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Knappach Toll, Balbridie: a late 3rd-millennium BC Beaker burial on Deeside, Aberdeenshire

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1. ABSTRACT

A short cist discovered during ploughing at Knappach Toll on Balbridie Farm, Aberdeenshire held the remains of an adult accompanied by a Beaker, fragments of a copper awl and 11 struck flints. Little survived of the skeleton except for cranial fragments, but these indicate that the person had been placed with the head to the west, with the artefacts also at that end. While the sex of the person is indeterminate, with the single surviving sexual dimorphic trait suggesting a male, the position of the body and the presence of the awl are more usually indicative of a female. Radiocarbon dating shows that the person died between 3775±35 years BP (SUERC-30852) and 2330–2040 cal BC (95.4% probability). Stable isotope analysis indicates that he or she grew up on basalt geology, like that of the region, or on chalk. Residue analysis of the Beaker has established that it had held ruminant animal fat such as butter or milk, probably for some time, and some of the flint pieces had been lightly used. The composition and constituents of the burial suggest links between north-east Scotland and East Yorkshire. They also evoke the cultural practices that were spreading across eastern Britain in the later 3rd millennium BC through the mechanisms of cultural transmission and migration.

2. INTRODUCTION

In February 2009, a large slab was disturbed during ploughing of a field at Knappach Toll on Balbridie Farm, Aberdeenshire. The farmer dragged the slab to a corner of the field and, returning to the spot, observed a large, stone-lined hole where it had been. Thinking it was a field drain he stepped inside it, but on closer inspection he realised it contained pieces of pottery and was of some antiquity. He removed a slab that lay above the southern edge of the cist, laid it inside, collected the sherds of pottery and placed them on the slab. He then informed the Aberdeenshire Council assistant archaeologist, Moira Greig, who contacted Historic Environment Scotland (formerly Historic Scotland). The contents of the cist were excavated and its construction was investigated by a team from the former Glasgow University Archaeological Research Division over two days in dry conditions. The work was carried out under the Human Remains Call-off Contract issued by Historic Environment Scotland, who funded and monitored the fieldwork and post-excavation work.

2.1 Site location

The cist lies on a river terrace to the north of the B9077 road, about 2.5km to the east of Banchory (Illus 1). From the road, the ground rises slightly to a low ridge that runs along the field's northern edge, reaching a height of 50m above OD. The cist lies *c* 5m south of the field's northern boundary at approximately 49m above OD (NGR NO 7369 9595). To the north of this boundary, the ground drops steeply beneath mature conifers to a level expanse beside the River Dee. The first edition Ordnance Survey 6 inch to the mile map of the area shows that the field had been enclosed and improved by 1865. By 2012 it had been planted with conifer saplings, although the cist itself was excluded and protected under a low mound of ploughsoil.

The solid geology at the site consists of metamorphic bedrock formed between 1,000 and 542 million years ago (Queen's Hill Formation – semipelite, psammite and pelite); these were originally sedimentary rocks that formed in shallow seas and were later altered by low-grade metamorphism. The superficial geology formed up to three million years ago in the Quaternary Period, when glaciers were scouring the land and meltwater was depositing moraines of till with outwash sand and gravel deposits (British Geological Survey [nd]).

2.2 Archaeological background

This part of the Dee valley was home to well-established communities in the 4th and 3rd millennia cal BC, with a ceremonial landscape flanking the river and dominated by large, communal monuments. Two substantial timber halls stood in the vicinity of Knappach Toll during the early Neolithic – one at Balbridie about 300m to the east and the other 1.5km to the north-east, across the river at Crathes (see Illus 1). Excavation of Balbridie timber hall in 1977–81 revealed that it had been built of prepared oak timbers; abundant carbonised grain was found inside it, along with sherds of Unstan Ware and worked flint (Canmore ID 36669; Ralston 1982). The similar but slightly smaller timber hall at Warren Field, Crathes was partially excavated in 2004. It was also built of dressed oak timbers, with relatively sparse pottery, flints and grain associated with it (Canmore ID 36670; Murray et al 2009). Both buildings stood during the early to mid-4th millennium BC and both were destroyed by fire.

By the mid-3rd millennium cal BC, the character of ceremonial activity in the landscape had shifted towards the construction and use of recumbent stone circles (Bradley 2005) and single burial in cists, often accompanied by Beakers, with some debate about whether the construction of these monuments preceded the common use of Beakers or whether these practices emerged concurrently (see Curtis & Wilkin 2012: 241–3). In the vicinity of Knappach Toll, a cluster of three cists was discovered during ploughing on a natural knoll in 1893, a kilometre to the SSE; they contained probable inhumations with Beakers and Beaker sherds (Shepherd 1986: 37) (see Illus 1). Other finds suggest the locations of settlement and other activity in the environs. Scatters of worked flint, including a barbed-and-tanged arrowhead, have been found along the south bank of the river within about a kilometre of the cist; a possible ring ditch has been identified through aerial photography to the east of Balbridie timber hall; and several extensive field systems which may incorporate burial cairns lie on higher ground to the SSW.

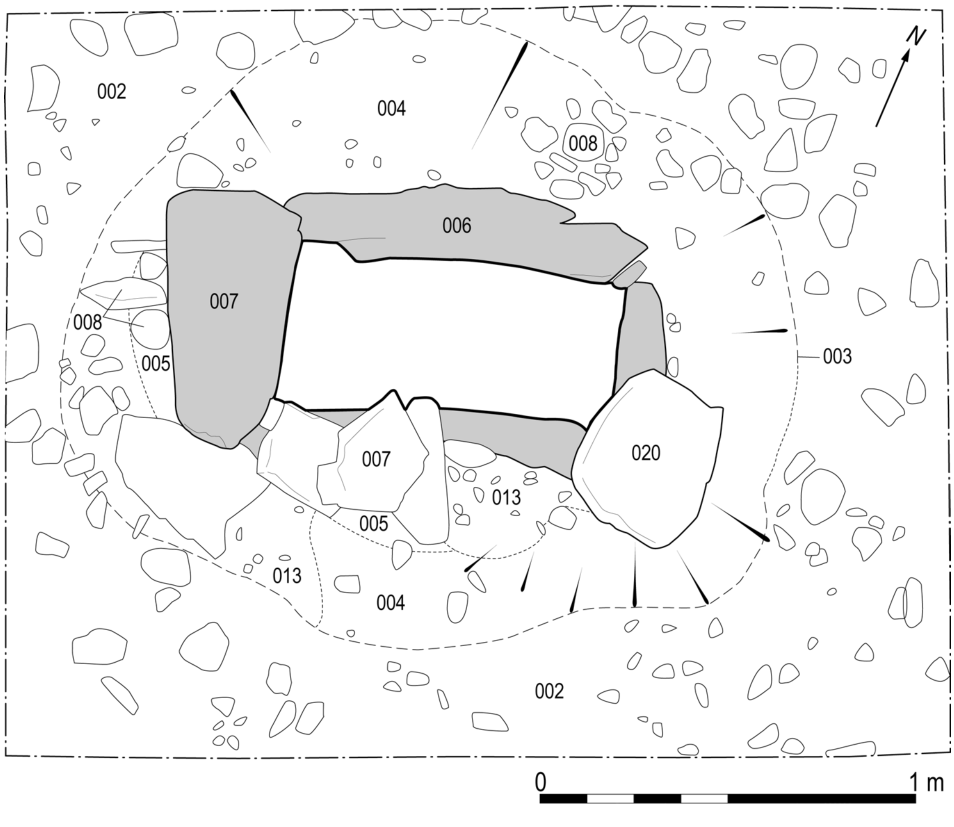
Illus 1 Location plan. © Northlight Heritage

North-east Scotland contains one of the highest concentrations in northern Britain of inhumation burials accompanied by Beakers in short cists (Shepherd 1986). These point to shared belief systems and social practices across the region's communities and their connections elsewhere along the eastern seaboard of the UK and to Continental Europe (Bradley 2005: 113; Shepherd 2012).

3. FIELDWORK METHODOLOGY

A trench measuring 2.5m NNE/SSW by 2m was excavated over the cist (Illus 2 & 3). After the loose, intrusive ploughsoil that covered the floor was removed, eight samples were taken on an east/west grid of the basal deposit to recover small fragments of bone or botanical material and allow testing for phosphate levels. Background samples were also taken from the ploughsoil, the upper subsoil and the lower subsoil. However, the decision was taken not to subject these samples to geochemical analysis, on the basis that the results were not likely to significantly inform interpretation.

As the landowner wished to leave the cist intact, no geological samples were taken of the slabs that formed it. The cist's construction was investigated by excavating opposing quadrants of the cut outside the structure. This allowed the recording of two cross-sections across the cist and the examination of half of each exterior face for artificial markings. Following excavation, the capping slab was replaced and the pit that held the cist was backfilled; the estate manager then sealed it with a thick layer of ploughsoil.



Illus 2 Pre-excavation plan of the cist. © Northlight Heritage

Illus 3 The cist before excavation, from the east. © Northlight Heritage

4. RADIOCARBON DATE

Table 1 shows the radiocarbon determination from a left temporal bone recovered from the cist. When calibrated at two standard deviations (95.4% confidence), it returns a date range of 2330–2040 cal BC. This is consistent with radiocarbon dates associated with other Tall Short-Necked vessels from north-east Scotland (see 7.1 'Report on the Beaker' below).

Table 1 Radiocarbon date from the Knappach Toll burial, calibrated using OxCal 4.3.2 (Bronk Ramsey 2017); IntCal13 atmospheric curve (Reimer et al 2013)

Site	Sample	Material	Area/ Context	Description	Depositional context	Uncal	$\delta^{13}C$	1σ (68.2%)	2σ (95.4%)
Knappach Toll, Balbridie	SUERC-30852	Human L temporal bone	9	Burial	Primary	3775±35 BP	-9.7‰	2280–2140 cal BC	2330–2040 cal BC

5. THE BURIAL

The ploughsoil that sealed the cist and its environs consisted of friable, dark grey-brown gritty sandy and stony silt that varied from 0.1m to 0.23m thick.

5.1 Contents of the cist

The sub-rectangular interior of the cist was defined by four side slabs (Context 006) that pitched slightly together towards the top, so that it measured 0.88m east/west by 0.4m at the top but 1.10m east/west by 0.77m at the base. The base was formed of the natural sandy gravel subsoil (Context 012) (Illus 4 & 5).

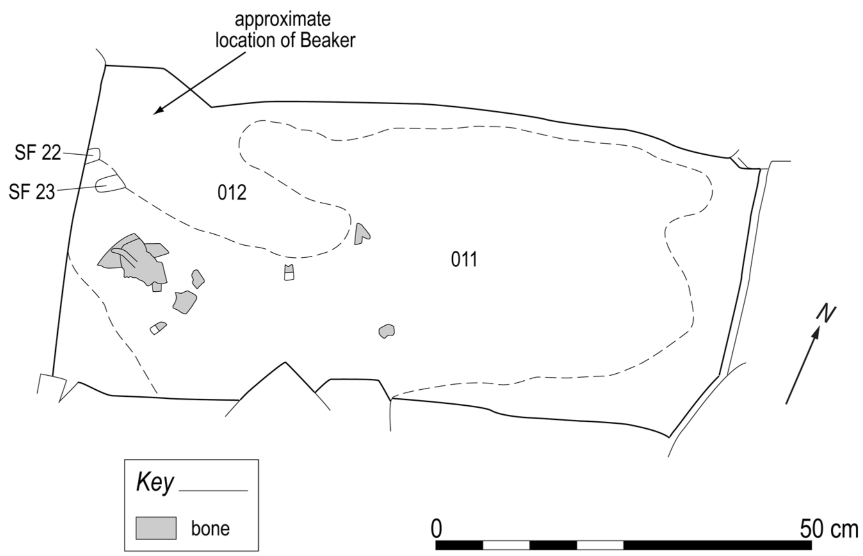
A thin, irregular spread of compacted, dark grey-brown, gritty sandy silt (Context 011) lay about a centimetre thick across the base, beneath and around the human remains (Illus 4 & 5). It may have derived from the decay of organic materials, including the body. Similar, amorphous stains have been identified in other Early Bronze Age cist burials, for example at Doons Law in Berwickshire (Clarke & Hamilton 1999) and at Mains of Scotstown, Sandhole Quarry and Tavelty Farm, all in Aberdeenshire (Ralston 1996).

At the western end lay a concentration of skull fragments, including part of a temporal bone found directly on top of a mandible. Several other cranial fragments and teeth lay in the same area and across the western half of the cist. Two worked flints (SF022 and SF023) lay to the north-west. Two conjoining fragments of a copper awl (SF025) were also recovered from a bulk sample taken from the basal deposit (Context 011) in the north-west corner. Taken together, the evidence suggests that a body was laid in the cist with the head to the west and the artefacts were placed behind the head. This would be in keeping with Beaker burial practice (Tuckwell 1975: 109; Shepherd 2012, and see 10 'Discussion' below).

Above was loose ploughsoil (Context 009) that had fallen in when the capping slab was dragged out of place by the plough. Human bone and teeth and pieces of worked flint, none apparently in situ, lay in it. A triangular slab (Context 014, not illustrated) sat in the north-west corner of the cist with the Beaker sherds lying on it, where the farmer had placed them. When he first observed the Beaker, it lay already broken in this corner of the cist (Ian Menzies, pers comm).

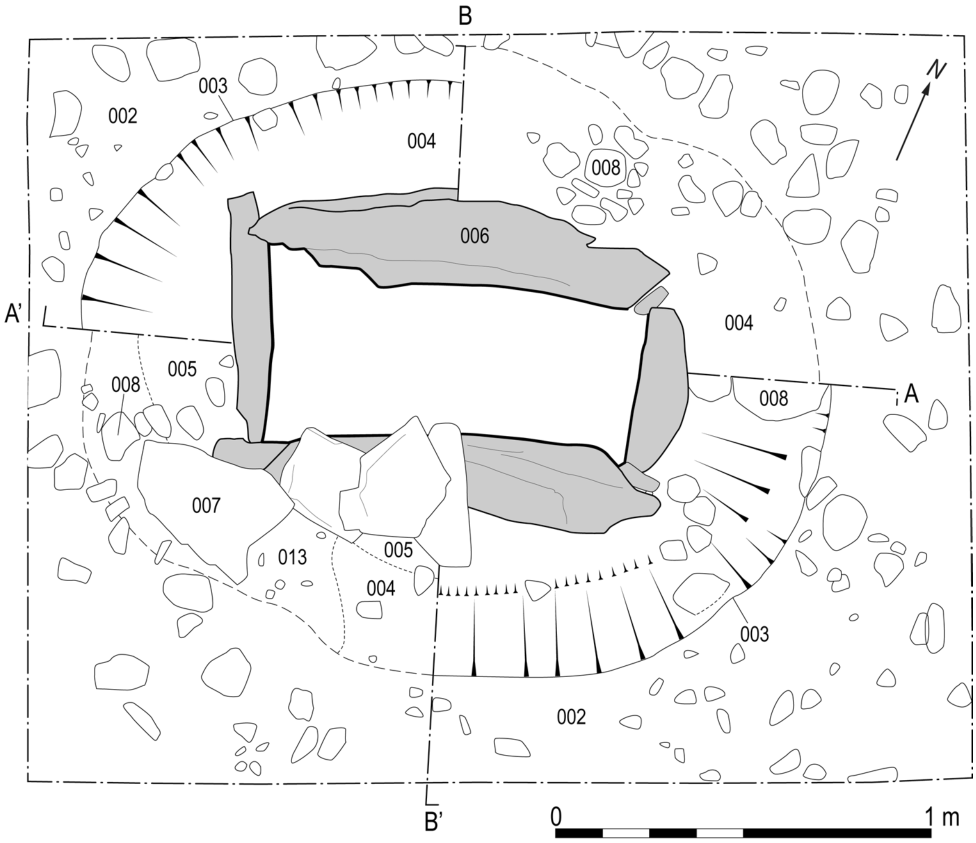
5.2 Construction of the cist

The cist had been constructed by first digging a large, sub-oval pit (Context 003) to contain the structure; it had been cut, 1.94m east/west by 1.7m and about 0.55m deep, into the yellow-orange coarse sand, pea grit and firmly set stones of the subsoil (Illus

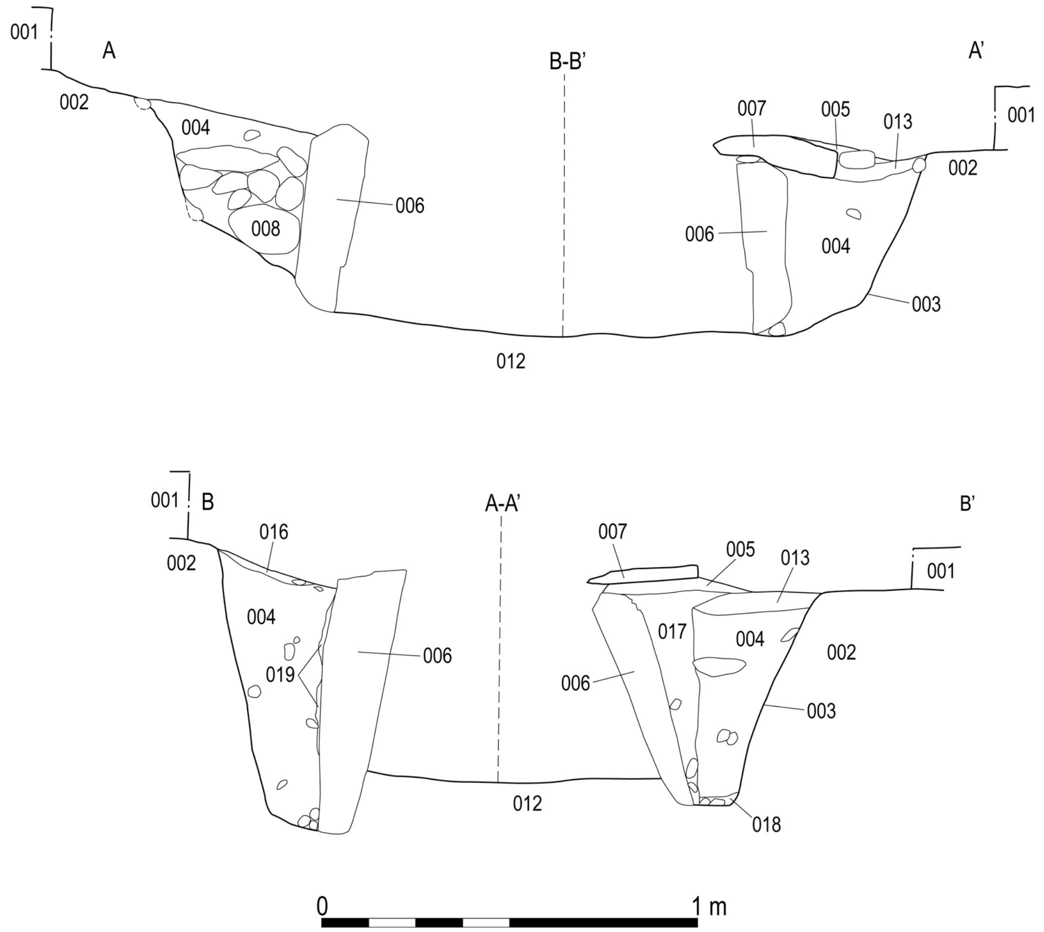


Illus 4 Plan of deposits inside the cist. © Northlight Heritage

Illus 5 The interior of the cist with skull fragments and basal deposit 011, from the north and above. © Northlight Heritage



Illus 6 Post-excavation plan of the cist. © Northlight Heritage



Illus 7 Sections across the cist structure. © Northlight Heritage

6 & 7). The upright slabs (Context 006) on the north and south were taller than the others and, to accommodate them, the builders had excavated near-vertical sides on the north and south, cutting away the lower subsoil in steps and setting the slabs hard against the edges of the cut. They dug the east and west sides to descend steeply to a gently sloping base in order to give the slabs on these sides greater height.

The eastern slab was of coarse-grained granite with an irregular surface. A small, pecked hollow measuring 2cm in diameter was observed in the centre of its inner face, about 0.33m from the base (Illus 8). The other slabs were of finer-grained, sedimentary rock and no markings were observed on their accessible faces.

The builders packed cobbles and small slabs (Context 008) behind the eastern slab and at the south-west and north-east corners, but relatively little packing material was observed elsewhere (Illus 7). Gaps at the lower corners were chocked with cobbles except on the south-east, and the north-east corner was also pinned with long, angular stones.

After the cist was constructed, light yellow gravelly sandy subsoil (Context 017) had been packed behind the base of the more steeply leaning southern slab. Then the rest of the pit outside the structure was backfilled with the coarse, dark orange-brown sand (Context 004) which had been dug out to make it. Roots had penetrated along the north face of the northern slab, leaving pockets of more humic, gritty loam (Context 019). On the north and south, the pit fill was sealed by a thin layer of light orange-brown sandy silt (Contexts 016 and 013), a remnant topsoil.

The builders set several slabs (Context 007) over the edge of the cist on the west and south to support the capping slab, which had an irregular underside. Over the western side they also set a large

Illus 8 The pecked hollow on the interior face of the eastern slab, from the west. © Northlight Heritage

Illus 9 The slab with a straight, serrated edge, set over west edge of the cist, from the east. © Northlight Heritage

slab with a serrated edge, which appeared to have been chipped to straighten it (Illus 2 & 9). Fine, pale yellow sand (Context 005) had been packed beneath the southern levelling slabs and partly over the western one before the capping slab was put in place (Illus 2 & 7).

The capping slab (Context 015, not illustrated) was an irregular triangle in plan, measuring 1.38m long by up to 0.68m wide and up to 0.10m thick. The surfaces were extremely irregular and weathered, and no artificial marks were observed on either face. When the capping slab was replaced, it became clear that a smaller slab (Context 020), found pitched at the cist's south-east corner, had been set to fill a gap created by its irregular shape (Illus 2 & 3).

6. THE HUMAN REMAINS

6.1 Skeletal analysis

Iraia Arabaolaza

Only some fragments of skull and some teeth were recovered from the cist. The bone surface presented erosion which was graded 3 according to the standards in Brickley & McKinley (2004). The sex of the skeleton was assessed using standards outlined by Buikstra & Ubelaker (1994). Since no pelvic bones were preserved, only the sexual dimorphic traits of the skull were potentially available for observation, and three of them were not observable due to incompleteness or poor preservation. Consequently, only the posterior zygomatic process could be estimated, and this indicated a possible male (?M). However, because of the lack of more visual traits for observation and estimation, it is more appropriate to estimate the sex of the remains as indeterminate.

The degree of dental attrition observed led to an age estimation of 33–45 years (Brothwell 1981). However, since the different attrition stages do not follow a fixed and constant sequence, their accuracy is limited. As a result, a more general age category of 'adult' was estimated for the skeleton, based on the complete eruption of the third molars. No measurements were taken from the skeleton due to the poor preservation of the cranial bones. The non-metric traits, as their name indicates, are traits which are not measurable but are recorded as either present or absent (Table 2). Some of them relate to genetic causes, while others are thought to be linked to environment, occupation and lifestyle (Brickley et al 1999) and are used to identify and compare different genetic groups. Standard traits identified by Berry and Berry (1967) for the cranial bones were studied in this analysis.

The identification of different pathological conditions depends upon the completeness and preservation of the bone. Although this skeleton's incomplete nature makes it difficult to identify evidence of pathology, several conditions were identified.

Caries or tooth decay, caused by bacteria found in dental plaque (Hillson 1996), was recorded on the second and third maxillary left molars. On both teeth the cemento-enamel junction was affected by the caries, distally on the second molar and mesially on the third molar. Calculus or tartar, a hard deposit of mineralised plaque, was recorded on all left molars as well as on the maxillary left second premolar and mandibular left first premolar (Hillson 1996). In archaeological remains, calculus indicates poor oral hygiene, although its presence and severity can be influenced by age, diet, ethnicity and systemic diseases (White 1997). Finally, a dental anomaly, dental pearl enamel, was also identified on the distal aspect of the second maxillary left molar (Illus 10).

Table 2 Non-metric traits identified on the skeleton from Knappach Toll

Trait	Right	Left	Number
Cranial			
Zygomaticofacial foramen	X	P	1 foramen
Tympanic dehiscence	X	P	
Auditory exostosis	X	A	
Mastoid foramen exsutural	X	P	
Mental foramen number	X	A	
Mandibular torus	X	A	
Mylohyoid bridge	X	N/O	

Illus 10 The caries and dental pearl enamel at maxillary left M2. © Northlight Heritage

6.2 Strontium, oxygen, carbon and nitrogen isotope analysis

Jane Evans & Angela Lamb

6.2.1 Method

Samples were submitted for analysis of strontium and oxygen isotopes on tooth enamel, and for analysis of carbon, nitrogen and sulphur isotopes on bone, in order to illuminate the diet and geographical origins of the person buried in the cist.

The tooth enamel samples were prepared by abrading the available enamel surface to a depth of >100 microns, cutting thin slices and cleaning all surfaces. Strontium was collected using Dowex resin columns and loaded onto a single Re Filament with TaF following the method of Birck (1986); the isotope composition and concentrations were determined by Thermal Ionisation Mass spectroscopy (TIMS) using a Thermo Triton multi-collector mass spectrometer. Oxygen isotopes were collected by treating small fragments of clean enamel (15–20mg) to extract PO_4 radicals and precipitated as silver phosphate, using the method of O'Neil et al (1994). Oxygen isotope measurements on each sample were analysed in triplicate by thermal conversion continuous flow isotope ratio mass spectrometry (TC/EA-CFIRMS). Results were converted to SMOW values using a value of 21.7‰ for silver phosphate precipitated from NBS120C (Florida phosphate rock), calibrated against certified reference material NBS127 (assuming $\delta^{18}O$ of NBS127 = +20.3‰ versus V-SMOW) at NIGL using fluorination (see Chenery et al 2010: appendix). The 1σ reproducibility for mass spectrometry controls in this batch of analysis were $\delta^{18}O$ = ±0.20‰ (1δ, n=14) and the mean repeatability of triplicate analyses was $\delta^{18}O$ = ±0.10‰ (1δ, n=12). Drinking water values were calculated using the calibration of Daux et al (2008: equation 4).

The samples for carbon and nitrogen analysis were prepared following a modified Longin method (Brown et al 1988). The collagen samples used for carbon and nitrogen analysis were redissolved in milliQ water and ultra-filtered to remove the <30 kDa component for sulphur isotope analysis. The residue from the filters was freeze-dried and ~12–14mg was weighed into tin capsules. Sulphur, carbon and nitrogen isotope analysis was by continuous flow isotope ratio mass spectrometry (CFIRMS).

6.2.2 Results

The strontium isotope composition is below the value predicted for this part of Scotland (Evans et al 2010), although data from this area are sparse and the geology is complex. The drinking water value is within the expected range for the eastern side of Scotland (Darling et al 2003). Data are presented in Table 3.

The low strontium isotope ratio is indicative of someone raised either on chalk or basaltic terrain and most likely basalt, given the combination of the signature with an elevated S concentration of 212 ppm and by comparison with the very few examples we have of such origins (Culduthel man (J Montgomery, pers comm) and individual Cnip-D (Montgomery et al 2003)). A basaltic origin would be more likely in the Scottish context and, although such rocks are not recorded on the $^{87}Sr/^{86}Sr$ isotope biosphere map of Britain (Evans et al 2010) due to their limited outcrop, such rocks are found locally in the Knappach Toll area. The oxygen isotope composition (–8.3) is also consistent with an eastern Scottish origin. There is thus no evidence that this individual was not local; the data could also be consistent with an origin in Antrim, Ireland, where large areas of basalt exist. Origins on chalk terrain (such as occurs in eastern and southern England and in parts of the Continent) are also possible, especially given other kinds of evidence for close links between north-east Scotland and East Yorkshire (see 7.1 'Report on the Beaker' below; Curtis & Wilkin 2012; Shepherd 2012) and the eventual mass displacement by Beaker-using people of steppe ancestry via the Netherlands (Olalde et al 2018) (see 10 'Discussion' below). The Knappach Toll individual plots on the lower margin of the enamel strontium dataset for individuals analysed across Britain in the Beaker People Project (Parker Pearson et al 2016: fig 6).

The carbon and nitrogen isotope composition for the individual from Knappach Toll suggests that he or she had a diet high in animal protein, but with no evidence of a marine component. The data have been compared with reference data from the Norse-period Scottish sites of Cnip and Galson in the Outer Hebrides (Richards et al 2001), Newark Bay, an Iron Age site on Orkney (Richards et al 2006), and Wetwang, an Iron Age chariot burial in Yorkshire (Jay & Richards 2006). The Scottish data define an array of values that result from a mixed diet of marine and non-marine protein components; the higher nitrogen values typify a marine component. The Wetwang dataset provides a reference set for a

Table 3 Strontium isotope data for the Knappach Toll individual (* A ±0.2 (1σ) blanket error, derived from the reproducibility of the NBS 120 C standard, is considered the best estimate of error for the $\delta^{18}O$ SMOW values and this results in ±0.4 (1σ) error on the calculated drinking water values)

Sample	ppm	$^{87}Sr/^{86}Sr$	Mean δ^{18}*O SMOW	n	Daux equation	Amt% N	Amt% C	at C/N	$\delta^{15}N$ AIR	1 SD	$\delta^{13}C$ P	1 SD	n
KT-09-SK1-e	212.1	0.707949	16.72	3	-8.3	14.9	43.6	3.4	10.14	0.1	-21.56	0.15	3

diet high in animal protein, with no evidence for any significant marine food input (Jay & Richards 2006). The Knappach Toll individual plots on the margin of the Wetwang dataset. In comparison with the Beaker People Project dataset, the Knappach Toll individual's values are slightly higher for carbon isotope ratio than the average range of −21.0±0.4‰ and slightly lower for nitrogen than the average of 10.3±0.7‰ for dentine (Parker Pearson et al 2016).

The application of sulphur isotope analysis to archaeological material is relatively new. A few studies have begun to assess the utility of $\delta^{34}S$ both as an indicator of palaeodiet and as an indicator of residency/mobility (Richards et al 2001; 2003; Privat et al 2007). Sulphur is a vital nutrient for animals, and an animal's sulphur composition derives from its food intake. At the base of the food chain, vegetation will inherit sulphur from the substrate and its $\delta^{34}S$ composition will vary with geology, giving rise to a large variety of terrestrial $\delta^{34}S$ sources (−19 to +30‰). This variety can enable residency/mobility studies as it can identify 'migrants' to an area based on non-local $\delta^{34}S$ signatures. Plant $\delta^{34}S$ will also be affected by soil processes and, near the coast, by sea spray, which can deposit marine sulphur and potentially blur the terrestrial/marine $\delta^{34}S$ distinction. Marine sulphate has a $\delta^{34}S$ value of about +21‰ and primary oceanic producers have +17–21‰, whereas freshwater producers can have a very wide range of $\delta^{34}S$ (−22 to +22‰), reflecting the oxidation state of sulphates. As there is minimal fractionation between trophic levels, this can usefully be applied to compare terrestrial, freshwater and marine consumers. Away from areas affected by sea spray, $\delta^{34}S$ can distinguish between marine and terrestrially based diets. For example, a study of modern fauna from the Canadian Arctic used $\delta^{34}S$ to distinguish between terrestrial mammals (<+10‰) and mammals living close to the coast and consuming marine fauna, such as polar bears (+16–18‰) (Krouse & Herbert 1988). The limitation of $\delta^{34}S$ for archaeological palaeodiet studies is that it may not be able to distinguish between truly marine diets and terrestrial diets in coastal locations due to the issue of sea spray. If it is used in combination with other palaeodietary isotopes (C, N) this may aid interpretations. For example, high $\delta^{13}C$ values (> −17‰) can also suggest a marine protein diet in C_3-plant environments.

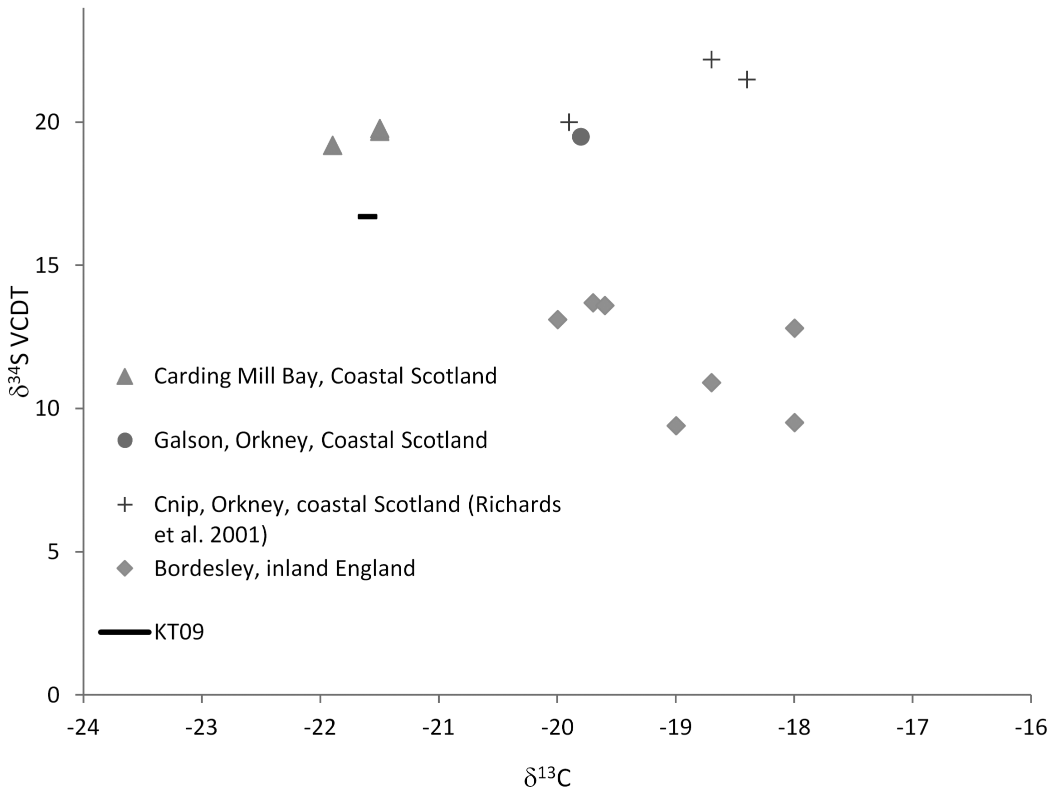
Theoretically, modern bone has a sulphur content of 0.18%. Privat et al (2007) suggest caution if the percentage of sulphur in collagen is greater than 0.6%, which suggests the presence of contaminants. This sample has a percentage of sulphur close to 0.18% and thus appears well preserved. Although still not fully established, it has been suggested that atomic N/S ratios can be used to assess sulphur in collagen quality in the same way C/N ratios

Table 4 Sulphur data for the Knappach Toll individual

Identifier 1	$\delta^{34}S$ VCDT	1 SD	n	% S	Amt% N	Amt% C	Amt% S	at C/N	at C/S	at N/S
KT09-SK1	16.7	0.13	2	0.21	14.9	43.6	0.21	3.4	563	165

are used for C and N analysis. If the atomic N/S ratio is outside the range of modern bone, caution should also be used (modern bone N/S ranges from 61–211 (Privat et al 2007)). The N/S ratio of this sample is 165 and thus well within modern range (Table 4).

The Knappach Toll individual has a relatively high $\delta^{34}S$ value (16.7‰), intermediate between UK coastal and inland archaeological values when compared to data presented in Richards et al (2001) (Illus 11). The $\delta^{13}C$ value (–21.6±0.15‰) and $\delta^{15}N$ value (10.1±0.1) suggest a largely terrestrially based protein diet with possibly some freshwater fish input.



Illus 11 Sulphur data for the Knappach Toll individual (KT09) compared to other UK archaeological data (Richards et al 2001). © Northlight Heritage

7. THE BEAKER

7.1 Report on the Beaker

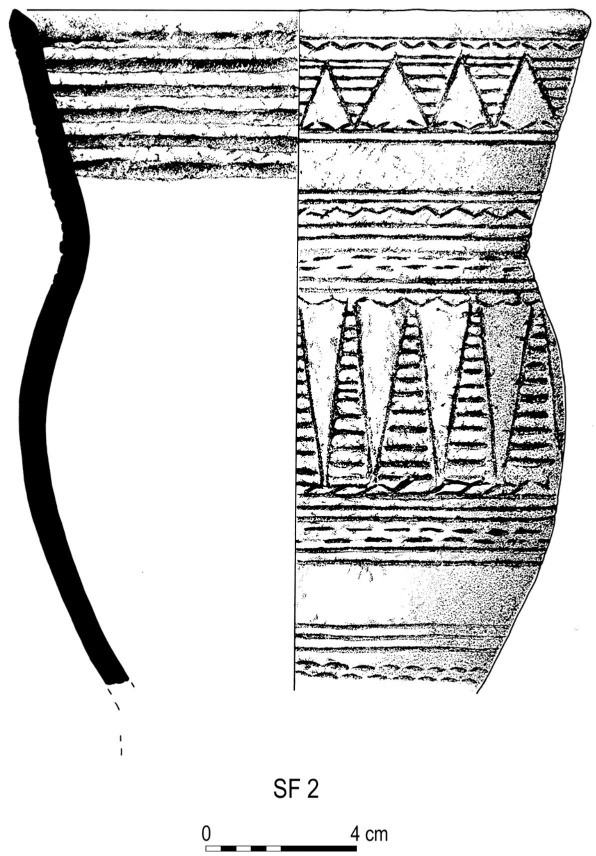
Neil Wilkin

The Beaker (SF002, Illus 12) was analysed according to the *Guidelines of the Prehistoric Ceramics Research Group* (PCRG 1997), with full details recorded in the archived report (held at the National Record of the Historic Environment maintained by Historic Environment Scotland). A catalogue of the sherds is also included with the project archive. The vessel is approximately 80–85% complete, including *c* 90% of the neck and rim and >90% of the upper body. These sherds are in relatively fresh condition. However, the lower body (*c* 3cm above base) is complete and abraded to only *c* 20–25%. The base is also incomplete, abraded and complete to only *c* 50%. The dimensions of the vessel are as follows: height *c* 190–200mm; rim diameter *c* 155mm; base diameter *c* 95mm; wall thickness *c* 7mm.

7.1.1 Detailed vessel description

The colour of the exterior surface is brown to dark brown (Munsell 5YR 5/6) while the interior is a yellow-buff to brown. Quartzatic inclusions are frequently distributed, with maximum size of 3–4mm, and with some showing on the surface of the vessel. Also evident on the surface are black mica platelets. Both inclusions of quartzatic grits and mica platelets are a common feature of Beakers from the north-east of Scotland, occurring in a high proportion of funerary vessels in the collection of the Marischal Museum, University of Aberdeen (author's personal dataset). Indeed, of the 11 Beakers excavated to modern standards (that is, from *c* 1970/80), and for which data are available, at least five have quartzatic grits.

The fabric has a cross-section comprising an oxidised exterior; a black, unoxidised core, and an oxidised interior, indicative of the open-air firing and incomplete burning of the carbonaceous matter



Illus 12 The Beaker. © Northlight Heritage

at the core of the wall. A number of sherds show evidence of residues, most notably the basal sherds, that may relate to the original use of the Beaker (see 7.2 'Organic residue analysis of the Beaker' below). There is evidence of burnishing to the undecorated areas of the exterior surface, with the unfilled isosceles triangles of the chevron patterns bearing an especially high sheen. A slip was applied to the exterior of the vessel prior to decoration and burnish. Further elaboration is represented by possible traces of a decorative white infill or inlay to a section of the neck. This feature occurs on a significant proportion of Beakers in north-east Scotland (*c* 57%) and has been identified on some as calcium hydroxyapatite (the major inorganic constituent of bone), derived from burnt, ground bone that was mixed with liquid to a soft paste and rubbed into the incised decoration (Curtis et al 2010). The low visibility of the white inlay on the Knappach Toll Beaker is perhaps understandable given the poor preservation of human remains within the short cist.

The vessel has a gently curving ovoid body with a relatively sharp angle between the neck and the body (Illus 12). The neck flares outwards at a uniform angle, terminating at an unusual rim that has been bevelled to the interior and exterior. Although the lower body of the vessel is not complete, an approximate height of 190–200mm can be proposed based upon the estimated base diameter of 95mm. This places the vessel among the upper size range of north-east Scottish Beakers of 120–220mm (cf Shepherd 1986: 29–32). The internal base of the vessel rises to a low omphalos. A neat, thin cordon (*c* 3–4mm wide) encircles the vessel at the base of the neck, just above the waist.

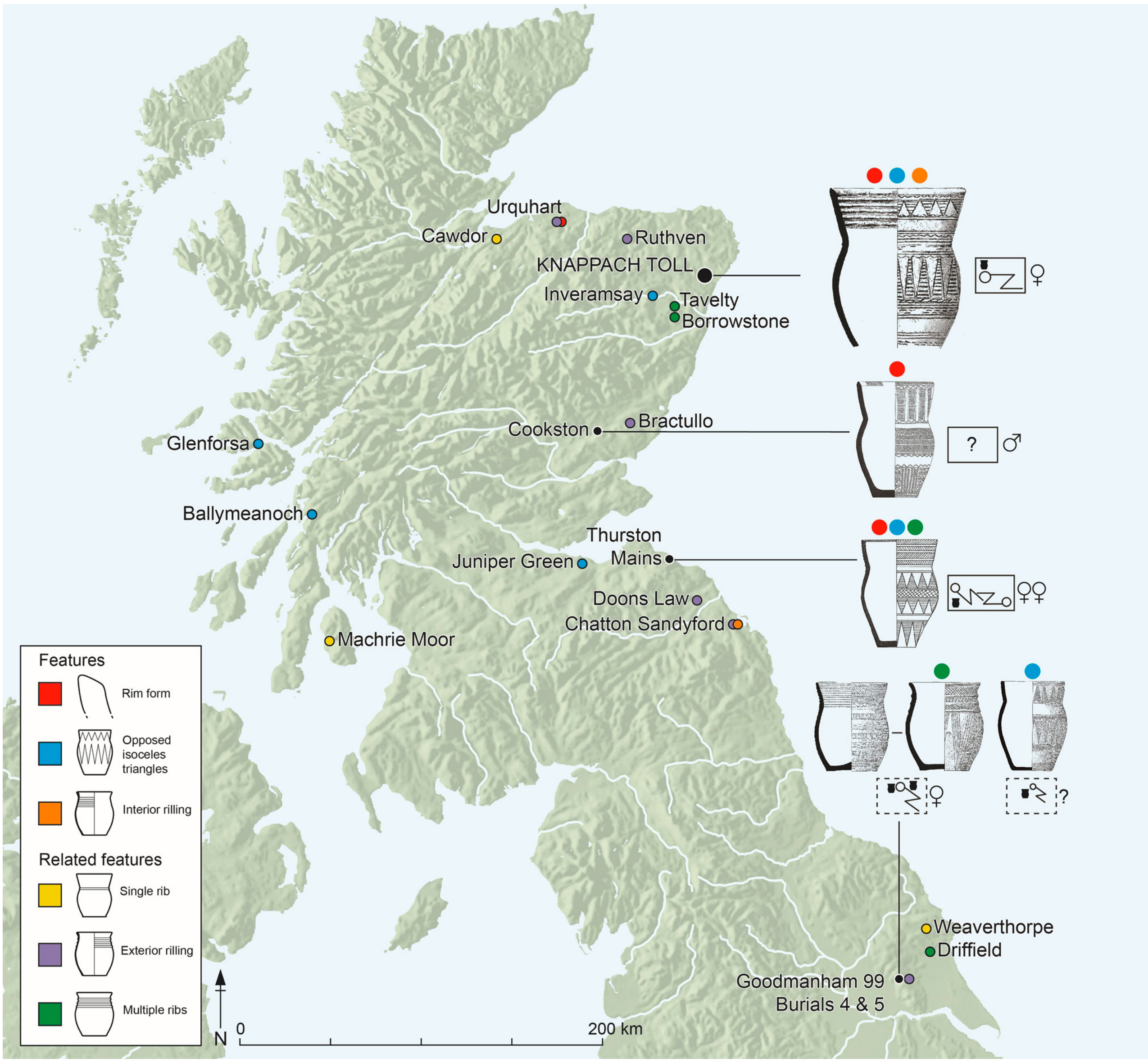
There are five zones of decoration: four on the exterior surface (two on the neck and two on the body) and one on the interior of the neck. The decorative zones on the exterior include Clarke's (1970) Southern British Motif Group 4, No. 29 (also forming No. 30); Primary Northern British/Dutch Motif Group 2, Nos. 16 and 17, and Late Northern Motif Group 3, No. 21. The decoration consists of a row of isosceles triangles to the neck and body respectively, both with encircling lines (including dashes and fringing/horizontal herringbone) to either side. The exterior decorated and undecorated bands thus nest around isosceles triangles on both the upper neck and body, creating a mirror image that is broken by the difference in the scale of the opposed isosceles triangles. The overall design is therefore centred upon opposed, filled and unfilled triangles – a relatively popular Beaker scheme (see 7.1.2 'The Beaker: traits and comparanda' below).

The decoration was executed using three techniques. The main technique was comb impression, with at least two combs utilised, one with teeth of 0.7mm diameter (for example, for the upper chevrons) and the other with teeth of 1–2mm diameter (for example, for the encircling lines). The fringes, dashes and the fill of the lower chevron pattern have been incised, possibly using the edge of a comb. Finally, the encircling lines on the inside of the neck were grooved using a blunt instrument (*c* 4–5mm) with irregular edges.

7.1.2 The Beaker: traits and comparanda

The Knappach Toll vessel sits comfortably within the overall decorative and morphological palette of Beaker pottery in Deeside and north-east Scotland, but also presents some unique features and evidence for inter-regional connections (see Illus 13). The closest parallels for the overall decorative design and form are the angular-necked vessels from Cookston, Angus (Coutts 1971: 48, fig 82a); Thurston Mains, East Lothian (Clarke 1970: no. 1648, fig 648: 'Skateraw'), and Goodmanham 99, Burial 5, East Yorkshire (Clarke 1970: no. 1309, fig 675). However, several individual features are rare and require further attention in relation to privileged connections within the wider Beaker network of eastern Britain. For instance, the double-bevelled rim, shaped to a blunt point, is a modest but relatively rare feature, although internal bevels alone are more common. Limited parallels include the vessel from Cookston, Angus (Coutts 1971: 48, fig 82a) and the unusual squat bowl from Urquhart, Moray (Clarke 1970: no. 1721, fig 723).

Opposed filled isosceles triangles (frequently associated with horizontal herringbone/fringing) are a recurrent decorative feature of funerary Beakers in north-east Scotland, frequently globular vessels from the Buchan region (Shepherd 1986: illus 20; Shepherd 2012: illus 17.6). However, the Beaker from Knappach Toll belongs to a more dispersed group with longer, angular necks and more ovoid bodies that stretch the opposed



Illus 13 Map showing connections between the key and related decorative and morphological features of the Knappach Toll Beaker and similar vessels from Northern Britain. The Beakers that share most in common with the Knappach Toll vessel (from Cookston, Thurston Mains, and Goodmanham 99) are shown as line drawings (vessels not to scale). Illustration by Craig Williams. © Northlight Heritage

isosceles motif across neck and body. This is also true of the vessels from Juniper Green, Midlothian (Clarke 1970: no. 1710, fig 710); Inveramsay, Aberdeenshire (Clarke 1970: no. 1457, fig 682); Ballymeanoch henge, Argyll and Bute (Clarke 1970: no. 1530, fig 711), and Glenforsa, Mull, Argyll & Bute (Clarke 1970: no. 1531, fig 676). Most closely comparable, however, is the design of the vessel from Goodmanham 99, Burial 5, East Yorkshire (Clarke 1970: no. 1309, fig 675; Kinnes & Longworth 1985: 85).

The single cordon or 'rib' positioned at the base of the neck of the Knappach Toll Beaker relates to the practice of placing up to six cordons on the neck of angular-necked Beakers. It is likely to be related to (or have its origins in) the single or double cordons placed immediately below the rim of non-funerary and typologically early Beakers (for example, Clarke's Northern British/North Rhine grouping, 1970, vol 1: 36–7). Shepherd (1986: 145) associated this feature with 'high-status' burials associated with 'archery' equipment, for instance at Tavelty, Aberdeenshire

(Ralston 1996: 143–5); Borrowstone, Cists 5 and 6, Aberdeenshire (Shepherd 1986: 13–15, illus 12), and Kellythorpe, Driffield, Yorkshire (Clarke et al 1985: 261–2). It is also a feature of some Continental European Beakers, including from the Netherlands (E Drenth, pers comm; for example, Clarke 1970: fig 455). A further notable parallel is Thurston Mains, East Lothian (Clarke 1970: no. 1648, fig 648: 'Skateraw'), which features five cordons to the neck, an internally bevelled rim and opposed isosceles triangles on the body of the vessel (Clarke 1970: no. 1648, fig 648). Furthermore, the globular, Short-Necked vessel from Machrie North, Cairn 24/7C, Isle of Arran, has a single cordon at the inflection between neck and body and filled chevron decoration on the lower body (Barber 1997: 88–91). The vessel from Inchnacoarach, Cawdor, Moray, also features only one cordon to the neck, also placed at the base of the neck, with the others applied to the body (Clarke 1970: no. 1730, fig 663). A small number of Beakers from England also feature a single cordon, also positioned at the base of angular necks (eg Clarke 1970: figs 526, 639–40).

The use of rilling on the inside of the neck is an unusual technique that is difficult to parallel on British funerary Beakers. Rilling is quite frequently applied to the exterior of the neck (eg Bractullo, Angus (Coutts 1971: 44, no 77a), Ruthven, Aberdeenshire (Clarke 1970: no. 1491, fig 277), and Doons Law, Berwickshire (Clarke & Hamilton 1999)), often on vessels that lack a clear separation between neck and body (eg 'S'-profiled vessels) (Case 2001: 369). The vessel from Urquhart, Moray (Clarke 1970: no. 1721, fig 723), despite its bowl-like profile, features rilling to an angularly set neck, double-bevelled rim, and (non-comb applied) herringbone and 'dash' decorative elements – all similar to the Knappach Toll repertoire (Clarke's Primary Northern British/Dutch, Motif Group 2, nos 16 and 17).

One of the few British funerary Beakers to feature internal grooving is from Chatton Sandyford, Burial 1, Northumberland (Jobey 1968; Clarke 1970: no. 647.2, fig 300). Notably, this Beaker (associated with two V-perforated jet or cannel coal buttons) was from a burial close to a second (Burial 2) with a very similarly decorated Beaker, with four ribs/cordons on its neck (Clarke 1970: no. 647.1, fig 299). Internal rilling occurs slightly more often on non-funerary Beakers, although it is still rare (eg Gibson 1982 vol 1: 119, 142; 2006: fig 3.6.3; MacGregor & Stuart 2008: 88–91).

Humphrey Case connected the use of internal rilling to the Late Neolithic Grooved Ware tradition (2001: 369; cf Manby 1999: 61, table 6.2; Brindley 1999), a claim that is noteworthy given the chronological overlap between Grooved Ware and Beaker deposition (Garwood 1999), and the socio-cultural relationships between communities using these respective ceramic traditions (eg Needham 2007). Thus internal rilling is more easily paralleled among the non-funerary Beaker assemblage, a claim that also applies to the use of external cordons and, indeed, Grooved Ware pottery. In typological terms, the Beaker can be assigned to Clarke's (1970) Late Northern (N3) grouping due to its decorative motifs (Motif Group 3, no. 21 and Motif Group 4, no. 29–30) and shape (Variation IV). Clarke observed that bevelled rims were more common in this group than any other (ibid: vol 1, 176), although the inner and outer bevel of the Knappach Toll vessel is rare. Within Shepherd's scheme for north-east Scotland (Shepherd 1986; following Lanting & Van der Waals 1972), the vessel belongs to Step 4 due to the relatively sharp angle between neck and body and the emphasis placed upon the neck by the use of internal rilling and cordon. In Needham's most recent, national Beaker scheme (Needham 2005), the vessel belongs to the wide-ranging Short-Necked group (ibid: 191–5), due to the presence of a neck depth of less than 35% of the overall height. However, the Knappach Toll vessel may not satisfy this requirement by very much, with its neck depth of *c* 33–34% based on the assumed total height of *c* 190–200mm. In Curtis & Wilkin's (2019) north-east Scottish scheme, it belongs to the Tall Short-Necked group.

Previous radiocarbon dates have suggested an overall currency of *c* 2350–1900 cal BC for Beakers from short-cist burials in north-east Scotland (Curtis et al 2008; Wilkin 2010). A notable number of Beakers with features (decoration, rim form, cordon and profile) similar to Knappach Toll are associated with relatively early dates (ie with ranges extending earlier than *c* 2200 cal BC at 95.4% probability). Indeed, the radiocarbon date obtained from the human remains, of 2330–2040 cal BC (95.4% probability; SUERC-30852; 3775±35 BP), is consistent with this view and spans both sides of the critical interface between the Chalcolithic and Early Bronze Age in our chronologies (cf Needham's (2005) 'fission' horizon at *c* 2200 cal BC and the adoption of both tin-bronze and the more widespread adoption of Beakers after this date). This date is consistent with other Tall Short-Necked vessels from north-east Scotland (Curtis & Wilkin 2019).

7.2 Organic residue analysis of the Beaker

Lucija Šoberl & Richard P Evershed

Lipid residues of cooking and the processing of other organic commodities have been found to survive in archaeological pottery vessels for several thousand years as components of surface and absorbed residues. The components of the lipid extracts of such residues can be identified and quantified through solvent extraction and using a combination of analytical techniques capable of achieving molecular level resolution, such as high-temperature gas chromatography (HTGC), GC/mass spectrometry (GC/MS; Evershed et al 1990) and GC-combustion-isotope ratio MS (GC-C-IRMS; Evershed et al 1994). Characterising lipid extracts to commodity type is only possible through detailed knowledge of diagnostic compounds and their associated degradation products formed during vessel use or burial. For example, triacylglycerols (TAGs) are found in abundance in fresh animal fats; however, they are degraded to diacylglycerols (DAGs), monoacylglycerols (MAGs) and free fatty acids during vessel use and burial, such that in archaeological pottery the free fatty acids tend to predominate. This has been observed in numerous pottery vessels (Evershed et al 2002) and verified through laboratory degradation experiments (eg Charters et al 1997; Dudd & Evershed 1998; Evershed 2008a; Evershed 2008b). An increasing range of commodities is being detected in pottery vessels, including animal products (for example, Evershed et al 1992; Copley et al 2003), leafy vegetables (Evershed et al 1991; Evershed et al 1994), specific plant oils (Copley et al 2005a) and beeswax (Evershed et al 1997b).

Animal fats are by far the most common class of residue identified from archaeological pottery, with compound-specific stable carbon isotope analysis allowing detailed characterisation of their source. GC-C-IRMS allows the carbon stable isotope ($\delta^{13}C$) values of individual compounds to be determined within a mixture. The $\delta^{13}C$ values for the principal fatty acids ($C_{16:0}$ and $C_{18:0}$) can be used to distinguish between different animal fats, such as ruminant and non-ruminant adipose fats and dairy fats (Evershed et al 1997a; Dudd & Evershed 1998), as well as to identify the mixing of commodities (Evershed et al 1999; Copley et al 2001). Research has demonstrated that dairy products were important commodities in prehistoric Britain, as illustrated through the persistence of dairy fats in prehistoric pottery (Copley et al 2003; 2005b). For an overview of the use of compound-specific stable isotopes in archaeology, see Evershed et al (1999) and Evershed (2008b).

7.2.1 Methods

A single sherd, weighing 1.680g, from the body of the Knappach Toll Beaker was received for lipid analysis. Lipid analyses were performed using established protocols which are described in detail elsewhere (Evershed et al 1990; Charters et al 1993). The identification of individual compounds was based upon eluting order, comparison of retention times to standards and comparison of mass spectra with known fragmentation patterns and the NIST spectra library. A detailed description of the methods is included in the archive report.

7.2.2 Results

Table 5 lists the concentration of lipids detected in the Knappach Toll sherd together with the analysed visible residue, and the assignments of the broad commodity group based on the molecular data retrieved.

The Knappach Toll Beaker displayed a very good preservation with high lipid concentration of 276.5μg g^{-1} sherd. The preservation of lipids in pottery is heavily influenced by degradative alterations that may occur during vessel use or due to post-burial conditions in the soil (Evershed et al 1999).

Illus 14 shows a partial gas chromatogram for the total lipid extract (TLE) of the absorbed residue, indicating the compounds detected, namely free

Table 5 Summary of the results of the organic residue analyses (FA refers to free fatty acids; MAG to monoacylglycerols; DAG to diacylglycerols; TAG to triacylglycerols)

Bristol sherd number	Lipid concentration (µg g^{-1})	Lipids detected	$\delta^{13}C_{16:0}$ ± 0.3 (‰)	$\delta^{13}C_{18:0}$ ± 0.3 (‰)	Predominant commodity type
SCO 32	276.52	FA, MAGs, DAGs, TAGs	-27.75	-34.25	ruminant adipose/ ruminant dairy

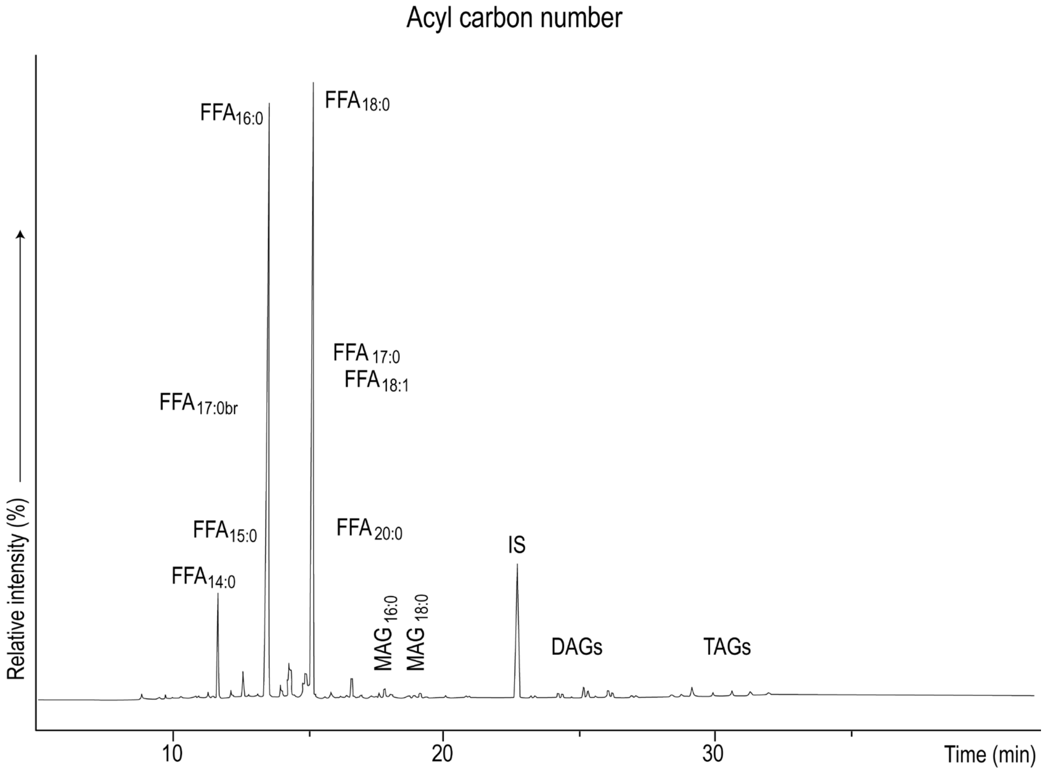
fatty acids, with high abundances of saturated $C_{16:0}$ and $C_{18:0}$ components. The presence of mono-, di- and triacylglycerols indicates a relatively good level of preservation, most likely due to the favourable post-burial conditions in the soil.

The Knappach Toll Beaker extract yielded an appreciable amount of lipids and was further submitted for stable carbon isotope ratio measurements. $\delta^{13}C$ values obtained for the $C_{16:0}$ and $C_{18:0}$ components are plotted in Illus 15. The values of modern reference fats are represented by confidence ellipses (1 standard deviation). All $\delta^{13}C$ values obtained for modern reference animal fats have been adjusted by the addition of 1.2‰ for the post-Industrial Revolution effects of fossil fuel burning (known as the Suess Effect; Tans et al 1979). Lines connecting the ellipses represent theoretical $\delta^{13}C$ values obtained through the mixing of these fats. The $C_{16:0}$ and $C_{18:0}$ $\delta^{13}C$ values of the Knappach Toll Beaker extract plot adjacent to the ruminant dairy fat reference confidence ellipse, thus indicating the likely lipid origin.

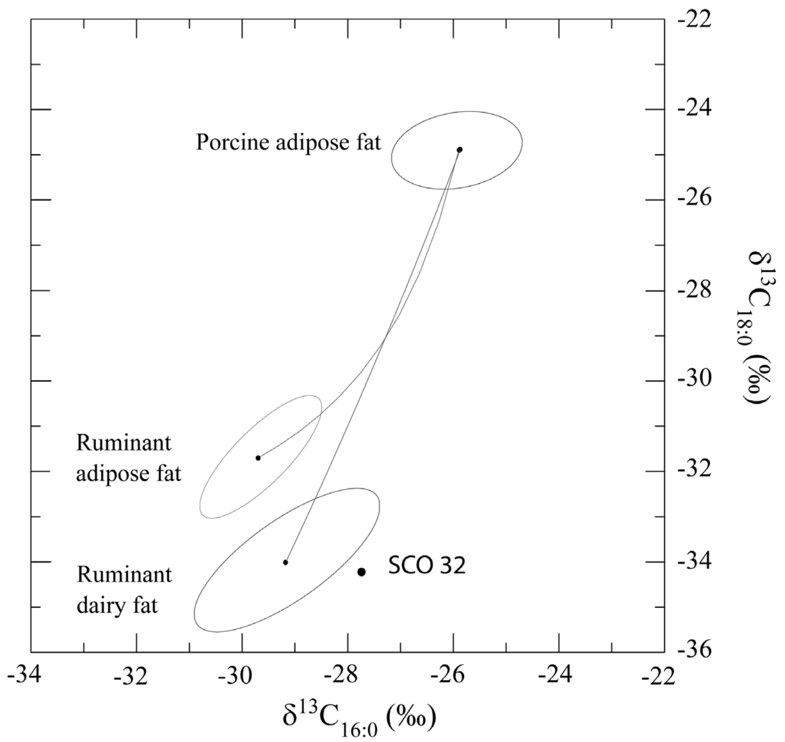
The animals that supplied the modern fats used to construct the reference isotope plot were reared on strict C_3 diets of forages/fodders and cereals. The slight displacement of $\delta^{13}C$ isotopic values for the Knappach Toll Beaker outside the ruminant dairy confidence ellipse may be due to the fact that the animals in prehistory were reared on diets which varied in $\delta^{13}C$ values compared to today's values. The $\delta^{13}C$ value, where the $\delta^{13}C$ values of most abundant fatty acids are subtracted from one another ($\delta^{13}C_{16:0} - \delta^{13}C_{18:0}$), reflect only the differences in metabolisms of animals, and are therefore a useful indicator of lipid origin when such variations in isotope values occur. Illus 16 displays the $\delta^{13}C$ value plotted against $\delta^{13}C_{16:0}$ value for the Knappach Toll Beaker. The ranges on the left side of the plot belong to the modern reference fats. $\delta^{13}C$ values obtained for the analysed Beaker extract confirm the presence of ruminant dairy lipids.

7.2.3 Conclusions

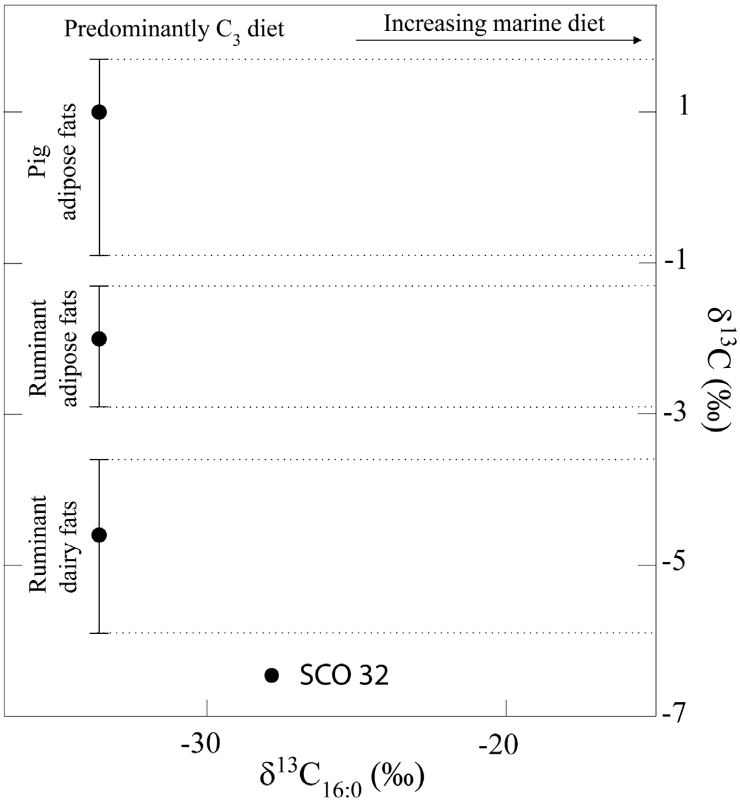
Lipid residue analysis of the Beaker revealed the excellent preservation of lipids absorbed within the vessel walls. Gas chromatograms of the lipid extract show the presence of compounds, indicative of partially degraded animal fat with free fatty acids



Illus 14 Partial HTGC profile of the trimethylsilylated total lipid extract from the Beaker illustrating the distribution of compounds characteristic of degraded animal fat. © Northlight Heritage



Illus 15 Scatter plot showing the $\delta^{13}C$ values of $C_{16:0}$ and $C_{18:0}$ fatty acids prepared from the total lipid extract of the Knappach Toll Beaker. © Northlight Heritage



Illus 16 Plot showing the difference between $\delta^{13}C$ values ($\delta^{13}C_{18:0}$ - $\delta^{13}C_{16:0}$) and $\delta^{13}C$ values obtained from the $C_{16:0}$ fatty acids extracted from the Beaker potsherd. The ranges for the modern reference fats are plotted to the left of the diagram with indicated standard deviation. © Northlight Heritage

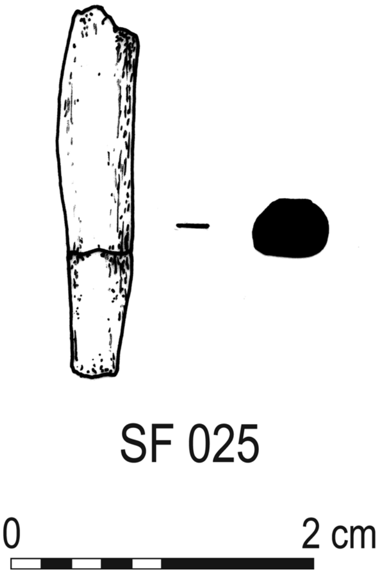
(palmitic and stearic acid predominantly), and mono-, di- and triglycerides. The sherd extract also displayed the presence of odd-carbon-number fatty acids with their branched homologues indicating the presence of ruminant animal fat, which was also confirmed by the preserved TAG distributions.

The measurement of $\delta^{13}C$ values of most abundant free fatty acids provided an additional confirmation that the lipids preserved in the walls of the Beaker can be assigned to a ruminant dairy source. These results, together with the absence of mid-chain ketones, which are formed during exposure to high temperatures, suggest that the vessel was used for the consumption of dairy products. Despite frequently referenced ethnographic reports of milk being used as a sealant for porous ceramic matrix (Rice 1987; Palmer 2002), modern degradation experiments have shown that such lipid concentrations, commonly found preserved in archaeological pottery, can only be the result of long-term vessel use to hold commodities with high dairy fat concentrations (Copley et al 2005b). A study from 2011 (Šoberl 2011) inferred that while most British Beaker vessels analysed were not used as cooking pots, the predominant presence of dairy fats and lipids originating from plants would suggest a specialised function. In conclusion, while historically Beakers have been associated with ritual feasting and the consumption of alcoholic beverages (Sherratt 1987; Guerra-Doce 2006; Rojo-Guerra et al 2006), organic residue analysis can provide further insight into the nature and type of these drinks.

8. THE AWL

Dawn McLaren (with scientific analysis by Susanna Kirk)

▸ **SF025** (Illus 17): Two heavily corroded, joining fragments of a small double-ended copper awl, sub-square in section, tapering gently at both ends. The tips of both ends have been lost and the overall length cannot be extrapolated. Non-destructive XRF and SEM-EDX surface analysis (by Susanna Kirk, NMS) shows that the fragments are copper with silver-rich inclusions. Remaining L: 11.5mm; central expansion: W: 2mm Th: 2mm; remaining ends W: 1.4mm Th: 1.2mm. Mass 0.1g. Sample 1, Context 011 (basal deposit in cist).



Illus 17 The copper alloy awl. © Northlight Heritage

The copper awl fragments were recovered during processing of a bulk sample taken of the basal deposit in the north-west corner of the cist. Although its exact original position is uncertain, the soil sample was taken from the area 5–20cm to the north of the surviving skeletal remains, the same part of the cist in which the Beaker sherds and struck lithics were found.

Although uncommon and easy to overlook during excavation due to their small size, several examples of copper and bronze awls are known from Early and Middle Bronze Age graves in Scotland (summarised in Sheridan 1999). Two main forms of awl have been recognised (Thomas 1968; Henshall & McInnes 1968; Sheridan 1999): a double-ended form with central expansion which is seen as an earlier, long-lived type, and a later type with flattened tang and no central swelling. Despite the fragmentary, corroded condition of the Knappach Toll awl, it appears to be of the double-ended variety.

Very few Bronze Age awls have been analysed scientifically, but at least one other copper (as opposed to bronze) example is known from Scotland, at Doon's Law, Berwickshire (Sheridan 1999). Here, the awl accompanied the crouched inhumation burial of a young adult female, associated with a complete Northern British/Northern Rhine Beaker and a group of flints (Clarke & Hamilton 1999). Other examples from Beaker-associated burials are known from Kirkcaldy, Fife (Childe 1944: 11, pl viii) and Springwood, Kelso (Henshall & McInnes 1968), although awls are also found in association with Food Vessels, urns, accessory vessels and burials with no ceramic associations (Sheridan 1999: 197).

Bronze and copper awls in Scotland, as elsewhere in Britain, are typically found with female burials, but this is not exclusively so (Sheridan 1999: 198). The sex of the associated individual here could not be determined. The function of these tools is not clear, but their use for tattooing, piercing leather and decorating jet or jet-like material has been suggested (Hunter 2000: 147; Hunter & Woodward 2015).

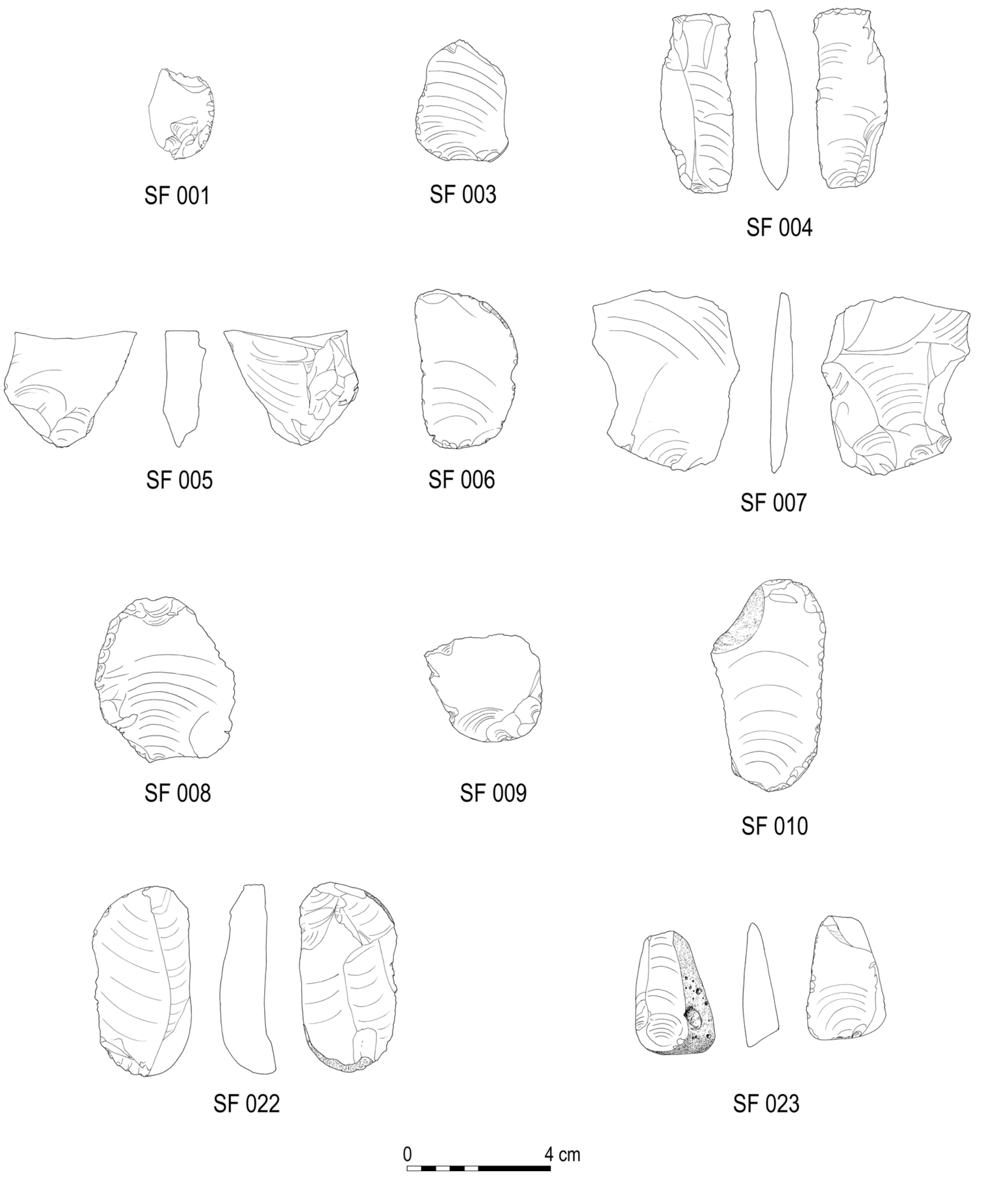
9. CHIPPED STONE ARTEFACTS

Torben Ballin

9.1 Description of the chipped stone assemblage

The lithic assemblage was retrieved from the intrusive ploughsoil within the cist, where the artefacts had been disturbed during its discovery. This report refers to the artefacts by their number in the catalogue (CAT no.). Eleven flint artefacts were recovered (Illus 18). Apart from one core (CAT 1), the assemblage comprises debitage, the waste resulting from the manufacture of stone tools. The pieces comprise five primary flakes, four secondary flakes (including one blade), one tertiary flake and one bipolar core. The finds were characterised according to standard typologies (eg Ballin 1999; 2000).

The abraded character of the pieces' cortex suggests that nodules were procured from local beach deposits, such as the shores of the North Sea. It was not possible to conjoin any artefacts, and the different raw material colours (grey, light brown



Illus 18 Chipped flint artefacts. © Northlight Heritage

and dark brown), size differences and differential patterning (small-dotted and marbled) suggest that the finds represent a minimum of five or six nodules.

One piece (CAT 5) is a blade (50 × 22 × 10mm), whereas all other pieces of debitage are elongated flakes (average dimensions of intact specimens: 44 × 30 × 10mm; L/W ratio 1.5:1). At first glance, the objects appear larger than one would expect to find along the east coast of Scotland, and they are considerably larger than flakes from the contemporary assemblage from the Kingfisher Estate in Aberdeen (average dimensions: 29 × 23 × 9mm; Ballin 2009; 2012), although flint nodules from that site are considerably larger (average dimensions: 42 × 31 × 22mm). Based on this comparison, the Knappach Toll blanks were probably selected for their large size.

All pieces of debitage were detached by the application of bipolar technique, with 50% being primary flakes, 40% secondary flakes and 10% tertiary flakes. The fact that half of the flakes and blades are primary blanks suggests that nodules were brought to the locale intact, although common practice in prehistoric times would have been to decorticate them at the source to avoid having to carry unnecessary weight back to the camp or settlement. The fact that this did not happen at Knappach Toll may reflect the proximity of the raw material source, but it most probably also reflects the character of the industry, which appears to have focused on the splitting of pebbles for blanks, and where oval primary flakes may have been preferred for the production of certain tools such as scrapers (cf the Kingfisher Estate assemblage; Ballin 2009).

Only one core was retrieved (CAT 1). It is a large and relatively slender bipolar core (52 × 27 × 12mm); the remaining cortex at either terminal shows that the length of the surviving core (52mm) corresponds to the length of the original nodule.

Although no formal tools were found at Knappach Toll, four pieces have faint use-wear along one lateral edge, most probably from their use as knives. The grave goods of the deceased include used (and still usable) informal (unmodified) tools, as well as unused tool blanks. The assemblage supports evidence from other, recently excavated assemblages of a technological shift in the region – from sophisticated platform techniques in the Neolithic to bipolar approaches in the Early Bronze Age period (Ballin forthcoming).

9.2 Lithics catalogue

Context 009:

▸ **CAT 1** Secondary bipolar core, grey flint (52 × 27 × 12mm). One lateral edge may have been used for cutting. SF022.

▸ **CAT 2** Secondary bipolar flake, grey flint (34 × 23 × 11mm). SF023.

Context 010:

▸ **CAT 4** Primary bipolar flake, grey flint (34 × 27 × 12mm). SF003.

▸ **CAT 5** Secondary bipolar blade, grey flint (50 × 22 × 10mm). The right lateral edge may have been used for cutting. SF004.

▸ **CAT 7** Primary bipolar flake, light brown flint (45 × 27 × 8mm). SF006.

▸ **CAT 8** Fragmented tertiary bipolar flake, grey flint (49 × 39 × 8mm). A small part of the distal end has broken off, as well as a segment of the right lateral side (frost-induced). The left lateral edge may have been used for cutting. SF007.

▸ **CAT 9** Primary bipolar flake, black and grey flint (50 × 38 × 12mm). SF008.

▸ **CAT 10** Primary bipolar flake, light brown flint (32 × 30 × 10mm). It is uncertain whether modification of the distal edge is expedient retouch, use-wear or natural damage. SF009.

▸ **CAT 11** Primary bipolar flake, grey flint (59 × 33 × 8mm). SF010.

Context 011:

▸ **CAT 3** Proximal-medial fragment of secondary bipolar flake, light brown flint (26 × 19 × 6mm). Sample 1.

10. DISCUSSION

The evidence from the cist at Knappach Toll may appear at first glance to evoke a straightforward sequence of acts. At some point between 2330–2040 cal BC (95.4% probability) and probably 2280–2140 cal BC (68.2% probability) (SUERC-30852), a community in north-east Scotland conducted some rites on a low ridge south of the River Dee. They dug a large hole and brought slabs from two different geological sources to build a stone box or cist inside it. In the cist they laid the flexed body of an adult, placed so that the head lay to the west. Beside the body, probably behind the head, they set a copper awl, a Beaker and some lightly used flint tools. Then they dragged a large slab over the cist, sealing the contents.

Behind the apparent simplicity of this sequence, however, lay a complex and highly prescribed set of practices. These in turn related to social connections and belief systems that were spreading across eastern Britain during the later 3rd millennium BC, having already developed in Continental Europe.

In its form, location and constituents, the burial at Knappach Toll sits firmly within prevailing contemporary traditions in north-east Scotland. This region, out of three studied by the Beakers and Bodies Project (with the Moray Firth area and East Central Scotland), contains the highest concentration of Beaker burials and accompanying evidence for significant cultural change during the Early Bronze Age (Curtis & Wilkin 2012). The choice of location, along the valley of a major river, is consistent with most other Beaker burials in the North-East (ibid: 244). Like this cist, many were placed at the top of natural gravel terraces or knolls and often in small groups (Shepherd 1986: 12–13); the immediate environs of the Knappach Toll burial, which had been planted with well-spaced conifers at the time of writing, could thus contain other, as yet undiscovered cists.

Nearly all of the recorded Beaker burials in north-east Scotland were flat graves like this one, with no evidence for a covering mound (Curtis & Wilkin 2012: 244). The slabs used to form it came from two different geological sources. Most were of fine-grained sedimentary rock, the solid geology beneath the site. The slab that formed the eastern side of the cist, at the feet of the individual, was of granite with a small, pecked hollow facing inward at its centre. Although its source is unknown, igneous rock forms the solid geology across extensive areas on the opposite side of the Dee, under uplands to the south of the site and upriver around Ballater. This slab may have been taken from a previous context of use, one which had some bearing on its re-use here. The use of chocking stones in the cist's construction has parallels elsewhere in the region, for example at Borrowstone to the north of the Dee, where at least one of a cluster of six cists was built with elaborate chocking stones beneath the capstone (Shepherd 1986: 13). Other, similar inhumation burials in short cists, which also included Beakers and flint implements, were being created along the River Dee around the same time – for example at Balbridie, 1km to the SSE (Canmore ID 36692), and at Park Quarry, 9km downstream (Canmore IDs 74325, 87288). Calibrated radiocarbon dates for human remains from Park Quarry are statistically identical to that from Knappach Toll, at 2280–2130 cal BC (3769±32; OxA-V-2172-14; Sheridan et al 2006) and 2290–2040 cal BC (3768±31; OxA-V-2243-45; Curtis et al 2008), both at 95.4% probability.

Analysis of Beaker burials across north-east Scotland by the Beakers and Bodies Project confirms that they were highly formalised, displaying a remarkable degree of consistency (Curtis & Wilkin 2012: 244–6). The communities that created them employed a uniform symbolic vocabulary, structured by strict grammatical rules that governed how the body was positioned, the objects that were placed with it and the choice of topographic location. Detailed analysis by Shepherd (2012) of 26 Beaker burials in the region also identified clear patterns in body position that correspond to gender. In north-east Scotland, bodies were most often laid in cists on a strict or approximate east/west orientation with lines of sight to the south. Males were consistently placed on their left side with head to the east and facing south (MLES), while females were usually placed on their right side with head to the west, also facing south (FRWS), albeit with some deviation from cardinal points within quadrants (ibid: 263).

In the Knappach Toll burial, the skull fragments were found at the western end of the cist, and the Beaker and the worked flints and copper awl fragments were found in the cist's north-west corner, suggesting they were placed by the head following standard practice. Copper awls are more often found with females (see 8 'The awl' above). Although the single surviving dimorphic trait on the cranial fragments indicated a possible male, the sex was indeterminate (6.1 'Skeletal analysis' above). Together, the evidence suggests that it was the body of a female which was placed in the cist, with her head to the west and very likely on her right side, facing south.

Shepherd's (2012) analysis found that virtually identical rules governed how bodies were positioned in Beaker burials on the East Yorkshire Wolds, creating a picture of 'a shared burial tradition uniting disparate areas of the North Sea coastal Beaker polity' (ibid: 261, 265). She also identified broad correlations between Beaker form and gender. Taller Step 3/4 vessels (with sinuous profile, bands of decoration and sharp bend defining the neck) are more often associated with males and with archers' equipment, while Step 5 vessels (with longer, accentuated necks and broader width to height ratio) are often associated with females (ibid: 268). In this respect the Knappach Toll burial with its Step 4 Beaker does not accord with the general pattern of associations. As Shepherd concludes, however, the many possible combinations of form, decorative scheme and motif used to create Beakers are likely to reflect not strict male–female distinctions but choices that suited individual relationships or histories. While the form of each burial may have identified the wider social identity of the deceased and the burial community, the individual Beaker placed in it may have marked out the person it accompanied (ibid: 273–8).

Given the evidently rule-bound nature of Beaker burials, it is likely that strict rules also prescribed people's roles in the acts that led up to the burial itself (Brück 2004: 318). The objects were probably placed behind the head, in keeping with prevailing practice (Tuckwell 1975: 109). The pieces of flint, over half of which are primary blanks, were struck from nodules that may have been brought to the site and four of them show faint traces of wear from their use, probably as knives (9 'Chipped stone artefacts' above). They may have been made especially for use in rites that culminated in the burial, as has been suggested for flint tools found in other Early Bronze Age burials (see Finlayson 2000: 150; Hunter 2000: 174; Finlayson in Clarke & Hamilton 1999). The copper awl may have evoked specific associations with decorating the body – for example, with tattoos, clothing or ornaments – as part of Beaker-complex rites (see Hunter & Woodward 2015).

The finely made, elaborately decorated Beaker may have been made especially for this person, perhaps for special use during life and ultimately to accompany her body after death. That Beakers were made specifically and exclusively for burial contexts has been argued both on the basis of ethnohistoric parallels and on the taphonomic grounds that they are regularly found whole and would have easily fractured along their coil-joints under the stress of everyday use (Boast 1995; Shepherd 2012: 276). However, the findings of organic residue analysis suggest that this vessel had held ruminant dairy products over an extended period of time, rather than that the porous fabric was simply sealed with milk (7.2 'Organic residue analysis of the Beaker' above). These findings are consistent with those of a wider study of organic residues in Early Bronze Age pottery, including over 200 Beakers, which identified predominantly ruminant dairy fats in Beakers from various contexts across Britain and concluded that in many cases 'vessels with long-term use-lives were deposited in burials' (Šoberl 2011: 217–18).

These arguments are not necessarily mutually exclusive. The Knappach Toll Beaker may have been made for a particular purpose or person, with complex cultural meanings encoded in its decoration and form, and used over a long period on a regular basis for ceremonies and other special occasions – perhaps for serving and drinking fermented milk (rather than for cooking or boiling, which would have caused damage and fracture) (Šoberl 2011: 91). Such drinks have been (and still are) part of everyday life as well as special occasions around the world, including more locally on the Scottish Isles during the post-medieval period (Fenton 1978; Abdelgadir et al 1998). Finally, this long-used, heavily symbolic, carefully curated pot was placed behind the head of the person for whom it was made, signifying her cultural identity and that of the burial community.

Recent research is changing narratives about the geographical and genetic origins of the communities who made and used Beakers as part of a suite of cultural practices and belief systems. The Beaker People Project (Parker Pearson et al 2016) combined osteological analysis, stable isotope analysis and Bayesian radiocarbon dating analysis of 285 burials from England, Scotland and Wales and included the Beakers and Bodies Project (Curtis & Wilkin 2012). It found evidence for considerable mobility within Great Britain among communities that practised Beaker burial, particularly in Scotland; across the sample set as a whole, nearly a third of individuals were buried in a different geological region from the one in which they grew up. The authors interpret the findings as indicating multi-directional mobility over generations, probably related to mobile subsistence strategies such as transhumance and hunting (Parker Pearson et al 2016). Modelling of radiocarbon dates suggests Beaker burial practices began in Britain in Wessex in 2475–2360 cal BC (95% probability) and then spread north to the Peak District, Scotland, other regions and finally Yorkshire (ibid).

Evidence for even broader geographical links has emerged through the recent analysis of DNA in 400 individuals across Europe who died in the Neolithic, Chalcolithic and Bronze Age, 226 of them associated with Beaker-complex artefacts. The results indicate that migration from the Eurasian steppe, spreading westward across Europe, played a key role in the spread of Beaker-related practices (Olalde et al 2018). In south and east Britain, the majority of people buried with Beakers and associated artefacts were most closely related to individuals in the Netherlands (ibid: 193). The Knappach Toll Beaker and its closest comparanda (7.1 'Report on the Beaker' above) have clear affinities with pots that were being made and placed with burials in the Netherlands (Clarke 1970), adding a material dimension to the genetic evidence for communication and intermarriage across the North Sea.

Close links between communities along Britain's eastern seaboard, as highlighted by Shepherd (2012), come into sharp focus through the burial at Knappach Toll. A very similar burial was composed on Doons Law, a glacial mound in Berwickshire, in north-east England. A cist here contained the fragmentary remains of a probable female with her head to the west; fragments of a copper awl, four unused flint flakes and a tool, and an intact Step 4 Beaker lay behind her head (Clarke & Hamilton 1999). She died between 2205 and 1780 cal BC (95.4% probability) or probably between 2130 and 1930 cal BC (68.2%) (AA-29066; ibid).

Among the three closest parallels to the Knappach Toll Beaker, one of the vessels was placed with the burial of a woman laid on her right side and facing south (Shepherd's (2012) FRWS) at Goodmanham 99, East Yorkshire (see 7.1 'Report on the Beaker' above). The strontium and oxygen isotopes in the Knappach Toll individual's tooth enamel could indicate she grew up on the basalt-derived soils of north-east Scotland; however, they could also point to her having spent her childhood on chalk geology, like the soils of East Yorkshire (see 6.2 'Strontium, oxygen, carbon and nitrogen isotope analysis' above). Her food was drawn mainly from terrestrial sources, with a high proportion of animal protein and little marine input (ibid). This accords with the findings of the Beaker People Project as a whole, indicating they were farmers rather than fishers (Parker Pearson et al 2016).

Whether the person whose body was placed in the cist was locally bred, had moved to the Dee from eastern England, was descended from Dutch migrants or had some other history, she and her burial community identified with a set of beliefs and practices that differed markedly from the ones that had held sway for earlier generations. Knappach Toll lay in an ancient ceremonial landscape that, up to 2,000 years before, had been dominated by large communal monuments – the timber halls that stood on opposite sides of the river in the late 5th to early 4th millennia cal BC (Ralston 1982; Murray et al 2009). In the late 3rd millennium, the footprints of these halls may have still been discernible on the ground and in the shared memory of local communities, as monumental expressions of social practices and belief systems that valued and demanded communal contributions and participation.

The Beaker-complex burial practices and the value systems that lay behind them seem to have placed more emphasis on the individual body and experience. That a burial community chose to create the cist at Knappach Toll a few hundred metres from the site of one Neolithic timber hall and within view of the site of another seems significant. The placing of the burial in this ancient ceremonial context suggests the community was aware of an earlier belief system and responded to its gravitational pull – perhaps either contesting it or grafting onto it – as happened at other Neolithic monuments in East Yorkshire and at Stonehenge (Parker Pearson et al 2007).

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12. REFERENCES

Abdelgadir, W S, Ahmed, T K & Dirar, H A 1998 'The traditional fermented milk products of the Sudan', *International Journal of Food Microbiology* 44(1–2): 1–13. https://doi.org/10.1016/S0168-1605(98)00090-7

Ballin, T B 1999 'Bipolar cores in Southern Norway: Classification, chronology and geography', *Lithics* 20: 13–22.

Ballin, T B 2000 'Classification and description of lithic artefacts: A discussion of the basic lithic terminology', *Lithics* 21: 9–15.

Ballin, T B 2009 'The lithic assemblage from the Kingfisher Industrial Estate, Aberdeen City', unpublished report commissioned by the Aberdeen City Council Archaeological Unit.

Ballin, T B 2012 'The lithic assemblage', *in* Johnson, M 'An early Bronze Age unenclosed cremation cemetery and Mesolithic pit at Skilmafilly, near Maud, Aberdeenshire', *Scottish Archaeological Internet Reports* 53. https://doi.org/10.9750/issn.1773-3808.2012.53

Ballin, T B forthcoming 'Neolithic and Bronze Age lithic industries from eastern Scotland: a comparative study', *Tayside and Fife Archaeological Journal.*

Barber, J (ed.) 1997 *The Archaeological Investigation of a Prehistoric Landscape: Excavations on Arran 1978–81.* Edinburgh: STAR Monograph 2.

Berry, R C & Berry, R J 1967 'Epigenetic Variation in the Human Cranium', *Journal of Anatomy* 101: 361–79.

Birck, J L 1986 'Precision K-Rb-Sr Isotopic Analysis: Application to Rb-Sr Chronology', *Chemical Geology* 56(1–2): 73–83. https://doi.org/10.1016/0009-2541(86)90111-7

Boast, R 1995 'Fine pots, pure pots, Beaker pots', *in* Kinnes, I & Varndell, G (eds) *'Unbaked Urns of Rudely Shape': Essays on British and Irish Pottery for Ian Longworth*, 69–80. Oxford: Oxbow Monograph 55.

Bradley, R 2005 *The Moon and the Bonfire.* Edinburgh: Society of Antiquaries of Scotland.

Brickley, M & McKinley, J (eds) 2004 *Guidelines to the Standards for Recording Human Remains.* Southampton: IFA Technical Paper No. 7, BABAO.

Brickley, M, Miles, A & Stainer, H 1999 *The Cross Bones Burial Ground, Redcross Way, Southwark, London: Archaeological excavations (1991–1998) for the London Underground Limited Jubilee Line Extension Project*. London: Museum of London Archaeology Service Monograph 3.

Brindley, A 1999 'Irish Grooved Ware', *in* Cleal, R & MacSween, A (eds) *Grooved Ware in Britain and Ireland,* 23–35. Oxford: Oxbow Books.

British Geological Survey, [nd] *Geology of Britain Viewer*. http://mapapps.bgs.ac.uk/geologyofbritain/home.html. Accessed February 2019.

Bronk Ramsey, C 2017 'Methods for Summarizing Radiocarbon Datasets', *Radiocarbon* 59(2): 1809–33. https://doi.org/10.1017/RDC.2017.108

Brothwell, D R 1981 *Digging up Bones.* Oxford: Oxford University Press.

Brown, G C, Ixer, R A, Plant, J A & Webb, P C 1988 'Geochemistry of Granites beneath the North Pennines and Their Role in Orefield Mineralization – Reply', *Transactions of the Institution of Mining and Metallurgy Section B – Applied Earth Science* 97: B47–B49.

Brück, J 2004 'Material metaphors: The relational construction of identity in Early Bronze Age burials in Ireland and Britain', *Journal of Social Archaeology* 4(3): 307–33. https://doi.org/10.1177%2F1469605304046417

Buikstra, J E & Ubelaker, D H (eds) 1994 *Standards for Data Collection from Human Skeletal Remains.* Arkansas: Arkansas Archaeological Survey Research Series No. 44.

Case, H 2001 'The Beaker culture in Britain and Ireland: groups, European contacts and chronology', *in* Nicolis, F (ed.) *Bell Beakers Today: Pottery, People, Culture, Symbols in Prehistoric Europe*, 361–77. Trento: Officio Beni Archeologici.

Charters, S, Evershed, R P, Goad, L J, Leyden, A, Blinkhorn, P W & Denham, V 1993 'Quantification and distribution of lipid in archaeological ceramics: implications for sampling potsherds for organic residue analysis and the classification of vessel use', *Archaeometry* 35: 211–23. https://doi.org/10.1111/j.1475-4754.1993.tb01036.x

Charters, S, Evershed, R P, Quye, A, Blinkhorn, P W & Reeves, V 1997 'Simulation experiments for determining the use of ancient pottery vessels: the behaviour of epicuticular leaf wax during boiling of a leafy vegetable', *Journal of Archaeological Science* 24: 1–7. https://doi.org/10.1006/jasc.1995.0091

Chenery, C, Müldner, G, Evans, J, Eckardt, H & Lewis, M 2010 'Strontium and stable isotope evidence for diet and mobility in Roman Gloucester, UK', *Journal of Archaeological Science* 37(1): 150–63. https://doi.org/10.1016/j.jas.2009.09.025

Childe, V G 1944 'Two cist burials at Kirkcaldy and their contents', *Proc Soc Antiq Scot* 78: 109–14.

Clarke, C M & Hamilton, J E 1999 'Excavation of a cist burial on Doons Law, Leetside Farm, Whitsome, Berwickshire, Borders Region', *Proc Soc Antiq Scot* 129: 189–201.

Clarke, D L 1970 *Beaker Pottery in Great Britain and Ireland*, 2 vols. Cambridge: Cambridge University Press.

Clarke, D V, Cowie, T & Foxon, A 1985 *Symbols of Power at the Time of Stonehenge*. Edinburgh: HMSO and National Museum of Antiquities of Scotland.

Copley, M S, Evershed, R P, Rose, P J, Clapham, A, Edwards, D N & Horton, M C 2001 'Processing palm fruits in the Nile Valley: biomolecular evidence from Qasr Ibrim', *Antiquity* 75: 538–42. https://doi.org/10.1017/S0003598X00088761

Copley, M S, Berstan, R, Dudd, S N, Docherty, G, Mukherjee, A J, Straker, V, Payne, S & Evershed, R P 2003 'Direct chemical evidence for widespread dairying in prehistoric Britain', *Proceedings of the National Academy of Sciences* 100(4): 1524–9. https://doi.org/10.1073/pnas.0335955100

Copley, M S, Bland, H A, Rose, P, Horton, M & Evershed, R P 2005a 'Gas chromatographic, mass spectrometric and stable carbon isotopic investigations of organic residues of plant oils and animal fats employed as illuminants in archaeological lamps from Egypt', *Analyst* 130: 860–71. https://doi.org/10.1039/B500403A

Copley, M S, Berstan, R, Dudd, S N, Aillaud, S, Mukherjee, A J, Straker, V, Payne, S & Evershed, R P 2005b 'Processing of milk products in pottery vessels through British prehistory', *Antiquity* 79: 895–908. https://doi.org/10.1017/S0003598X00115029

Coutts, H 1971 *Tayside Before History: A Guide-Catalogue Collection of Antiquities in Dundee Museum*. Dundee: Dundee Museum and Art Gallery.

Curtis, N & Wilkin, N 2012 'The regionality of Beakers and bodies in the Chalcolithic of North-East Scotland', *in* Allen, M J, Gardiner, J, & Sheridan, A (eds) *Is there a British Chalcolithic? People, Place and Polity in the Later 3rd Millennium*, Prehistoric Society Research Paper 4, 237–56. Oxford: Oxbow Books and the Prehistoric Society.

Curtis, N & Wilkin, N 2019 'Beakers and bodies in north-east Scotland: a regional and contextual study', *in* Parker Pearson, M, Sheridan, A, Jay, M, Chamberlain, A, Richards, M & Evans, J (eds) *The Beaker People: Isotopes, Mobility and Diet in Prehistoric Britain*, 213–54. Oxford: Oxbow Books and the Prehistoric Society.

Curtis, N, Wilkin, N, Hutchison, M, Jay, M, Sheridan, A & Wright, M 2008 'Radiocarbon dating results from the Beakers and Bodies Project', *Discovery and Excavation in Scotland* 8: 223–4.

Curtis, N, Popovic, L, Wilkin, N & Wright, M 2010 'The Moon, the Bonfire and the Beaker? Analysing white inlay from Beaker pottery in Aberdeenshire', *PAST: The Newsletter of the Prehistoric Society* 65: 1–3. http://www.prehistoricsociety.org/files/past065.pdf. Accessed 14 August 2018.

Darling, W C, Bath, A H & Talbot, J C 2003 'The O and H stable isotopic composition of fresh waters in the British Isles: 2, Surface waters and groundwater', *Hydrology and Earth System Sciences* 7(2): 183–95. https://doi.org/10.5194/hess-7-183-2003

Daux, V, Lécuyer, C, Héran, M A, Amiot, R, Simon, F, Fourel, F, Martineau, F, Lynnerup, N, Reychler, H & Escarguel, G 2008 'Oxygen isotope fractionation between human phosphate and water revisited', *Journal of Human Evolution* 55(6): 1138–47. https://doi.org/10.1016/j.jhevol.2008.06.006

Dudd, S N & Evershed, R P 1998 'Direct demonstration of milk as an element of archaeological economies', *Science* 282: 1478–81. https://doi.org/10.1126/science.282.5393.1478

Evans, J A, Montgomery, J, Wildman, G & Boulton, N 2010 'Spatial variations in biosphere 87Sr/86Sr in Britain', *Journal of the Geological Society* 167(1): 1–4. http://dx.doi.org/10.1144/0016-76492009-090

Evershed, R P 2008a 'Experimental approaches to the interpretation of absorbed organic residues in archaeological ceramics', *World Archaeology* 40: 26–47. https://doi.org/10.1080/00438240801889373

Evershed, R P 2008b 'Organic residue analysis in archaeology: the archaeological biomarker revolution', *Archaeometry* 50: 895–924. https://doi.org/10.1111/j.1475-4754.2008.00446.x

Evershed, R P, Heron, C & Goad, L J 1990 'Analysis of organic residues of archaeological origin by high-temperature gas chromatography and gas chromatography mass-spectrometry', *Analyst* 115: 1339–42. https://doi.org/10.1039/AN9901501339

Evershed, R P, Heron, C & Goad, L J 1991 'Epicuticular wax components preserved in potsherds as chemical indicators of leafy vegetables in ancient diets', *Antiquity* 65: 540–4. https://doi.org/10.1017/S0003598X00080145.x

Evershed, R P, Heron, C, Charters, S & Goad, L J 1992 *in* Pollard, A M (ed.), *New Developments in Archaeological Science*, 187–208. Oxford: Oxford University Press.

Evershed, R P, Arnot, K I, Collister, J, Eglinton, G & Charters, S 1994 'Application of isotope ratio monitoring gas chromatography–mass spectrometry to the analysis of organic residues of archaeological origin', *Analyst* 119: 909–14. https://doi.org/10.1039/AN9941900909

Evershed, R P, Mottram, H R, Dudd, S N, Charters, S, Stott, A W, Lawrence, G J, Gibson, A M, Conner, A, Blinkhorn, P W & Reeves, V 1997a 'New criteria for the identification of animal fats preserved in archaeological pottery', *Naturwissenschaften* 84: 402–6. https://doi.org/10.1007/s001140050417

Evershed, R P, Vaughan, S J, Dudd, S N & Soles, J S 1997b 'Fuel for thought? Beeswax in lamps and conical cups from Late Minoan Crete', *Antiquity* 71: 979–85. https://doi.org/10.1017/S0003598X00085860

Evershed, R P, Dudd, S N, Charters, S, Mottram, H, Stott, A W, Raven, A, van Bergen, P F & Bland, H A 1999 'Lipids as carriers of anthropogenic signals from prehistory', *Philosophical Transactions of the Royal Society of London Series B – Biological Sciences* 354: 19–31. https://doi.org/10.1098/rstb.1999.0357

Evershed, R P, Dudd, S N, Copley, M S, Berstan, R, Stott, A W, Mottram, H, Buckley, S A & Crossman, Z 2002 'Chemistry of archaeological animal fats', *Accounts of Chemical Research* 35: 660–8. https://doi.org/10.1021/ar000200f

Fenton, A 1978 *Northern Isles: Orkney and Shetland.* Edinburgh: John Donald.

Finlayson, B 2000 'Wear analysis of the lithics', *in* Hunter 2000: 149–50.

Garwood, P 1999 'Grooved Ware in Southern Britain: Chronology and interpretation', *in* Cleal, R & MacSween, A (eds) *Grooved Ware in Britain and Ireland*, 145–76. Oxford: Oxbow Books.

Gibson, A 1982 *Beaker Domestic Sites*. Oxford: British Archaeological Reports, British Series, 107, 2 vols.

Gibson, A 2006 'The Pottery', *in* Simpson, D D A, Murphy, E M & Gregory, R A (eds), *Excavations at Northton, Isle of Harris*, 90–133. Oxford: British Archaeological Reports, British Series, 408.

Guerra-Doce, E 2006 'Exploring the significance of Beaker pottery through residue analyses', *Oxford Journal of Archaeology* 25(3): 247–59. https://doi.org/10.1111/j.1468-0092.2006.00260.x

Henshall, A S & McInnes, I J 1968 'A Beaker grave at Springwood, Kelso, Roxburghshire', *Proc Soc Antiq Scot* 100: 79–85.

Hillson, S 1996 *Dental Anthropology.* Cambridge: Cambridge University Press.

Hunter, F 2000 'An Early Bronze Age cemetery at West Water Reservoir, West Linton, Scottish Borders', *Proc Soc Antiq Scot* 130: 115–82.

Hunter, J & Woodward, A (eds) 2015 *Ritual in Early Bronze Age Grave Goods: An Examination of Ritual and Dress Equipment from Chalcolithic and Early Bronze Age Graves in England.* Oxford: Oxbow Books.

Jay, M & Richards, M P 2006 'Diet in the Iron Age cemetery population at Wetwang Slack, East Yorkshire, UK: carbon and nitrogen stable isotope evidence', *Journal of Archaeological Science* 33(5): 653–62. https://doi.org/10.1016/j.jas.2005.09.020

Jobey, G 1968 'Excavations of Cairns at Chatton

Sandyford, Northumberland', *Archaeologia Aelina* 4th series, 46: 5–50.

Kinnes, I A & Longworth, I H 1985 *Catalogue of the Excavated Prehistoric and Romano-British Material in the Greenwell Collection*. London: British Museum Publications.

Krouse, H R & Herbert, M K 1988 'Sulphur and carbon isotope studies of food webs', *in* Kennedy, B V & LeMoine, G M (eds) *Diet and Subsistence: Current Archaeological Perspectives*, 315–22. Calgary: University of Calgary Archaeological Association.

Lanting, J N & Van der Waals, J D 1972 'British beakers as seen from the Continent: a review article', *Helenium* 12: 20–46.

MacGregor, G & Stuart, E 2008 'Everything in its place: excavations at Eweford West, Overhailles, Pencraig Wood and Eweford Cottages (3300–1700 BC)', in Lelong, O & MacGregor, G (eds) *The Lands of Ancient Lothian: Interpreting the Archaeology of the A1*, 69–98. Edinburgh: Society of Antiquaries of Scotland.

Manby 1999 'Grooved Ware sites in Yorkshire and Northern England: 1974–1994', *in* Cleal, R & MacSween, A (eds) *Grooved Ware in Britain and Ireland*, 57–75. Oxford: Oxbow Books.

Montgomery, J, Evans, J A & Neighbour, T 2003 'Sr isotope evidence for population movement within the Hebridean Norse community of NW Scotland', *Journal of the Geological Society* 160: 649–53. https://doi.org/10.1144/0016-764903-037

Murray, H K, Murray, C & Fraser, S M 2009 *A Tale of the Unknown Unknowns: A Mesolithic Pit Alignment and a Neolithic Timber Hall at Warren Field, Crathes, Aberdeenshire*. Oxford: Oxbow Books.

Needham, S 2005 'Transforming Beaker culture in North-West Europe: processes of fusion and fission', *Proceedings of the Prehistoric Society* 71: 171–217. https://doi.org/10.1017/S0079497X00001006

Needham, S 2007 'Isotope aliens: Beaker movement and cultural transmissions', *in* Larsson, M & Parker Pearson, M (eds) *From Stonehenge to the Baltic: Living with Cultural Diversity in the Third Millennium BC*, 41–6. Oxford: British Archaeological Reports, International Series, 1692: 41–6.

Olalde, I, Brace, S, Allentoft, M E, Armit, I, Kristiansen, K, Booth, T, Rohland, N, et al 2018 'The Beaker phenomenon and the genomic transformation of Northwest Europe', *Nature* 555: 190–6. https://doi.org/10.1038/nature25738

O'Neil, J R, Roe, L J, Reinhard, L & Blake, R E 1994 'A rapid and precise method of oxygen isotope analysis of biogenic phosphate', *Israel Journal of Earth Science* 43: 203–12.

Palmer, C 2002 'Milk and cereals: identifying food and food identity among Fallāhīn and Bedouin in Jordan', *Levant* 34: 173–95. https://doi.org/10.1179/lev.2002.34.1.173

Parker Pearson, M P, Cleal, R, Marshall, P, Needham, S, Pollard, J, Richards, C & Ruggles, C 2007 'The age of Stonehenge', *Antiquity* 81(313): 617–39. https://doi.org/10.1017/S0003598X00095624

Parker Pearson, M, Chamberlain, A, Jay, M, Richards, M, Sheridan, A, Curtis, N, Evans, et al 2016 'Beaker people in Britain: migration, mobility and diet', *Antiquity* 90: 620–37. https://doi.org/10.15184/aqy.2016.72

Prehistoric Ceramics Research Group 1997 *The Study of Later Prehistoric Pottery: General Policies and Guidelines for Analysis and Publication*. Salisbury: Prehistoric Ceramics Research Group.

Privat, K L, O'Connell, T C & Hedges, R E M 2007 'The distinction between freshwater- and terrestrial-based diets: methodological concerns and archaeological applications of sulphur stable isotope analysis', *Journal of Archaeological Science* 34: 1197–204. https://doi.org/10.1016/j.jas.2006.10.008

Ralston, I B M 1982 'A timber hall at Balbridie Farm: the Neolithic Settlement of North East Scotland', *Aberdeen University Review* 168: 239–49.

Ralston, I B M 1996 'Four short cists from north-east Scotland and Easter Ross', *Proc Soc Antiq Scot* 126: 121–55.

Reimer, P J, Bard, E, Bayliss, A, Beck, J W, Blackwell, P G, Bronk Ramsey, C, Grootes, P M et al, 2013 'IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0–50,000 Years cal BP', *Radiocarbon* 55(4): 1869–87. https://doi.org/10.2458/azu_js_rc.55.16947

Rice, P M 1987 *Pottery Analysis: A Sourcebook*. Chicago: University of Chicago Press.

Richards, M P, Fuller, B T & Hedges, R E M 2001

'Sulphur isotopic variation in ancient bone collagen from Europe: implications for human palaeodiet, residence mobility, and modern pollutant studies', *Earth and Planetary Science Letters* 191: 185–90. https://doi.org/10.1016/S0012-821X(01)00427-7

Richards, M P, Fuller, B T, Sponheimer, M, Robinson, T & Ayliffe, L 2003 'Sulphur isotopes in palaeodietary studies: a review and results from a controlled feeding experiment', *International Journal of Osteoarchaeology* 13: 37–45. https://doi.org/10.1002/oa.654

Richards, M P, Fuller, B T & Molleson, T I 2006 'Stable isotope palaeodietary study of humans and fauna from the multi-period (Iron Age, Viking and Late Medieval) site of Newark Bay, Orkney', *Journal of Archaeological Science* 33(1): 122–31. https://doi.org/10.1016/j.jas.2005.07.003

Rojo-Guerra, M Á, Garrido-Pena, R, Martínez-de-Lagrán, Í G, Treserras, J J & Matamala, J C 2006 'Beer and Bell Beakers: Drinking rituals in Copper Age inner Iberia', *Proceedings of the Prehistoric Society* 72: 243–65. https://doi.org/10.1017/S0079497X00000840

Shepherd, A N 2012 'Stepping out together: men, women and their Beakers in time and space', *in* Allen, M J, Gardiner, J & Sheridan, A (eds) *Is there a British Chalcolithic? People, Place and Polity in the Later 3rd Millennium*, Prehistoric Society Research Paper 4, 257–80; CD97–107. Oxford: Oxbow Books and the Prehistoric Society.

Shepherd, I A G 1986 *Powerful Pots: Beakers in North-East Prehistory*. Aberdeen: Anthropological Museum, University of Aberdeen.

Sheridan, J A 1999 'Copper awl', *in* Clarke, C M & Hamilton, J E 'Excavation of a cist burial on Doons Law, Leetside Farm, Whitsome, Berwickshire, Borders Region', *Proc Soc Antiq Scot* 129: 189–201 (197–8).

Sheridan, A, Parker Pearson, M, Jay, M, Richards, M & Curtis, M 2006 'Radiocarbon dating results from the *Beaker People Project: Scottish samples*', *Discovery and Excavation in Scotland*, new series, 7: 198–201.

Sherratt, A 1987 'Cups That Cheered', *in* Waldren, W H & Kennard, R C (eds) *Bell Beakers of the Western Mediterranean: Definition, Interpretation, Theory and New Site Data*, 81–114. Oxford: Archaeopress.

Šoberl, L 2011 'Pots for the Afterlife: Organic Residue Analysis of British Early Bronze Age Pottery from Funerary Contexts', unpublished PhD thesis, University of Bristol.

Tans, P P, de Jong, A F M & Mook, W G 1979 'Natural atmospheric 14C variation and the Suess effect', *Nature* 80: 826–8.

Thomas, N 1968 'Appendix 1: note on the Carricknab awl', *in* Collins, A E P & Evans, E E 'A cist burial at Carricknab, Co. Down', *Ulster Journal of Archaeology* 31: 16–24.

Tuckwell, A 1975 'Patterns of burial orientation in round barrows of East Yorkshire', *Bulletin of the Institute of Archaeology* 12: 95–117.

White, D J 1997 'Dental calculus: recent insights into occurrence, formation, prevention, removal and oral health effects of supragingival and subgingival deposits', *European Journal of Oral Sciences* 105: 508–22. https://doi.org/10.1111/j.1600-0722.1997.tb00238.x

Wilkin, N 2010 'Beakers and Bodies Project: Death and burial in Early Bronze Age Aberdeenshire', Presentation given to Society of Antiquaries of Scotland, recorded on 11 October 2010 in the Royal Society of Edinburgh. www.socantscot.org/resource/beakers-and-bodies-project-by-dr-neil-wilkin-university-of-aberdeen/. Accessed February 2019.