Rural life, Roman ways? Examination of late Iron Age to late Romano-British burial practice and mobility at Dog Hole Cave, Cumbria

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Abstract

The scarcity of Romano-British human remains from northwest England has hindered understanding of burial practice in this region. Here, we report on the excavation of human and non-human remains and material culture from Dog Hole cave, Haverbrack. Foetal and neonatal infants had been interred alongside a horse burial and puppies, lambs, calves and piglets in the very latest Iron Age to early Romano-British period, while the mid-late Roman period was characterised by burials of older individuals with copper-alloy jewellery and beads. This material culture is more characteristic of urban sites, while isotope analysis indicates that the later individuals were largely from the local area. We discuss these results in terms of burial ritual in Cumbria and rural acculturation.

Keywords

Horse burial, infant burial, gold-in-glass beads, rural settlement

Introduction

Reviews of material culture and burial practice in Roman Britain have yielded a number of consistent patterns in relation to the north and west – that inhumation burials are 'essentially absent' (Esmonde Cleary, 2009: 215; Pearce, 2013: 22-23) and those that are present are linked to military sites (Esmonde Cleary, 2009: 215), and that 'Roman' material culture is rare outside forts and other military structures (Esmonde Cleary, 2009: 199; Brindle, 2016: 330). Indeed Brindle (2016: 330) recently said that the few Roman artefacts in rural settlements from northern England suggests 'only limited interaction between the occupants of most farmsteads and the military.' These patterns match a broader, widely discussed, distribution of more the visible aspects of Roman culture – such as villas and temples - that are concentrated in the south and east of the country (Mattingley, 2006). While some of this patterning is undoubtedly due to taphonomic processes, such as the soils in the northwest being very bad for bone preservation, this cannot be the sole reason that Roman material culture is effectively missing from the rural sites in the region. Little is also known of Romano-British rural burial practice in northwest England, as few burials have been excavated. The Roman cemeteries at Carlisle in the later Roman period have produced few graves which have been subject to adequate recording and investigation, while Brougham in the Eden Valley is largely a cremation cemetery (Cool, 2004).

Here we report on the rural site of Dog Hole Cave (hereafter Dog Hole), in Haverbrack, Southern Cumbria, which departs from some of these well-established NW v. SE generalizations. The cave contains a unique assemblage of Romano-British human and non-human remains and artefacts. These include a late Iron Age to Early Roman concentration of foetal and neonatal remains associated with a horse burial, and later adult and sub-adult human burials with artefact types most closely paralleled with southern, urban or military sites. To examine the question of the origins of the people in Dog Hole we have also undertaken stable and radiogenic isotope analysis on the human remains, an approach that has been highlighted as lacking for rural Romano-British populations (e.g. Eckardt et al., 2014). The assemblage from Dog Hole has previously been classified as a burial chamber and later dog den (Benson & Bland, 1963), a votive deposit (King, 1974), burial site (Branigan and Dearne, 1992), and most recently as a potential shrine (Allen et al. 2018). Using data from excavations in 2010-11 and incorporating material from earlier excavations where appropriate, we examine these interpretations, discussing the material culture and human remains from Dog Hole and what this can tell us about the representation of 'Roman' culture in a rural setting.

Dog Hole

Dog Hole, Haverbrack (SD482801) is situated in Carboniferous limestones near the Kent Estuary close to the villages of Storth and Sandside in the north eastern corner of Morecombe Bay (Fig. 1). The cave has a vertical entrance hole (approximately 1.5 m x 1 m) and lies in a small valley between limestone pavements just below the brow of Haverbrack Hill (Fig. 1). Below the cave entrance is a vertical shaft for 3m, followed by a steep (35-40°) slope 4 m long and trending in a westerly direction, with a further 2.5 m vertical section leading down to a chamber (9 m long by 3 m wide), on a North-South orientation, with a narrow shaft dug through the deposits at the northern end (Fig. 2).

We excavated a small portion of the cave in 2010-11 to undertake conservation work. A full history of excavations at the site up until 2010 is given in Wilkinson et al. (2011). Briefly, Dog Hole was first excavated by Dr Wilfred Jackson in 1912 (Jackson, 1913). Donald Benson and Keith Bland (along with

other members of the 1st Milnthorpe Scouts) subsequently excavated the site from 1956 onwards, publishing their results in 1963 (Benson & Bland, 1963; Bland, 1994). Their excavations uncovered the main chamber in which a considerable number of human remains, along with those of a variety of other species, and a number of artefacts were found. Later caving activity created a shaft through the remaining sediment on the north side of the chamber, and it is this area that was excavated in 2010-11. A small additional chamber was also uncovered through a very narrow passage (a 'squeeze' in caving terms), at the base of the north shaft, and slightly lower than the base of our excavations (Fig. 2). The site entrance is located amongst limestone pavement that is currently covered by woodland. The topography makes it highly unlikely that the human and larger non-human remains were washed in or fell in by accident. There is no known nearby or contemporaneous settlement associated with the cave, so the source of the people and non-human animal remains is unknown. However, Sandside Quarry has removed over two thirds of the hill in which Dog Hole is found (Fig. 1), so any evidence for settlement here will have been lost.

Excavation

The excavations in 2010-11 focussed on a small area to the north of the main chamber (Fig. 2) where past caving activity had occurred. Here, corrugated iron shoring that had been used when the north shaft was dug through the archaeological deposits was in very poor condition and would have endangered the archaeology if it had collapsed. We excavated a small vertical section of sediment, replacing the shoring as we dug. This excavation also allowed us to investigate research questions that had been raised by the 1950s excavation, such as 'were the remains placed in the cave, or thrown in from the top?' and 'were the human remains deposited as articulated skeletons?'. The site has a heavily clast (rock) dominated matrix, with clast sizes ranging from boulder (>0.25m) to pebble (0.004-0.064 m) on the Wentworth Scale (Dincauze, 2000: 278). The sediment containing human and non-human remains, artefacts and finer gravel sat between these clasts. The sediment was very wet and sticky with occasional voids (See SI section1), and this, combined with the limited space, meant it soon became apparent that it would not be possible to excavate using standard archaeological techniques (i.e. trowelling and single context recording). We therefore divided the area to be excavated into three columns, A, B, C, and the excavation proceeded in ~20cm deep spits (Fig. 3). The site datum was placed as a bolt in the cave wall level with the top of layer 1, and all depths were recorded from this (Figs 2-3). Owing to the difficulties of excavating the matrix, all sediment was wet sieved to 1 mm at the surface to recover small bones and artefacts[1]. During the excavation, sections B and C petered out, and section AA was added to the left of A, as the cave wall expanded to the West as the section became deeper (Figs 2-3)[2]. With the exception of the charcoal rich layer (hereafter CRL), no single contexts were identified, despite a total sediment depth of 2 m being removed. However, careful analysis of the bones and artefacts within the spits has demonstrated that there was spatial integrity to the material particularly, but not exclusively, from beneath the CRL.

Results

Osteology

The majority of finds from Dog Hole were human and non-human bones (Number of Identifiable Specimens Present (NISP) = 8689 (incl. micromammals) (Table 1)). For full details of the osteological analyses and the methodologies employed see supplementary information (SI). The remains were

almost all disarticulated, although some human and non-human Associated Bone Groups (ABGs) were identified (Table 2). The disarticulation is likely to be the result of both the excavation methods used in the 1950s, and taphonomic processes within the cave, where specimens have moved between clasts over time (see SI section 5 for further discussion). All human remains that have been radiocarbon dated are from the latest Iron Age to Romano-British periods, while the non-human remains date from the latest Iron Age to Medieval periods (Table 3, Fig. 4). The combined results from the 1950s and 2010-11 excavation provide a minimum number individuals (MNI) of 28 humans (Table 1), making Dog Hole the largest collection of Romano-British inhumations in northwest England. There are also considerable numbers of sheep (MNI = 34), cattle (MNI = 33), and dogs (MNI = 32). One of the most striking features of the Dog Hole assemblage is the age profile of the human and non-human animals, particularly from below the CRL, and the body part representation of the different species. To explore these more fully we describe the assemblages in stratigraphic order from the base of the 2010-11 excavations upwards.

Horse and neonatal infants

In layer 10 at the very base of our excavations[3] part of an articulated horse was discovered, comprising the distal portion of a right forelimb including radius, carpals, metacarpals, lateral metapodia, 2nd phalange and neck (atlas, axis and cervical vertebrae) (Fig. 5). The neck of the animal disappeared into the section, suggesting that more of the skeleton (and potentially the entire horse) was originally buried. In close association were the fragmentary remains of two neonatal humans, one of which was radiocarbon dated to cal AD 5-125, while the horse was dated to cal AD 52-215 (Table 3). Two further neonatal humans were found in the layers above the horse but below the CRL, and an additional neonatal human and a foetus of approximately 30 weeks lay above the CRL in layers A5 and B4 respectively (Table 4). As well as very young human remains, a considerable number of foetal and neonatal non-human remains, particularly puppies, lambs, calves and piglets, were recovered from the same layers below the CRL (Table 4), and a juvenile canid ABG was recovered from the same level as the horse (Layer 10). While bitches can produce young throughout the year, pigs and sheep have a birthing season lasting from late winter to early summer, but peaking in spring. The deposit at Dog Hole must therefore coincide with this time of year. Adult human remains were also recovered from these layers, but tended to be isolated teeth and phalanges, which may have originated from higher in the cave (see below). No articulated adult human remains, or larger bones, were recovered from these layers. Adult non-human remains present consisted of cattle cranial fragments and phalanges, pig metapodia, and all body parts of sheep/goat and dogs. Other associated bone groups were also recovered - a canid skull in layer 9 and cattle first phalanges in layer 8 (Table 2).

The charcoal rich layer

The charcoal rich layer (CRL, also known as context 4) was a distinctive black horizon covering almost the entire surface of the excavation between layers 5 and 6. It contained small quantities of highly fragmented burned bones, and several large pieces of charcoal, identified by Alan Clapham as lime (*Tilia* sp.) and birch (*Betula* sp.). The burned bones were very black in colour and appeared to be the result of a highly reducing fire, or perhaps more likely, a poor fire made of wet wood that was repeatedly going out (Kirsty Squires, pers. comm). All identifiable bones from this layer were from sheep/goat or medium mammal (n=10). Burned bones were also present in layers above and below the CRL, but not in such dense quantities (i.e. 108 identifiable bones were found in the 5 spits below the CRL, and 50 specimens in the 5 spits above). Nearly all of these burned remains were

sheep/goat, although isolated cattle, pig, dog and amphibian bones were also recovered. Large charcoal pieces from immediately below the CRL contained lime (A6, B6) and hazel (*Corylus* sp., B6), while those above contained lime (B5) hazel (C5) and oak (*Quercus* sp., C4).

Above the CRL

The pattern of the remains above the CRL showed an increase in complete or semi-complete large human and non-human bones (e.g. Fig. 6). All body parts of adult sheep/goat and adult cattle crania, metapodia and phalanges were well represented, and neonatal lambs were also found throughout. Several large pieces of charcoal were recovered from this area, again containing lime. Two sections were different to the main types of deposition. The first, section A3 and A4, was largely a void towards the side of the cave wall, while layers 1 and 2 across the site (i.e. A1, B1, C1, and A2, B2 and C2) were behind the original shoring (see SI section 1) and appeared to be the spoil of previous excavations, where bones were fragmented and mixed with occasional modern debris such as a crisp packet and aluminium buttons.

Main chamber

The material excavated in the 1950s is here designated as 'Main Chamber'. This contained the majority of the long bones from all species, including the adult human remains. A particular feature is the dominance of cattle teeth and lower limbs (metapodials, sesamoids and phalanges) in the assemblage (SI Section 3). The pattern is not so marked for the other domesticates (sheep/goat and pig), but all appear to be lacking in meat bearing limb bones such as the femur. There is very limited evidence of butchery on all species, with a maximum of 3% butchery and 2% gnawing on bones from the main chamber, indicating that they were quickly buried and not left around for scavengers (SI Section 3). Radiocarbon dating has shown that there were multiple phases of deposition in the main chamber, with two cattle bones dated to the Romano-British period, and cattle, red deer and dog specimens that are early and later medieval (Table 3). While some of the non-human remains are going to be related to these medieval deposits, others appear to have a more clearly Romano-British stamp, such as a small toy dog skull and two bandy-legged (terrier-type) long bones.

The human remains from the 1950s excavation comprised at least 23 individuals, based on the presence of 23 right distal humerii. Disarticulated innominates (hip bones; both left and right) that preserved the auricular surface were aged using seriation, resulting in an age estimation for thirteen individuals (one adolescent, three young adults, six middle adults and three old adults), plus a minimum number of six children based on the presence of left and right ilia (age categories follow Buikstra and Ubelaker (1994)). Sexing the adult innominates resulted in an estimate of five males, five females, two probable males and two probable females, with four that could not be sexed (Table 5).

While the majority of human long bones excavated in the 1950s were complete, the complete bones from the 2010-11 excavations tended to be small compact bones such as phalanges, carpals, tarsals and isolated teeth, and long bones were highly fragmented (See S section 4). This suggests that many of the isolated adult teeth and phalanges found in the 2010-11 excavation had come from the corpses above and had been washed through the sediment over time. We have not, therefore, increased the MNI for age categories of children and above following our excavation.

Discussion of osteology

Whatever explanation is provided for the deposition of the non-human remains, it does not represent a typical assemblage reflecting accumulations of general refuse from a nearby settlement.

A more varied range of elements might be expected for the main food domesticates at such a site, representing the meat-bearing limb bones of food waste. A greater proportion of butchery marks might also be expected – no layer contains more than 3% of bones with butchery marks (SI section 3) – whereas contemporary settlement sites with similar preservation could easily comprise 15-20% butchered bones.

Functional explanations for the use of the cave include the possible dumping of butchery waste and birthing casualties. The presence of large numbers of lower legs and heads of cattle, sheep/ goat and pigs in the main chamber are typical of primary butchery waste involving the removal of skins and disarticulation of the extremities. The pattern for cattle at least seems to have been established in the earliest phases. Furthermore, the presence of a horse in the lowest level could also be interpreted as the opportune disposal of a large carcass from an animal not commonly consumed in Roman Britain (Simoons 1994). The neonatal remains could represent the disposal of animals that died natural deaths and were also not fit to be eaten. While such functional explanations must be considered, the presence of deliberate human burials throughout the cave from foetal to old individuals implies a more ritualised context, with at least some animals used to accompany the dead or symbolise a particular deity. The predominance of neonatal human remains in the lowest layers below the CRL indicates the deliberate accompaniment of foetuses and infants with lambs, piglets and puppies.

Material Culture

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. A few additional items from the 1950s excavations such as an iron axe-head and whetstones are unlikely to be part of grave furniture, but the vast majority of the finds appear to be related to the interments. There are several 20th-century finds, which in part result from documented activity in recent times, such as the 1957 excavations and digging in the mid-1980s in an attempt to extend the cave system (Wilkinson et al. 2011). A full description and catalogue of all finds, with measurements as appropriate, can be found in SI section 2. Some finds, particularly incomplete and corroded iron objects, are most likely to be modern debris and are not discussed further.

Personal ornaments - beads

There are up to 192 complete or fragmentary beads, the uncertainty arising from the fact that some broken bead fragments may belong together. The beads fall into eight types, which are described in Table 6 and shown in Fig. 7. The majority of specimens are small blue beads (n = 167), but gold-in-glass and cylindrical jet/shale beads are present. There are five gold-in-glass beads, of two different types (Fig. 7), with one additional specimen recovered from the 1950s excavation (Benson & Bland, 1963). They are known elsewhere in the north of England, occurring for instance at Hartlepool, Cleveland where a necklace worn around the neck of a skeleton contained 12 jet beads and 26 glass, of which 13 were gold-in-glass (Daniels *et al.* 1987, 1-4), and the cemetery of Low Borrowbridge, Tebay, Cumbria where 12 out of 67 beads from a necklace found in a possible inhumation burial (pit 301, 3rd century) were of the gold-in-glass type; others were of blue, black and green glass, jet and shale (Howard-Davis 1996, 115, fig. 5:13). At Brougham five cremations have examples of this type, dating to the 3rd century AD (Cool 2004, 386-387).

Thirteen cylindrical jet or shale beads were also recovered, with an additional 8.5 from the 1950s excavation (Benson & Bland, 1963). These are commonly found in late Roman contexts. Jet or shale beads are represented by burials of 3rd-4th century date in York, notably at the Railway cemetery

(RCHM 1962, 143; Allason-Jones 1996). They are found in other major towns, such as Southwark in London, at Poundbury, Dorset and Colchester, as well as in military and rural contexts. A large collection of segmented beads was found in South Shields, though all are longer than the Dog Hole Cave examples (Allason-Jones and Miket 1984, 302-3, nos 3-34). The difficulty of distinguishing shale from jet without geological analysis means that the precise material is often uncertain. The two materials frequently overlap in geographical distribution. For example, shale is common at South Shields despite the proximity to the source of jet in Whitby (Eckardt 2014, 120).

*Personal ornaments – metalwork (*Fig. 8*)*

There are fragments of three bracelets from the 2010 and 2011 excavations, to which can be added five whole or fragmentary bracelets recovered in 1957 (Benson and Bland 1963, 63, I-V). A curved fragment of iron of circular section (SF256) may be part of a bracelet but the lack of surviving terminals makes this uncertain.

Two fragments of an undecorated broad silver-alloy bracelet (SF 263 and SF225), do not join but almost certainly belong to the same item. The absence of terminals makes classification impossible but the broad band and slight rib are found in Romano-British bracelets, including some with snake's head terminals (e.g. Cool's Groups X and XI; 1983, 146-151). SEM EDX analysis indicated a strong presence of silver together with copper (S. Newman, pers. comm).

A copper-alloy penannular bracelet with grooved terminals belongs to Cool's Group VI (1983, 747), a type which runs through the Roman period. This example7 with grooved terminals of circular section (SF259) has an almost identical parallel, but in this case complete, found in 1957 (Benson and Bland 1963, 63, fig. 2a). They share the same incised chevron decoration, the only difference being that the grooves at the terminals do not run all the way round the bracelet. There is little doubt that they represent a pair. Other parallels for the bracelet (SF259) include one from a mid 4th century inhumation at Kelvedon, Essex (G19; Rodwell 1988, fig. 51, no 86), found with two other bracelets. This example lacks the oblique and vertical incised lines of the Dog Hole find, as does a broken, undated, bracelet from Lansdown, Bath, Avon (Cool 1983, fig. 40, 6).

There are two fragments of a torc-twisted bracelet with an expanding loop in square-section wire (SF260, 261), and the surface appears to have been tinned (Fig. 8). There are also two more corroded fragments of torc-twisted copper-alloy square-sectioned wire (SF214, 228) that may belong to the same object but have been buried in different conditions. The bracelet with expanding arms conforms to Cool's Group III, subgroup A, with simple terminals (Cool 1983, 130-135). The type is overwhelmingly of later Roman date, from late 3rd to 4th century date. An example from Fox Hole Cave in the Peak District not only closely parallels the Dog Hole object in form, but also comes from a cave deposit. Fox Hole Cave was identified as a possible burial site and the bracelet there may have been an object buried with the dead (Branigan and Dearne 1992, 68, fig. A2, no 5). An identical bracelet was found at Brougham, Cumbria in a Phase 2 cremation burial, dated there to the late 3rd-4th century (Cool 2004, 164, fig. 4.150, no 4). The bracelet (SF 260 and 261) also closely resembles an example found at Dog Hole Cave in 1957; it has a square section but is not twisted (Benson and Bland 1963, IV, fig. 6).

There is a fourth possible bracelet in iron, curved and of circular section (SF256), but lacking the diagnostic terminals to prove the identification. Undecorated iron bracelets of simple circular section are known from late Roman contexts, such as the Lankhills cemetery, Winchester (e.g. Clarke 1979, 311, no 125 in Gr. 143).

Two joining fragments of thin wire of circular section, and split to half width at one surviving end probably belong to a copper-alloy loop ear-ring (SF215, SF236). The lack of terminals makes it difficult to assign this object to any particular type. It could belong to one of several forms of plain looped ear-ring in Allason-Jones's typology, particularly the long-lived Types 1-3, or less likely her rarer Type 12 (1989a, 5-6, 12).

There is a single example of a copper-alloy finger-ring (SF267) with a plain band of shallow D-shaped profile. This simple form is not closely datable. Two additional finger rings were reported by Benson and Bland (1963).

Footwear – hobnails

Hobnails were used in the soles of leather shoes or sandals. In total up to 44 hobnails were recovered in 2010-11, while an unquantified amount of 'miscellaneous iron studs' , presumably hobnails, were found in earlier investigations (Benson and Bland 1963, 65, XI). Once the leather sole of the shoe had decayed, the nails, which are small and relatively dense, were easily dispersed from their original position. The 44 hobnails at Dog Hole Cave from the 2010-11 excavations and an unspecified number of additional examples found in 1957 may therefore represent no more than the hobnails from a single pair of shoes. It is notable that all but two were found above the CRL (Fig. 9a), indicating their association with the later phases of the site.

Pottery

Roman pottery is confined to two sherds, a small body sherd of Black-Burnished Ware (BB1) (SF202), and a flake of buff pottery, probably from a mortarium, with subrounded black mineral inclusions (SF38). BB1 began to appear in northern Britain in the AD 120s as a result of expanded marketing, perhaps military contracts, from its origin in south-eastern Dorset (Tyers 1996). While this small fragment is not closely diagnostic of date, BB1 was present in both military and civil contexts in Cumbria and northern Lancashire from *c.* 120-*c.* 350/70 (Webster 2011, 66). A single fragment of potential prehistoric pot was also found (SF 197), although it may also form part of a daub. It if were to be pottery, this small fragment would be the only evidence of prehistoric activity at the site.

Discussion of material culture

The majority of the material culture recovered from Dog Hole is from the later Romano-British period (mid 3rd to 4th centuries), which matches the radiocarbon dates from the adult and sub-adult human remains. Necklaces as a type of personal ornament become more popular in the later Roman period (Cool 1983, 297), and analysis of the deposition of beads, whether as components of bracelets or necklaces, shows a consistent association with female graves. For example, in the cremation cemetery at Brougham, deposits with glass beads were found exclusively in female graves or those with children, and were entirely absent from male graves (Cool 2004, 389). At that site, as elsewhere, glass beads are closely correlated with a specific gender and age group. As a result Cool suggests that the Brougham cemetery provides independent evidence for the view that glass bead necklaces were a personal ornament that only females wore.

Gold-in-glass beads have been extensively discussed by Boon (1977), Guido (1979), Cool (2004; 2010), and Eckardt (2014, 45-50, fig. 2.7) and they occur in Britain on a range of sites, including villas and rural burial sites, temples and urban contexts (Eckardt 2014, appendix). They are known to have been first manufactured in Egypt and Rhodes, but by the Roman period they were made in various places including Dacia. The distribution on the continent shows they are present on the Rhine-

Danube frontier and in southern Russia, but were absent from Spain, Italy, Gaul and Germany before the 4th century (Eckardt 2014, 46). Boon (1977) suggested that the gold-in-glass beads were introduced by military personnel, with the Sarmatians (Iazyges) the favoured candidate, given their attested movement to Britain under Marcus Aurelius about AD 175 (Eckardt 2014, 47). Eckardt's review of the evidence (2014, 45-50) confirms that this type of bead arrived in Britain with immigrants, although not specifically with the Sarmatians. They are predominantly a female ornament, suggesting that they were brought by women following soldiers on detachment (Eckardt 2014, 49). Their subsequent distribution argues for absorption of the immigrant military personnel and their families into civilian contexts. However, the dispersal of some of these distinctive beads through trade or exchange may account for small numbers present on necklaces not associated with incomers. Cool (2010) has argued that overall composition should be taken into account when considering the possible origin or associations of a necklace. Those composed entirely of gold-in-glass beads are considered more likely to indicate foreign origin, while necklaces with only one or two may have been traded or exchanged after restringing, thereby losing their ethic affinities (Eckardt 2014, 49). In some cases, however, necklaces with a few gold-in-glass beads, when found in association with other unusual beads, may retain their integrity as indicators of foreign origin (Eckardt 2014, 49-50).

The 2010 and 2011 excavations recovered three bracelets which are similar or identical to examples found in 1957. The presence of two probable pairs of bracelets found across the 1957 and 2010/11 excavations suggests that the deposits into which the bracelets had been placed had only partially been removed in the 1950s. From the 1st to 3rd century, precious metal bracelets were worn by high-status individuals in Roman Britain. Cool notes that the practice of wearing copper-alloy bracelets, often in groups of six or more, only became fashionable in the 4th century (1983, 23-28). Bracelets were worn almost exclusively by women. They occur in a minority of late Roman burials, either worn on the body at burial, or placed singly or in small groups with the deceased (Philpott 1991, 142-149).

Hobnails, representing nailed footwear buried with the dead, are frequent finds in both cremation and inhumation burials in Roman Britain (Philpott 1991, 165-175, fig. 28). They are most commonly found, where datable, in 4th century graves. The position of the shoes varies; although most were worn, some were deposited in the grave away from the feet. The latter practice has been interpreted by some as evidence of a belief that the dead required shoes for a journey in the afterlife (e.g. Macdonald 1979, 407-408; Philpott 1991, 167-175). However, Quita Mould makes the apposite observation with respect to the cemetery at Brougham that the presence of hobnails in burials may have more to do with the construction of shoes – whether made with or without hobnails – than the choice of shoes as grave furniture (2004, 392). She notes that it is quite possible that every individual who was cremated either wore shoes or had them placed on the pyre; the presence of hobnails simply indicates that some people were buried wearing iron-shod shoes.

Finger-rings are frequent grave finds in Britain and may represent items simply left on the body at burial (Philpott 1991, 142-149). By contrast, earrings are rare finds in graves, although they may have been misidentified in early reports. Only twelve had been recorded in inhumations up to 1990 (Philpott 1991, 152), although a further six were recorded in the Brougham cemetery alone (Cool 2004, 382).

Staining

From the 2010-2011 excavations 13 human bones had green staining indicating proximity to the copper alloy jewellery, with an additional 30 green-stained bones from the 1950s excavation. These

bones were largely from the neck, wrist/hand and ankle regions (See SI section 4 for more detail). Copper-staining was found on metacarpals from the thumb (n = 1) and third finger (n=2), as well as three proximal hand phalanges, suggesting that jewellery was worn on the thumb and central finger. For those copper-stained specimens that could be aged (32 out of 43), ten were from individuals <18 years of age, representing at least two individuals as two left metacarpals and two left radii were present. The position of the staining suggests that at least some of the jewellery was worn or placed on the neck, hands and ankles of the bodies when they were buried.

Isotope analysis

Isotope analysis was performed on seven adult humans. Six lower second molars from the 1950s excavation and an upper second molar from the 2010-11 excavation were sampled for strontium (Sr), oxygen (O), carbon (C) and lead (Pb) isotopes, and lead concentrations (Pb ppm). Three cattle lower third molars from the main chamber were sampled for Sr and Pb isotopes, and a lower molar from the articulated horse was sampled for Sr only. Crown development of the human second molar begins at 2.5 years and ends at 7.5 years (AlQahtani et al., 2010), allowing us to see if an individual is likely to have moved between their childhood location and where they were finally buried. It is important to note that the isotope analysis does not allow us to determine where someone grew up, but does allow us to exclude specific regions that are not compatible with the isotope values of an individual. Full details of methods are given in Supplementary Information section 7.

The results of the isotope analyses are shown in Table 7. The $^{87}Sr/^{86}Sr$ values range from 0.7097 to 0.7121 (mean = 0.7105 ± 0.00196‰ (2SD)), while the $\delta^{18}O_{phos(SMOW)}$ values range from 17.26 ‰ to 18.19 ‰ (mean = 17.87 ± 0.6188 (2SD)). Enamel carbon values range from $\delta^{13}C$ -16.2 ‰ to -13.9 ‰ (mean = -14.6 ± 0.76‰ (2SD)). For Pb we focus on the $^{207/206}Pb$ and $^{208/206}Pb$ results in the following discussion as galena (lead ore) values are available for these ratios (from Rohl, 1996), but all five lead ratios and Pb concentrations are reported in full in Table 7. The $^{206/204}Pb$ results range from 18.2888 to 18.4720 (mean = 18.3548 ± 0.1168 (2SD)) and $^{207/204}Pb$ range from 15.6199-15.6413 (mean = 15.6345 ± 0.01568 (2SD)). Pb concentrations range from 0.51-1.77 ppm (mean 1.01 ± 0.9596 (2SD)). The implications of these results are discussed in full below.

Discussion

As described in the Introduction, Dog Hole is important because it appears to run counter to many generalizations about Roman Britain, particularly the north, and here we discuss the findings from the site and their wider context. Dog Hole clearly represents a multiple phase deposit, and we propose at least three periods of deposition – the first in the latest Iron Age to early Romano-British period, when foetal and neonatal humans and non-human animals were being deposited near a horse burial (phase 1). Deposits from this phase were overlain by the Charcoal Rich Layer (CRL) between layers 5 and 6, which has a radiocarbon date that is indistinguishable from the material below (Fig. 4, table 3). Subsequent to this, adults and older children were buried at the site, along with the deposition of complete dogs, and the heads and feet of cattle and other animals in the later 3rd and 4th centuries (phase 2). The early medieval period saw the deposition of further non-human remains in the cave[4], culminating in the probable stashing of antlers which had had their tines sawn off between AD 881-1013 (phase 3). These antlers were on the top of the sediment when the cave was first accessed in the 1950s (Benson & Bland, 1963; Wilkinson et al., 2011). That the entrance shaft contained further animal remains (Jackson, 1913), and that a dog mandible has been dated to

AD 1220-1280 indicates that deposition of non-human remains continued at the site well into the medieval period. A particularly interesting aspect is the continuity of activity at the cave, with dogs being deposited in the site for at least 1000 years, if not longer.

Is the material Romano-British?

While some aspects of the assemblage postdate the Roman period, there are numerous reasons to believe that the overall picture presented above is correct. Some items have clear potential to move around in a clast-rich cave sediment, such as that found in Dog Hole, including the hobnails, microfauna, beads, neonatal remains, and human teeth. We have plotted these in Fig. 9, and it can be seen that all hobnails bar two were found above the CRL (Fig. 9a). Plotting the microvertebrates does not show the concentration of remains that might be expected if they had been washed to the same levels within the deposit (Fig. 9b), and a similar distribution is seen in the neonatal human remains (Fig. 9c). The human teeth show a slightly different pattern (Fig. 9d) and this may be because they are somewhat heavier or denser than those of the smaller/younger animals and have therefore been carried further. The only items that show considerable movement are the beads (Fig. 9e), which with many measuring <3mm (Table 6), this is perhaps not surprising. It is also worth mentioning here that our comprehensive sieving regime, wet sieving to 1mm for all deposits, is the reason that such a large accumulation of beads and foetal remains has been recovered. Other reasons to suppose that the remains, particularly below the CRL, have not been greatly disturbed, are the ABGs or partial skeletons that were discovered in the main chamber and in layers 2-10 of the 2010-11 excavation (Table 2 and SI section 4). The radiocarbon dating of specimens has presented them in date order, with older specimens at the bottom, and younger at the top. In no case, for those specimens where we have stratigraphic information, has the order been reversed. Finally, artefact types found in our excavation match those found by Benson & Bland (1963), and all indicate a later Romano-British date.

Funerary ritual

Phase 1

The bones of an adult horse associated with the remains of one foetal and four neonatal humans, and the partial skeleton of a young dog, recall traditions of burial from the later Iron Age, and also Romano-British deposits from pits and wells in Southern England (see below). To place a horse within the site would not have been an easy matter - either alive or dead it would have needed to be manoeuvred through the relatively small entrance hole, and then lowered 11-12 m into the cave. It was lying horizontally at the bottom of the deposit with the lower leg and hoof tightly flexed beneath the radius and the neck outstretched, suggesting it had not moved much if at all since deposition (Fig. 5). The horse was an old animal implying it had some value in life, which was then transferred through its inclusion in the cave. In the late Iron Age the ownership of a horse would have brought considerable status (Cross 2011). The revered and ritual nature of the burial of horse remains in the Iron Age is reflected in deposits from Danebury, Hampshire although the majority of these were isolated bones or articulating limbs (Grant 1991; Moore-Colyer 1993, 63). It has been suggested that at this time horses provided a link ‘between the earthly and otherworld existence’ (Moore-Colyer 1993, 64).

As noted above the presence of new born lambs in Dog Hole makes the season of deposition for some of the neonatal remains likely to be around spring time, and perhaps relates to a seasonally specific ritual. Furthermore, Scott (1991) suggests that the burial of infants alongside animals is more likely to be gender-specific, and a ritual undertaken by women. The number of neonatal pig and dog remains decline in the upper layers while the number of neonatal lamb remains increase, perhaps indicating a change in the ritual towards the disposal of lambs over piglets and dogs from the early to the later Roman periods.

Animal sacrifice played a considerable role in many Roman and Iron Age religious ceremonies, often in honour of specific deities (Henig 2003, 118). This often coincided with the use of natural features, frequently watery places (Fulford 2001, 199). Such an occurrence in a cave has numerous parallels (Branigan and Dearne 1992, 33), although Dog Hole appears to be on a unique scale. The large late Iron Age and early Roman temple sites elsewhere in Britain tend to be dominated by one or two domestic species (Downey *et al.* 1980; King 2005). The association between sheep and Roman temples is relatively common and can be observed at Snow's Farm, Haddenham (Beech 2006), Great Chesterford (in King 2005) , Harlow (Legge and Dorrington 1985) and Uley (Levitan 1993). Many of these include animals that died as neonates and in their first year (culls in spring and autumn). These traits fall into King's *Group A* sites (2005), where seasonal culls of very young sheep/ goats have been interpreted as the result of spring festivals or celebrations (King, 2005, 358), with animals provided from the local economy.

Although there are some similarities in the presence of neonatal animals at temple sites, they rarely have such a variety of taxa present, and dog and human remains are generally absent. The Dog Hole assemblage is therefore not typical of a traditional Roman temple or place of worship. In a Roman context dogs have been linked to ideas of 'healing/birth/fertility and to death and the afterlife' (Ferris, 2018, p58). In addition dogs were commonly associated with the underworld (Ferris, 2018); in the context of human burials in a cave this appears potentially relevant – although it should be noted that many of the other animal species present have no such chthonic associations. A potential parallel to the earliest activity at Dog Hole is seen at North End Pot, North Yorkshire, where Iron Age human remains have been found along with dog and horse remains (although the latter species have not been radiocarbon dated) (Lord and Howard, 2013: 247).

Dog Hole also has some parallels with the Springhead ritual shaft where a number of human infant burials were recovered alongside mature and neonatal dogs (Grimm *et al.* 2011). The deposition of at least 30 lambs, piglets and puppies from a plunge pool/ tank at Cuddington is also similar, although there were no associated human remains (Holmes 2015). At Dunstable, Bedfordshire, a cesspit was filled and abandoned prior to AD 150 (Matthews et al., 1981). This cesspit was 9.15m deep, and between 3.6-7.0m depth a human infant (<6months in age) and bones from neonatal sheep (MNI = 6), cattle (MNI = 2) and dogs (MNI = 14 incl. 12 neonate skeletons) were found, as well as adult cattle, horse, sheep, and dogs (Matthews et al., 1981). The cattle and horse were represented by lower limbs, while the majority of the adult sheep (MNI = 2) and dog (MNI = 3) skeletons were present. A white-tailed sea eagle and a raven were also recovered from this level (Matthews et al., 1981). Matthews et al (1981) suggested that the pit had originally been intended to be a well, but was used as a cesspit instead. One of the best examples of a Roman well is that at Oakridge, Hampshire. Filled between the 2nd and 4th centuries AD it contained primary butchery waste, human remains, puppies, dogs, calves, lambs and piglets (Maltby 1994). Closer to Dog Hole, the well at Heslington East, York included the skeletons of a puppy, calf and primary butchery waste (Roskams *et al.* 2013). A well at Rudston Villa, Yorkshire was filled between the 4th and 6th centuries AD and contained human infant burials, lambs and sheep/ goat lower legs (Chaplin and Barnetson

1980). There is also Dalton Parlours, West Yorkshire where a few neonatal sheep/ goat, cattle and pigs were recovered alongside sheep/ goat, cattle and pigs primary butchery waste and a few human remains (Berg 1990), and Shiptonthorpe, east Yorkshire, where a water hole was used for inhumations of neonatal infants alongside dog skulls (Mainland 2006). At Burnby Lane, Hayton, East Yorkshire, a minimum of 33 human foetuses and neonates (of 43 gestational weeks or younger) were found, one of which was buried with a lamb of ~10 months old (Langston & Gowland, 2015; Jaques, 2015). The practice of careful burial of infants at Burnby Lane was a continuation from the Iron Age into the Roman period (Millett & Woodhouse, 2015: 530). Interestingly, and in contrast to Dog Hole, they concluded from the burial of non-human ABGs (especially sheep) that there was no seasonal pattern in the deposition (Millet & Woodhouse, 2015: 540). Similar examples are known from the wider Roman Empire, such as the association between buried puppies and human infants at a mid 5thcentury villa in Umbria (Ferris, 2018). The deposition of humans and animals in disused wells has been described as a symbolic closure ceremony (Rattue 1995, 27). However, it is also possible that they provided a convenient opening to the underworld, a role that would also have been fulfilled by Dog Hole.

Phase 2

The adult human and cattle remains were mainly located in the main chamber. The cattle bones were largely those from the head and feet of the animal, particularly the metapodia, which exhibited cutmarks from skinning. The restriction of elements to head, lower leg and feet of cattle is unusual outside of a primary butchery context. The legs were deposited fresh, implied by the recovery of numerous accessory bones, though it is not clear whether they were attached to skins. It could be that they represented a token offering from the killing and consumption of cattle at a nearby settlement – the meat being too valuable to dispose of in the cave. This would also explain the very low MNI of neonatal cattle, and higher age range of these animals compared to the other domesticates. In addition, their use for ploughing and transport make older cattle valuable, so it may be expected that they would not be culled early. However, it is also reminiscent of 'head and hoof' finds that have been identified in Neolithic and Bronze Age Europe (Grant 1989; Piggott 1962), where the skins of animals with the crania and feet attached accompanied human burials. Throughout Europe the head, hooves and skins of cattle, sheep and horses have also been recovered from areas indicative of their display in prominent places such as outside a tomb, the house of the animal's owner, or at a sacred site such as a bog or watery place (Josefson and Olofsson 2006, 73; Moore-Colyer 1993, 61; Piggott 1962, 114). Possible examples of 'head and hoof' burials closer to Dog Hole come from two early medieval cattle found in Solway Moss, Cumbria (Hodgkinson et al., 2000: 122-135) and horse remains from Kinsey Cave, N. Yorkshire, where Romano-British artefacts and horse bones radiocarbon dated to the early-Mid Romano-British period were found in a scree slope outside the cave (Lord et al., 2007; Lord and Howard, 2013). The head and hooves of cattle and sheep/ goats are frequently recorded as butchery waste from ritual features, and have been noted in considerable quantities at the sites of Springhead, Kent; Oakridge, Hampshire; Dalton Parlours, Rudston Villa and Heslington East, in Yorkshire, which have already been discussed. It may therefore not simply be a product of the functional deposition of butchery waste following the skinning and early dismemberment of a carcass, but have greater symbolic value. They may represent the sacrifice and consumption of a whole animal, where the meat-bearing elements are disposed of elsewhere following consumption. Alternatively, they may have contained the skins of the animals and represent the offering of a valuable raw material.

It is possible that there is also a practical explanation for the high level of cattle metapodia, as several are of similar date to the humans. The human bodies would need to have been transported to the site, and then to be lowered into the cave, and they could have been wrapped in cattle skins for ease of transport. While this explanation would account for the high number of metapodia present (as they are often left for ease of handling in the tanning process (Dobney et al. 1996)), it is harder to account for the skulls, as the extra weight of a cattle skull attached to the skin would make the wrapped body much more unwieldy.

The cave is also filled with fist-sized clasts, the majority are limestone, but greywacke and (rarely) tuff also occur. Their presence is not the result of roof-fall or flood events and they must have been deliberately placed within the cave. It is likely that the bodies were covered with these clasts once they had been deposited. There is a considerable depth of them within the site - over 4m of deposits must originally have been present, with some 2-3m of sediment between the horse burial and the later human burials in the main chamber (Fig. 2). This demonstrates that the placement of the clasts must have been a substantial undertaking and may have formed a deliberate part of the burial or perhaps later mourning ritual.

Adopting Roman ways?

The burial practice seen within phase 1 at the site is perhaps most consistent with the continuation of an Iron Age tradition. With such a dearth of burials in Cumbria it is difficult to envisage what the local Iron Age tradition might be, but the burial of people in caves is known from other locations elsewhere in northern England (Lord and Howard, 2013; O'Regan, in prep.), and would therefore predate Roman influence.

In contrast, the finds from Phase 2 are consistent with Romano-British burial practice as it had developed by the 4th century. By this time over much of Britain a multiplicity of localised regional practices had been largely replaced by a narrow range of more homogenous and geographically extensive burial rites. In most instances late Roman practice consisted of extended inhumation, often buried without durable grave furniture, but a minority of young women and girls were buried with personal ornaments, notably necklaces and bracelets, both types of jewellery that became popular in the 4th century. The narrow, gender-specific rite shows that in particular circumstances it was desirable to deposit jewellery, whether worn or unworn, with the deceased. Although these practices are best known from large cemetery excavations in towns of southern and eastern England, smaller samples of burials show the same rites in civil settlements such as York and Carlisle. The practice has been interpreted as provision of jewellery as a symbolic dowry for unmarried women and girls who died young, or as gifts for the underworld gods (Macdonald 1979). The burial of a small number of the dead with necklaces, using gold-in-glass beads which probably originate in Rhodes, Egypt or the eastern empire, and jet or shale beads, the use of multiple bracelets, and burial with hobnailed footwear suggests an awareness of burial practices drawn from late Romano-British culture as found in major Roman towns and urban /military communities, while retaining a preference for certain signifiers of their foreign background such as exotic gold-in-glass beads. It is perhaps surprising that a rite most commonly associated with towns and large cemeteries has been identified in a rural site in Cumbria. Therefore the nature of what appears to be formal grave furniture poses questions about the character and cultural affiliations of the local rural population.

By the late Roman period the countryside of north-west England had seen more than two centuries of military occupation and administration. The landscape was no longer solely the preserve of

people of native descent farming on their ancestral lands. Military control of land and settlement by incomers or their descendants, in particular retired soldiers and their families, created a more heterogeneous rural population. Land grants were made to legionary veterans on completion of their service, and although these have not been recorded to auxiliary veterans on retirement (Shotter 2004, 139; Birley 1979, 97-99), Shotter considers that military land allotments, or purchases, would be situated on good quality land in river valleys or near the coast (2004, 139). Occasional finds in the Northwest countryside point to the location of the landholdings of former soldiers. For example, Julius Januarius, a retired *decurio* probably formerly serving in Lancaster, set up an altar at Bolton-le-Sands in the Lune valley. In Cheshire, the diploma of a Spaniard Reburrus dated AD 103 found near Malpas is very likely another example. Auxiliary veteran settlement has been postulated for the vicinity of the fort at Ribchester, implied by the Roman name *Bremetenacum veteranorum*, probably by Sarmatians after AD 175 (Richmond 1945). A find from north Wales also warns against the assumption that these settlers' farms would have been architecturally or morphologically distinctive. A Roman will on a writing tablet, found near Trawsfynydd 5km from the nearest fort at Tomen y Mur, implies the presence of a literate citizen yet it appears to emanate from a rural settlement of wholly native type, interpreted as the farm of an auxiliary veteran (Tomlin 2004). These, and no doubt many other undocumented examples, indicate the presence of a resident rural population some of whose origins may have lain in the empire outside Britain but who were familiar with Roman military structures and cultural practices, even if their farms remained resolutely native in style.

A hint that some of those using caves in Roman Britain were of immigrant origin has come from work on the limestone caves in Yorkshire. Lord and Howard (2013, 247-248) suggest that those who made use of Yorkshire caves may have a link with immigrant military personnel and their families due to the discovery of military accoutrements found in caves. At Victoria Cave, the presence of a Norican name *Annamus* as graffiti on a pottery vessel suggests a connection with Noricum (in modern-day Austria and part of Slovenia), where such a limestone environment used for exploitation of lead would be familiar (Lord and Howard, 2013: 247-248).

Origins and mobility

The presence of burial practices that appear to be more urban than might be expected for a rural site, brings with it the possibility that the people buried at Doghole were not local to the area. This possibility prompted our isotope analyses of the adult remains. Such analyses have been performed on a number of Roman sites, from urban centres such as London (Shaw et al. 2016), Winchester (Eckardt et al., 2009; Chenery et al., 2010) and York (Leach et al. 2009, Müldner et al. 2011), to smaller military forts and associated settlements such as Catterick (Chenery et al. 2011) and Scorton (Eckardt et al., 2015). However, there have been far fewer isotope analyses on inhabitants of rural settlements in Roman Britain, and none from Northwest England.

Comparison of the Dog Hole Sr and O data with the Biosphere Isotope Domains Map (Evans et al., 2018) demonstrates that the $\delta^{18}O_{phos(SMOW)}$ values are similar for all Dog Hole individuals and do not discriminate between regions in the UK. In contrast, five of the seven individuals have $^{87}Sr/^{86}Sr$ isotope values compatible with the region around Dog Hole and are therefore likely to be local to the area, while two others (DH 212 and DH 488) have slightly elevated $^{87}Sr/^{86}Sr$ values. The values of DH 222 and DH 488 are compatible with a number of geologies, including those of the southern Lake District, parts of Scotland, Wales and SW England, and DH 222 is also compatible with the Pennines. Examination of the Pb isotopes allow us to investigate the origins of these people further. Figure 10

shows $^{208/206}$Pb vs $^{207/206}$Pb plotted in comparison with Cumbrian and Mendip galena (lead ore) (Rohls, 1996), and a sample of humans from Roman London (Shaw et al. 2016). This demonstrates that almost all the Dog Hole Pb values plot away from the Mendips ore and the urban Roman samples, but are encompassed within the variation of the Cumbrian galena, indicating a local origin for these people. The outlier is DH 2010 which sits within the Mendip and Roman London samples, and may indicate that this individual spent their childhood away from Cumbria. Their Sr and O values suggest that they are likely to be from Western or Southern Britain, including Lowland Scotland, the southern Lakes, Wales, the Mendips, the South West, and Sussex. This individual (DH 2010) also had a lower δ^{13}C value in comparison with all other samples (Table 7), again suggesting that they had grown up in a different location. Examination of the Pb concentrations indicates that all individuals have a low level of lead incorporated into their tooth enamel (Table 7). Two have Pb concentration values expected for an entirely background lead signature (<0.7‰), while the others are slightly elevated, but still sit at the bottom end of the distribution for Roman London (Shaw et al., 2016). These values indicate that the people buried at Dog Hole were not engaged in any major industrial activity such as lead mining or smelting, although most had some low-level contact with lead in their childhood. In conclusion, all but one individual from Dog Hole have Pb isotope values that are consistent with the lead ore fields of the Lake District. It is therefore most parsimonious to suggest based on the Sr, O and Pb isotope results that all individuals except DH 2010 were growing up in the region of Dog Hole or the southern Lake District between 2.5-8 years of age.

Final discussion

The data presented above provide evidence for a cave that has been used in multiple ways from the latest Iron Age into the medieval period, with a particular focus on the Romano-British period. Similar to other late Iron Age and Romano-British cave, well, or shaft deposits, we appear to have a dominance of human and non-human foetuses and neonates, in our case at the base of the site in association with a horse burial. This is the first time such an association has been documented in Northwest England, but it is interesting to note that the military-associated cremation cemetery at Brougham near Penrith also had horse-related activity only 100-200 years later than the placement of the horse at Dog Hole. At Brougham, 10 cremation and pyre sites included horse remains, most notably three with evidence for the cremation of whole horses (Bond and Worley, 2004), one of which was buried with a male and is dated to Phase 2 (~240-270 AD), while partial horse remains buried with a female are dated to Phase 1 (~AD 200-240). Cremation of horses is an unusual rite, and is unparalleled elsewhere in Roman Britain (Bond and Worley, 2004). Brougham also had an unusual number of funerary inscriptions for people with local Celtic rather than Germanic or Latin names (Fitzpatrick, 2004), perhaps suggesting that horses had some significance for the local population, in which case the lowest level at Dog Hole may be the earliest identification of this in the region. Goddesses associated with horses such as Epona (who also seems to have a countryside association) are attested to in northern Britain, with inscriptions to Epona being found on both the Antonine and Hadrian's Wall (de la Bedoyere, 2002: 250).

There is increasing evidence from isotope analysis that using the presence of grave goods to identify immigrants can be flawed. To take two Romano-British examples, at Lankhills, Winchester, an adult male burial that had previously been suggested to be local was found to have isotope values consistent with being Pannonian (Chenery et al. 2010), and recent work at Scorton, N. Yorks, determined that six out of nine individuals sampled for isotope analysis (three of whom had crossbow brooches), were from overseas (Eckardt et al. 2015). The mid-late Roman individuals at Dog Hole have burial practices that appear at first glance to be those of urban Britain, with the

presence of beads, hobnails and copper alloy bangles within the cave. The closest substantial Roman sites to Haverbrack are the forts at Lancaster (18km to the south), Burrow in Lonsdale (14km to the east), and Watercrook (11km to the north), all of which remained in use into the 4th century (Potter 1979; Jones and Shotter 1988). Each fort, with its associated *vicus,* had its own cemetery close by (cf. Iles and Shotter 2009; Shotter and White 1995), and they are unlikely to have transported people to Dog Hole for burial. The isotope analysis demonstrates that most of the people buried at Dog Hole are likely to be from the local region, with the southern/central Lake District the furthest likely area for two individuals based on the combination of Sr, O and Pb isotopes, and one individual exposed to Mendip ore based on Pb alone.

Considering the various suggestions for the use of Dog Hole, from ritual or shrine interpretations (King, 1974; Allen et al., 2018) to a burial place (Benson and Bland, 1963; Branigan and Dearne, 1992), we consider it to have been a burial place. While there are undeniable ritual aspects to burial, the site does not appear to match those sites which have previously been identified as temples or shrines in Roman Britain (as discussed above). Rather it appears to have been the burial place of a local population, perhaps performing rites which continued from the late Iron Age into the early Roman period, before switching to a more recognisably 'Romano-British' burial practice in the mid-late Roman period. The combination of the isotope results with the artefact studies suggests a level of acculturation or adoption of more urban burial practices by the rural population. Whether, as we have suggested this relates to military retirees moving into the area and introducing their practices, or the observation and subsequent adoption of urban practices by a rural population we cannot say. As discussed by Eckardt et al. (2014: 540) the adoption of overseas practices in the Roman period could relate to the fact that many of the incomers were of high status and therefore their activities were seen as desirable. In the same way, urban Romano-British burial rites could have been attractive, with the desire for emulation, for those who lived in more rural areas.

Conclusions

Dog Hole was used from the latest Iron Age to the late Roman period for inhumations. We can divide these into two phases, the first is latest Iron Age to early Romano-British, and involved the deposition of a horse in association with foetal and neonatal human, sheep, pig, dog and cattle remains. This combination suggests some type of ritual association for the site, perhaps in Spring, although the exact nature of the ritual is unknown, and may simply be a continuation of a local Iron Age burial practice. In the later Roman period the site was used for inhumations, largely of adults and subadults, and coinciding with the deposition of non-human heads and feet, particularly from cattle. The humans were buried with jewellery including gold-in-glass, jet, and blue beads, copper alloy bracelets, finger- and ear-rings, and shoes. These are items that are more usually associated with larger Roman towns, and may indicate that retiring soldiers introduced these more urban practices into the countryside in the later Roman period. To determine whether there was any evidence for mobility, seven teeth were sampled for Sr, O and Pb isotope analysis. The results suggest that six of the seven individuals were from the region, and one was likely to have moved into the area from somewhere else in western Britain. We therefore consider that phase two in Dog Hole shows the adoption of urban burial practices into a rural setting in the later Roman period, although the exact method of transmission is unknown. Dog Hole provides evidence for Romano-British burial practice in northwest England, an area that has largely been neglected in discussion owing to the paucity of evidence. This study has also provided isotope data from a rural, and local, Romano-British population, which are underrepresented in isotope studies to date. We hope that this paper has gone some way towards redressing these imbalances.

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Footnotes

1) This allowed the recovery of the largest assemblage of beads known from a cave site in Britain, as well as large quantities of microfauna that inform us about the environment of the site. However, sorting the residues was very time-consuming.

2) Owing to the difficulties of excavating on a steep wet slope, two steps were cut into the lower deposit to stop the excavator constantly sliding down towards the squeeze, and damaging the underlying matrix. These were denoted ‘step one’ and ‘step two’, with step two the lower of the two steps. The material from these steps is listed as step one and step two in the supplementary information, but has been included in the overall NISP and MNI calculations and in the material culture section in the main paper.

3) This is not necessarily the base of the site, as excavations ceased in layer A10.

4) Although burial of humans in caves did continue in the area (cf. the early medieval date on human remains from Kirkhead Cave near Grange over Sands (Smith, 2012))

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Taxa	NISP (1950s excavation)	NISP (this excavation)	NISP (site total)	MNI (older individuals)	MNI (foetus + neonate)	MNI (site total)
Human	1482	1247	2729	23	5	28
Cattle	483	671	1154	39	5	44
Sheep/ goat	206	1037	1243	43	21	64
Sheep		15	15	-	-	
Goat		1	1	-	-	
Pig	251	351	602	25	25	50
Equid	2	30	32			1
Dog	218	501	719	44	7	51
Cat	10	11	21			1
Deer	7	2	9			1
Red deer	4*	1	5			1
Roe deer	11	3	14			1
Rabbit/ hare		2	2			
Rabbit		1	1			1
Hare	1	0	1			1
Badger	7	1	8			1
Hedgehog		1	1			1
Mole		3	3			1
Red squirrel		11	11	2		2
Micro mammal		1342	1342			
Shrew (common)		55	55	27		27
Field vole		317	317	32		32
Bank vole		3	3			1
Wood Mouse		4	4			2
Rat		1	1			1
Domestic fowl		7	7			1
Pheasant		4	4			1
Passerine		16	16			1
Bird		8	8			
Frog/ toad		384	384	32		32
Total	2682	6030	8712	244	63	319

Table 1. Dog Hole NISP and MNI for all taxa from each excavation, and an amalgamated total for the site as a whole. *an additional 151 red deer antler fragments were identified from the 1950s excavations, they have not been included here as they are likely to be early medieval (see Table 3).

Layer	Associated bone group
Main chamber	Canid, mature (humerus, radius, ulna, tibia, metapodials, phalanges)
	Hare, mature (pelvis, tibia, rib, vertebra)
	Roe deer mature (humerus, radius, metacarpal, 1st phalange)
	Pig (occipital, humerus, radius, femur, metatarsal, metapodial, 2nd phalange, sacrum)
	Pig neonatal (humerus and ulna)
Layer 2	Canid, neonate (humerus, 1st phalange)
	Sheep/ goat, neonatal (humerus, pelvis, femur, patella, sesamoids, vertebrae)
	Pig, perinatal (metapodials, phalanges)
Layer 3	Human, adult (crushed cranium, mandible)
Layer 4	Canid, mature (radius, ulna, pelvis, tibia, calcaneus, metapodials, phalanges, vertebrae),
	Sheep/ goat, neonatal (humerus, metacarpal, femur, rib)
	Human, adult (two lumbar vertebrae)
Layer 5	Human, sub-adult (four lumbar vertebrae)
Layer 8	Cattle 1st phalanges
Layer 9	Canid skull (occipital, parietal, frontal, maxilla)
Layer 10	Equid partial skeleton (teeth, vertebrae, radius, metapodia, carpals/ tarsals and phalanges)
	Canid, juvenile (pelvis, femora, tibia, metatarsals, fibula)

Table 2. Associated Bone Groups (ABGs) identified from Dog Hole Cave, see SI section 4 for discussion of neonatal human remains.

species	material	source/ position within cave	Lab number	Uncalibrated date (BP)	Calibrated date at 95%
dog	Mandible	Bland (no 9), MC	OxA-22032	770 ± 26	AD 1220-1280
Red deer	Antler	Bland, top of MC	OxA-13593	1110 ± 27	AD 881-995
Red deer	Antler	Bland, top of MC	OxA-13594	1091 ± 27	AD 892-1013
Cattle	Metapodial	Bland, MC	OxA-14174	1211 ± 26	AD 712-890
Cattle	Metapodial	Bland, MC	OxA-22033	1642 ± 29	AD 335-534
Cattle	Metapodial	Bland, MC	OxA-22034	1690 ± 27	AD 257-414
Human	Humerus	Bland, MC	OxA-14173	1746 ± 27	AD 235-381
Human	Humerus	Bland, MC	OxA-15994	1743 ± 30	AD 234-385
Human	Humerus	Bland (290), MC	OxA-22031	1711 ± 25	AD 252-395
Dog	Mandible	(at base of NS – ex situ)	OxA-15995	1890 ± 30	AD 56-217
Lime wood	Charcoal	Charcoal Rich Layer (CRL), NS	SUERC-35185	1875 ± 30	AD 70-224
Human (neonate)	Femur	A10 (base of site), NS	OxA-31061	1941±26	AD 5-125
Horse	Tooth	AA10 (base of site), NS	SUERC-39126	1895 ± 30	AD 52-215

Table 3. All radiocarbon dates for Dog Hole Cave, Haverbrack. Calibrated using Oxcal v.4.3.2 Bronk Ramsey (2017), r:5 IntCal 13 atmospheric curve (Reimer et al., 2013). MC = Main Chamber, NS = North Shaft (site of 2010-11 excavation).

layer/ species	Humans	Calves	Puppies	Lambs	Piglets
Main Chamber		2	2	6	17
1	2		1	2	3
2				11	5
3		4		10	6
4	8			22	29
5	12	2	1	19	9
6	21	1	2	3	
7	84	2	5	6	15
8	41			6	19
9	40	2	2	21	32
10	69	2	4	9	21
Total	**277**	**15**	**17**	**115**	**156**

Table 4. Number of Identified Specimens Present (NISP) for foetal and neonatal human and non-human remains throughout the site.

Sex / Age	Male	?male	indet	?female	Female	could not be sexed
Adolescent (12-20 yrs)	1					
Young Adult (20-35 years)	1	1			1	2
Middle Adult (35-50 years)	1	1		1	2	2
Old adult (50+)	2				2	

Table 5. Sexing late adolescent and adult innominates from the Main Chamber, Dog Hole. Sexes based on both right and left innominates. Where both left and right innominates have been in the same age category, they have been counted as one. Inclusion of sex estimates gives a higher minimum number of individuals than those represented by age categories alone (i.e. an MNI of 17 vs. 13).

Bead type	**Sample size***	**Guido group**	**Measurements (H = height, D = diameter, L = length)**	**condition**	**Dating evidence**	**reference**
1) Translucent wound glass beads of identical mid blue colour	87	Group 7iv	D = 4.0-5.0 mm; H = 3.0-4.0mm	very good with no pitting on the surface	Iron Age – Early Medieval	Guido 1978, 69-70
2) Very small pale green glass wound bead of globular/spherical form	9	Group 7ii, and Group 6iib	D = 1.0-2.5 mm; H ~3.0 mm	Largely poor with pitted and decayed surfaces	Majority are Roman in date and made throughout the Roman period	Guido 1978, 66, 69
3) Thin-walled beads in mid to dark blue translucent glass, spherical, slightly larger examples have thicker walls.	80	Group 7	D < 3.0 mm, H <2.0 mm			
4) Elongated drawn cylindrical beads in pale green slightly translucent glass, clear longitudinal striations caused by the drawing process	2		L = 7.5 mm, D = 3.5 mm	differential etching of the surface through decay	Roman to Early Medieval period, most popular in Britain after the 3rd century AD	Guido (1978, 95)
5) 'Gold-in-glass' beads consisting of two conjoined elongated ovoid segments in clear glass with gold leaf interior	2 (+ 1 from 1950s excavation)		H = 8.5 mm, D = 2.5 mm			Benson and Bland 1963, no XIV, fig 11; Boon (1977, 199)
6) Clear yellowish tinged glass beads with a globular body, roughly broken off collars, and	3		H = 4.0-5.0 mm, D = 2.5 – 4.5 mm			Boon (1977, fig. 1.1; Guido 1978, 93-94,

distinct ribbing on the surface						fig. 37, no 3);
7) A very small cylindrical bead, in dark amber glass, translucent, wound	1		H = 2 mm, D = 2 mm		short cylindrical glass beads in colours other than blue or green are rare in Roman Britain	Guido (1978, 96)
8) Small cylindrical segmented beads, in opaque black highly polished jet or shale (1 x single segment, 10 x 2 segments, 2 x 3 segments)	13 (+ 8.5 from 1950s excavation)		D = ~6mm		late Romano-British contexts	

Table 6. Summary bead descriptions and catalogue from the 2010-11 excavations (See SI for full details). * >40 beads were recovered from the 1950s excavation (Benson & Bland, 1963), only the jet/ shale and gold-in-glass beads have been added in to the totals here.

sample	Sr (ppm)	$^{87}Sr/^{86}Sr$ (cor)	$\delta^{13}C$ PDB	$\delta^{18}O$phos (SMOW)	$\delta^{18}O$carb (SMOW)	Pb mg/kg (ppm)	$^{206}Pb/^{204}Pb$	% 2σ	$^{207}Pb/^{204}Pb$	% 2σ	$^{208}Pb/^{204}Pb$	% 2σ	$^{207}Pb/^{206}Pb$	% 2σ	$^{208}Pb/^{206}Pb$	% 2σ
DH-No.211	71.5	0.709726	-14.4	17.7	26.6	1.77	18.3552	0.015	15.6413	0.02	38.3727	0.03	0.8521	0.006	2.0906	0.01
DH-No.212	78.4	0.711452	-14.7	18.2	27.0	1.59	18.3521	0.025	15.6351	0.02	38.3530	0.03	0.8520	0.006	2.0899	0.01
DH-No.213	50.0	0.710108	-14.7	17.8	26.6	0.83	18.3636	0.016	15.6396	0.02	38.3146	0.03	0.8517	0.006	2.0865	0.01
DH-No.214	68.85	0.70973	-14.3	17.3	26.1	0.92	18.3437	0.015	15.6379	0.02	38.3324	0.03	0.8525	0.006	2.0897	0.01
DH-No.488	79.5	0.712125	-14.1	17.9	26.7	0.81	18.2888	0.017	15.6199	0.02	38.2195	0.03	0.8541	0.006	2.0898	0.01
DH-No.489	57.4	0.709721	-13.9	18.1	26.9	0.51	18.3082	0.016	15.6280	0.02	38.2893	0.03	0.8536	0.006	2.0914	0.01
DH-No.2010	33.8	0.710882	-16.2	18.1	26.9	0.64	18.4720	0.026	15.6399	0.02	38.4568	0.03	0.8467	0.006	2.0819	0.01

Table 7. Stable and radiogenic isotope results for human remains from Dog Hole Cave, Cumbria. See SI section 7 for analytical methods, calibrations and Sr data for horse and cattle.

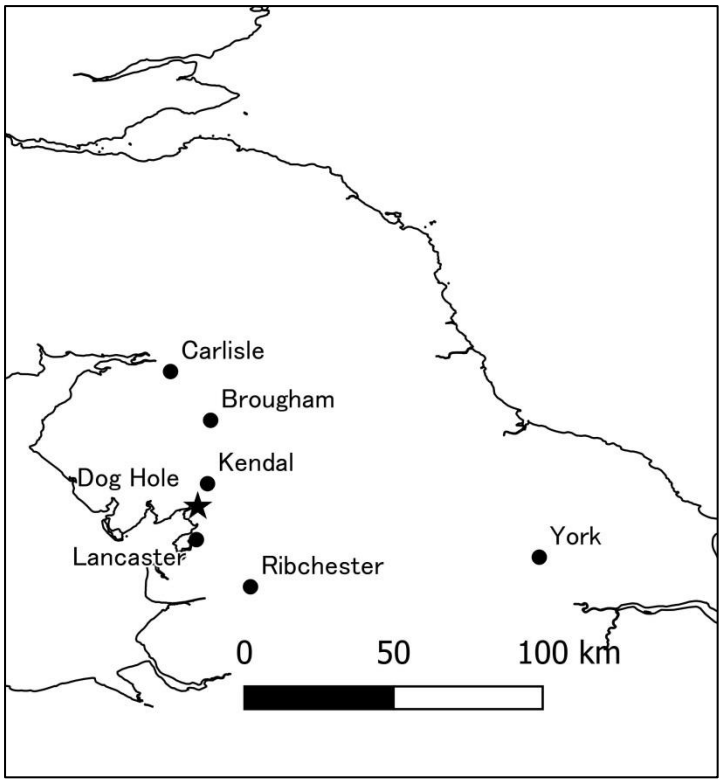

Figure 1. Map showing the location of Dog Hole (black star), with other key Roman sites mentioned in the text. UK basemap © EuroGeographics for the administrative boundaries

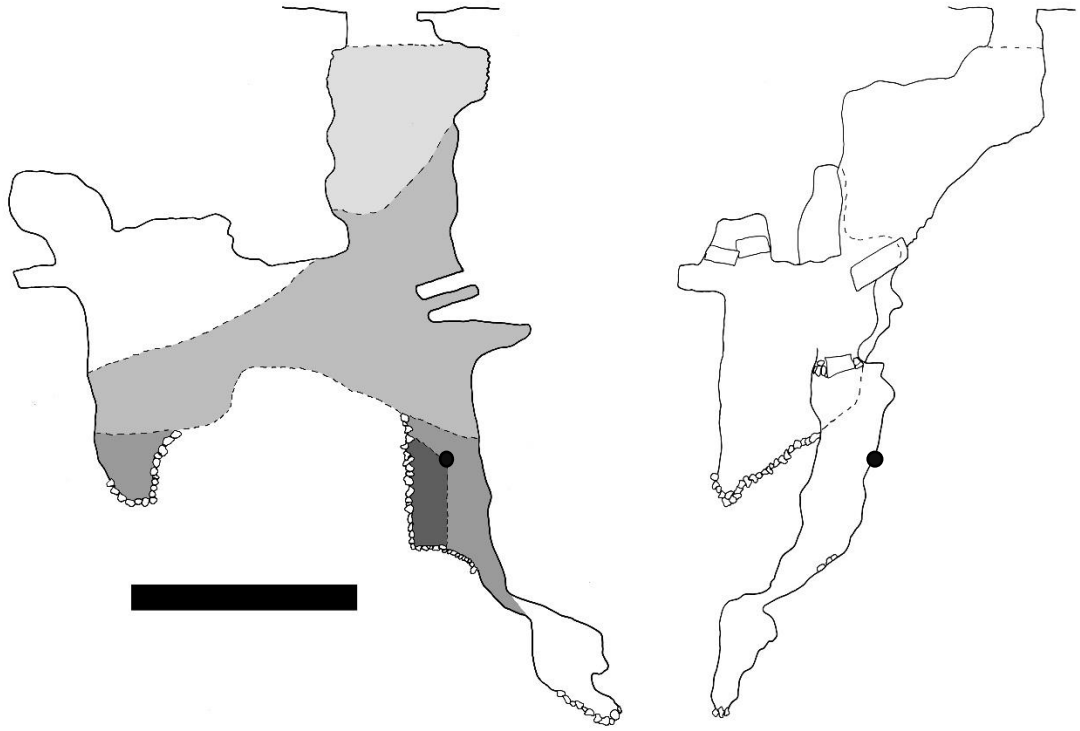

Figure 2. Cross sections of Dog Hole Cave. Scale bar = 5m. Left: South-North cross-section showing areas excavated during earlier excavations – light grey excavated by Jackson (1913), mid-grey by Benson & Bland (1963), darker grey by unknown cavers (1960s-1980s), darkest grey excavated by O'Regan et al., in 2010 (See Wilkinson et al., 2011 for more information). Right: East-West cross section of the entrance shaft, descending to the north shaft, showing the narrow squeeze into the dead-end passage at the base. In both images the black dot denotes the site datum used during the 2010-11 excavation.

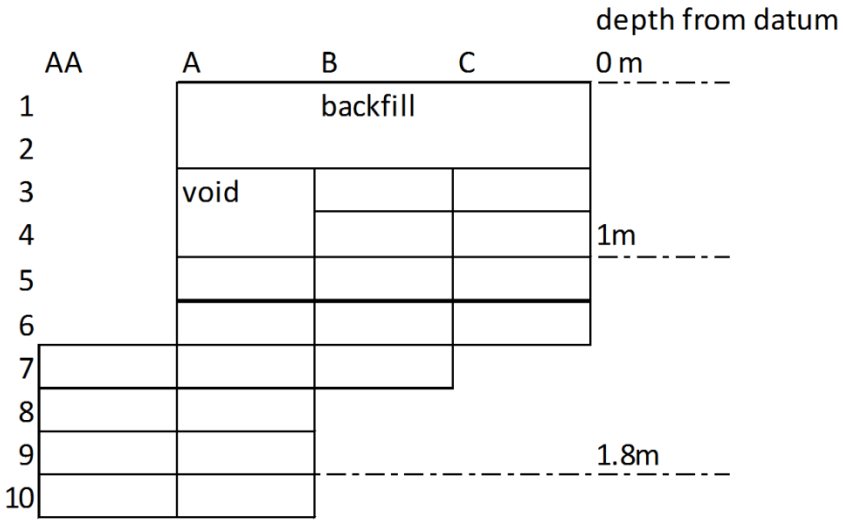

Figure 3. Schematic representation of the excavated deposits, showing the spits and columns, with associated depths below the site datum. The thicker black line between layers 5 and 6 denotes the Charcoal Rich Layer (CRL).

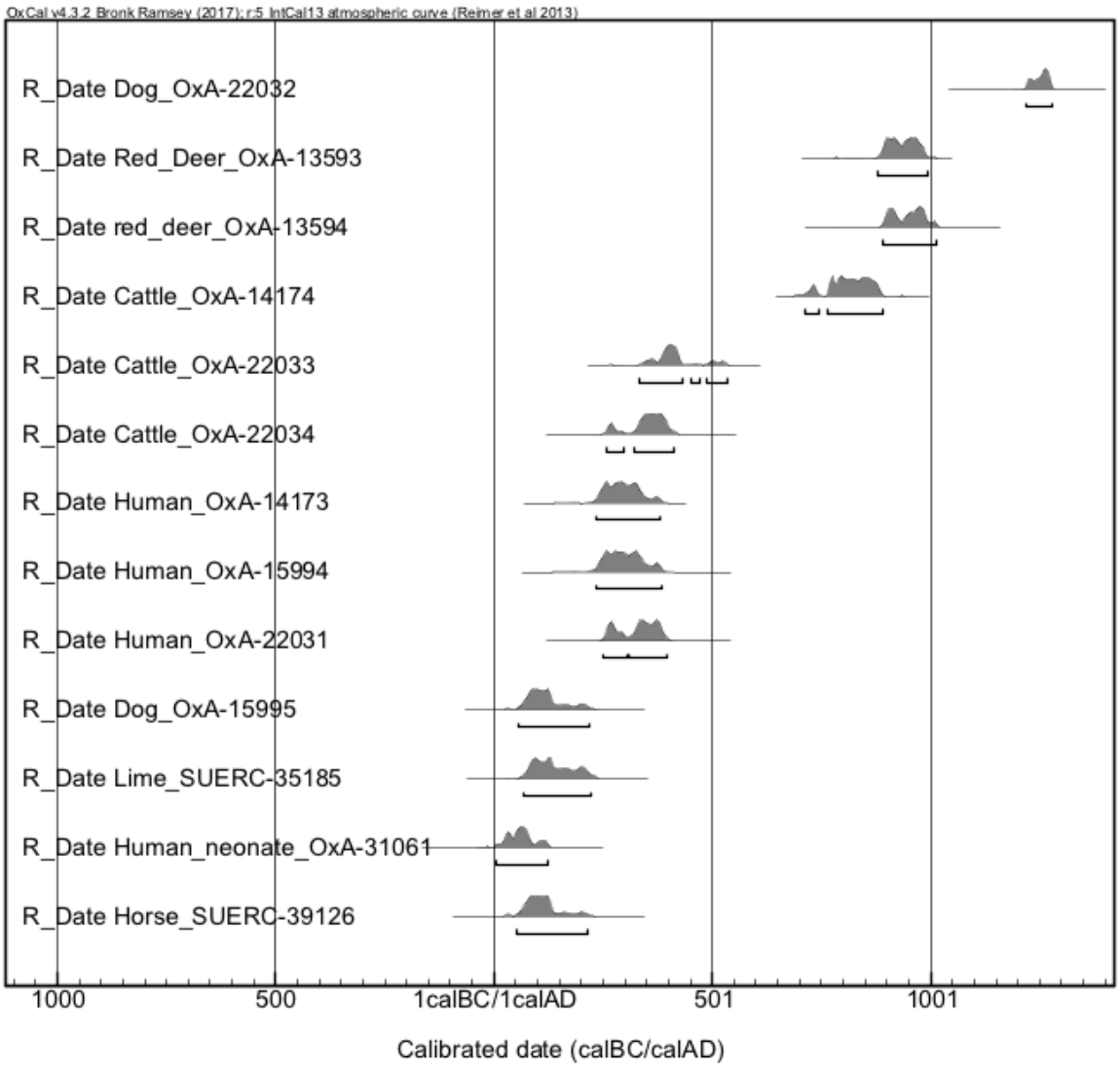

Figure 4. All calibrated radiocarbon dates from the site, demonstrating that the dates fall into three approximate phases. Calibrated using Oxcal v.4.3.2 Bronk Ramsey (2017), r:5 IntCal 13 atmospheric curve (Reimer et al., 2013).

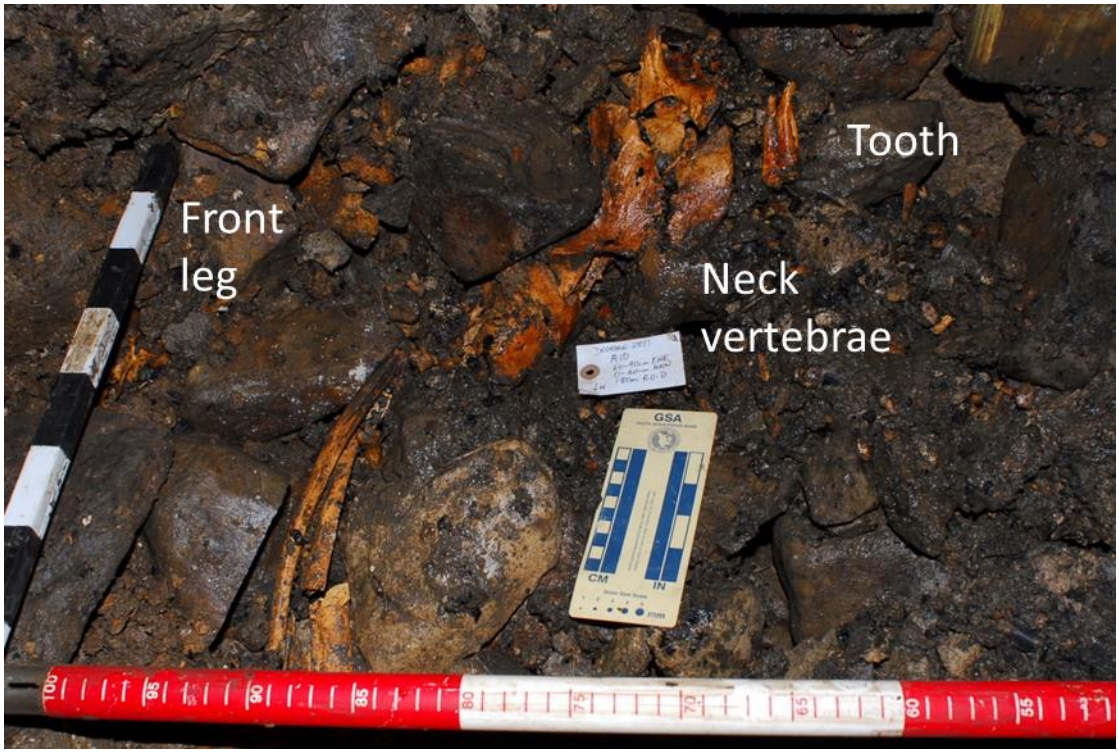

Figure 5. Annotated photograph of the articulated horse in layer AA10, at the base of the north shaft.

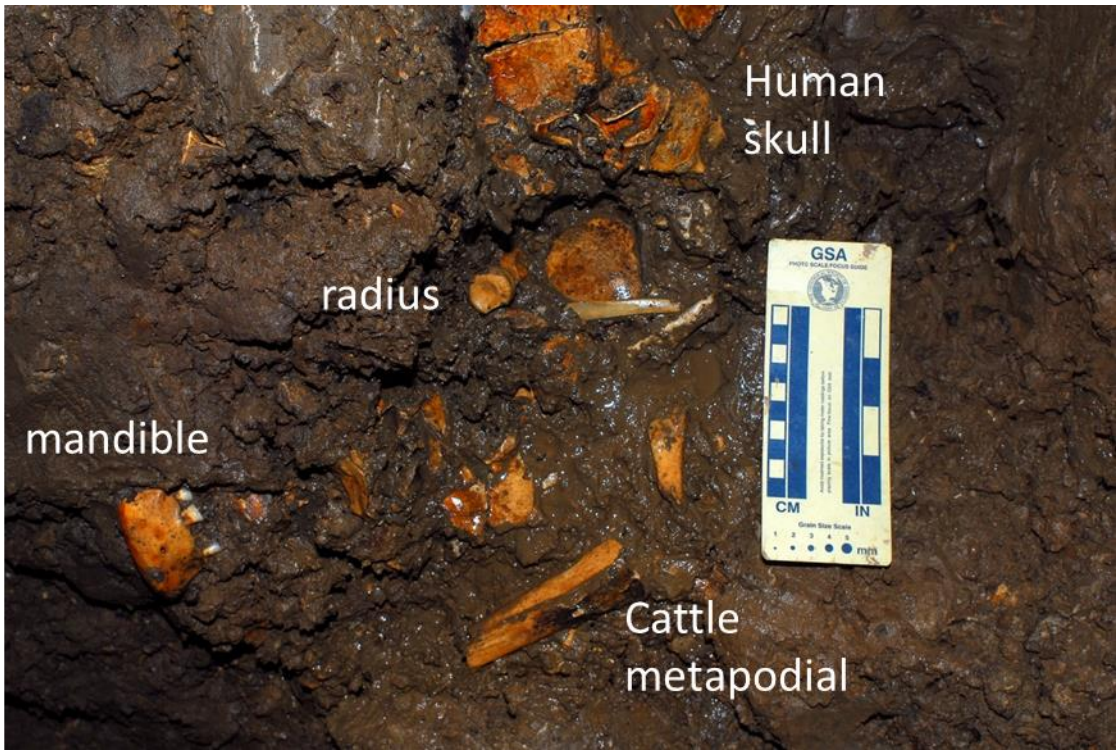

Figure 6. Annotated photograph of layer B3 showing close association of human and non-human remains, and the density of the sediments and clasts in the north shaft.

Fig. 7. Romano-British beads from Doghole Cave, Cumbria. Scale = 5mm. From Left: Blue beads = Type 1 (SF10-13), Long green bead = Type 4 (SF 142), elongated gold-in-glass bead = Type 5 (SF113), round gold-in-glass bead = Type 6 (SF158), small amber/ rainbow bead = Type 7 (SF150), and three-part jet bead = Type 8 (SF97). See Table 6, and Supplementary information section 2 for more information.

Fig. 8. Metal jewellery from Dog Hole Cave. Scale bar = 2cm. Top left, fragment of silver alloy bangle number (SF225); Bottom left, Cooper-alloy penannular bracelet with incised chevron decoration (SF259); Bottom right, two pieces of a copper-alloy torc-twisted bracelet (SF 260, SF 261); Top right: two refitting pieces of a probable ear-ring (SF215, SF236).

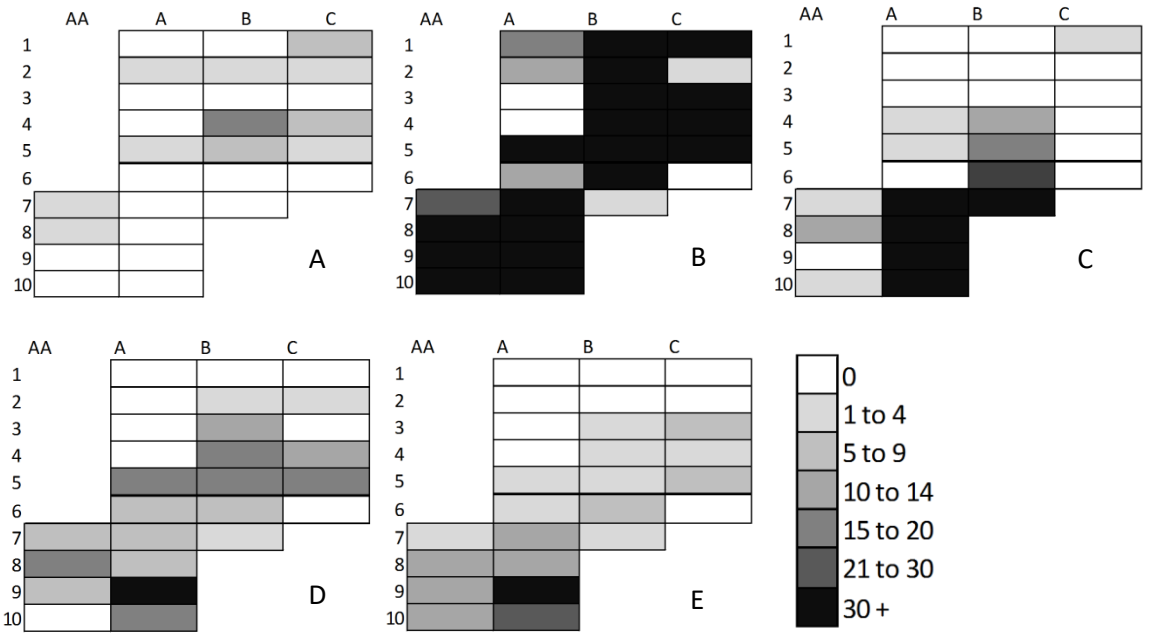

Fig. 9. Schematic diagram of the north shaft excavations showing the distribution of a) hobnails, b) microfauna, c) foetal remains, d) adult teeth and e) beads, through the layers. The greyscale key indicates the density of finds in each spit.

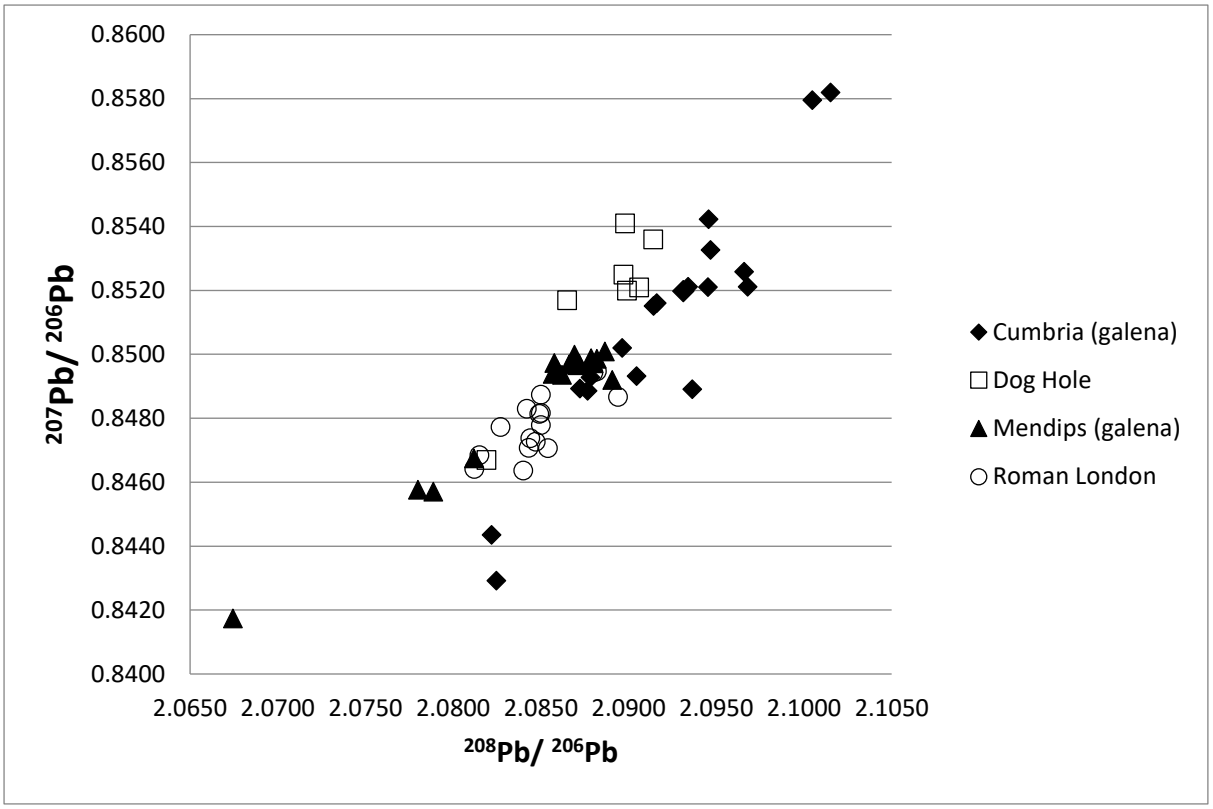

Fig. 10. Lead isotope graph showing the similarity between Dog Hole and Cumbrian galena, and individuals from Roman London and Mendip galena. Galena data from Rohl (1996), Roman London data from Shaw et al. (2016).