Hole 2010 Interface B5 and Context 4	Type 1. rounded conical form	H 4.0 D 4.0, hole 1.5	Glass	Bead
64	Dog Hole 2011 AA8 – A8/7	Type 1. Truncated conical form	H 3.5 D 5.0, hole 2.0	Glass	Bead
65	Dog Hole 2011 A9b 'step' 1.65-1.70m, 30-70cm ENE, 65-75cm NNW	Type 4. Half of light green translucent drawn cylindrical bead; very marked parallel drawing marks in matrix	H 6.0 D 3.0, hole 1.5	Glass	Bead
66	Dog Hole 2011 A9b 'step' 1.65-1.70m, 30-70cm ENE, 65-75cm NNW	Type 2. Very small pale green translucent glass bead, spherical; pitted surface	H 2.0 D 2.5, hole 1.5	Glass	Bead
67	Dog Hole 2011 A9b 'step' 1.65-1.70m, 30-70cm ENE, 65-75cm NNW	Type 2. As above, penannular (through post-burial deterioration?)	H 2.0 D 2.5, hole 1.5	Glass	Bead
68	Dog Hole 2011 A9c 1.55-1.60 B.O.D.	Type 1. Very small dark blue translucent glass bead, globular /spherical form	H 2.0 D 3.0, hole 1.0	Glass	Bead
69	Dog Hole 2011 A9c, c. -1.65-1.70m	Type 1. As above, pitted surface	H 2.0 D 3.0, hole 1.0	Glass	Bead
70	Dog Hole C1	Type 1. mid blue, rounded conical form	H 3.0 D 5.0, hole 1.5	Glass	Bead
71	Dog Hole Lower C2	Type 8. Two-segmented cylindrical jet bead, one segment longer than other; polished to high gloss	H 8.0 D 5.5, hole 2.5	Jet	Bead

72	Dog Hole 2011 AA8	Type 1 bead. Rounded conical form	H 4.5 D 3.5 hole 2.0	Glass	Bead
73	Dog Hole C5	Small body sherd of Black-burnished 1 pottery (BB1), with trace of incised curving decoration. Undiagnostic form, external surface has area of mid brown surface, over black interior and exterior surfaces and dark grey core (dated broadly AD120-350/70) Wt 2.4g	L 26+ W 13+ T 6	Ceramic	Pottery
74	Dog Hole 2011 A8 20.07.11	Type 8. Segmented cylindrical jet bead, one segment longer than other; polished to high gloss; one end polished, other concave with matt finish	H 7.0 D 5.0, hole 2.5	Jet	Bead
75	Dog Hole 2011 A8 20.07.11	Type 1. rounded conical mid blue glass bead	H 3.0 D 4.5, hole 2.0	Glass	Bead
76	Dog Hole 2011 A8 20.07.11	Type 1. rounded conical mid blue glass bead	H 4.0 D 5.0, hole 1.5	Glass	Bead
77	Dog Hole 2011 A8 20.07.11	Type 3. Very small dark blue translucent glass bead, globular /spherical form	H 3.0 D 4.0, hole 1.0	Glass	Bead
78	Dog Hole 2011 A8 20.07.11	Type 3. Very small dark blue translucent glass bead, globular /spherical form	H 2.0 D 3.0, hole 1.5	Glass	Bead
79	Dog Hole 2011 A8 20.07.11	Type 3. Very small dark blue translucent glass bead, globular /spherical form	H 2.0 D 3.0, hole 2.0	Glass	Bead
80	Dog Hole 2011 A8 20.07.11	Type 3. Very small dark blue translucent glass bead, globular /spherical form	H 2.5 D 3.0, hole 1.5	Glass	Bead
81	Dog Hole 2011 A8 20.07.11	Type 3. Very small dark blue translucent glass bead, globular /spherical form	H 1.0 D 2.5, hole 1.0	Glass	Bead
82	Dog Hole 2011 A8 20.07.11	Type 2. Small translucent spherical light green glass bead with light ribbing on surface	H 2.0 D 3.0, hole 1.5	Glass	Bead
83	Dog Hole 2011 A7 -1.40m B.O.D.	Type 1. Rounded conical mid blue glass bead.	H 3.0 D 5.0, hole 1.0	Glass	Bead
84	Dog Hole 2010 Interface of C5 and B5 with context 4	Type 1. Rounded conical mid blue glass bead.	H 3.5 D 5.0, hole 2.0	Glass	Bead
85	Dog Hole 2011 A10g, 1.85-1.90 BOD, 80cm ENE, 80cm NNW	Type 3. Very small mid blue glass, v corroded and penannular, pitted surface; spherical? Globular (as Type 3 but lighter in colour than most examples)	H 1.5 D 3.0, hole 2.0	Glass	Bead
86	Dog Hole 2011 10 A. C. Clean up round house C1.80m BOD	Type 3. Very small mid blue globular/spherical translucent bead, pitted surface	H 2.0 D 3.0, hole 2.0	Glass	Bead
87	Dog Hole 2011 10 A. C. Clean up round house C1.80m BOD	Type 3. Very small mid-dark blue translucent glass globular/spherical bead	H 2.0 D 3.0, hole 1.5	Glass	Bead

88	Dog Hole 2011 10 A. C. Clean up round house C1.80m BOD	Type 3. Very small mid-dark blue translucent glass globular/spherical bead	H 2.0 D 3.0, hole 1.5	Glass	Bead
89	Dog Hole 2011 A10b 79m [sic] ENE 80cm WNW 1.80BOD	Type 3. mid-dark blue small spherical/globular bead	H 2.3 D (3.8) D hole 1.5	Glass	Bead
90	Dog Hole 2011 AA10-A10c	Type 3. thin walled mid/dark blue; globular/spherical	H 1.9 D 2.7 D hole 1.5	Glass	Bead
91	Dog Hole 2011 A10c-AA10c	Type 3. mid blue translucent glass bead, pitted, decayed surface, tiny	H 2.7 D 2.7	Glass	Bead
92	Dog Hole 2011 A10c-AA10c	Type 3. dark blue glass spherical/globular decayed surface,	H 2.4 D 2.7	Glass	Bead
93	Dog Hole 2011 A10c-AA10c	Type 3. Small green glass bead pitted decayed surface, globular	H 1.8 D 2.8	Glass	Bead
94	Dog Hole 2011 A10 70-80cm B.O.D. 70cm ENE, 60cm NNW	Type 1. rounded conical form of glass bead, mid blue glass	H 3.7 D 4.6	Glass	Bead
95	Dog Hole 2011 A10 70-80cm B.O.D. 70cm ENE, 60cm NNW	Type 1. globular form, wider than normal but still slightly conical, mid blue glass	H 2.2 D 4.6	Glass	Bead
96	Dog Hole 2011 1.80 B.O.D. ‘step’ 75cm ENE 90cm NNW	Type 3. wound and asymmetrical, pitted surface, light blue translucent glass, globular/spherical	H 1.6 D 2.8	Glass	Bead
97	Dog Hole 2011 AA10 -1.70-1.80m, 90cm-1.20m ENE, 0-70cm NNW	Type 8. Segmented cylindrical jet bead of three segments, of equal length; one end has very fine saw/file marks; other is partly polished; polished surface.	H 11.0 D 5.0, hole 3.0	Jet	Bead
98	Dog Hole 2011 AA8	Type 8. Single segment of jet bead, cylindrical in form with polished ends and surface, one end concave, other convex	H 4.0 D 6.0, hole 3.0	Jet	Bead
99	Dog Hole 2011 AA8	Type 1. blue glass bead, rounded conical in form	H 4.0 D 5.0, hole 2.0	Glass	Bead
100	Dog Hole C5	Type 1. blue glass bead, rounded conical in form	H 3.5 D 5.0, hole 1.5	Glass	Bead
101	Dog Hole 2010 C5	Type 3. Small mid-dark blue translucent spherical bead	H 3.5 D 3.5, hole 1.5	Glass	Bead
102	Dog Hole 2010 C5	Type uncertain. Small fragment of uncertain type of glass bead, light blue translucent	H – D -	Glass	Bead
103	Dog Hole 2011 AA8	Type 1. rounded conical form, translucent mid blue	H 3.0 D 5.0, hole 1.5	Glass	Bead
104	Dog Hole 2011 A9b 1.60m BOD	Type 3. Very small light blue bead globular/spherical	H 2.0 D 3.0, hole 1.5	Glass	Bead
105	Dog Hole 2011 A9b c. 1.70m BOD, 30-50cm ENE, 70-90cm NNW	Type 1. Small mid/dark blue globular/spherical glass bead translucent	H 3.0 D 3.5, hole 1.5	Glass	Bead

106	Dog Hole 2011 A9b c. 1.70m BOD, 30-50cm ENE, 70-90cm NNW	Type 3 bead. Very small mid/dark blue globular/spherical glass bead translucent [cf Type 3]	H 1.5 D 3.0, hole 2.0	Glass	Bead
107	Dog Hole 2011 A9b c. 1.70m BOD, 30-50cm ENE, 70-90cm NNW	Type 3 bead. Tiny mid-blue translucent globular/spherical glass, translucent	H 1.5 D 2.5, hole 1.0	Glass	Bead
108	Dog Hole 2011 A9b c. 1.70m BOD, 30-50cm ENE, 70-90cm NNW	Type 3 bead. Tiny light green translucent globular/spherical; v thin walled	H 1.5 D 2.5, hole 1.0	Glass	Bead
109	Dog Hole 2011 A9b c. 1.70m BOD, 30-50cm ENE, 70-90cm NNW	Type 3 bead. Tiny light green translucent globular glass bead, with a very narrow flat band of copper alloy wrapped around the bead, probably part of the clasp attachment.	H 1.5 D 2.5, hole 1.0	Glass	Bead
110	Dog Hole 2011 A9b 1.75m-1.80 BOD	Type 3 bead. Very small pale green glass bead in two pieces; globular/spherical?	H 1.5 D 2.0, hole 1.0	Glass	Bead
111	Dog Hole 2011 A10b 90cm ENE 80cm NNW 1.85B.O.D	Type 3 bead. Very small globular/spherical mid blue glass bead, damaged and about two-thirds present	H 2.0 D 2.5, hole 1.0	Glass	Bead
112	Dog Hole 2011 A10-AA10c	Type 3 bead. Very small globular mid blue translucent glass bead	H 3.0 D 3.0, hole 0.5	Glass	Bead
113	Dog Hole 2010 B6	Type 5 bead. Elongated, segmented ‘gold in glass’, white glass with gold interior	H 8.5 D 2.5, hole 0.5	Glass	Bead
114	Dog Hole 2010 B6	Type 1 bead. Rounded conical form	H 3.5 D 5.0, hole 2.0	Glass	Bead
115	Dog Hole 2010 B6	Type 1 bead. Rounded conical form	H 3.5 D 4.5, hole 0.5	Glass	Bead
116	Dog Hole 2010 B6	Type 1bead. Rounded conical form	H 4.0 D 4.5, hole 1.0	Glass	Bead
117	Dog Hole 2011 A9c -1.75m OD 40-80cm ENE 0-40cm NNW	Type 3 bead. Mid blue rounded, globular bead, translucent glass, pitted surface	H 2.0 D 3.0, hole 1.0	Glass	Bead
118	Dog Hole 2011 A9c -1.75m OD 40-80cm ENE 0-40cm NNW	Type 3 bead. Mid blue rounded, globular bead, translucent glass [identical to 117, 119] , pitted surface	H 2.0 D 3.0, hole 1.0	Glass	Bead
119	Dog Hole 2011 A9c -1.75m OD 40-80cm ENE 0-40cm NNW	Type 3 bead. mid blue rounded, globular bead, translucent glass, pitted surface	H 2.0 D 3.0, hole 1.0	Glass	Bead
120	Dog Hole 2011 A9b[or 6] c 160-170 BOD	Type 3 bead. very small globular/spherical bead translucent blue glass	H 2.0 D 3.0, hole 1.0	Glass	Bead

121	Dog Hole 2011 A9b[or 6] c 160-170 BOD	cf Type 3 bead. Pale green translucent; v small globular/spherical glass bead	H 2.0 D 2.5, hole 0.5	Glass	Bead
122	Dog Hole 2011 A9b 'step'	Not archaeological – a crinoid stem fragment	H 1.0 D 2.0, hole 0.5	fossil	fossil
123	Dog Hole 2010 'Unstrat Base of shirt residue'	Type 3 bead. Very small mid –dark blue translucent glass, globular/spherical thin walled [cf Type 3]	H 1.5 D 3.0, hole 1.0	Glass	Bead
124	Dog Hole 2011 'Homeless bead' [unstratified?]	Type 3 bead. Mid/dark blue translucent glass, globular/spherical, pitted surface	H 2.0 D 3.0, hole 1.0	Glass	Bead
125	Dog Hole 2010 'Not known (after AONB visit)'	Type 3 bead. Mid/dark blue translucent glass, globular/spherical, pitted surface, as SF124	H 2.5 D 3.0, hole 1.5	Glass	Bead
126	Dog Hole 2011 B7 -1.5m BOD	Type 3 bead. Very small pale blue glass, pitted surface glob/spherical	H 2.0 D 2.5, hole 1.0	Glass	Bead
127	Dog Hole 2010 Step 3	Type 3 bead. Very small mid blue glass, globular/spherical mid blue; pitted and some decay; globular	H 3.0 D 3.5, hole 1.0	Glass	Bead
128	Dog Hole 2010 Step 3	Type 3 bead. Very small mid blue glass; pitted and some decay; globular in form	H 2.0 D 3.0, hole 0.5	Glass	Bead
129	Dog Hole 2010 Step 3	Type 3 bead. Very small mid blue glass; pitted and some decay; globular in form	H 2.0 D 3.0, hole 0.5	Glass	Bead
130	Dog Hole 2010 Step 3	Type 3 bead. Very small mid blue glass; pitted and some decay; globular in form	H 2.0 D 3.0, hole 0.5	Glass	Bead
131	Dog Hole 2010 Step 3	Type 3 bead. Very small mid blue glass; pitted and some decay; globular in form	H 1.5 D 3.0, hole 1.5	Glass	Bead
132	Dog Hole 2010 Step 3	Type 3 bead. Very small mid blue glass; pitted and some decay; globular in form	H 1.5 D 3.0, hole 1.5	Glass	Bead
133	Dog Hole 2010 Step 3	Type 3 bead. Very small mid blue glass; pitted and some decay , lost one side; globular in form	H 1.5 D 3.0, hole 1.5	Glass	Bead
134	Dog Hole 2010 Step 3	Type 3 bead. Very small mid blue glass; pitted and some decay, lost one side; globular in form	H 1.5 D 3.0, hole 1.5	Glass	Bead
135	Dog Hole 2010 Step 1	Type 1 bead, rounded conical form	H 3.5 D 5.0, hole 0.5	Glass	Bead
136	Dog Hole 2010 Step 2	As Type 3 bead small mid blue translucent globular/spherical pitted surface	H 3.0 D 3.5, hole 0.5	Glass	Bead
137	Dog Hole 2010 Step 2	Type 3 bead small mid blue translucent globular/spherical pitted surface, smaller and a little flatter than 136	H 2.0 D 3.0, hole 2.0	Glass	Bead
138	Dog Hole 2010 Step 2	Type 3 bead small mid blue translucent globular/spherical pitted surface	H 2.0 D 2.5, hole 0.5	Glass	Bead
139	Dog Hole Step 3	Type 1 bead, near-cylindrical form	H 3.5 D 5.0, hole 1.5	Glass	Bead

140	Dog Hole Step 3	Type 1 bead, irregular near-cylindrical form	H 3.0 D 4.5, hole 1.5	Glass	Bead
141	Dog Hole Step 2	Type 1 bead, rounded conical form	H 3.5 D 5.0, hole 1.5	Glass	Bead
142	Dog Hole 2011 A9b (Step) - 1.65m OD, 30cm ENE, 80 cm NNW	Type 4 bead. Elongated drawn green glass bead, strongly marked parallel striations, cylindrical, edges appear roughly broken off, and not finished.	H 7.5 D 3.5, hole 1.0	Glass	Bead
143	Dog Hole 2011 A9b (Step) - 1.65m OD, 30cm ENE, 80 cm NNW	Type 3 bead. Very small blue mid blue translucent pitted surface, annular/globular	H 2.0 D 3.0, hole 1.5	Glass	Bead
144	Dog Hole 2011 A9b (Step) - 1.65m OD, 30cm ENE, 80 cm NNW	Type 3 bead. Very small blue mid blue translucent pitted surface, annular/globular	H 2.0 D 3.0, hole 1.5	Glass	Bead
145	Dog Hole 2011 A9b (Step) - 1.65m OD, 30cm ENE, 80 cm NNW	Type 3 bead. Very small blue mid blue translucent pitted surface, annular/globular	H 2.0 D 3.0, hole 1.5	Glass	Bead
146	Dog Hole 2011 A9b (Step) - 1.65m OD, 30cm ENE, 80 cm NNW	Type 3 bead. Very small blue mid blue translucent pitted surface, annular/globular	H 2.0 D 3.0, hole 1.5	Glass	Bead
147	Dog Hole 2011 A9b (Step) - 1.65m OD, 30cm ENE, 80 cm NNW	Type 3 bead. Very small blue mid blue translucent pitted surface, annular/globular	H 2.0 D 3.0, hole 1.5	Glass	Bead
148	Dog Hole 2011 A9b (Step) - 1.65m OD, 30cm ENE, 80 cm NNW	Type 3 bead. Very small blue mid blue translucent pitted surface, annular/globular	H 2.0 D 3.0, hole 1.5	Glass	Bead
149	Dog Hole 2011 A10b 1.80-1.85m BOD ‘step’ 40cm ENE 80-100cm NNW	Type 3 bead. Very small blue mid blue translucent pitted surface, annular/globular	H 2.0 D 3.0, hole 1.5	Glass	Bead
150	Dog Hole 2010 A5	Type 7 bead. Very small cylindrical bead, in amber glass, translucent, wound?	H 2.0 D 2.0, hole 0.5	Glass	Bead
151	Dog Hole 2010 A5	Type 8 bead. Two-segmented jet bead, one end polished with countersunk hole; other terminal knife trimmed and not polished	H 5.0 D 6.0, hole 2.0	Jet	Bead
152	Dog Hole 2011 B7 -1.30mm	Type 8 bead. two-segmented jet bead segments; both ends matte and concave, exterior highly polished	H 6.5 D 6.0, hole 3.0	Jet	Bead
153	Dog Hole 2011 AA9	Type 3 bead. Green glass globular/spherical bead, pale green glass	H 2.0 D 3.5, hole 1.5	Glass	Bead
154	Dog Hole 2011 AA9	Type 1 bead. fragment of wound bead.mid blue translucent glass	H 2.5 D 4.5	Glass	Bead
155	Dog Hole 2010 C2	Type 1 bead. Rounded conical form, mid blue translucent glass	H 4.0 D 5.0, hole 2.0	Glass	Bead

156	Dog Hole 2010 C2	Type 1 bead. Broken end of bead in slightly paler translucent blue glass than most examples	H 2.0 D 4.0, hole 1.0	Glass	Bead
157	Dog Hole 2010 C2	Type 6. Gold-in-glass bead, clear glass with yellowish tinge, striations on globular body, either end around the hole is a short cylindrical collar (Boon calls it a 'neck') which has been crudely broken off and not smoothed, slight surviving trace of gold-coloured metal	H 4.0 D 3.5, hole 1.5	Glass	Bead
158	Dog Hole 2011 A10c 50-80 ENE 0-10 NNW 1.75-1.80m B.O.D.	Type 6 bead. Gold-in-glass, clear glass with faint yellowish tinge, globular form with ribbed or striated surface, and short narrowed collar around the hole (shorter than on 157) but also roughly broken off (Guido 1978, fig. 37, no 3)	H 4.0 D 4.5, hole 2.0	Glass	Bead
159	Dog Hole 2011 A10c 50-80 ENE 0-10 NNW 1.75-1.80m B.O.D.	Type 3 bead. Small mid blue translucent, globular/spherical form, surface pitted	H 3.0 D 3.5, hole 1.5	Glass	Bead
160	Dog Hole 2010 C4	Type 1 bead. squat example, with globular (doughnut) form, mid blue translucent colour	H 2.5 D 5.0, hole 1.5	Glass	Bead
161	Dog Hole 2010 C4	Type 1 bead. Fragment only, rounded conical form	H 3.0 D 4.5, hole 1.5	Glass	Bead
162	Dog Hole 2011 A9b 'step' -1.70-1.80m OD, 40-70 cm ENE 60-80cm NNW	Type 1 bead. Squat version, 'doughnut'- shaped	H 3.0 D 4.5, hole 2.0	Glass	Bead
163	Dog Hole 2011 A9b 'step' -1.70-1.80m OD, 40-70 cm ENE 60-80cm NNW	Type 2. Very small green glass translucent with vertically ribbed surface (deliberate, not due to corrosion or decay), like tiny melon bead	H 2.0 D 2.5, hole 1.5	Glass	Bead
164	Dog Hole 2010 B6	Type 3 bead. very small darkish blue translucent glass, globular, pitted surface	H 2.0 D 2.5, hole 1.0	Glass	Bead
165	Dog Hole B6 and small amount of C6	Type 2 bead. small green translucent thin walled, globular, vertical ribbing/striation, surface pitted [uncertain if deliberate or effect of selective decomposition]	H 1.5 D 2.5, hole 1.5	Glass	Bead
166	Dog Hole 2010 C2	Type 1 bead. Rounded conical glass bead	H 3.0 D 4.5, hole 1.0	Glass	Bead
167	Dog Hole 2010 C2	Type 1 bead. very small mid blue fragment, uncertain form	H - D 4.0	Glass	Bead
168	Dog Hole 2010 C2	Type 8 bead. Fragment of three-segmented jet bead, probably narrower in original diameter than other examples	H – D -	Jet	Bead
169	Dog Hole 2011 A9c -1.65m ,	Type 3 bead. Very small globular mid-dark blue translucent, bead	H 2.0 D 2.5, hole 0.5	Glass	Bead

	60cm ENE 0-37cm NNW				
170	Dog Hole 2011 A9c 1.65 BOD, 80cm WSW 0-30cm ESE	Type 3 bead. Very small globular mid-dark blue translucent, bead	H 2.0 D 3.0, hole 1.0	Glass	Bead
171	Dog Hole 2011 A9b -1.55m-1.60m	Type 1 bead, with evidence of manufacturing with poorly finished work around hole, showing trailing/winding of glass, and asymmetrical finish	H 3.5 D 5.0, hole 2.0	Glass	Bead
172	Dog Hole 2011 A9c -1.65m, 0-30cm NNW, 80cm ENE	Type 1 bead. Conical shape, more tapering than most examples	H 4.0 D 4.5, hole 2.0	Glass	Bead
173	Dog Hole 2011 AA9 21/07/2011	Type 8 bead. Two-segmented jet bead, one end has groove of lathe-turning mark, other end is slightly concave and matte	H 7.0 D 5.5, hole 2.5	Jet	Bead
174	Dog Hole 2011 AA9 21/07/2011	Type 1 bead. Mid blue squat rounded conical form	H 3.5 D 5.5, hole 2.0	Glass	Bead
175	Dog Hole 2011 AA9 21/07/2011	Type 1 bead. Rounded conical form	H 4.0 D 5.5, hole 2.0	Glass	Bead
176	Dog Hole 2011 AA9 21/07/2011	Type 1 bead. Rounded conical form	H 3.5 D 5.0 hole 2.0	Glass	Bead
177	Dog Hole 2011 AA9 21/07/2011	Type 1 bead. Rounded conical form	H 3.5 D 5.0, hole 1.0-2.0	Glass	Bead
178	Dog Hole 2011 AA9 21/07/2011	Type 1 bead. Rounded conical form	H 3.5 D 5.5, hole 1.0-2.0	Glass	Bead
179	Dog Hole 2011 AA9 21/07/2011	Type 1 bead. Flattish broader conical form	H 3.0 D 5.0, hole 0.5-1.5	Glass	Bead
180	Dog Hole 2011 AA9 21/07/2011	Type 1 bead. Rounded conical form	H 3.0 D 5.0, hole 1.0-2.0	Glass	Bead
181	Dog Hole 2011 AA9 21/07/2011	Type 1 bead. Rounded conical form	H 4.0 D 4.5, hole 1.5-2.0	Glass	Bead
182	Dog Hole 2011 A9c 20-60cm ENE, 0-30cm NNW, -1.65-1.70m	Type 1 bead. Taller than usual with asymmetrical profile, and slight groove from imperfect winding	H 4.5 D 4.0, hole 2.0	Glass	Bead
183	Dog Hole 2011 AA9	Type 8 bead. Jet/shale, two-segmented bead, one very short with lightly polished ends	H 5.0 D 6.0, hole 2.5	Jet	Bead
184	Dog Hole 2011AA9 -1.65-1.70m, 90cm ENE, 0-40cm NNW	Type 1 bead. Rounded conical form	H 4.0 D 4.5, hole 1.0	Glass	Bead
185	Dog Hole 2011AA9 -1.65-1.70m, 90cm ENE, 0-40cm NNW	Type 1 bead. Rounded conical form	H 3.5 D 5.0, hole 1.0	Glass	Bead
186	Dog Hole 2011AA9 -1.65-1.70m, 90cm	Type 1 bead. Rounded conical form	H 3.0 D 5.0, hole 1.5	Glass	Bead

	ENE, 0-40cm NNW				
187	Dog Hole 2011AA9 -1.65-1.70m, 90cm ENE, 0-40cm NNW	Type 1 bead. Squat 'doughnut' form	H 2.5 D 5.0, hole 1.0	Glass	Bead
188	Dog Hole 2011 A10c 40-50cm ENE, 40-60cm NNW, -1.75m	Type 6 bead. Elongated barrel-shaped gold-in-glass bead, with clear evidence of 'gold' in bead, collar roughly broken off and not finished	H 5.0 D 2.5	Glass	Bead
189	Dog Hole 2011 A10c 40-50cm ENE, 40-60cm NNW, -1.75m	Type 3 bead. Very small blue glass, globular/spherical bead, pitted surface	H 2.0 D 3.0, hole 1.5	Glass	Bead
190	Dog Hole 2011 A10c 40-50cm ENE, 40-60cm NNW, -1.75m	Type 3 bead. Very small blue glass, globular/spherical bead, pitted surface	H 2.0 D 3.0, hole 1.5	Glass	Bead
191	Dog Hole 2011 A10c 40-50cm ENE, 40-60cm NNW, -1.75m	Type 3 bead. Very small blue glass, globular/spherical bead, pitted surface	H 2.0 D 3.0, hole 1.5	Glass	Bead
192	Dog Hole 2011 A10c 40-50cm ENE, 40-60cm NNW, -1.75m	Type 3 bead. Very small blue glass, globular/spherical bead, pitted surface	H 2.0 D 3.0, hole 1.5	Glass	Bead
193	Dog Hole 2011 A9b	Type 3 bead. Broken fragment, mid translucent blue glass, very small, with large hole and thin wall	H 2.0 D 3.0, hole 1.5	Glass	Bead
194	Dog Hole 2011 A9b	Type 3 bead. broken fragment, mid translucent blue glass, very small, with large hole and thin wall	H – D -	Glass	Bead
195	Dog Hole 2011 A9b	Type 3 bead. broken fragment , mid translucent blue glass, very small, with large hole and thin wall	H – D -	Glass	Bead
196	Dog Hole 2011 – A7 1.40m below datum	Oval shaft of iron pin, incomplete, broken at both ends	L 15+ D 3.5-4.0	Iron	Pin
197	Dog Hole 2011 A9c 40-80 cm ENE 0-40cm NNW -1.75m	Small fragment of burnt clay. The surviving surface is smoothed and light pink in colour, the fabric has numerous vegetable impressions, probably straw, suggesting structural daub. There are some angular mid brownish red inclusions, and matrix includes a small poorly wedged element of white clay. Wt 2.3g	L24+ W11+ T 11+	Ceramic	Fired clay
198	Dog Hole 2010 B6	One hobnail with circular/ovoid head, and short shank, bent over at tip. Corrosion products at right angles to shank suggest mineralised leather surface.	L 15	Iron	Hobnail

199	Dog Hole 2010 B6	One small indeterminate fragment of (laminated) wrought iron sheet	L 26+. W 16+. T 4	Iron	Sheet
200	Dog Hole 2010 B6	Four tiny fragments of iron, one with small hole – indeterminate		Iron	Uncertain
201	Dog Hole 2010, C2	Pair of iron hobnails, corroded together, one with bent shank intact but missing head, other with domed circular head and bent shank. Traces of a third corroded hobnail are also attached forming a row of three.	L 30.1, W12.6 H 11.6	Iron	Hobnail
201	Dog Hole 2010, C2	Pair of iron hobnails, corroded together, one with bent shank intact but missing head, other with domed circular head and bent shank. Traces of a third corroded hobnail are also attached forming a row of three.	L 30.1, W12.6 H 11.6	Iron	Hobnail
202	Dog Hole 2010, C2	Domed circular iron head of hobnail with corroded fragments of possible shank.	D 9.9 H incomplete 4.3	Iron	Hobnail
203	Dog Hole 2010, C5	Iron pin(?) of circular section, one pointed terminal, curved shank near head and slight irregular swelling at head.	L 49.0 D of shank 2.6-2.9	Iron	Pin?
204-205	Dog Hole 2010, C5	Two small fragments of iron wire, point at one end of the longer suggests a pin but very fragmentary and incomplete. Both have a modern break which suggests these were part of same object.	L 16.8 max D2.3 ; L7.2 max D 2.2;	Iron	Wire/pin
205	Dog Hole 2010, C5	See above		Iron	
206	Dog Hole 2010, C5	Circular domed head of hobnail, broken and bent shank present	D 11.8-13.0	Iron	Hobnail
207	Dog Hole 2010, STEP 2	Iron hobnail slightly bent shank; domed oval head	H 17.0 W 9.8	Iron	Hobnail
208	Dog Hole 2010, STEP 2	Possible pin or needle, with thin circular 'shank'; one end has a rounded point; the other end is broken so original function is uncertain.	L 49.3 D of shank 2.3-2.4		Pin/needle?
209	Dog Hole 2010, STEP 2	Fragment iron wire, twisted along shank. Pin/needle?	L 33.7 D 2.4	Iron	Pin/needle
210	Dog Hole 2010, C4/C6	Tip of shank bent at right angle	D 10.38 L 16.30	Iron	
211	Dog Hole 2010, C4/C6)	Tip missing off one; two conjoined hobnails, linked by corrosion	D11.42 L13.64	Iron	Hobnail

		products; domed heads, tip of shank of one missing;			
212	Dog Hole 2010, C4/C6	Two conjoined hobnails, linked by corrosion products; domed heads, with thickness of leather preserved by corrosion products at 4.2mm	L15.57D 11.64; L 14.58 D11.54 -	Iron	Hobnail
213	Dog Hole 2010, A5	Hobnail, intact, with oval domed head and curved shank.	D 8.2-9.9 oval head; L 11.3	Iron	Hobnail
214	Dog Hole 2010, unstratified base of shaft	Fragment of copper-alloy, twisted square-section wire from bracelet; more corroded than the two bracelet fragments SF260-261; probably part of same object as SF228	L 18.3 D 3.0-3.4	Copper-alloy	Bracelet
215	Dog Hole 2010, Step 1	Fragment of copper-alloy loop earring, of circular section; joins 236		Copper-alloy	Ear-ring
216	Dog Hole 2010, B5	Fragment of iron hobnail, corroded domed head, broken, shank missing	L – D 13.29	Iron	Hobnail
217	Dog Hole 2010, B5	Iron hobnail; broken, shank missing	L – D 11.57	Iron	Hobnail
218	Dog Hole 2010, B5	Fragments of iron hobnail. Head and shank incomplete	L – D 10.32+	Iron	Hobnail
219	Dog Hole 2010, B5	Iron hobnail, domed head	L incomplete 11.59 D 12.98	Iron	Hobnail
220	Dog Hole 2010, B5	Fragment of iron hobnail, domed head only present, shank missing	L – D 11.64	Iron	Hobnail
221	Dog Hole 2010, B5	Fragment of iron hobnail, shank only, head missing	L 6.8 D7.2 of shank only.	Iron	Hobnail
222	Dog Hole 2010, B5	Fragments of iron hobnail, tip of shank only	L - D -	Iron	Hobnail
223	Dog Hole 2010, B5	Section of iron wire; corrosion obscures the original form (section probably circular or /oval)	L 34.1mm	Iron	?pin/wire
224	Dog Hole 2010, B2	Very corroded hobnail domed head with fragment of shank.	D 7.6-7.7	Iron	Hobnail
225	Dog Hole 2010, B4	Fragment of broad silver alloy bracelet, flat underside, external side has raised mid rib; undecorated, terminals missing	W 8.3, L 30.9+ incomplete, T 1.7	Silver-alloy	Bracelet
226	Dog Hole 2010, A2	Flat thin iron sheet, undiagnostic – but possibly post-medieval/modern sheet metal iron	L 38.7+ W 23.2 T 1.3	Iron	Sheet
227	Dog Hole 2010, A2	Possible fragment of hobnail – small domed circular with depression in dome – a small fragment and corroded – not diagnostic or certain;	D 6.9	Iron	Hobnail

228	Dog Hole 2010, A5	Copper-alloy, twisted square-section wire from bracelet; more corroded than the two bracelet fragments SF260-261 but possibly part of the same item. Probably part of SF214	Profile of section H 2.67-2. Overall L 26.7mm	Copper-alloy	Bracelet
229-235	Dog Hole 2010, C4	229. L 17.07 D 11.50 230. L 15.96 D 11.95 thickness of leather 4.95 231. L 15.61 D 10.39 232. L 17.56 D 10.54 tip of shank bent over 233. L 13.88 D 10,59 tip bent over 234. L 13.00 D 10.57 235. D12.23 shank missing Domed heads, rapidly tapering shanks where present and not obscured by corrosion. Tips bent in some cases. Former presence of leather preserved in some cases		Iron	Hobnail
236	Dog Hole 2010, C3	Fragment of copper-alloy loop earring, of circular section, at terminal wire is split to half width; joins 215		Cua	Ear-ring
237	Dog Hole 2010, A7 1.45m	?Pin of circular section, slight bend at one end; wire, probably pin with slight swelling at one end and narrowing to point at other. Date uncertain	L 63.26 D 2.52	Iron	?pin
238-255	Dog Hole 2010, B4	238. L 17.09 D 11.66 thickness of leather c. 4.2mm 239. L 17.03 D 12.87 240. L 15.66 D12.3 Tip of shank bent over at right angle 241. L 16.99 D 11.90 242. L 14.00 D 11.02 Tip of shank bent over at right angle. 243. L 16.56 D 11.41 244. L 15.37 D 11.00 Ridge of corrosion showing thickness of leather about 4.5mm 245. L 12.7 D 10.65+ - shank incomplete 246. L – D12.25 domed head only 247. L- D 11.40 head only 248. l – D11.96 shank broken 249. L – D broken 8.74 250. L 16.09+ shank fragment only, bent 251. shank fragment only 252. shank fragment only 253. small fragment of head 254. small fragment of shank 255, small fragment of iron wire?13.3mm long D 2.00mm, function uncertain		Iron	Hobnail

		All (except wire fragment 255) are consistent with hobnails, with domed heads and short shanks, often bent at end at a right angle			
256	Dog Hole 2011, AA10 (90cm-1.20m, ENE 0-70cm NNW, -1.75 to 1.80m)	Incomplete and broken at both ends; circular-section iron rod with slight curve. Wider end 5.4 x 4.2; narrower end D 5.2; this could be a fragment of iron bracelet.	L 40.8 +	Iron	?Bracelet
257	Dog Hole 2011 A8	Small curved piece of iron bar with square section tapering to narrow end, broader at other. This could just be bow brooch but part of attached deposit is a circular flat disc (D 4.6) with a transverse groove, like small screw head; at the junction of narrower and broader elements of the 'bow' – this may be a modern piece.	L 29.7, incomplete W 4.8 T 4.8;	Iron	Bar?
258	Dog Hole A10B (A9b?) (-1.65 to -1.70m, 10cm ENE, 70-90cm NNW)	Possible iron bow brooch, heavily corroded, in two fragments. The larger is a curved length of iron, possibly D-shaped section at narrower end but too corroded to be certain. The smaller piece contains within the concreted corrosion products a T-section thin iron sheet – uncertain object.	Two fragments: L 29.2 W 4.6 T 5.0 (incomplete) and L 11.8 W 10.0; squarish	Iron	
259	Dog Hole 2011, A10B -1.87m, 70cm ENE, 80cm NNW	About half of a penannular copper-alloy bracelet, of circular section narrowing towards the surviving terminal. There are five grooved rings at terminal, and further incised decoration around the outer edge, consisting of groups of oblique lines, vertical lines and two pairs of lines forming chevron, then two oblique lines, five vertical lines and two more oblique lines.	Overall D 60 D of circular section 4.87-3.27 at terminal	Copper alloy	Bracelet
260, 261	Dog Hole 2011, A9B -1.68 B.O.D. 30 cm ENS [sic] 80 cm NNW	Two fragments of a torc-twisted bracelet in square-section wire, one fragment with an expanding loop and three coils of wire. Surface appears to have been tinned.	Square section measures 2.36-2.39.	Copper-alloy	Bracelet
262	Dog Hole 2011, A8	About half of a thin copper-alloy band of cylindrical form, which appears to have enclosed or surrounded an organic material, now decayed. A flat thin sheet of metal appears to divide the cylinder into two but is now bent out of position. This appears to be a small binding or joining band; probably modern. Precise function uncertain. [Could this be attachment on the end of a pencil for an eraser?]	D 9.6 H 6.1	Copper alloy	Uncertain

263	Dog Hole 2011, AA8	Fragment of silver-alloy bracelet, tapering in width from 5.5-6.5 mm, with a flat back and slight rib on front. This fragment is almost certainly from the same broken bracelet as no 225 but the pieces do not join.	L 25+ T 2	Silver alloy	Bracelet
264	Dog Hole 2011, AA7 -1.20 to -1.35m	Small section of broken iron wire with tightly bent hook, tapering to a point. Date uncertain.	L 12.7 D of wire 2.1; W of 'gape' 5.9	Iron	hook
265	Dog Hole 2011, AA7 -1.20 to -1.35m	Disc-headed split shaft rivet; aluminium, modern	D 5.6 L 4.5	aluminium	rivet
266	Dog Hole 2011, A7 -1.35m	Curved iron object, heavily corroded; possibly a hobnail shank with a small surviving irregular projecting part of head.	L 14.7 W 5.5	Iron	Hobnail
267	Dog Hole 2011, -1.75m B.O.D. 70cm ENE, 75 cm NNW	Small copper-alloy finger-ring with plain band, shallow D-shaped profile; broken into two fragments	Ext D 18; W of band 2.5; T of band 1.5mm, 8mm ; band 2.5; T of band 1.5mm,	Copper alloy	Finger-ring
268	Dog Hole 2011, AA8	Slightly domed head rivet with split shaft attached to leather or thick textile, modern, aluminium	D 8.0 L 8.0	Aluminium	rivet
269	Dog Hole 2010, B5	Morse key/tapper in composite materials, plated copper alloy, steel and plastic or resin board. Not recorded in detail.		Mixed	Morse-code
270	Dog Hole 2010, C2	Pen knife; mother of pearl scales either side of handle secured by small metal rivets; small plain shield-shaped cartouche on one side; folding blade, and semi-circular metal terminals on either end. A 20th-century object	L 69.2 W 11.6 T 7.2	Iron, mother-	Pen-knife
271	Dog Hole 2010, STEP 2	Small flat disc-shaped rivet with attached split shaft on rear	D 5.5		Rivet
272	Dog Hole 2010, STEP 2	Flat disc-shaped rivet with split shaft which is attached to fibrous material, thick textile; identical to 273	D 8	Aluminium	rivet
273	Dog Hole 2010, STEP 2	Flat disc-shaped rivet with split shaft which is attached to fibrous material, thick textile; identical to 272	D 8	Aluminium?	rivet
274	unlabelled box with iron object	Small heavily corroded iron object, with one domed end; the corrosion products appear to have preserved the former surfaces of a now-lost organic material; a hobnail in which corrosion products have preserved the impression of leather.	L 15.65 D 12.80	iron	Hobnail

Table S1. Small finds descriptions and catalogue for the 2010-11 excavations of Dog Hole Cave, Haverbrack. See Section 8 for a list of finds from earlier excavations.

3.0 Zooarchaeology

Report by Matilda Holmes

3.1. Introduction

Excavations at Dog Hole produced over 5000 fragments of non-human animal bone identified to taxa. Those from the main chamber (M) came from the Keith Bland collection, and were hand collected only. All layers from the 2010-11 excavations were sieved, so differences in the recovery of very small bones of birds, fish and mammals will exist between the two areas of the site. Bones were recorded from context 2, Layers 1-10, Charcoal Rich Layer (= context 4 in site records) and steps 1-3 of the 2010-11 excavation, which are included in further analysis.

Due to problems of movement through the strata, precise dating of layers was not possible, but the earliest material has been radiocarbon dated to the late Iron Age/early Roman period. Dates for the material in the main chamber spans the third to thirteenth centuries, although the condition of a few bones throughout the cave suggest they are recent additions.

3.2. Methodology

Bones were identified using the author's reference collection. Due to anatomical similarities between sheep and goat, bones of this type were assigned to the category 'sheep/goat' unless a definite identification[40] could be made. Micromammals were identified to taxa from mandibles and crania only. Bones that could not be identified to species were, where possible, categorised according to the relative size of the animal represented (micro – rodent sized; small – cat/rabbit sized; medium – sheep/pig/dog size; or large – cattle/horse size). Ribs were identified to size category where the head was present, vertebrae were recorded when the vertebral body was present, and maxilla, zygomatic arch and occipital areas of the skull were identified from skull fragments.

Tooth wear and eruption were recorded (using guidelines from Grant, and Payne[41]), as were bone fusion, metrical data,[42] anatomy, side, zone[43] and any evidence of pathological changes, butchery[44] and working. The condition of bones was noted on a scale of 0-5, where 0 is fresh bone and 5, the bone is falling apart.[45] Other taphonomic factors were recorded, including the incidence of burning, gnawing, recent breakage and refitted fragments.

[40] Zeder and Lapham 2010; Zeder and Pilaar 2010.

[41] Grant 1982; Payne 1973.

[42] von den Driesch 1976.

[43] Serjeantson 1996.

[44] Lauwerier 1988; Sykes 2007.

[45] Lyman 1994, 355.

All 2010-11 layers had been sieved, which meant that recording all fragments was impractical, so only fragments that could be identified to taxa and/ or anatomy were recorded. Articulated or associated fragments were entered as a count of 1, so they did not bias the relative frequency of species present. However, much of the material had been sorted and re-bagged previously, which meant that the identification of associated bone groups was only possible in a few cases.

Quantification of taxa used a count of all fragments (NISP – Number of Identified SPecimens), and Minimum Number of Individuals (MNI). For cattle, sheep/goat, pig and dog the MNI was calculated from the greatest number of left or right sides of long bones with the epiphysis or metaphysis (end of the bone) present; left or right mandibles with dp4 or permanent premolars and/ or first to thirds molars present; and left or right loose mandibular third molars. MNI for micromammals was calculated from the greatest number of left or right mandibles, and for frogs/ toads from the number of tibiofibulae divided by two. Quantification of anatomical elements was carried out using a restricted count of epiphyses or metaphyses, selected skull fragments specified above, mandibles containing the dp4 and/ or first to third molars, based on Grant.[46] Mortality profiles were constructed based on tooth eruption and wear[47] and bone fusion.[48]

3.3. Taphonomy and Condition

Bones were generally in very good condition (Table S2), although those from lower layers were slightly less well preserved than those from the main chamber and Layers 1-4. Unsurprisingly this is due largely to the age of the assemblage, with older fragments being worse affected by geological and biomechanical modifications. Some bones recorded as poorly preserved showed signs of surface erosion, most likely caused by water-borne chemicals etching the surface. The presence of intrusive material is implied by a few fresh bones from the main chamber and Layers 1 to 4.

The number of fresh breaks may be attributed to the increase in weight of substrate, seemingly affecting layers above and below the CRL independently. Fragments that could be refitted were uncommon, which may largely be due to the sorting of material prior to analysis meaning that fragments deemed 'unidentifiable' were bagged separately. Alternatively, it may have been caused by movement of broken fragments through the site matrix. The relatively high proportion (3.5%) of refitted fragments from Layer 10, is due to the inclusion of the partially articulated horse skeleton that was bagged on its own.

The ratio of loose teeth to those remaining in the mandible can be a useful taphonomic indicator, particularly as a high proportion of teeth at Dog Hole were loose (Table S2).

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[46] Grant 1975.

[47] Hambleton 1999.

[48] O'Connor 2003.

Sheep/goat, canid and pig teeth from the main chamber were generally recovered in association with mandibles and maxillae suggesting that they were subject to minimal post depositional movement, only being separated upon excavation and cleaning. No cattle mandible fragments were identified, although the number of loose first and second cattle molars (42) is roughly twice that of third molars (22), which implies that they were from associated mandibles when first deposited. The original excavators[49] did find complete cattle mandibles, but the bone disintegrated on excavation. The subsequently isolated teeth were retained in the archive. The majority of loose teeth from Layers 3 to 7 were not associated with their respective crania or mandibles, implying that they were either deposited as such, having first been left long enough for the connective tissue to break down and the teeth become loose, or were subject to considerable post-depositional movement, during which they became separated. The few layers that had greater proportions of teeth remaining in mandibles included high numbers of sheep/goat, dog and pig mandibles (main chamber) and dog mandibles (Layers 8 to 10).

Despite the assemblage being sorted prior to cataloguing a number of unfused bones were recovered in association with their loose epiphyses. This implies that, in some areas of the cave, there was little post-depositional movement once the connective tissue holding the epiphyses (ends of the bone) to the metaphyses (end of the shaft) had broken down. These were recovered from the main chamber, Layers 3-5, the CRL and Layer 10. A number of associated bone groups (ABGs) were also recorded (Table 2MT), again suggesting that there was limited movement of some material in the main chamber, particularly upper Layers 2 and 4 and lower Layers 8 and 10. No complete skeletons were observed, which may be related to the sorting of the assemblage noted previously (and illustrated by the presence of the roe deer bones and a number of dog hind leg, vertebrae and foot bones from the main chamber that were packed separately from the other bones of ABGs from the area that were probably originally the same animals), although it is also consistent with the emphasis on various carcass parts discussed further below. Partial skeletons included dogs from the main chamber and Layers 2, 4 and 10, and horse from Layer 10; pig and hare from the main chamber; and neonatal sheep/goats from Layers 2 and 4. Other associated remains were from isolated joints such as the roe deer foreleg from the main chamber and cattle foot bones from Layer 8.

The presence of high numbers of cattle, sheep/goat and dog carpals, tarsals and sesamoids in association with the bones of the lower legs suggests that they were articulated, with at least enough muscle and sinew to stop these small elements being lost prior to deposition. The presence of large numbers of accessory bones alongside the associated metapodials and phalanges lends itself to a more detailed examination of the possible movement of bones through the strata, based on the principal that the larger metapodials and possibly phalanges will be less likely to move than the smaller carpals, tarsals and accessory bones

[49] Benson and Bland 1963.

(sesamoids, navicular and pisiform). Bones were split into those from larger mammals (cattle and horse) and those from medium sized mammals (sheep/goat, pig and canid). If there was no movement of bones through the layers it may be expected that similar proportions of each of the bone groups would be recorded. Data from the main chamber are not included as smaller bones were unlikely to be recovered given the absence of sieving. For both groups it seems that there may have been some movement of smaller bones, as they become more common between Layers 4 to 7 (Fig. S3). Very few were recovered from the CRL, which may indicate that the lowest levels (8 to 10) contain more secure deposits than those above.

Unsurprisingly, the greatest proportions of burnt bone came from below the CRL, again reflecting some movement of material (Table S2). The near absence of gnawing suggests that bones had not previously been available for dogs to chew on. Of the isolated examples of gnawed bones, nearly all had been affected by canids, including a cat tibia from the main cave. A single sheep/goat astragalus had been fully digested, most likely by a dog; and a domestic fowl metacarpal from Layer 1 had been chewed by a rodent, possibly while *in situ*.

In summary, it appears that the areas exhibiting most evidence for movement of material are Layers 4 to 7, given the high proportions of loose teeth and accessory bones, and absence of ABGs. Further discussion of the taphonomy of the site will be made below, where appropriate.

3.4 Carcass Representation and Butchery

Very few bones bore butchery marks (Table S2); the greatest proportions came from the main chamber and Layers 6 and 7. Not all butchery will leave marks on bones, and it is possible that a careful technique using a knife will not mark the bone at all. The majority of butchery marks (64%) were typical of knife work, which is markedly different to the highly standardised, large-scale chop-marks caused by the butchery industry of contemporary urban areas.[50] Instead, it suggests that disarticulation of the carcasses was done with more care, on a smaller-scale, perhaps by those processing the occasional animal on a household level. Many of the butchery marks from Layers 3 to 10 related to the disarticulation or jointing of the carcass through the long bones and vertebrae. Occasional observations of skinning marks came from two sheep/goat zygomatic areas of the skull in Layer 10 and cattle and roe deer phalanges in Layers 7 and 9 respectively. A rather different picture is apparent in the assemblage from the main chamber. Half the butchery marks are consistent with the skinning of cattle carcasses, in the form of knife cuts to the distal metapodials, and there are a few observations of filleting not observed from other areas of the cave.

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[50] Maltby 2007.

In general, the locations of butchery marks in all layers suggest a strong emphasis on portioning carcasses through the trunk and disarticulation of the lower leg below the knee or hock. The large-scale skinning marks observed on metapodials in the main chamber are not echoed in lower layers, which implies that the deposits in this area of the cave were peculiar to earlier disposal practices.

One of the most interesting features of the assemblage lies in the carcass parts represented, which varied considerably by taxa and sometimes by layer. In all layers cattle are largely represented by foot (phalanges), lower leg (metapodia) and crania (Fig. S4; Table S3), with a greater proportion of mandibles (represented by loose teeth) and metapodials recorded from the main chamber.

Within the canid assemblage all parts of the carcass are represented (Fig. S5; Table S4), with some spatial variation. A greater number of mandibles were recovered from below the CRL (Layers 6-10), along with two partial skulls from Layers 9 and 10. The main chamber is again unusual, in the large number of crania, mandibles and upper limb bones recorded, with almost no metapodials or phalanges. It is possible that these latter elements moved through the strata post-depositionally, leading to them being better represented in the lower layers, or were overlooked due to the absence of sieving in the earlier excavations.

Nearly 50% of the sheep/goat assemblage also consisted of foot and lower leg bones, although there was more variation than observed in the cattle and canid remains (Fig. S6). A relatively high number of first cervical vertebrae (atlas) were recorded from Layer 3, and this bone also accounts for the high proportion of vertebrae in Layers 6 and 7 (Table S5). As with the canid assemblage, sheep/goat mandibles were more common in lower Layers 9 and 10. There were also a relatively high number of upper limb bones recorded, compared to the cattle and canid remains, particularly notable in Layers 8-10. When considered in terms of age, the greater numbers of upper limb and lower leg bones came from neonates. Discrepancies in foot bones, which are more commonly recovered from older sheep may be due to recovery, but it seems likely that complete lambs were deposited, contrasting with a predominance of lower legs and feet of mature sheep/goats.

Pig remains exhibited a slightly different pattern, being best represented by upper fore and hind limbs (Fig. S7; Table S6), suggesting a different pathway for the remains of these animals prior to deposition. The one outstanding exception is in the main chamber, where many mandibles were recovered, paralleled in the cattle data above. As with the sheep/goat data, it is likely that piglets were disposed of whole, compared to just the lower legs and feet of older animals.

The bones and teeth of micromammals were found together, and although only the mandibles were identified to taxa, long bones are generally recorded in quantities consistent with the remains of whole animals. The bones from most parts of amphibians are also recovered, although cranial elements are scarcer than those of micromammals, as they are smaller and more fragile.

3.5 Species Representation

A diverse number of taxa were recovered, comprising the major food domesticates (cattle, sheep/goat, pig), non-food domesticates (dog, horse and cat), wild taxa (red and roe deer, rabbit, hare, badger and hedgehog), micromammals (mole, red squirrel, common shrew, field vole, bank vole, wood mouse and rat), amphibians (frog or toad) and birds (domestic fowl, pheasant and passerine). Detailed numbers for all layers are given in Table S7. Some attempt was made to investigate whether the canid bones were from dogs or foxes comparing them to metapodial measurements detailed by Ratjen and Heinrich.[51] The results are illustrated in Fig. S8, which shows that with one exception, all metapodial measurements lay within the dog group. Only a fourth metacarpal from Layer 2 more likely came from a fox. The majority of pig remains were consistent with domestic animals, although a single unfused femur from the main chamber was notably large, and may have come from a wild animal.

The pathways that led to the deposition of these groups of animals would also have been diverse, some involving deliberate human disposal, while others more likely to have resulted from pit falls. The assemblage is dominated by the major food domesticates and micromammals, with amphibians and the major non-food domesticates (notably canids) also present in considerable quantities (Fig. S9). The dominance of major domesticates in the main chamber is unsurprising, as this material was not sieved, so the recovery of very small bones of amphibians, birds and micromammals would be limited. The presence of a large number of these very small taxa, and the smallest bones from larger taxa in lower levels is testament to the dedicated sieving programme that was implemented.

To investigate relative proportions of the two largest groups of animals they were split into the major micromammals (Fig. S10) and major domesticates (Fig. S11). Within the first group, it is of interest from an environmental viewpoint that amphibian remains are considerably more common in the upper Layers 1 and 2 and, to a lesser extent, in Layers 9 and 10. It is therefore possible that a change in external conditions to a drier environment led to a decrease in frog and toad numbers in the area (See Supplementary Material section 6 for further information), this would be consistent with the third to fourth century drier and warmer conditions that are known from elsewhere in Britain.[52] Consequently, proportions of shrews and voles are greater in Layers 3 to 8, and although the number of voles decreases from Layer 8, shrew numbers increase in Layers 9 and 10 (Fig. S10). The

[51] Ratjen and Heinrich 1978.

[52] Kingston 2010.

increase in shrew bones in levels 5 and 8 to 10 could reflect their movement through the layers above and below the CRL.

The large group of major food domesticates is dominated by sheep/goat and cattle remains, of which the former are generally most common, present between 40-50% of the assemblage, with cattle generally present around 30-40% (Fig. S11). Higher quantities of cattle in the main chamber may be due to the absence of sieving (and therefore possibly limited retrieval of the smaller bones of sheep/goat) combined with the bias introduced by the considerable number of loose teeth recovered. Cattle also predominate in Layer 3, which was sieved, so it may relate to a real change in deposition. The proportion of pig remains is fairly consistent, making up around 20% of the assemblage, with the exception of Layers 2 and 3 where numbers of pigs and sheep/goat fall relative to a rise in cattle; and Layers 5 and 6, where sheep/goat numbers spike, relative to a drop in the numbers of both cattle and pig.

The MNI was calculated for selected taxa (Table S8) to enable a more reliable quantification of how many animals were involved in the accumulation of the assemblage. As was evident in the NISP count, cattle, sheep/goat, pig and canids are best represented in the main chamber (Table S7). The remains of fewer animals came from the lower levels, although the MNIs of sheep/goats, pigs and canids increased in the lowest Layers (9 and 10). Cattle were not as abundant in the lower levels, consistent with the NISP calculations. The MNI counts were calculated separately for neonatal remains (Table S8), again indicating that the greatest numbers of calves, piglets and puppies were deposited in the lower levels, while lambs and piglets were also common in the middle levels (4 and 5).

The MNI of amphibians, shrews and field voles is far greater than that of the domesticates from the same layers (Table S8), and suggests the presence of a considerable life assemblage. The biomass of these animals would most likely have been considerably higher than that of the major domesticates in the vicinity of the site and again emphasise the different formation processes affecting the two types of assemblage. It is unlikely that the micromammal assemblage accumulated as a result of predator behaviour, the majority of bones were complete, and there was no evidence for acid etching that might be expected if it had been digested. Furthermore, the nature of the cave was not conducive to owls. It is most likely that the small mammals were incorporated as a result of pit falls. The trend in the NISP count for frogs and toads is borne out by the MNI data, which indicate that they were most common in Layers 1, 2, 9 and 10, relative to an increase in field voles in Layers 4 to 8 (Table S8).

3.6. The Assemblage

In this section, data relating to the animals themselves will be considered, such as age of death, metrical analysis and pathology.

3.6.1 Cattle

Problems arise in the interpretation of fusion data because of the limited range of anatomical elements available. Metapodials and phalanges comprised the majority of the assemblage, and these can provide ageing data relating to neonates (proximal metapodial), early (phalanges) and intermediate (distal metapodial) fusion stages, but there will be an under representation in the number of elements useful for identifying animals that died during the late or final fusion stages. Nonetheless, the data show some interesting trends. Evidence for neonatal bones comes from a single unfused proximal metapodial in the main chamber, and a number of porous bones in Layers 9 and 10 (Table S9), indicating a small number of calves present. Lower numbers of neonatal bones observed for all the main taxa in the main chamber is to be expected given the absence of a sieving programme. The lack of any cattle mandibles retaining their teeth in the assemblage means that data from tooth wear is limited to the analysis of third molars recovered from the main chamber. This is also problematic, as it doesn't take into account animals that died before the eruption of the third molar, but the ratio of loose first and second molars to third molars suggests that it is likely they originated as teeth from mandibles with fully developed dentition. Furthermore, only two deciduous fourth premolars (dp4) were recovered, again indicating that very few mandibles or teeth of juvenile animals were present, as the dp4 is lost at about the same time the third molar comes into wear. Results suggest that the majority of animals died at around maturity, at wear stage G or H (Table S10), with two more elderly examples at stage J, and a number of younger animals that died at stages E and F. The older animals that died at wear stages H and J would have been at similar ages to those represented by the four fused vertebrae that indicate elderly animals in the final fusion stage (Table S9).

The picture changes slightly in Layers 7 to 10 (Table S9). As well as the evidence for young calves from porous bones, there are a number of mortalities apparent in the early fusing bones, while the intermediate fusing bones are fused. This suggests the presence of both older and younger cattle, with increasingly younger animals in Layers 9 and 10.

A number of pathological cattle bones were observed. First and second phalanges with lipping to the proximal articular surface were recorded in the main chamber and all Layers except 1, 6 and 7. In most cases this was mild, but moderate and severe examples were also noted and in these cases they included exostosis to the proximal or distal end as well. Two metacarpals from Layer 4 and a metatarsal from the main chamber also exhibited exostosis to the proximal surface. When taken together, these pathological changes affecting the metapodials and phalanges are consistent either with age-related changes through natural wear and tear, or may have been exacerbated by a life of work for draught purposes[53]. The proximal epiphysis of a large mammal humerus was also recorded with pitting to the surface that likely came from cattle and again is consistent with changes caused by wear and tear to the joint, although as it came from an animal less than four years of age, it is more likely to

[53] Bartosiewicz *et al.* 1997.

indicate the animal's use for draught purposes than osteoarthritis. Two metatarsals were also recorded with signs of pathology. One from Layer 4 had a sinus on the proximal anterior shaft, consistent with the draining of infection from within the bone, and another from Layer 7 had a massive swelling to the medial aspect of the distal shaft suggesting a knock.

The large number of cattle metapodials meant that some attempt at sexing could be made for the bones deposited in the main chamber. Fig. S12 shows the ratios of length and breadths for suitable metacarpals, where a large group of smaller, slender bones indicates female animals. There are two outliers that are likely to be males or castrates, and a smaller group of three indeterminate bones that may be smaller males or large females. Even with these indeterminate groupings of possible males, the majority of cattle in the main chamber were probably female.

A number of bones were complete enough for wither heights to be calculated,[54] indicating animals between 0.95m and 1.25m tall (Table S11). The apparent decrease in the size of cattle in the main chamber may result from the larger sample, but it is consistent with a general reduction in size that occurred throughout the country during the Saxon period.[55]

Given the broad range of dates for the main chamber, measurements of Dog Hole cattle were compared with Roman and Saxon animals. The widths of the large group of 3rd molars plotted within the range recorded for Roman data from Elms Farm, Essex,[56] with a very similar mean (15.0 from Dog Hole and 15.4 from Elms Farm). A group of metatarsals from Layer 4 also compared well with the data from Elms Farm, Essex.[57] In many areas of the country the importation of new stock during the Roman period saw an increase in the size of cattle by the early Saxon period. Dog Hole animals were relatively small compared to early Saxon data, the Dog Hole mean being 1.09m compared to 1.12m from West Stow and 1.22m from Orton Hall Farm.[58] The presence of a large group of females may explain the smaller animals, but the minimum measurements at Dog Hole lie well outside the other Saxon sites (0.95m at Dog Hole, 1.01m at West Stow and 1.07m at Orton Hall Farm), suggesting that the Dog Hole animals were native stock. As mentioned above, the general diminution in size throughout the Saxon period,[59] means that the wither heights are also comparable to late Saxon animals in the Danelaw, which would agree with the later date for

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[54] Using indices from Fock 1966, and Matolcsi 1970.

[55] Holmes 2014.

[56] Albarella *et al.* 2008.

[57] Albarella *et al.* 2008.

[58] Holmes 2014.

[59] Holmes 2014.

some of the bones disposed of in the main Chamber. None of the neonatal bones were complete enough to be used to establish the probable age of gestation.

3.6.2. Sheep/Goat

Sheep/goat were represented by a greater variety of long bones, providing a more reliable sample to investigate using fusion data (Table S12). A considerable number of neonatal bones were recorded from all layers indicating the deposition of lambs (Tables S8, S13), particularly in layers just above the CRL, and the lowest layers. The presence of neonatal animals is reflected in the tooth wear data in Layers 4 (wear stage A) and 5 (wear stage B). Data from the main chamber indicates the presence of animals at a range of age stages, with a peak in juvenile and subadult animals both in tooth wear and fusion data (Tables S10, S12). There is a general increase in younger animals through the layers (Fig. S13), observed in the proportion of early and intermediate fusing elements, particularly from Layers 5 and 6. There were few mandibles suitable for tooth wear calculations from the lower layers, but those that were present also indicate the presence of juvenile and subadult animals.

A single sheep/goat 1st phalange from Layer 2 had exostosis to the medial and lateral aspects of the posterior shaft indicating a possible knock or other trauma to the area. As with the cattle assemblage, there were few bones either complete enough or from animals old enough to be used for metrical analysis from the lower layers, although the width of the 3rd molar and distal breadth of the tibia fell within the size ranges observed at the contemporary site of Elms Farm, Essex.[60] Wither heights were recorded where possible (Table S14), suggesting that sheep were approximately 55cm tall,[61] with a greater range of sizes observed from the main chamber, most likely a product of sample size. The large number of foetal bones meant that some attempt to estimate the time of gestation could be undertaken using data from Prummel[62]. The results show that animals as young as 70-80 days gestation to around the time of birth are present in Dog Hole (Table S13), which could indicate that either foetal lambs or pregnant ewes were deposited. There is some indication that there was a predominance of very early foetuses in the earliest Layers 5-10, although it is possible that these very small bones moved further through the strata than the slightly larger bones of the older lambs. Both early and later foetuses were recorded in the main chamber and Layers 2-4.

3.6.3. Pigs

The number of neonatal pig bones recorded from Dog Hole is greater than other livestock (Tables S8, S15), comprising over half of all bones in Layer 7, and around a third of bones in other layers. This is reflected in the fusion data, where there is a general absence of fused intermediate, late or final fusing long bones, suggesting that all pigs deposited in the cave

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[60] Albarella *et al.* 2008.

[61] Using indices from Teichert 1975.

[62] Prummel 1989.

died in the first year or two of life (Table S15). The mandibles from the main chamber also reveal juvenile pigs (Table S10), with a peak in those that died at wear stage D before the 3rd molar is fully erupted, that would have been approximately 12-16 months of age.[63]

No fused long bones were complete enough to be used for metrical analysis, however, the large number of neonatal bones provided ample data to investigate the approximate age of gestation (Table S16), indicating that animals were between 60 days and full term. As with lambs, the youngest piglets came from Layers 7 to 10, with slightly older animals from later Layers 2 to 4 and the main chamber.

3.6.4. Dogs

In contrast to the sheep and pig assemblages, relatively few neonatal dog bones were recorded in the upper levels, being more common in Layers 5 to 10 (Tables S8, S17), although they were present in the main chamber and Layer 1. In all phases animals were likely to be mature at death, with a large proportion of vertebrae fused that comprise the final fusion group. Dogs that died as subadults are best represented in the main chamber and Layers 8 to 10. Results from tooth wear on mandibles in the main chamber[64] also indicate the deaths of animals at a range of ages (Table S10). Results were rather inconclusive, suggesting that they were generally over 6 months old, with peaks at stages C (6 to 24 months), E (24 to 36 months) and G (over 48 months). Few mandibles from lower layers were available, but two from Layer 9 were at wear stage F, and two from Layer 10 at stages E and D indicating animals around two to four years of age. Three puppies were evident whose 1st molars had not yet come into wear, from Layers 7 and 8.

A considerable number of dog bones exhibited signs of pathology. Fourth metacarpals from Layers 2 and 7 had exostosis to the shaft and a rib from Layer 8 had been broken but re-healed at the head and shaft, all of which imply that the animals had been subject to trauma, causing extra bone growth or broken bones, respectively. Other pathological changes were more consistent with age – a humerus from the main chamber with lipping on the distal condyles, a 2nd phalanx from Layer 5 had lipping at the proximal and distal ends, while a lumbar vertebra from Layer 7 had exostosis to the articular surface. One of the mandibles from Layer 10 was missing the 3rd premolar that had fallen out some time before death as the alveolar space had healed over, indicating that this may have been an elderly animal. A single bacculum was recovered from Layer 5 indicating a male animal.

Eight dog crania recovered from the main chamber were complete enough to comment on. Three out of five with the parietal bone intact had a sagittal crest, while one skull with no sagittal crest was notably small and domed consistent with the presence of a toy breed. The presence of a dog radius and ulna from the main chamber were recorded as having ‘bent

[63] Lemione *et al.* 2014.

[64] Following Horard-Herbin 2000.

shafts', suggesting they were from a bandy-legged breed such as a terrier. Unfortunately, there were no long bones complete enough to calculate shoulder heights. However, a number of calcanei and 1st mandibular molars were recovered from the main chamber representing a range of sizes (Table S18), further implying that different types of dog were present. The presence of bandy legged and toy dogs is typical of the Roman period, as these types of dogs are generally not found in the Saxon period, only being re-introduced in the medieval period.

3.6.5. Horse

Few horse bones were recovered, with the exception of a partial horse skeleton from Layer 10 comprising bones from the foreleg (radius, carpals, metacarpals, lateral metapodials, second phalange) and neck (atlas, axis and cervical vertebrae). Numerous loose teeth from Layers 8, 9 and 10 may relate to the same individual, although it is notable that no skull fragments or mandibles were present (Table S19). Unfortunately none of the bones were complete enough for the height or stature of the animal to be investigated. Other horse remains were generally limited to lower layers, and comprised lower leg bones and teeth from Layers 4 to 7, although a tarsal and loose tooth were also recovered from the main chamber. All bones were fused, suggesting that mature animals were present.

3.6.6. Cat

In contrast to the horse remains, cat bones were recovered from the main chamber and upper Layers 1 to 5 and the CRL (Table S19). The bones were largely from the lower limbs and vertebrae, but with two upper limb bones recovered from the main chamber. One of the lateral metapodials from the main chamber was from a very small individual. Most bones were fused indicating that cats were mature, although a single unfused proximal tibia came from an animal under 19 months of age.

3.6.7. Wild animals

Deer were largely represented by antler fragments, identified to both red and roe species (Table S19). As well as the ABG from the main chamber comprising bones from a roe deer foreleg, including three phalanges recorded separately that were most likely originally associated with the ABG, other roe deer phalanges were recovered from Layer 9. All bones were fused. A deer pelvis and corresponding right femur recovered from the main chamber had exostoses indicating that these were also from the same individual, although identification to specific taxa was not possible.

Hare and/or rabbit remains were also infrequent, recovered throughout the cave, comprising a hare partial skeleton (the hind leg and torso) from the main chamber, a rabbit femur from Layer 4 and two loose teeth from Layers 4 and step 1. The presence of a rabbit femur from Layer 4 is unexpected as these animals were not widely introduced into Britain until the twelfth century,[65] and this layer is believed to be Roman in date, however, it had the appearance of fresh bone, which suggests it is intrusive.

Other wild taxa were occasionally recovered (Table S19), including bones from a juvenile badger in the main chamber and Layer 9. The tooth from a hedgehog was recorded from Layer 6 and mole bones and teeth in Layers 3 and 4. Red squirrel bones from Layers 3, 5, 8, step 2 and 10 were represented by loose teeth and occasional long bones. See additional discussion in the section on Palaeoenvironment below.

3.6.8. Birds

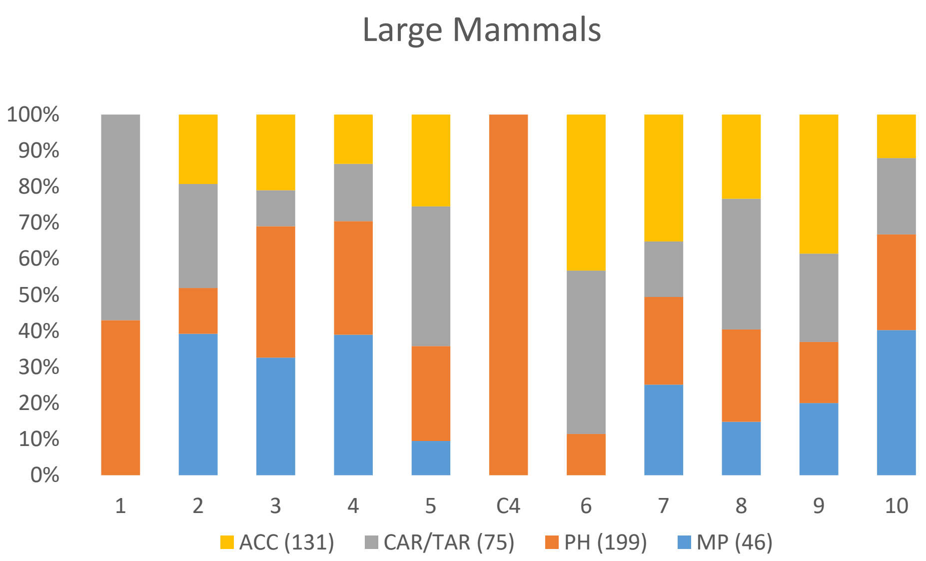
Bird remains were rare, present as occasional finds from Layers 1 to 10 (Table S20). The majority recorded were from passerine species – small birds such as robins – with domestic fowl and pheasant also identified. Bones from the latter were distributed in several layers, and the very fresh condition implies that it was a fairly recent pit fall or deposit. The domestic fowl bones found in Layer 10 were also fresh and most likely modern intrusive finds.

3.7. Discussion

For full discussion of the above findings, see main text.

[65] Sykes and Curl 2010.

Section 3: Figures



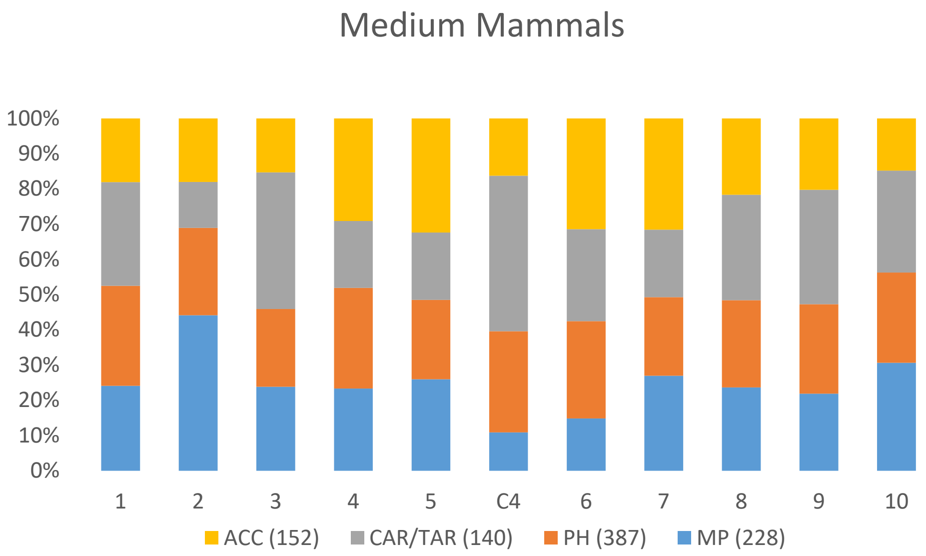


Figure S3. Relative proportions of various lower leg and foot bones by layer. Top: Large mammal= cattle and horse. Bottom: medium mammal= Sheep/goat, pig, dog; Bone abbreviations: Acc= navicular, pisiform, sesamoids; Car/ Tar= carpals and tarsals; MP= metapodials and lateral metapodials; PH= phalanges and lateral phalanges. (n)= number of fragments.

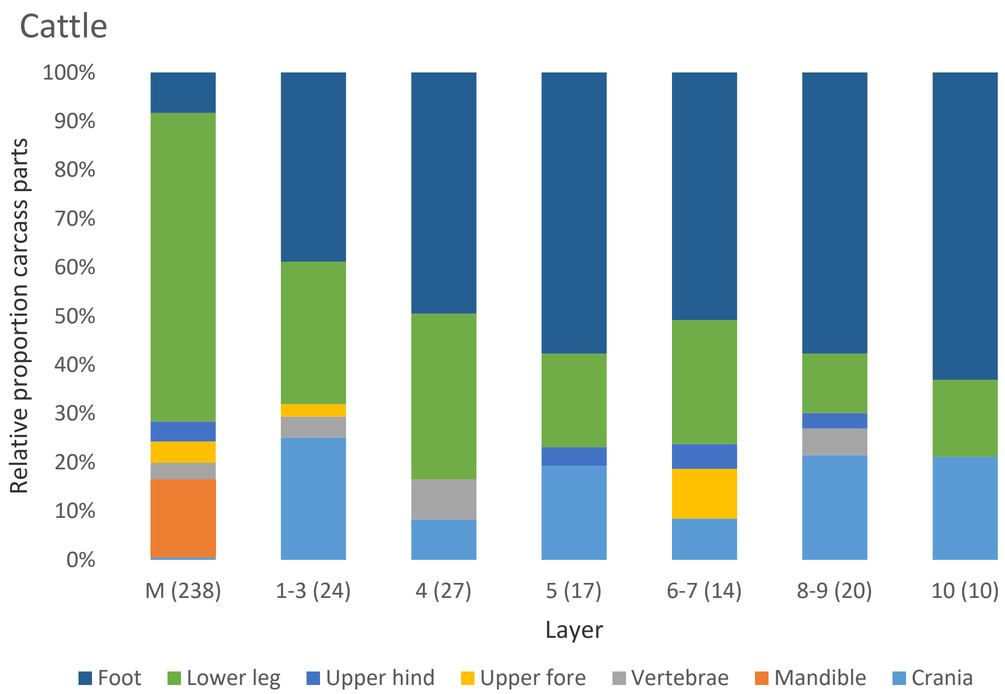


Figure S4. Relative proportion of selected cattle carcass parts by phase. (n)= sample size. Crania= occipital, zygomatic and hyoid; mandibles MNE based on loose teeth; vertebrae= Atlas, axis and sacrum; upper fore= scapula, humerus, radius; upper hind= pelvis, femur and tibia; lower leg= metapodials; foot= phalanges. Long bones and vertebrae counted where epiphyses were present.

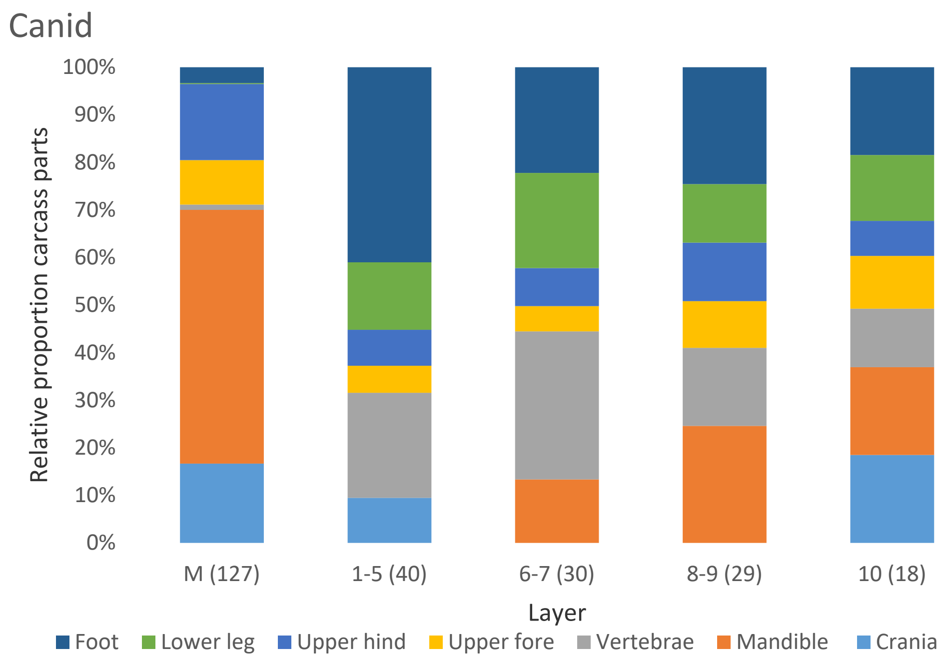


Figure S5. Relative proportion of selected canid carcass parts by phase. (n)= sample size. Crania= occipital, zygomatic and hyoid; mandibles with dp4/ M1/ M2/ M3; vertebrae= Atlas, axis and sacrum; upper fore= scapula, humerus, radius; upper hind= pelvis, femur and tibia; lower leg= 3rd and 4th metapodials; foot= phalanges. Long bones and vertebrae counted where epiphyses were present.

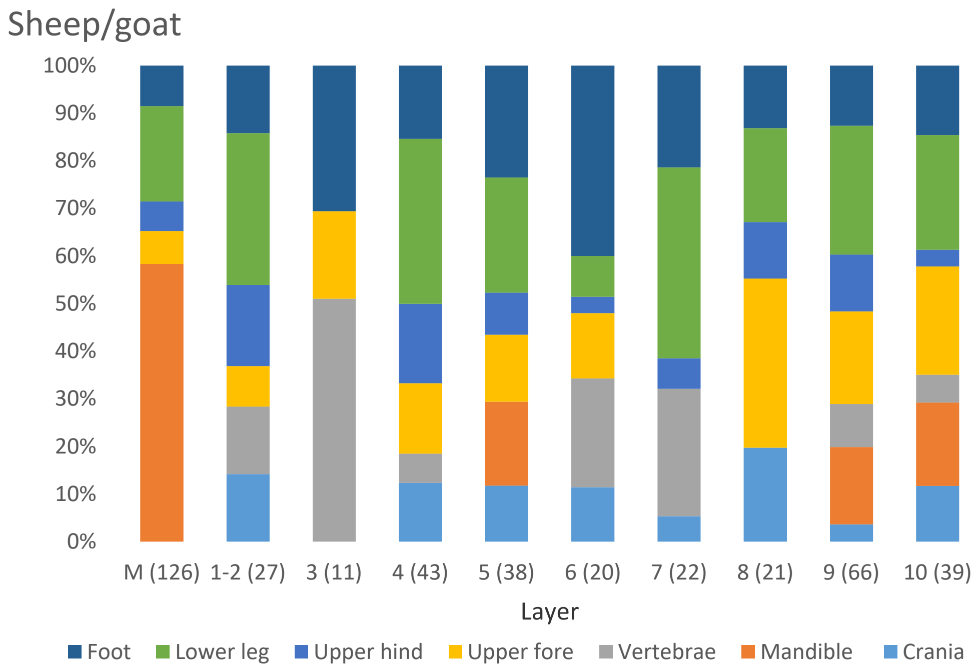


Figure S6. Relative proportion of selected sheep/goat carcass parts by phase. (n)= sample size. Crania= occipital, zygomatic and hyoid; mandibles with dp4/ M1/ M2/ M3; vertebrae= Atlas, axis and sacrum; upper fore= scapula, humerus, radius; upper hind= pelvis, femur and tibia; lower leg= metapodials; foot= phalanges. Long bones and vertebrae counted where epiphyses were present.

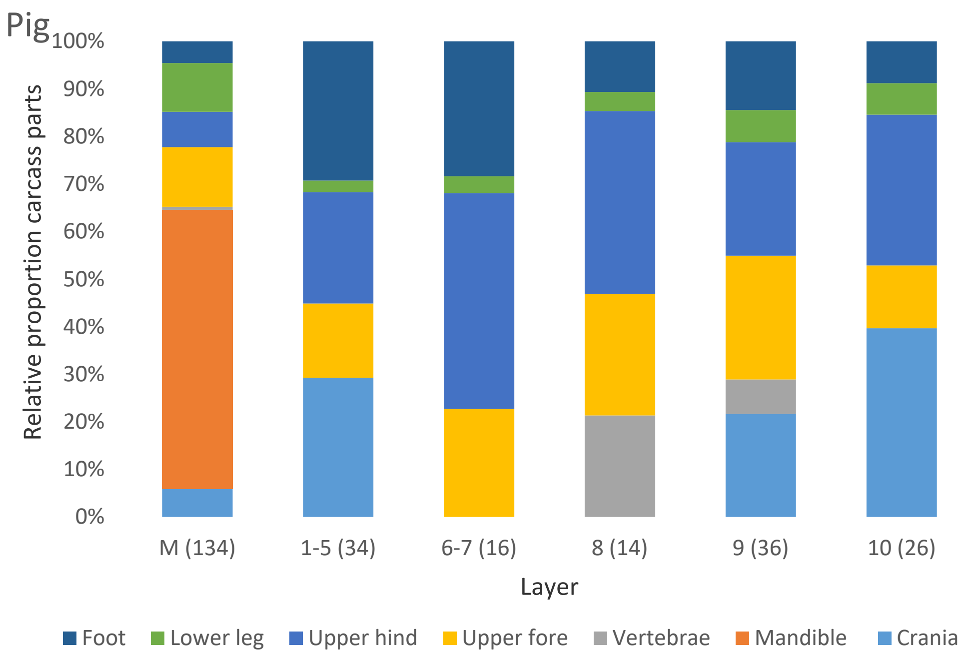


Figure S7. Relative proportion of selected pig carcass parts by phase. (n)= sample size. Crania= occipital, zygomatic and hyoid; mandibles with dp4/ M1/ M2/ M3; vertebrae= Atlas, axis and sacrum; upper fore= scapula, humerus, radius; upper hind= pelvis, femur and tibia; lower leg= 3rd and 4th metapodials; foot= phalanges. Long bones and vertebrae counted where epiphyses were present.

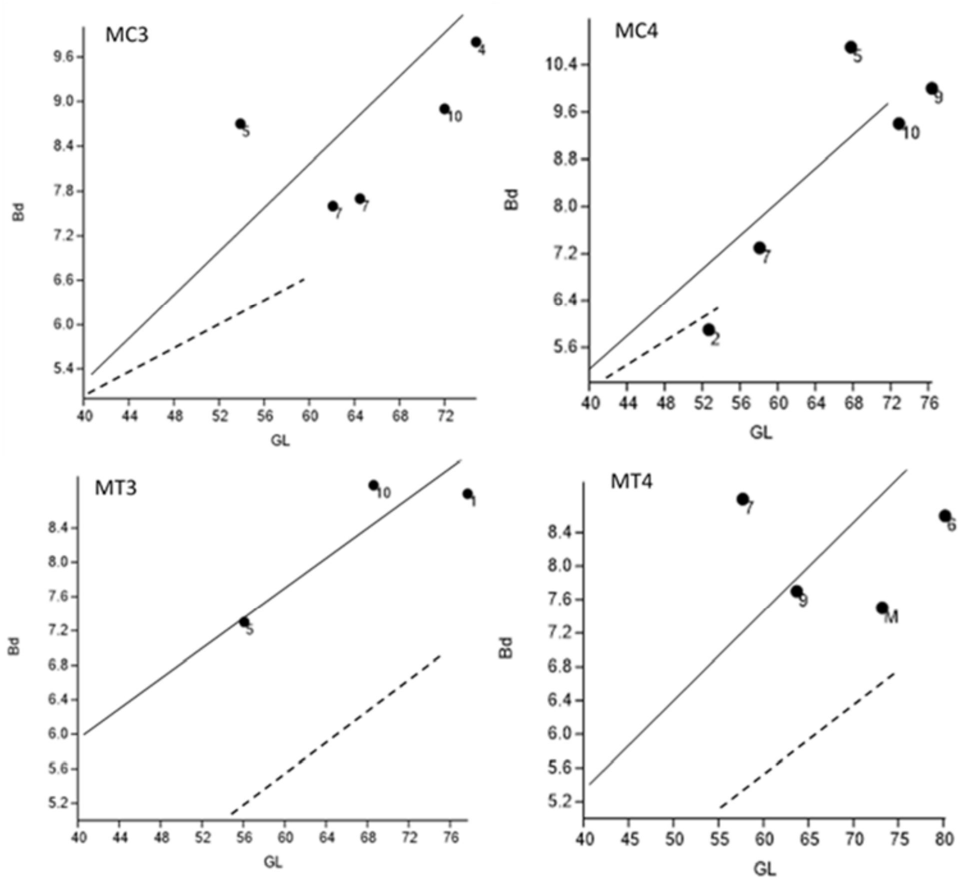


Figure S8. Dog vs fox distinction (Ratjen and Heinrich 1978). Solid line= dog plot; broken line= fox plot. MC3= 3rd metacarpal; MC4= 4th metacarpal; MT3= 3rd metatarsal; MT4= 4th metatarsal; GL= greatest length; Bd= greatest breadth of distal end. Layer numbers shown next to points.

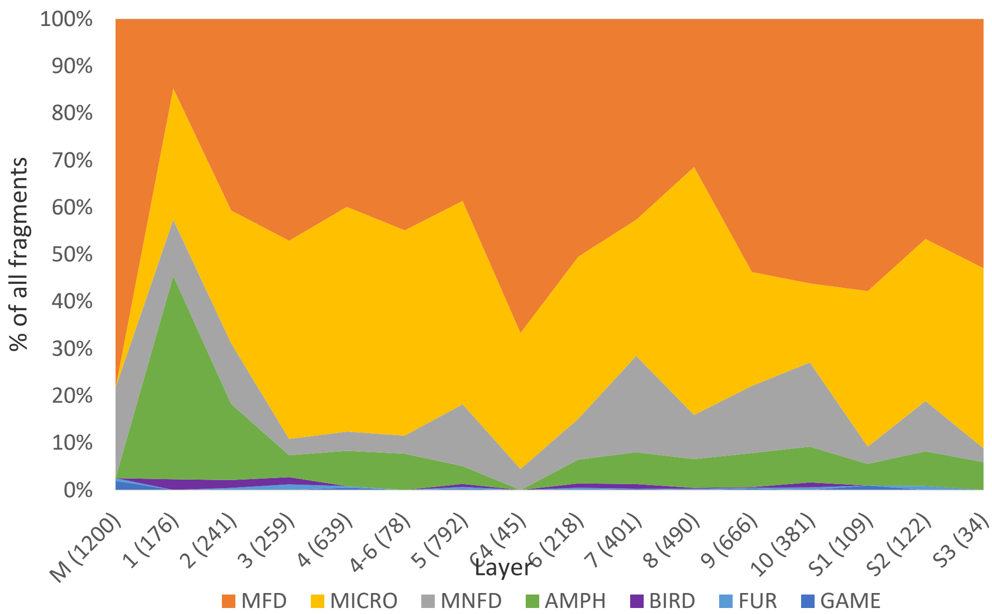


Figure S9. Relative proportion of taxa groups by layer. MFD= major food domesticate (cattle, sheep/goat, pig); MNFD= major non-food domesticate (horse, dog, cat); Micro= micro mammal; Amph= amphibia; Bird= birds; Fur= fur-bearing taxa (badger, hedgehog, mole, red squirrel); Game= deer, rabbit, hare. (n)= total number of fragments recorded to taxa).

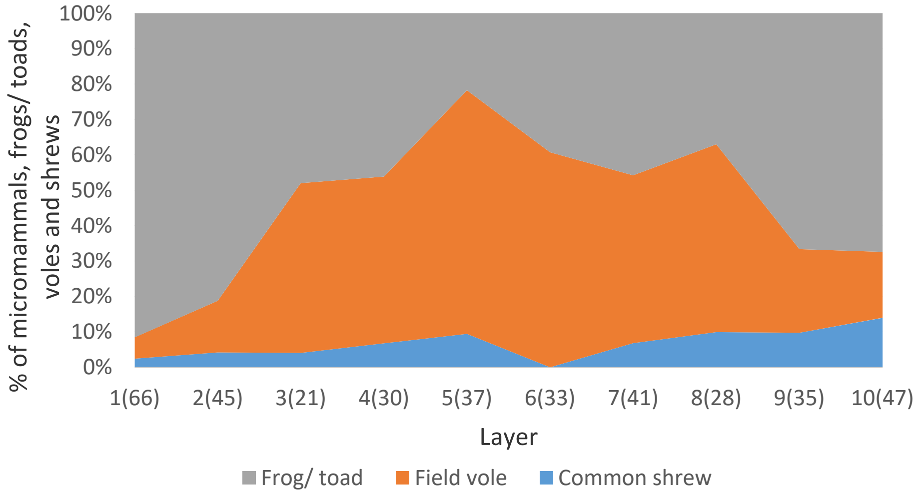


Figure S10. Relative proportions of the most common microfauna recovered by layer. (n)= number of fragments.

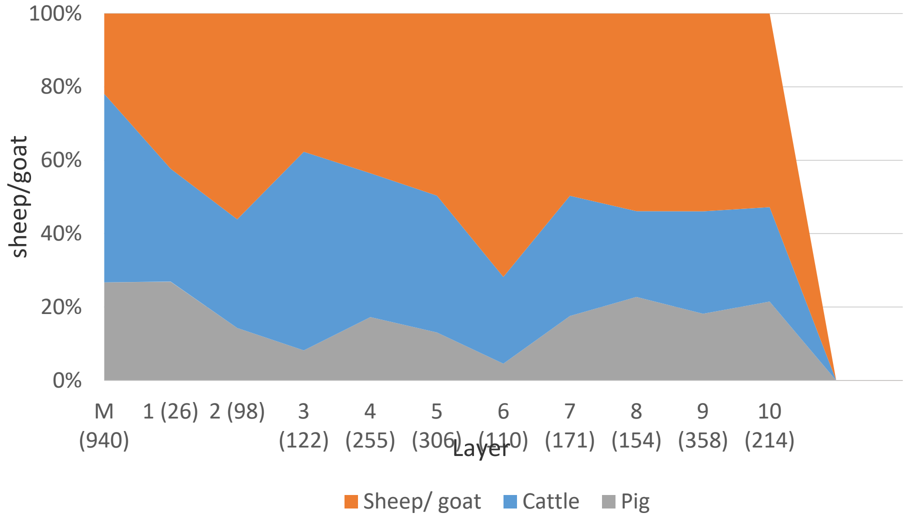


Figure S11. Relative proportion of cattle, sheep/goat and pig remains from the major layers. (n)= total number of fragments recorded to taxa.

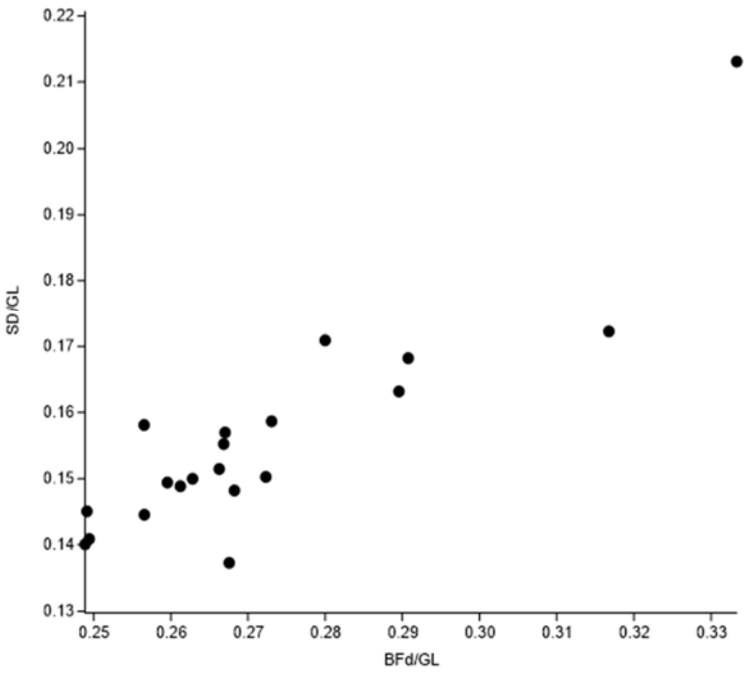


Figure S12. Cattle metacarpal measurements (for definitions see von den Driesch 1979)

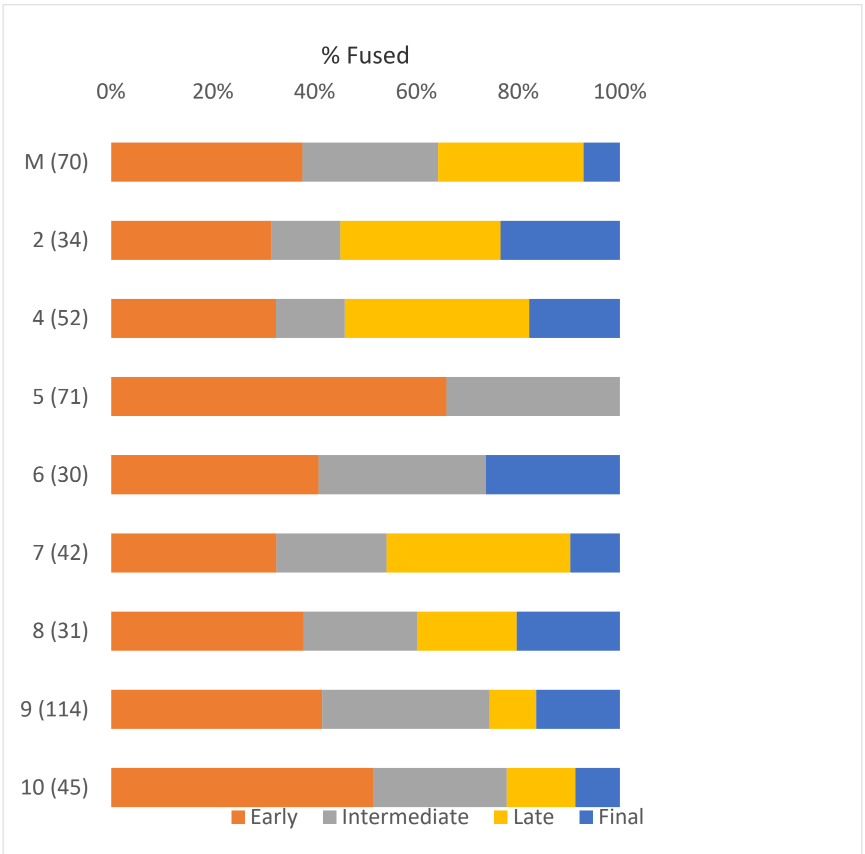


Figure S13. Sheep/goat bone fusion by layer (n= number of bones). Only layers with >30 bones included.

Section 3: Tables

Layer	Condition 0	1	2	3	4	5	Total	Taphonomy % burnt	% Butchery	% Gnawing	% Fresh break	Ratio loose teeth*
M	-	73	17	8	2	-	463	-	3	2	2	5:7
1	1	69	22	7	1	0	154	3	-	1	0	
2	1	35	42	18	3	1	223	2	-	-	3	
3	0	55	33	9	4	0	214	4	1	-	4	5:0
4	-	68	18	13	-	0	558	4	1	0	2	8:0
5	0	50	28	20	3	0	598	3	1	0	3	6:3
CRL												
6	0	49	39	11	2	0	209	8	2	0	1	6:0
7	0	39	38	20	3	-	355	4	2	0	1	5:1
8	0	64	17	18	-	0	422	6	-	0	2	4:3
9	0	35	40	19	4	1	584	7	1	0	3	13:11
10	0	41	31	23	4	0	345	5	1	0	4	3:9

Table S2. Condition and taphonomic factors affecting the assemblage. Teeth not included unless stated. Condition based on Behrensmeyer (1978) 0= fresh bone; 1= very good; 2= good; 3= fair; 4= poor; 5= very poor. % loose teeth= ratio of loose mandibular dp4/M1/M2/M3 to those remaining in the mandible. Darker colours indicate higher proportions in each category.

Element	M	1	2	3	4	5	6	7	8	9	10
Partial skull											1
Horn core + frontal	4					1		1		1	
Occipital					1	1				2	
Zygomatic			1	2	1					1	1
Hyoid	1		1			2	1			1	1
Maxilla with teeth				1	1				1		
Loose maxillary tooth*	8			1						1	
Loose mandibular tooth*	22			1	1						
1st cervical vertebra	1			1	2						
Cervical vertebra	3										2
Lumbar vertebra	3										
Thoracic vertebra	3									4	2
Sacrum	6									1	
Caudal vertebra								2			
Scapula	1						1				
Humerus P	2							1			
Humerus D	6										
Ulna P	4										
Radius P	3										
Radius d		1									
Pelvis	1					1		1		1	
Femur P	4										
Femur D	5										
Tibia P	3										
Tibia D	1										
Calcaneus											1
Metacarpal P	38		1	1	2	1					1
Metacarpal D	49			1	3						1
Metatarsal P	36		2	1	3	1		2		2	
Metatarsal D	50		1	2	3	2		2		1	
1st phalange**	2		1	3	4	3	1	1	2	2	2
2nd phalange**	14		1	2	4	3		2	2	2	2
3rd phalange**	1			2	4	3	1	1	1	2	2
Total	271	1	8	18	29	18	4	13	6	21	16

Table S3. Cattle element representation (Fragment count). *dP4, M3; **adjusted for frequency bias

Element	M	1	2	3	4	5	6	7	8	9	10
Partial skull	10									1	1
Occipital						1					1
Maxilla with teeth				1		1				1	1
Mandible with teeth	32							1	1	1	1
Loose maxillary tooth*						1		2	1	1	
Loose mandibular tooth*							1			2	1
1st cervical vertebra						1		2		2	
2nd cervical vertebra		2						4		1	2
Cervical vertebra	4				2	4		4		2	2
Thoracic vertebra	2			2		4		8	2	8	
Lumbar vertebra	8	2	2			12	2	7	2	6	8
Sacrum	2		1			3	1			1	
Caudal vertebra						6					
Scapula	2	1				1	1			1	1
Humerus P	7				1					1	
Humerus D	7									1	
Radius P	7							1		1	1
Radius d	5										1
Ulna	15					1			1	1	1
Pelvis	10					2				1	
Femur P	7							2		2	1
Femur D	10			1				1			
Tibia P	10					1			1	1	1
Tibia D	11										
Calcaneus	6					3					1
3rd metacarpal P						1		2			1
3rd metacarpal D						1		2			1
4th metacarpal P			1			1		2	1	3	1
4th metacarpal D			1			1		2		1	1
3rd metatarsal P		1	1			2					1
3rd metatarsal D		1				1					1
4th metatarsal P	1						1	1		2	
4th metatarsal D							1	1		1	
1st phalange**	3	1	1		1	1	1	1	1	1	1
2nd phalange**	3	1	1	1	1	1	1	1	1	1	1
3rd phalange**		1	1		1	1		1	1	1	1
Total	162	10	9	5	6	51	9	45	12	45	33

Table S4. Canid element representation (Fragment count). *dP4, M3; **adjusted for frequency bias

Element	M	1	2	3	4	5	6	7	8	9	10
Horn core + frontal				1	2					1	
Occipital					2	1		1		1	1
Zygomatic			1		2	2				1	3
Hyoid		1	1			1	2		3		
Maxilla with teeth						1					2
Mandible with teeth	32					2				3	2
Loose maxillary tooth*					2					2	
Loose mandibular tooth*	21			1	2	2	3	1	2	5	
1st cervical vertebra			2	4	2		3	3		2	2
2nd cervical vertebra				1			1				
Cervical vertebra			1	3				4	2	7	1
Thoracic vertebra			4		2	6		4	4	26	2
Lumbar vertebra					2	6	8	4	4	8	4
Sacrum			1					2		3	
Caudal vertebra					2						
Scapula	3		1	1	2	2	1		1	1	2
Humerus P	4		1	2	2	3			2	3	5
Humerus D	5		1		4	3			3	5	6
Radius P	4						3		2	6	
Radius d	3								1	3	
Ulna	2					4			1	1	
Pelvis	2	1	1		3	3	1	1		2	1
Femur P	3		1		1			1	2	2	
Femur D	1		2		1					1	
Tibia P	4				3	1			1	5	1
Tibia D	7		1		1	1				1	
Calcaneus	4			1	1	1				1	2
Metacarpal P	7	1	2		5	5		3	2	5	1
Metacarpal D	16		1		2	4	2	2	1	3	1
Metatarsal P	10		3		6	1		3		6	4
Metatarsal D	12		2		2	1		2	1	6	5
1st phalange**	5		1	1	2	3	2	2	1	3	1
2nd phalange**	4		1	1	2	3	2	1		2	1
3rd phalange**	5		1	1	1	2	3	1	1	2	3
Total	154	3	29	17	56	58	31	35	34	117	50

Table S5. Sheep/Goat element representation (Fragment count). *dP4, M3; **adjusted for frequency bias

Element	M	1	2	3	4	5	6	7	8	9	10
Partial skull	2										1
Occipital	1			1		2				2	2
Zygomatic											1
Maxilla with teeth	9			1							
Mandible with teeth	30										
Loose maxillary tooth*					1						
Loose mandibular tooth*	14										
1st cervical vertebra									2		
Cervical vertebra						2		2	2		2
Thoracic vertebra									8	1	2
Lumbar vertebra		2								6	
Sacrum	1									2	
Scapula	6	2			2			2	1	8	2
Humerus P	9									1	2
Humerus D	8								1	1	1
Radius P	6		1		1			1	1	1	
Radius d	3		1		1			1	1	1	
Ulna	3				2	3		1	2	2	1
Pelvis	1		1		1	2		1	2	4	4
Femur P	4				1			2		1	1
Femur D	5				1	1		2		1	1
Tibia P	5				1	2		2	2	3	3
Tibia D	4			1	1			1	2	2	3
Calcaneus	5			1	3			1		1	
3rd metacarpal P	7					1				1	
3rd metacarpal D	6					1				1	
4th metacarpal P	3										
4th metacarpal D	3										
3rd metatarsal P	4									1	1
3rd metatarsal D	3									1	
4th metatarsal P	8						1		1	1	2
4th metatarsal D	8										1
1st phalange**	2		1	1	1		1			2	1
2nd phalange**	3			1	1	1				1	
3rd phalange**	2		1		1	1	1	1	1	1	1
Total	165	4	5	6	18	16	3	17	26	46	32

Table S6. Pig element representation (Fragment count). *dP4, M3; **adjusted for frequency bias

Layer

Taxa	M	C2	1	2	3	3-4	4	4-6	5	5-CRL	CRL	6	7	8	8-9	8-10	9	10	S1	S2	S3	1-10	CLAST	NF	MPP	MT	U
Cattle	483		8	29	66		100	9	114	4	2	26	56	36	5		100	55	20	30	4	3		1	1	2	
Sheep/goat	206		11	55	45		107	18	152	7	25	78	83	82	3	3	189	110	32	17	10	4	3	2		1	
Sheep					1		4					1	2	1			4	2									
Goat																		1									
Pig	251		7	14	10		44	8	40	1	3	5	30	35	8	8	65	46	11	10	4			1			1
Equid	2						2		3			2	1	1			6	13		1						1	
Dog	218		17	27	9	2	24	3	100	3	1	17	81	45	7		89	55	4	11	1	2		1	1	1	
Cat	10		4	4					1		1									1							
Deer	7						1						1														
Red deer	4*								1																		
Roe deer	11								1								2										
Rabbit/ hare							1												1								
Rabbit							1																				
Hare	1																										
Badger	7																1										
Hedgehog												1															
Mole				1			2																				
Red squirrel					3				3	1				1				2		1							
Micro mammal		6	42	58	95	5	248	28	233	5	7	58	84	207	4	3	136	49	29	26	12	4		3			
Shrew (common)			2	2	1	1	7	1	13	1	1		4	8			7	6		1							
Field vole			5	7	12		49	4	95	1	5	17	28	43	1		17	8	7	15	1	2					
Bank vole					1		1											1									
Wood Mouse						1		1	1								1										
Rat				1																							
Domestic fowl			3	1														3									
Pheasant																								1		1	2

Passerine				2	4				3			2	4	1													
Bird		1	1	1					2	1							1	1									
Frog/ toad		7	76	39	12		48	6	30	1		11	27	30			48	29	5	9	2	4					
Total	647	7	100	202	247	9	591	72	762	24	45	207	374	460	28	14	618	352	104	113	32	15	3	9	2	6	3

Table S7. Species representation by layer. *an additional 151 red deer antler fragments were identified from the 1950s excavations, they have not been included here as, based on stratigraphy in the main chamber and our radiocarbon dates (Table 3MT), they are likely to be early medieval. Additional layer abbreviations are as follows: C2 = modern debris at the top of the shaft, S1, S2 and S3 are Steps 1, 2 and 3 respectively, NF and MT are from the base of the shaft towards the squeeze, while MPP is from within the squeeze (PP denotes 'phreatic passage'), U = unstratified.

Layer	Cattle O	Cattle N	Sheep/goat O	Sheep/goat N	Pig O	Pig N	Canid O	Canid N	Common shrew	Field vole	Red squirrel	Amphibian
M	26	1	9/27	1	5/15	1/6	4/30	2				
1				1		1	1	1	2	1		7
2	1		1	1		1	1		1	1		5
3	2		1	1		1	1		1	2	1	2
4	2		2	2	1	1	1		4	5		5
5	1		2	2	1	2	2		6	9	1	2
6			2	1	1		1	1		4		1
7	1		2		1	2	1	2	1	3		2
8			1	1	1	2	1	1	3	6		3
9	1	1	3	2	1	3	2	1	4	1		6
10	1	1	2	1	2	2	1	1	4	1		5
All**	31	2	12/27	7	7/15	6	6/30	2	27	32	2	32

Table S8. Minimum number of individual taxa represented for the major layers. N= neonatal animals; O= older animals. *All layers included so totals will differ from those calculated for major layers only. **/** indicates numbers of longbones/mandibles

Fusion stage		M	1	2	3	4	5	6	7	8	9	10
Neonate	% fused	0		100	100	100	100		100		100	100
Early		90		60	94	96	91	100	80	80	85	82
Intermediate		0		100	100	100	100		100	100	50	0
Late		67	100						0			
Final		50									0	0
Total	N	47	1	9	23	38	27	3	17	11	22	18
Porous bones	%	4									5	6

Table S9. Cattle fusion stages by layer (% fused). Where no number is given, data were not available. The number of porous bones is given as a %NISP of all bones.

	Cattle		Sheep/goat									Pig	Dog		
Wear Stage	M	4-6	M	3	4	5	6	8	9	10	S1	M	M	9	10
A					1							2			
B			1			2						7	2		
C			4						2			8	9		
D			5				1		1		1	9	5		1
E	4		3							1			9		1
F	2	1	2			1							4	2	
G	6		1	1	1			1	1		1		7		
H	8		2												
J	2		2												
Total	22	1	20	1	2	3	1	1	4	1	2	26	15	2	1

Table S10. Tooth wear stages for the major domesticates for all suitable mandibles by layer (for tooth wear stages see Hambleton (1999) and Horard-Herbin (2000) for dogs).

Cattle	M	3	4	5	7
950-1000	3				
1001-1050	7				
1051-1100	21	1			
1101-1150	19		2		
1151-1200	6	1	1	1	1
1201-1250	1		1		
Total	57	2	4	1	1

Table S11. Shoulder heights (in mm) for cattle calculated from various bones

Fusion stage		M	1	2	3	4	5	6	7	8	9	10
Neonate	% fused	60	0	38	100	45	57	0	60	100	73	75
Early		79	0	67	67	60	58	93	90	56	68	65
Intermediate		56		29	75	25	30	75	60	33	54	33
Late		60		67	0	67	0		100	29	15	17
Final		15		50	100	33	0	60	27	30	27	11
Total	N	70	2	34	17	52	71	30	42	31	114	45
Porous bones	%	6	50	6	24	10	13	3		13	6	9

Table S12. Sheep/goat fusion stages by layer (% fused). Where no number is given, data were not available

Days	M	2	3	4	4-6	5	8	9	S1	10	Total
70-80			1								1
80-90		2					1	1	1	1	6
90-100					1						1
90-112				2		1	1	1		1	6
100-110	1										1
112-131				2							2
120-136			1								1
neonate			1							1	2
Total	1	2	3	4	1	1	2	2	1	3	20

Table S13. Approximate gestation age for foetal bones of sheep/goat

Sheep/goat	M	4	7	9
540-550	1	1		2
551-560			1	
561-570	3			
571-580				
581-590				
591-600	1			
601-610				
611-620	1			
Total	6	1	1	2

Table S14. Shoulder heights (in mm) for sheep/goat calculated from various bones

Fusion stage		M	1	2	3	4	5	6	7	8	9	10
Neonate	% fused	85		0	0	0	100	100		80	0	43
Early		36	0	0	0	88	50	0	0	0	8	9
Intermediate		14			0	0	0	0	0	0	33	0
Late		0		0		0	0		0	0	0	0
Final		0	0				0		0	0	0	0
Total	N	94	3	5	6	29	16	4	15	30	51	37
Porous bones	%	17	33	40	33	28	31		53	30	24	24

Table S15. Pig fusion stages by layer (% fused). Where no number is given, data were not available

Days	M	2	3	4	4-6	7	8	9	S1	S2	10	Total
60-70						1						1
70-80						1	2	2			2	7
80-90	2			1		1	1	2	1	1	1	11
90-100	1			1	1			1				4
100-110		1										1
120-130						1			1			2
neonate				1								1
Total	3	1		3	1	4	3	5	2	1	3	27

Table S16. Approximate gestation age for foetal bones of pig.

Fusion stage		M	1	2	3	4	5	6	7	8	9	10
Neonate	% fused	100	100	100			100	50	100	100	100	100
Early		96	100	100	100	100	100	86	88	100	100	100
Intermediate		85	100	100	100	100	90	50	100	100	71	82
Final		88	100	100	50	0	90	67	90	50	69	80
Total	N	83	10	12	4	12	63	11	42	16	46	35
Porous bones	%	1	6				1	12	6		2	7

Table S17. Canid fusion stages by layer (% fused). Where no number is given, data were not available.

	Calcaneus	1st mandibular molar			
	M	M		Layers 7-10	
	GL	L	Ba	L	Ba
Minimum	22.8	15.7	5.8	19.3	8.2
Maximum	47.7	24.2	10	24.5	10.1
Mean	39.3	20.5	8.1	22	9.2
N	8	37	36	4	4

Table S18. Canid measurements from the main chamber (M) and lower layers. GL = Greatest Length, L = length, Ba = anterior breadth. Measurements taken according to von den Driesch (1976).

Element	M					1	2		3	4				5				C4	6		7		8		9			S1	S2			10	
	Horse	Cat	Deer	Badger	Lagomorpha	Cat	Cat	Mole	Red Squirrel	Horse	Deer	Lagomorpha	Mole	Horse	Cat	Deer	Red Squirrel	Cat	Horse	Hedgehog	Horse	Deer	Horse	Red Squirrel	Horse	Deer	Badger	Lagomorpha	Horse	Cat	Red Squirrel	Horse	Red Squirrel
Partial skeleton			1		1																												
Antler			1								1					2						1											
Mandible		2		1					1				1				1																
Maxilla		1		2																													
Loose tooth									1			1		2			2		2	1			1		4			1				2	2
Vertebrae						2						12			1																	4	
Scapula		1	2	1																													
Humerus			2										1																				
Radius		1	3																					1								1	
Ulna		1						1																									
Pelvis			3																														
Femur			3	1								1																			1		
Tibia		2		1																													
Metapodial		2	1	1		1	2			2															2		1		1			3	
Carpal/ tarsal	2								1					1							1											2	
Phalanges			3			1	2											1								2				1		1	
Total	2	10	19	7	1	4	4	1	3	2	1	14	2	3	1	2	3	1	2	1	1	1	1	1	6	2	1	1	1	1	1	13	2

Table S19. Anatomical representation (NISP) of horse, cat, deer and smaller mammals. Labels S1 and S2 indicate Step 1 and Step 2 respectively.

	1		2			3	5	5	6	7	8	9	10		MT	NF	U	U
Element	Bird	Domestic fowl	Bird	Domestic fowl	Passerine	Passerine	Bird	Passerine	Passerine	Passerine	Passerine	Large bird	Bird	Domestic fowl	Pheasant	Pheasant	Pheasant	Domestic fowl
Skull			1															
Vertebra							1						1					
Synsacrum						1												1
Rib	1																	
Coracoid										1						1		
Scapula		1																
Humerus								1	1					1				
Ulna						1		1		2								
Carpometacarpal		1								1								
Pelvis						1								1				
Femur								1	1		1							
Tibia		1		1	1									1	1			
Tarsometatarsal					1												1	
Longbone fragment												1						
1st phalange							1											
Total	1	3	1	1	2	3	2	3	2	4	1	1	1	3	1	1	1	1

Table S20. Element representation of bird bones from all layers (NISP)

4.0 Human Osteology

Report by Hannah O'Regan and Kirsty McLeod

4.1. Introduction

Benson and Bland[66] provide an overview of the human remains from the 1957 excavation, with updated sex and ageing information provided in our main text. Here we expand on certain aspects of the assemblages from both the 1957 and 2010-11 excavations. We particularly examine the MNI calculated from the 2010-11 excavation, the position of the human remains within the cave, and pathologies.

4.2. Methodology

Human skeletal material was assessed according to the standards recommended by Brickley and McKinley.[67] A full catalogue of the human remains was compiled using the guidelines for recording human disarticulated and co-mingled remains.[68] Each bone was catalogued according to the following criteria; site, year, context, depth, bone, element of bone, side, fusion, erosion, completeness of bone, gnawing, staining, measurements (where applicable), colour, pathology, age and sex.

Analysis of the adult skeletal remains was carried out using the ageing and sexing methods detailed in Buikstra and Ubelaker.[69] Age assessment of adults was based on bone development and degeneration, including the auricular surface[70] the pubic symphysis[71] and tooth attrition.[72] Age estimation for non-adults used dental development,[73] postcranial epiphyseal union[74] and development of the skeletal elements.[75] The sexual identification of non-adult human skeletal material was not performed because secondary characteristics of bone do not manifest until a person reaches puberty.[76] The bones of the adult and subadult human remains were highly fragmented (see below) but most of the neonatal and foetal remains were 100% complete and their positions were plotted to assess patterns of bone

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[66] Benson and Bland 1963.

[67] Brickley and McKinley 2004.

[68] McKinley 2004.

[69] Buikstra and Ubelaker 1994.

[70] Lovejoy *et al.* 1985.

[71] Brooks and Suchey 1990.

[72] Lovejoy 1985.

[73] Ubelaker 1989.

[74] Schaefer *et al.* 2009.

[75] Fazekas and Kósa 1978; Molleson and Cox 1993; Schaefer *et al*. 2009.

[76] Bass 2005.

movement within the cave. Due to the large amount of loose teeth recovered during excavations, a separate MNI analysis using teeth was carried out.

4.3. Results

4.3.1. Distribution of skeletal elements 2010-11

A total of 1595 teeth and bone fragments were identified as being human bone with 1465 of known context. Almost half of the human bones discovered in the excavated area were found in column A (n=766), and over 50% of these were in section A9. A total of 1059 human bones (72%) were located under the CRL.

4.3.2. Taphonomy: completeness and erosion

The completeness of elements can give an insight into how much post-depositional activity has occurred and is a useful indicator of how much data may be collected particularly for metric analyses. Following Brickley and McKinley,[77] the disarticulated elements were categorised as being <25%, 25-50%, 50-75% or >75% complete (Table S21). No evidence of cut marks or gnawing by scavengers was observed on any of the human remains from 2010-11 (see below for discussion of potential cut marks on material from the main chamber). For the 2010-11 excavation 1586 bones were assessed for surface erosion. Each bone was recorded using a scale of 0-4 with 0 being no erosion and 4 heavy erosion,[78] and the majority of bones had excellent or very good surface preservation (Table S21).

4.3.3. Minimum number of Individuals (MNI)

1015 bone fragments (excluding teeth) were identified and grouped by age; adult (>18yrs, n = 407), non-adult (<16yrs, n = 325), neonatal (38-42 gestational weeks, n = 282) and foetal (<38 gestational weeks, n = 1). A total of 580 bones were classed as of unknown age. To prevent duplication of bones during the counting process, only bones that were more than 50% complete (n = 638) were included in the MNI calculation. The MNI was calculated by counting the number of repeated skeletal elements (excluding the bones of the hands and feet) within the adult, non-adult, neonatal and foetal specimens with the most recurrent bone in each assemblage equalling the absolute MNI.

The right clavicle occurred most frequently in the adult disarticulated material and gave an MNI of 6 adults. The right ischium was the most frequent among the non-adult material and gave an MNI of 3 non-adults. The right ulna was the most common bone amongst the neonatal material and gave an MNI of 4 neonates. Measurements of one left femur gave an

[77] Brickley and McKinley 2004.

[78] based on McKinley 2004.

estimated age of 30 gestational weeks and this was added to the total. Therefore, the MNI for the human bone assemblage from 2010-11 is 14.

4.3.4. Location of neonatal remains

The neonatal and foetal skeletal remains were in a good state of preservation and most were 100% complete. The position of these bones within the excavated area was plotted to determine burial patterns and bone movement within the cave (Fig. 9c). Of the 283 neonatal bones present, 277 were within the excavated area and six were of unknown context.

The neonatal/foetal bones within each section of the excavated area were sorted by bone type, and left and right elements were identified. Potential individuals were identified if they were located in the same area, and were of the same age and had the same state of preservation (Table 22, Fig. S14). Using these criteria, the MNI for neonatal children was increased to five, increasing the overall MNI for the human bone assemblage to 15.

4.3.5. Age Assessment

Adult remains were too fragmentary to age, with the exception of four mandibles and three maxillae that were aged using toothwear[79] (Table S23. Non-adult remains (n = 325) were largely aged by dental development and epiphyseal fusion[80]. A total of 113 bones were aged using epiphyseal fusion; 46 bones gave an estimated age of 6 months to 2 years, 51 bones gave an estimated age of 2-8 years and 16 bones gave an estimated age of 8-15 years. Seven mandible and maxillary fragments were considered suitable for age estimation by dental development and this showed that there were at least five non-adults (Table S23). Infant remains, probably of the same individual, with an estimated age of 2-4yrs were found above the CRL with a left and right mandible located in section B3 and a left maxilla in section A3. All other specimens were located in the bottom of the excavated area (A9-AA10). The MNI for non-adults can therefore be increased from 3 to 5, changing the MNI for the 2010-11 bone assemblage to 17.

X-rays taken of some of the children and adolescent specimens from both the 1950s and 2010-11 excavations suggested that the Ubelaker[81] methodology may have over-estimated

[79] Lovejoy 1985.

[80] Dental development following Ubelaker 1989; epiphyseal fusion following Schaefer *et al*. 2009.

[81] Ubelaker 1989.

their ages, a known issue with this system[82]. Therefore the ages above should be regarded as towards the upper age boundary for these individuals.

4.3.6. Dental analysis

Isolated human teeth and others in mandibular and maxillary fragments were discovered in abundance during excavations and through the sieving of sediments. A total of 289 human teeth were recovered and included; 88 incisors, 49 canines, 59 pre-molars and 93 molars. Of the 232 isolated teeth, 207 were of known context, and their location is plotted in Fig. 9dMT.

4.3.7. MNI based on dentition

The left first incisor of the mandible most frequently occurred in the adult dentition and gave an MNI of 14 adults. The left first incisor of the maxilla was the most recurrent tooth among the non-adult material and gave an MNI of 8 nonadults. Therefore the MNI based on dentition is 22.

4.3.8. Summary of 2010-11 excavations

The excavated human disarticulated bone fragments equalled 1,595 with most bones being highly fragmented and less than 25% complete. The human MNI is 17 (6 adults, 5 non-adults, 5 neonatal and 1 foetal) with 72% of human bone found under the CRL. The MNI based on teeth gives a higher number of 22 individuals (14 adults and 8 non-adults). Age estimation has provided a variety of ages within the sample ranging from 0 to 50 years.

4.4. Palaeopathology

Overall, the Dog Hole individuals, from both excavations, had relatively few pathologies. Those that were identified (caries, calculus, hypoplasia, fracture, spinal degenerative joint disease (SDJD), osteoarthritis, cribra orbitalia, porotic hyperostosis and harris lines) are described below.

4.4.1 Dental Pathology

A palaeopathological examination of all teeth (n = 434) has revealed a relatively healthy population with only 27.7% of teeth displaying calculus and 1.8% of all teeth displaying dental caries (note that encrypted or unerupted teeth were not included in these calculations). In calculating these proportions all teeth that were still *in situ* in mandibles were counted as if they were isolated teeth, as these formed the majority of the sample.

Caries is the progressive demineralisation of the enamel surface, which can extend to the loss of the entire tooth[83]. Carious lesions are the most common dental disease found in archaeological excavations[84]. Eight examples of caries were present in the Dog Hole sample

[82] AlQahtani *et al*. 2014.

[83] White *et al*. 2012, 455.

[84] Hillson 2001.

of 434 teeth. Six of these caries were on molars (M^1 = 1, M^2 = 1, M^3 = 1, M_2 = 2, M_3 = 1), a P^2 and an I^1. Often associated with caries, abscesses form when bacterial infections invade the body tissue of the mandibles and maxillae. A single abscess, located approximately in the position of the M_1, was identified in an adult mandible.

Calculus is mineralised plaque[85] and frequently develops on the lower incisors and upper molars as they are the teeth nearest the salivary glands.[86] Calculus was identified on a minimum of 120 out of 434 teeth in the assemblage, the majority of which were molars (n = 48).

Six isolated teeth from the 2010-11 excavation showed evidence of Dental Enamel Hypoplasia (DEH). These are lines or pits on the enamel surface, which, like Harris lines (below), indicate metabolic stress in the individual.[87] Of the six teeth affected, three were incisors, two were canines, and one a premolar. One of the incisors had two hypoplastic bands, while the others were all single lines.

4.4.2. Osteoarthritis

Osteoarthritis is a degenerative joint disease usually common with advancing age[88] when the body gradually loses the ability to maintain joint cartilage.[89] An individual with bones that show eburnation (bone polishing) can be diagnosed as having osteoarthritis.[90] Other diagnostic criteria include; osteophytes, sclerosis, joint surface pitting and alteration of joint surfaces.[91] Limited evidence for osteoarthritis was identified at Dog Hole; eburnation was observed on the inferior distal surface of a left humerus and on the proximal surface of a distal hand phalanx.

4.4.3. Spinal degenerative joint disease (SDJD)

Vertebral osteoarthritis is a direct consequence of spinal stress due to the strain placed on the spine through bipedal posture and mechanical loading.[92] With advancing age, degenerative change in the form of osteophytes can be observed on vertebral body margins, which in later stages is followed by an increase in porosity in the vertebral body.[93] SDJD was scored according to Brothwell's criteria, where stage I indicated mild lipping, and stage III indicates considerable osteophytic growth and widespread porosity of the vertebral

[85] White *et al.* 2012, 456.

[86] Roberts and Manchester 2010.

[87] White *et al.* 2012, 455-456.

[88] Roberts and Manchester 2010.

[89] Mann and Hunt 2005.

[90] Waldron 2009.

[91] Rodgers *et al.* 1987.

[92] Bridges 1994.

[93] Brothwell 1981.

body surface and, in some cases, eburnation. The following vertebrae were affected (only those vertebrae that were >30% complete were recorded): Cervical 10 out of 73 (stage I = 1/73, stage II = 4/73, stage III = 5/73), Thoracic 19 out of 148 (Stage I = 11/148, Stage II = 6/148, Stage III = 3/148), Lumbar 21 out of 74 (Stage I = 9, Stage II = 11, Stage III = 1). Two of the lumbar vertebrae were a refitting L4 and L5 from level B4 which were stage II and stage III respectively.

4.4.4. Schmorl's nodes

The degeneration of intervertebral discs exerting pressure on the vertebral body of the spine can cause Schmorl's nodes. Schmorl's nodes are usually observed on the lower thoracic and lumbar vertebrae.[94] Severity of Schmorl's nodes was recording using the scheme of Üstündağ[95] where those of less than 2mm depth and less than half the width of the vertebrae are classified as stage I, and deeper and wider lesions are classified as stage II. Presence of Schmorl's nodes in the Dog Hole assemblage was as follows (only those vertebrae that were >30% complete were recorded): cervical: 0 out of 73; Thoracic 21 out of 148 (Stage I = 14/148, Stage II = 7/148); Lumbar 7 out of 74 (Stage I = 5/74, Stage II = 2/74).

4.4.5. Cribra Orbitalia

Cribra orbitalia is amongst the most frequent pathological lesions seen in ancient human skeletal collections.[96] It is a condition exhibiting coral-like lesions of the eye orbits. The causes of cribra orbitalia are debated, with the traditional explanation of iron-deficiency anaemia now in doubt, with additional suggestions of megablastic anaemia (i.e. Vitamin B_{12} deficiency), malaria, or scurvy, being put forward.[97] Similar lesions can also be observed in other conditions such as vitamin C and D deficiency, infections and tumours.[98]

The presence of cribra orbitalia was scored using Steckel.[99] A combined total of 22 left orbits and 19 right orbits were identified from the 1957 and 2010-11 excavations. Of these, 10 had lesions consistent with cribra orbitalia, seven with stage II, and three with stage III.

4.4.6. Porotic Hyperstosis

Porotic Hyperstosis is a condition exhibiting coral-like lesions of the cranial vault, usually the parietals and occipital.[100] Like cribra orbitalia it has been suggested that that these lesions indicate a severe form of iron-deficiency anaemia,[101] but megablastic or haemolytic

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[94] Saluja *et al*. 1986.

[95] Üstündağ, 2009.

[96] Walker *et al*. 2009.

[97] Walker *et al*. 2009; Smith-Guzmán, 2015.

[98] Roberts and Manchester 2010.

[99] Steckel 2006.

[100] White *et al.* 2012, 449.

[101] Roberts and Manchester 2010.

anaemia are considered more likely.[102] One occipital fragment from the 2010-11 excavation presented with lesions associated with porotic hyperstosis.

4.4.7. Fractures

An adult distal radius from the Main Chamber (1957 excavation), had a broken and healed fracture to the articulation. A second possible healed fracture was seen in a misaligned but thoroughly remodelled shaft of a proximal hand phalanx from the 2010-11 excavation.

4.4.8. Trauma: cutmarked bones

Three potentially cut-marked human remains were identified in the 1950s assemblage. Bland[103] published two rib fragments with possible cut marks on them. The re-analysis of the remains also identified a complete and fully-fused right clavicle with multiple potential cut marks on the inferior surface towards the sternum (Fig. S15). Together these marks suggest that at least one individual may have experienced interpersonal violence.

4.4.9. Osteochondritis Dissecans

Osteochondritis dissecans is the fragmentation and collapse of a joint usually caused by the death of bone tissue and commonly affects young individuals especially males in the first decade of life.[104] One left proximal thumb phalanx presents with a circular area of lesions on the proximal end commonly found with osteochondritis dissecans (Fig. S16).

4.4.10. Periostitis

One femoral shaft and one tibial shaft from the main chamber had isolated patches of woven bone consistent with periostitis. This is an inflammation of the periosteum that is caused by trauma or infection and may be a symptom of a number of different diseases.[105]

4.4.11. Harris Lines

The femora and tibiae from the 1950s excavations were X-rayed at Alder Hey Children's Hospital to determine the presence of Harris lines within the population. Harris lines are lines of the cessation of growth, often associated with childhood illness or malnutrition,[106] but have more recently been suggested to be a normal part of growth.[107] For this study, the presence of a Harris line was defined, following Mays,[108] as a line that extended over half the width of the diaphysis (see Fig. S17 for example). The presence of Harris lines, per bone,

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[102] Walker *et al.* 2009.

[103] Bland 1994.

[104] Roberts and Manchester 2010.

[105] White *et al*. 2012, 446.

[106] Aufderheide and Rodríguez-Martín 1998.

[107] Papageorgopoulou *et al*. 2011.

[108] Mays 1995.

are presented in Table S24. Only two bones had more than one line, indicating multiple occasions when growth ceased within these individuals.

4.5. Stained bones

A total of 43 human bones from Dog Hole had green staining indicating proximity to copper alloy jewellery (13 from the 2010-11 excavation and 30 from the 1950s excavation). In contrast only two non-human bones (both pig) had green staining, indicating a strong association between the copper alloy staining and human remains. The staining was largely found on the upper and lower limbs, consistent with jewellery being worn on the wrists and ankles (Table S25). Notably, only the left humerii, radii and metacarpals were stained, and the radii indicate an MNI of 3 individuals, at least two of whom were non-adults. Iron (orange) staining shows a slightly different pattern, with 27 human bones having staining, and eight non-human remains, comprising one pig, 1 sheep/goat, three cattle, one dog and two unidentified. The orange staining was largely identified on material from the 1950s excavation (and may be due to the excavation methods used), while only three human bones from the 2010-11 excavation showed these stains.

4.6. Human osteology summary (Main Chamber and 2010-11)

As discussed in the main text there were a minimum number of 28 individuals from the site. This is probably a considerable underestimate, given that not all of the chamber has been excavated, and even the small portion that we excavated contained large quantities of neonatal remains. Sexing using the adult innominates indicated that at least 4 males and two probable males, 4 females and two probable females were present. Overall, the population appears to have been healthy, with very few pathologies noted, except Cribra orbitalia, possible porotic hyperostosis, and Harris lines indicating that there were some deficiencies/illness experienced during youth and adulthood. Two fractures, on a phalange and a radius, were also noted.

Section 4: Human osteology Tables and Figures

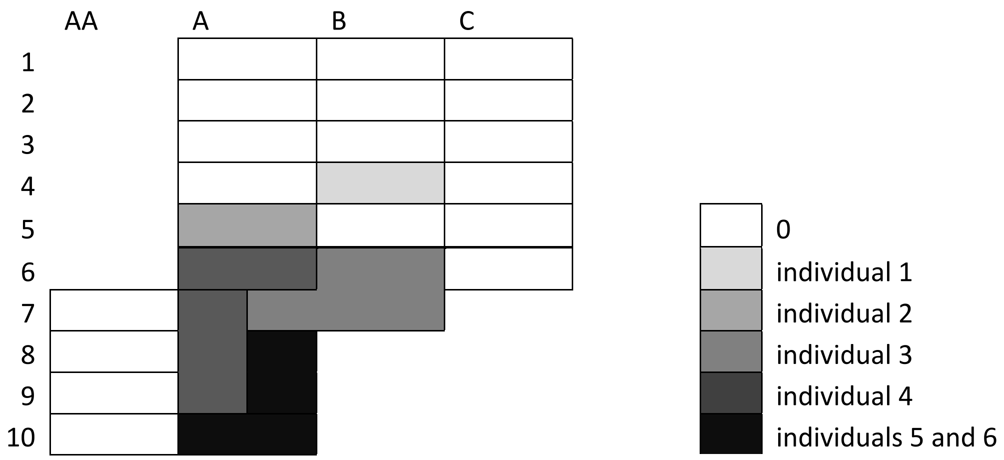

Fig. S14. Location of foetal and neonatal individuals within the 2010-11 excavation.

Fig. S15. Human clavicle from the main chamber with possible cutmarks.

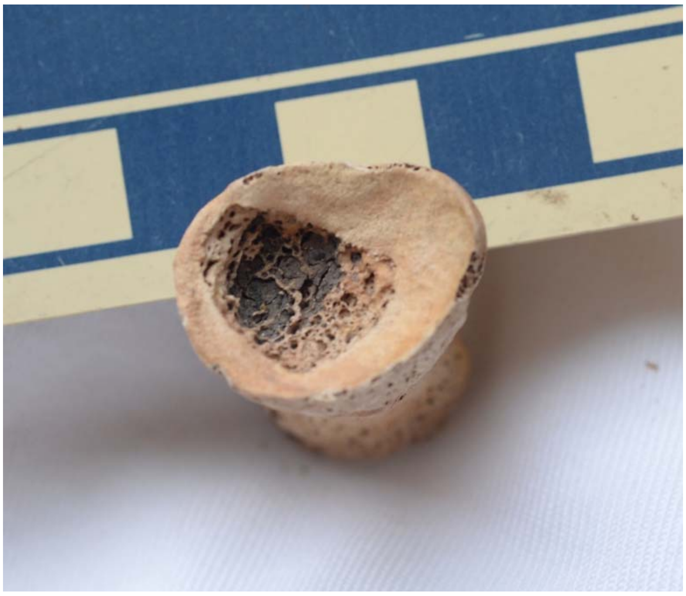

Fig. S16. Osteochondritis dissecans on human first phalanx from A9c, Dog Hole.

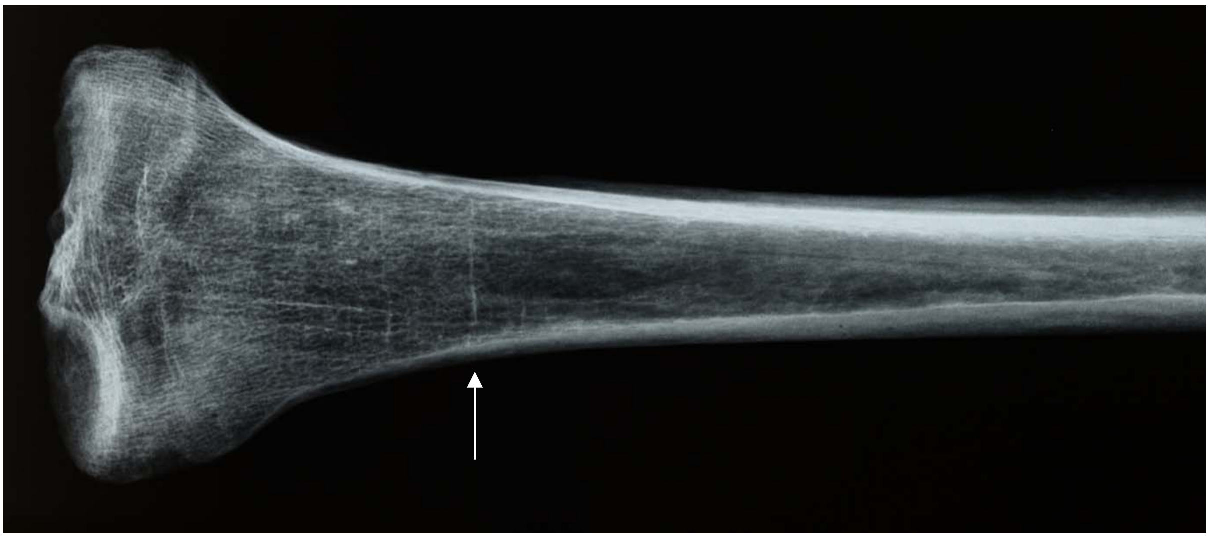

Fig. S17. X-ray showing Harris line (marked with white arrow) on the proximal third of an adult tibia.

IFA Erosion category	0	1	2	3	4
Proportion (and number) of bones (n = 1586)	62.1% (n = 985)	27.9% (n = 443)	8.1% (n = 129)	1.6% (n = 25)	0.25% (n = 4)
% completeness	<25%	25-49%	50-75%	>75%	
Dog Hole human remains (n = 1595)	42.6% (n = 679)	11.1% (n = 177)	14.5% (n = 231)	31.9% (n = 508)	

Table S21. Classification of IFA erosion categories (McKinley, 2004) and completeness (Brickley & McKinley, 2004) for human remains from the 2010-11 excavation at Dog Hole.

Bone	Side	Age	Layer
Femur	1 left 3 left 1 right	foetal neonatal neonatal	B4 A5, B6, A10 A10
Tibia	3 right	Neonatal	A9
Humerus	2 right 1 left	neonatal neonatal	A7 A10
Ulna	2 left 4 right	neonatal neonatal	A6, B7 A7, A9, A10
Radius	2 right 2 left	neonatal neonatal	A7, A10 A8, A10
Clavicle	1 left	Neonatal	B7
Scapula	1 left 1 right	neonatal neonatal	A10 A10
Ischium	1 left 1 right	neonatal neonatal	A10 A8-A10
Ilium	2 right 1 left	neonatal neonatal	A7, A10 A10

Table S22. Body part, side, and location of potential foetal and neonatal human ABGs from the 2010-11 excavation at Dog Hole.

Location	Mandible or maxilla?	Side	Age (years)	Age estimation method
A3	Mand	R	20-30	Tooth wear
B3	Mand	R	35-40	Tooth wear
B3	Max	R	35-50	Tooth wear
C3	Max	L	30-35	Tooth wear
B3	Mand	both	2-4	Dental development
B4	Mand	L	35-45	Tooth wear
A5	Max	L	2-4	Dental development
B5	Mand	R	24-30	Tooth wear
B5	Max	both	30-35	Tooth wear
AA9	Max	L	1-2	Dental development
A9	Max	R	3-5	Dental development
A9	Max	L	2-4	Dental development
AA10	Max	L	16-20	Dental development
A10	Mand	R	9.5-14.5	Dental development

Table S23. Adult and juvenile mandibles and maxillae aged using dental development (Ubelaker, 1989) and tooth wear (Lovejoy, 1985), shown in stratigraphic order within the site. Note that the majority of younger individuals were towards the bottom of the excavation.

Bone	proximal or distal?	Harris lines present	Presence (%)
Femur	distal (n=29)	3 adults (1 line each), 1 non-adult (4+ lines)	4/29 = 13.8%
Tibia	proximal (n = 17)	1 adult (1 line)	1/17 = 5.9%
Tibia	distal (n = 15)	3 adult (2 x 1 line, 1 x 2 lines)	3/15 = 20%

Table S24. Presence of Harris lines in the human distal femora and proximal and distal tibiae from Dog Hole.

Body part	Copper alloy stained human remains	Iron stained human remains
Cranium	Occipital (n = 1)	Parietal (n = 1) Temporal (n = 1)
Axial skeleton	Scapula (n = 1) Rib (n = 1) Vertebrae : axis (n = 1), other cervical (n = 2) Sacrum (n = 1) Ilium (n =1)	Scapula (n = 1) Clavicle (n = 1) Rib (n = 1) Vertebrae: cervical (n = 1), thoracic (n = 1) Ilium (n = 1)
Arm	Humerus (n = 3) Radius (n = 3) Ulna (n = 1) Carpals: Hamate (n = 1), navicular (n = 1) Metacarpals: MC1 (n = 1), MC3 (n = 2) Phalanges: first (n = 3)	Humerus (n = 3) Metacarpals: MC2 (n = 1), MC3 (n = 2), MC4 (n = 1) Phalanges: first (n = 1)
Leg	Femur (n = 1) Patella (n = 1) Tibia (n = 9) Fibula (n = 4) Tarsals: talus (n = 1), calcaneum (n = 1) cuneiforms (n = 3).	Femur (n = 2) Patella (n = 3) Tibia (n = 4) Fibula (n = 1) Tarsals: calcaneum (n = 1)

Table S25. Summary of copper and iron stained human remains from Dog Hole categorised by body part.

5.0. Site taphonomy

Cave taphonomy is complex and the presence of voids between clasts can allow material to slip downwards through the site. This is particularly common along cave walls, as water moves its way through the site (e.g. as suggested for Gough's Cave by Jacobi and Higham[109]). At Dog Hole this was seen in the 2010-11 excavation by the void found in A3 and A4, where material had washed down or collapsed below this area. While the radiocarbon dates (see main text) indicate a chronological order within the site, it is clear there has been some movement of material within the site, and below the CRL. Here we summarise the evidence for this movement, based on the accumulation of the small finds and bones.

Refitting parts of two artefacts were found within the cave. Two fragments of the same ear-ring, a thin circular sectioned wire loop (SF215, 236), were found in C3 and Step 1, and two fragments of silver-alloy bracelet (SF225, 263) that appear to belong together were found in B4 and AA8. Modern contaminants were also noted as aluminium clothing rivets were identified in AA7, AA8 and Step 2. It is notable that these specimens all appear to be from column AA (at the side of the shaft) and the 'steps', suggesting that they had moved from the top of the site to the base, potentially fairly recently. The distribution of apparently recent bones of pheasant, rat and rabbit indicates similar movement (one pheasant bone was from the modern debris, and two others were unstratified at the base of the shaft, the rat specimen was found in Layer 2, and a rabbit specimen was in Layer 4).

Marks on some of the bones are consistent with water erosion, implying that at some point water was percolating if not running through the fills, which would provide a good medium for the transport of small bones and teeth. This is exemplified by the movement of some burnt material from the CRL into the strata below (Table S2). However, like the human neonatal remains, several non-human ABGs were also recovered (Table 2MT) suggesting minimal disturbance to some contexts. The presence of accessory bones indicates that the lower leg bones of animals were deposited still fleshed, although their predominance in Layers 3 to 7 (Fig. S3) indicates some vertical movement of bones through the strata. This suggests that the passage of bones was dependent on the area of deposition, with some staying together and others travelling through the layers. In terms of the individual columns, human bone fragments were present throughout AA7-AA10, with the majority from AA10 where bones from the skull, thorax, hands and feet were in abundance. In column A, only 49 fragments of human bone were found in the sections above the CRL, and 717 bones below. Bones of the skull, thorax and hands are well represented in sections A7-A10 with bones of the os coxae, legs and feet appearing in section A9 where the majority of bones from this column are found. Most of the human bones contained within column B can be found in section B5 where bones from the skull, thorax and hands are of great quantity. A decrease in all bones can be observed after B5 with the exception of hand bones which increase in

[109] Jacobi and Higham 2009.

section B6 and then decline in B7. Column B ceases after this point. Column C contains the least amount of human bone with the majority of bone in this column located in sections C3 and C4. Bones of the skull, thorax, hands and feet are well represented in these sections and eventually decrease by section C6, at which point Column C ceased due to the curvature of the cave wall.

In summary, the distribution of human remains showed that there were relatively few in the topmost layers (consistent with these being cavers' spoil as discussed in section 1) and were found in increasing numbers towards the bottom of the site. Long bones from the arms and legs were largely absent, while bones from the hands, feet and thorax were present throughout, and the densest accumulations were in AA10, A9, B5, and C3 and C4. The location of the neonatal bones and isolated teeth can be seen in Fig. 9MT.

Overall, there is evidence for some movement of material within the site, but as discussed in the main text, there appears to have been different patterns for the various artefacts and bone types. Overall we are confident that the remains from below the CRL are less affected by movement than those above, for the reasons outlined in the main text.

The speed of deposition can also be implied from the animal remains. There was very little gnawing on the bones, and none observed from Layer 4 down, indicating that most material was disposed of quickly, or that it was at least kept away from dogs. This again implies that deposits were made while fresh, rather than being left on a midden and later moved into the cave.

6.0. Palaeoenvironment

The large number of bones from wild taxa provides a backdrop to the environment of Dog Hole. It is hard to know for sure how these animals came to be in the cave, but some such as the micromammals, frogs/toads, moles and hedgehog most likely lived around the cave, and became the victims of accidental falls into the hole. The red squirrel and badger may also represent animals living nearby, although the value of their fur could mean they were disposed of by human action. Similarly, the deer and rabbit may have been hunted and eaten first.

Palaeoenvironmental evidence is limited, and the most useful evidence we have are the small mammals. The dominance by field voles *Microtus agrestis* (with low numbers of bank voles *Myodes glareolus*), suggests long grassy vegetation rather than woodland – potentially quite damp. The presence of common shrews *Sorex araneus* is also consistent with this,[110] as are the large numbers of amphibian bones. The small amount of red squirrel *Sciurus vulgaris* could be 'pitfall' remains from animals in surrounding woodland but could also be 'archaeological' e.g. bones associated with skins – a difficulty in interpretation that has also been a problem in other Cumbrian sites.[111] The charcoal suggests access to woodland somewhere in the vicinity.

More broadly much woodland clearance had taken place in North West England by Roman times, with varying amounts of woodland recorded from the small number of pollen sites from southern Cumbria and north Lancashire.[112] Pollen from relatively local peat cores (from sites approximately 10km NW of Dog Hole) show some woodland with varying amounts of clearance during Roman times[113] – broadly consistent with our evidence for open conditions but with sources of wood available. Clearly there is scope for variation in the surrounding vegetation during the several hundred years of Romano-British activity at the site. For example although the location is now woodland it was much more open at the time of the excavations in the 1950s.

[110] Harris and Yalden 2008.

[111] e.g. Clare *et al.* 2008; Collingwood 1909.

[112] Dark 2000.

[113] Coombes *et al.* 2009; Dickinson 1975.

7.0 Isotope methods and analysis

7.1. Analytical Method for lead (Pb) and strontium (Sr) isotopes

The enamel surface of the tooth was abraded from the surface to a depth of >100 microns using a tungsten carbide dental bur and the removed material discarded. An enamel sample was cut from the tooth using a flexible diamond edged rotary dental saw. All surfaces were mechanically cleaned with a diamond bur to remove adhering dentine. The resulting sample was transferred to a clean (class 100, laminar flow) working area for further preparation. In a clean laboratory, the sample was first cleaned ultrasonically in high purity water to remove dust, rinsed twice, and then soaked for an hour at 60°C, rinsed twice, then dried and weighed into pre-cleaned Teflon beakers. The sample was mixed with ^{84}Sr tracer solution and dissolved in Teflon distilled 8M HNO_3 and converted to bromide form using 0.5M HBr.

It was passed through an Eichrom AG1 anion resin column to collect the Pb and then the residues from this column were converted to chloride form and strontium was collected using Eichrom AG50X8 resin columns.

Strontium was loaded onto a single Re Filament following the method of Birck[114] and the isotope composition and strontium concentrations were determined by Thermal Ionisation Mass spectroscopy (TIMS) using a Thermo Triton multi-collector mass spectrometer. The international standard for $^{87}Sr/^{86}Sr$, NBS987, gave a value of 0.710278 ± 0.000016 (n=43, 2SD) during the analysis of these samples. Blank values were in the region of 50pg.

Pb isotope analysis of the samples was conducted using a Thermo Fisher Neptune Plus MC-ICP-MS (multi-collector inductively coupled plasma mass spectrometer). This mass spectrometer is fitted with the Jet interface, in which enhanced sensitivity is achieved through the use of a large volume interface pump (Pfeiffer On-Tool Booster 150) in combination with the Jet sampler and X skimmer cones. Prior to analysis, each sample was appropriately diluted (using Teflon distilled HNO_3) and spiked with a solution of Thallium (Tl), which is added (in a ratio of ~1_Tl:10_Pb) to allow for the correction of instrument induced mass bias. Samples were then introduced into the instrument via an ESI 50µl/min PFA micro-concentric nebuliser attached to a desolvating unit, (Cetac Aridus II). All isotopes of interest were simultaneously measured using the cup configuration shown in Table S26.

Each acquisition consisted of 75 ratios, collected at 4.2-second integrations following a 60 second de-focused baseline measurement.

The precision and accuracy of the method was assessed through repeat analysis of NBS 981 Pb reference solution, (also spiked with Tl). The average values obtained for each of the

[114] Birck 1986.

mass bias corrected NBS 981 ratios were compared to the known values for this reference, (taken from Thirlwall[115], Pb double spike: $^{206}Pb/^{204}P$ = 16.9417, $^{207}Pb/^{204}Pb$ = 15.4996, $^{208}Pb/^{204}Pb$ = 36.724, $^{207}Pb/^{206}Pb$ = 0.91488, $^{208}Pb/^{206}Pb$ = 2.1677). All sample data were subsequently normalised, according to the relative deviation of the measured reference values from the true value. The analytical errors reported for each of the sample ratios were propagated relative to the reproducibility of the session NBS 981, to take into account the errors associated with the normalisation process.

7.2. Analytical method: oxygen in structural carbonate

For the isotopic analysis of phosphate carbonate oxygen, approximately 3 milligrams of prepared enamel was loaded into a glass vial and sealed with septa. The vials were transferred to a hot block at 90°C on the GV Multiprep system. The vials were evacuated and 4 drops of anhydrous phosphoric acid are added. The resultant CO_2 was collected cryogenically for 14 minutes and transferred to a GV IsoPrime dual inlet mass spectrometer. The resultant isotope values are treated as a carbonate. $\delta^{18}O$ is reported as per mil (‰)($^{18}O/^{16}O$) normalized to the PDB (PeeDee Belemnite) scale using a within-run calcite laboratory standard (KCM) calibrated against SRM19, NIST reference material and were converted to the SMOW (Standard Mean Ocean Water) scale using the published conversion equation of Coplen[116]: SMOW=(1.03091 x $\delta^{18}O_{VPDB}$) +30.91. Analytical reproducibility for this run of laboratory standard calcite (KCM) for δ^{18}OSMOW is ± 0.03‰ (1 s.d., n=9) and δ^{13}CPDB is ± 0.02‰ (1 s.d., n=9). The carbonate oxygen results $\delta^{18}O_{SMOW(c)}$ are converted phosphate values $\delta^{18}O_{SMOW(p)}$ using the equation of Chenery et al.[117] ($\delta^{18}O_{SMOW\,(p)} = 1.0322*\delta^{18}O_{SMOW\,(c)} - 9.6849$). It should be noted that oxygen data can be presented in a number of forms. Here we use $\delta^{18}O_{(phosSMOW)}$ as most human data is in this form. However, the other commonly used form $\delta^{18}O_{(carbSMOW)}$ is also documented in Table 7MT.

7.3. Non-human strontium results

Strontium isotope analysis was run on four non-human specimens for comparison with the human remains (Table S27). The horse sample was from the articulated horse at the base of the site, and the strontium value is consistent with it being raised in the local region. The cattle were more variable, with two having Sr values consistent with the northwest (Cattle 2 and Cattle 3), while the other has a much more radiogenic value (0.7164) that is unusual in the British Isles. Such values have previously been found at other sites, but their interpretation is still uncertain[118].

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115 Thirlwall 2002.

116 Coplen 1988.

117 Chenery *et al.* 2012.

118 Montgomery *et al.* 2007; Waddington and Montgomery 2017.

7.4. Trace Element Analysis - methodology (Simon Chenery)

Individual samples of tooth enamel were dissolved using concentrated nitric acid in PFA vials (Savillex, LLC), taken to dryness and reconstituted with a mixture of 1% v/v dilute nitric acid and 0.5% hydrochloric acid to give a calcium concentration of c. 75 $mg.L^{-1}$.

These solutions were then analysed by an Agilent 8900 series ICP-MS. The instrument was operated using He collision gas, H_2 reaction gas or O_2 reaction gas cell modes to minimise spectral interferences. Calibration was performed using a series of synthetic multi-element solutions (QMX Laboratories) and quality control solutions were obtained from separate sources to calibration solutions. Concentrations were corrected for: (i) matrix suppression, using a series of added internal standard elements (Sc, Rh, In, Te and Ir); (ii) residual interferences, using factors calculated from single element standards and (iii) blank contributions. Data quality were evaluated using chemical control solutions for accuracy and precision; duplicates for typical sample reproducibility and digestion blanks for total method detection limits. Typical accuracy and precision over the range of elements was better than 10% RSD, significantly away from the detection limit.

Section 7: Tables

High 4	High 3	High 2	High 1	Ax	Low 1	Low 2	Low 3	Low 4
	^{208}Pb	^{207}Pb	^{206}Pb	^{205}Tl*2	^{204}Pb	^{203}Tl*2	^{202}Hg*1	
					^{204}Hg			

Table S26. Cup configuration for Pb isotope analyses. [1] Measured to allow for the correction of the isobaric interference of ^{204}Hg (Mercury) on ^{204}Pb. *2 Measured to allow for the correction of instrumental mass bias

Sample	Sr ppm	^{87}Sr/^{86}Sr (cor)
Horse	324	0.710606
Cattle 1	105	0.716418
Cattle 2	182	0.712127
Cattle 3	138	0.710464

Table S27. Strontium isotope and concentration values for Dog Hole horse and cattle remains.

8. Previous Finds (from Benson and Bland 1963)

I. Bracelet (Fig. z (x 3/4)). 5-stranded, twisted wire. Maximum diameter 7.4 cm. Hook fasteners at each end. The wire itself stands half-oval in cross-section with base externally (width 0.15 cm.).
II. Bracelet (Fig. 2a and b (x i / z)). Solid, penannular, incised. Maximum diameter 6.4 cm. Material of bracelet mainly oval in cross-section (max. diam. 0.3 cm.), but tending to be more circular towards terminals. Decorations simple, pattern ribbed and incised, "characteristic of toilet articles of the second and third centuries A.D."
III. Bracelet (Fig. 3 (x i / z)). Solid penannular. Maximum diameter 5.7 cm. Slight and indistinct ribbing of terminals. Cross-section laterally flattened oval (max. diam. 0.25 cm).
IV. Armlet (Fig. 6 (x 2/ 3)). Penannular, undecorated. Maximum diameter 9.9 cm. Made from single piece of square bronze wire (? tinned surface) 0.2 x 0.2 cm. Ends overlapping and twisted round each other.
V. Bracelet (not illustrated). Circular, 3 fragments. Diameter *c.* 10.5 cm. Made from a single strand of twisted wire. The cross-sectional dimensions of the bronze wire of this bracelet is identical with that of (IV) and both appear to contain a higher proportion of copper than bracelets (II) and (III), suggesting a common origin.
VI. Finger-ring (Fig. 5 (x 2/I)). Diameter *c.* 2 cm. Made from a single piece of bronze wire. The bezel (max. diam. 0.8 cm.) is formed by the two free ends of the wire
VII. Finger ring (not illustrated). Smaller, simpler. Diameter 1.4 cm. Made from a single piece of flattened bronze wire. (Max. width 0.1 cm.).
VIII. Terminal of bronze bracelet (Fig. 4 (x i / i)). Flattened, tongue-shaped.
IX. Axe-head ‘Rectangular ended head, curved bit and flange. Maximum length 14.5 cm. Cutting edge 5.4 cm. Head hole 2.5 x 3.25 cm. Hammerhead width 2.4 cm. Weight 10 oz.
X. ‘Penannular brooch. External diameter 3.3 cm. Humped cross-pin. Terminals indeterminable.’
XI ‘Miscellaneous iron studs. Large heads. Very corroded.’ (Benson and Bland 1963, 65) [these are almost certainly hobnails].
Jet beads; 8½ beads of Whitby jet; 6 ½ have a simple deep division into two segments; one has three segments; one is divided into four segments by narrow, straight-sided, annular incisions’ (p. 66).
Beads ‘small translucent blue-green glass, varying shades. Size varies from 0.15 to 0.25 cm. in depth. 10 and a half found in all’
XIV. Bead ‘translucent yellow segmented glass. Length 0.9 cm. Guido comments: ‘Appears to have been coated with gold and to have had striations along its axis which may have been filled with a contrasting colour’
XII. Beads. ‘Opaque blue glass. Basal diameters range from 0.3 to 0.5 cm. Made by the core-wound process. 19 beads and 6 fragments found in all.

Stone objects included: two whetstones – one globular with a single used face and the other elongate with all faces used (Bland, pers. obs.); a fragment of a ?net-sinker'- a pierced sandstone of irregular shape.

9.0. References

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