Bell Beaker people in Britain: migration, mobility and diet

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The 'Bell Beaker folk' have long been considered a prime example of migration in prehistory. This phenomenon is manifested by the appearance, during the third millennium BC across much of western Europe, of a combination of new pottery forms, new inhumation rites and unusual skeletal morphology (specifically brachycephalic or broad-headed skulls). In the late 1970s, at the height of the processualist reaction against migration-based explanations in archaeology, this archaeological 'culture' was newly interpreted as the diffusion of a cult package (Burgess & Shennan 1976). Yet the case for migration of Beaker-using people to the British Isles remained firmly supported (*e.g.* Waddell 1978).

Within continental Europe, recent research into non-metric dental morphological traits (Desideri & Besse 2010) and strontium isotope analysis of tooth enamel (Price *et al*. 2004) have shifted the focus back to Beaker users as migrant groups, demonstrating the arrival of incoming populations at the end of the Neolithic into parts of Switzerland, Bavaria, Austria, the Czech Republic and Hungary. More recently, analyses of ancient DNA are providing further support for Bell Beaker migrations within continental Europe (Haak *et al.* 2014; Allentoft *et al*. 2015; Hervella *et al*. 2015).

The debate about the arrival of the Beaker package in Britain was revived in 2002 by the discovery of the Amesbury Archer, buried near Stonehenge in *2380–2290 cal BC* (*95% probability*; *OxA-13541*; Barclay and Marshall 2011: fig. 58). From the oxygen isotope ratios for his tooth enamel, he was probably a long-distance migrant to Britain from continental Europe (Chenery & Evans 2011). But how typical was his pattern of lifetime mobility for the wider population of Britain during the Chalcolithic–Early Bronze Age?

The skeletal remains of 264 individuals in Britain (Figure 1) from that period (*c*.2500 BC–1500 cal BC) have been analysed, as part of the Beaker People Project (BPP), for isotope ratios (strontium, oxygen, sulphur, nitrogen and carbon), radiocarbon-dating, osteology and dental microwear. The sample ranges geographically from the north of mainland Scotland to the Wessex heartland of southern England. The BPP was accompanied by a smaller, regional

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project in northeast Scotland – the Beakers & Bodies Project (Curtis & Wilkin 2012) – and the full results of both will be published together (Parker Pearson *et al*. forthcoming). The BPP is the first large-scale strontium and oxygen isotope investigation of human skeletons excavated from across Britain, aiming to establish whether the Bell Beaker people were immigrant groups (Childe 1929: 194–6) or indigenous converts to a 'Beaker package' of cult practices and prestige goods (Burgess & Shennan 1976).

Chronology

The earliest dates for Bell Beakers in the second quarter of the third millennium BC have been obtained in Iberia and southern France (Müller & van Willigen 2001). Yet across much of the rest of Europe the Bell Beaker phenomenon was not present until the middle of that millennium. Their earliest appearance in Britain was relatively late, with no cases dateable to before 2500 BC.

For the BPP, a Bayesian approach, utilizing 193 new radiocarbon dates as well as previous dates from a further 82 burials, has been adopted for the interpretation of the period of use of Beakers in graves. This assumes that the sampled dates are uniformly distributed across the time period of investigation (Bayliss *et al.* 2007; Buck *et al.* 1992; 1996). Although this use of a uniform distribution to model the chronology of Beakers is far from ideal – especially if Bell Beakers originated at a given time in a given place, were gradually produced in greater numbers over time, and then decreased as their popularity waned – it is the most useful because it makes the fewest assumptions about the distribution of dates.

The model estimates the first use in Britain of Bell Beakers in burials to have occurred in *2475–2360 cal BC* (*95% probability*) and probably *2450–2385 cal BC* (*68% probability*). Their first use in funerary contexts started in Wessex (84% probability), followed by the Peak District (61% probability), Scotland (47% probability), other regions (44% probability) and finally Yorkshire (36% probability; Figure 2).

The end of use of Beakers in burials in Britain is estimated to have occurred in *1905–1810 cal BC* (*95% probability*) and probably *1880–1840 cal BC* (*68% probability*). Their last use in graves in Scotland occurred earlier, in *2130–2045 cal BC* (*95% probability*) or *2120–2080 cal BC* (*68% probability*).

Beakers stopped being placed in burials in Scotland before any other area (100% probability), followed by Yorkshire (58%), the Peak District (58%), other areas (49%) and finally Wessex (49% probability; Figure 2). The overall period of use of Beakers as grave goods is estimated to be *480–640 years* (*95% probability*) and probably *515-600 years* (*68% probability*). In northern Britain it seems that Food Vessels (a wholly British and Irish style of post- and late-Beaker pottery; Wilkin 2014) replaced Beakers, whereas Beakers continued to be used in Wessex long after the introduction of Food Vessels in that region.

Bell Beaker burials can be divided into three chronological stages within Britain (Figure 3; Needham 2005; 2007; 2012), a scheme that is entirely supported by the new radiocarbon dates (with just two exceptions that could potentially be explained by curated bodies being provided with anachronistic grave goods; see Booth *et al.* 2015). The earliest period (*c*.2450/2400–2300 cal BC) is characterized by Low-Carinated Bell Beakers, while non-perishable grave goods include copper knives, stone wristguards, barbed-and-tanged flint arrowheads, flint tools and flakes, boars' tusks, bone pins, antler or bone spatulae, belt rings, iron pyrites strike-a-lights, gold hair-tress rings and other ornaments; the most lavishly equipped example is the Amesbury Archer's grave, containing the full range of the non-perishable artefacts placed in the earliest group of graves (Fitzpatrick 2011).

The second period begins around 2300/2250 cal BC with a 'fission horizon' (Needham 2005), in which a wide range of pot styles was adopted for funerary use. From this point onwards, these British pots are known simply as 'Beakers' to distinguish them from the earlier pan-European style of Bell Beaker. While copper continued to be used for knives and daggers at first, it was succeeded around 2200/2150 BC by bronze and, from a similar date, flint skeuomorphs of these forms were also placed in graves. Other stone artefacts include battle-axes and axe-hammers. Prestige ornaments in jet and amber such as V-perforated buttons, beads, 'pulley rings' and disc beads were also deposited as grave goods, along with bronze awls and bone pins in Period 2 (*c*.2200/2150–1950 cal BC). By 1950 BC, Food Vessels were being used both in inhumations and cremations and a widespread rite of in-urned cremation in Food Vessel Urns (larger versions of Food Vessels), Collared Urns and Cordoned Urns had commenced (although the practice of unaccompanied cremation burial appears to have continued from the Late Neolithic through the Chalcolithic into the Early Bronze Age).

Needham's third period (*c*.1950–1810 cal BC) equates with Wessex I, the horizon of gold-provisioned burials (both inhumations and cremations) of Britain's Early Bronze Age (Piggott 1938), recently confirmed by a single date from an inhumation in a round barrow at West Overton G1 of 2020–1770 cal BC (95% confidence [SUERC-26203; 3550±35BP]; Needham *et al*. 2010).

Human osteology

Estimated age and sex of skeletons were needed for analyzing the isotopic data in terms of social and gender differences. The selection of skeletal remains for sampling was dictated by the presence of dental enamel suitable for isotopic analysis. The sample is not, therefore, entirely representative of the archaeologically retrieved population. There is a deliberate bias in avoiding the very young and many of the elderly (whose molars were missing or severely worn). Slightly more male skeletons are present than female or those of unknown sex, and more middle-aged adults than those of other ages. Examples of trauma were few; none were as dramatic as the case of chronic infection in the Amesbury Archer's left knee (McKinley 2011: 80–1).

Statistical analyses of the Peak District sample confirm the existence of significant differences in cranial length measurements between Early Neolithic (*c*.3800–3400 cal BC) and Beaker/Bronze Age (*c*.2500–1500 cal BC) individuals, confirming the transition from dolichocephalic (long-headed) to brachycephalic (broad-headed) cranial forms. Certain individual skulls exhibited occipital flattening, a cranial modification probably caused by infants lying flat on their backs or being secured to a cradle-board. In contrast, two Neolithic-period skulls exhibit artificial cranial deformation resulting from infant head-binding to produce long skulls. This evidence for artificial skull deformation was recognized at the time of excavation (Bateman 1861; Wilson 1863: 273–4) but has been largely forgotten; it goes some way to resolving the long-term debate about the existence of racial types of brachycephalic Bell Beaker people and dolichocephalic Neolithic people across many parts of Europe (Abercromby 1912; Childe 1925: 90; Brothwell 1960; Brothwell & Krzanowski 1974; Gerhardt 1976; Brodie 1994) by introducing a cultural explanation for some of these differences in cranial shape.

Carbon, nitrogen and sulphur isotopes: diet and mobility

Isotope ratios from skeletal collagen provide useful insights into diet but, as part of a multi-isotope study of both bone and dentine to provide evidence for lifetime changes, they can also contribute to investigating mobility. Collagen chemistry reflects that of dietary protein, ultimately leading back to plants at the base of the food chain which themselves reflect the isotope ratios found in their natural environment (*e.g.* atmospheric carbon, soil nitrogen, geological sulphur). This is very similar to the way in which strontium and oxygen isotope ratios are used as evidence for mobility except that the regional environmental distinctions are much clearer for those chemical elements than for carbon, nitrogen and sulphur.

The carbon isotope ratios for this project reveal a relatively restricted range of values that suggests both a consistent background environmental signal across Britain, and also a relatively consistent diet across the entire group with no noticeable variation from the north of Scotland to the south of England (Jay & Richards 2007; Jay *et al.* 2012). By contrast, dental microwear analysis (Mahoney 2007) reveals consistent regional differences in the physical properties of foods consumed. Samples from central and southern England had a harder diet – foods requiring greater compressive forces, such as seeds or nuts – compared with more northern regions in England and Scotland, where a softer but still abrasive diet – consistent with a greater dietary emphasis on plant foods and their contaminants – was consumed.

No individuals from the period *c*.2500–1500 cal BC had a significant marine component in their diet, despite the fact that many of the sites where they were buried, particularly in Scotland, are very close to the coast. In general, people of the Beaker period were omnivores, with a relatively high level of animal protein in their diet.

This project has provided an unprecedented dataset of carbon and nitrogen isotopes at the British scale with a consistent analytical foundation, and no regional distinctions in diet have been found amongst the humans, suggesting that climate differences within Britain had little effect on the regional dietary resource values at this time. Since temperature and rainfall have an effect at the continental scale (*e.g.* van Klinken *et al.* 1994), the consistency of the $\delta^{13}C$ data for both bone and dentine, with very few outliers present, may indicate that much of the mobility revealed by other isotope ratios (see below) relates to movement *within* Britain, and not at a continental scale.

When compared to similarly large Iron Age datasets which are directly comparable in terms of analytical factors (see Jay *et al.* 2012), there is a statistical difference between the two periods, with the BPP dataset depleted in $\delta^{13}C$ (difference between the means of 0.6‰). Isotopic analysis of animal bones from some of the sites (*e.g.* Irthlingborough, Gayhurst, Barrow Hills, and the Yorkshire Wolds), together with other comparable domesticated herbivore data, shows an even clearer distinction between the periods. This shift is independent of the nitrogen isotope ratios and is more likely to relate to long-term changes in management of domesticated animals (*e.g.* leafy fodder) and/or deforestation (*e.g.* amount of woodland in grazing areas) than to changes in human consumption patterns such as a hypothesised concentration on pastoralism as opposed to cereal consumption (see Stevens and Fuller 2012).

The BPP analyses were of collagen from both bone and tooth root dentine for each individual. Bone remodels during life and thus its values reflect an averaged lifetime dietary input, albeit weighted more towards adolescence than later life. The tooth root results reflect only childhood diet because primary dentine forms early on and is not remodelled in the same way. Whilst secondary and tertiary dentine can form during life in the pulp chamber, the amounts involved are slight. Since the BPP processed entire roots (in order to produce enough collagen for sulphur analysis) the homogenized bulk product from each tooth is unlikely to have produced an isotope ratio significantly affected by dentine that formed after childhood. All collagen data retained for interpretation, from both bone and dentine, fell within the quality parameters usually considered indicative of samples free from contamination or diagenetic alteration (van Klinken 1999).

The average carbon isotope values are -21.2 ± 0.3‰ for bone and -21.0 ± 0.4‰ for dentine. The $\delta^{15}N$ ratios show more variation than the carbon isotope ratios (10.2 ± 0.6‰ for bone; 10.3 ± 0.7‰ for dentine), most likely reflecting local environments rather than differences in diet. For example, there is a broad distinction between those individuals buried on chalk bedrock and those buried west of the chalk ($\delta^{15}N$ ratios of 10.0 ± 0.7‰ for Cretaceous and young terrains to the east, and 10.4 ± 0.5‰ for older terrains to the west). This distinction is also present for domesticated herbivores (5.6 ± 0.6‰, n = 58, as opposed to 6.2 ± 0.5‰, n = 32). Among those with unusual $\delta^{13}C$ and $\delta^{15}N$ values are two from Kent (Figure 4); whether these ratios indicate migration from outside Britain or merely non-normative dietary histories within Britain is unclear.

Across the dataset, $\delta^{13}C$ and $\delta^{15}N$ values are slightly higher for dentine than for bone (by 0.2 ± 0.3‰ for carbon and 0.2 ± 0.5‰ for nitrogen). The majority of teeth used for the project were second molars or premolars, chosen specifically to avoid the probable period for breastfeeding, so the difference between the fractions is unlikely to have been caused by breastmilk. It is possible that there is a physiological cause for this systematic difference, but other interpretations include the possibility that childhood diet in this overall population differed from that of adults in a consistent way across the whole of Britain at this time.

Extreme (more than 3 standard deviations from the mean) carbon and nitrogen isotope ratio differences between bone and dentine in nine individuals, from sites located across Britain, may reflect migration between different childhood and later-life environments, as supported in several cases by the other isotope data. For example, one of the Boscombe Bowmen from a multiple burial in Wessex (Fitzpatrick 2011) is included in this group, with a $\Delta^{13}C_{(bone\text{-}dentine)}$ value of 0.9‰ (Figure 5). The strontium and oxygen isotope ratios for this individual have been interpreted as being indicative of migration, possibly from Wales (Evans *et al.* 2006). The bone–dentine difference here may therefore be the result of such mobility.

Sulphur isotope analysis was also carried out, but detailed results cannot be presented here for lack of space (see Jay *et al*. 2012: 233–4; Parker Pearson *et al*. forthcoming). Regional variation in collagen $\delta^{34}S$ does occur, likely to be caused mainly by geology and distance from the coast but also possibly by dietary differences. Whilst carbon and nitrogen isotope ratios reveal no dietary difference between northern and southern Britain of the kind revealed by dental microwear, there are regional $\delta^{34}S$ distinctions. References to $\delta^{34}S$ ratios are made below for particular cases of interest.

Strontium and oxygen isotopes

Identifying people whose tooth enamel has strontium isotope ratios that could not, or are unlikely to, have been obtained as a result of a childhood spent in the region of burial is not always simple: enamel strontium isotope ratios are a weighted average produced from diet over many months, possibly even a couple of years (Montgomery *et al.* 2010). It is often impossible, therefore, to untangle and identify all the different contributions and, if food is procured locally from two or more rock types, the resulting human isotope ratio may not be characteristic of either, and can in some instances be mistaken for something completely different (Montgomery 2010). However, such difficulties were largely overcome by the BPP because the majority of individuals were excavated from geographically restricted regions of chalk and limestone that have been well characterized (Figure 6). This was not the case for Scotland where individuals were sampled from a wide range of geological terrains, many of which have no comparative data from either the local biosphere or other archaeological skeletons. As a result, it has not been possible to constrain local ranges for the Scottish burials as tightly as regions within England.

Individual mobility, however, has been indicated for many of the individuals from Scotland by analysing dentine mineral (not to be confused with the collagen discussed above) which is not resistant to diagenetic strontium changes caused by the burial environment, as the enamel is. The strontium isotope ratio of the dentine can provide an indication of the trend towards the values of the burial soil and, hence, the local geology (Montgomery *et al*. 2007). The comparison between the unaltered enamel value and that from the dentine, which is equalizing with the burial environment, can suggest whether the enamel shows a likely non-local signal even if the geological ranges for Scotland generally are not tightly constrained.

There are few age-related or gender differences in mobility as revealed by strontium isotope analysis. Both men and women, young and old, were mobile. The proportion of males to females among 'movers' is no different to that from the entire sampled population.

As a whole, the proportion of detected likely lifetime migrants in the sample is 29% on strontium isotope analysis alone (Table 1). The real figure is likely to be higher since those who moved between similar geological regions will generally have remained undetected and this table only identifies migrants with a Sr isotope difference of > 0.001 between the enamel value and the environmental value, the latter being based either on measured dentine analysis (this study) or taken from Evans *et al*. (2010). Such a numerical cut-off does not always equate to the distance a migrant may have moved and overlooks migrants with small but significant differences. The total could also include instances of long-distance corpse transport as well as lifetime mobility. The proportion of Chalcolithic movers increases from 31% in *c*.2450-2300 cal BC to 32% in *c*.2300–2150 cal BC, to 34% thereafter in the Early Bronze Age (Table 1).

There are also considerable differences between regions, with highest mobility in northern Scotland, Yorkshire and the Peak District. It should be noted, however, that the complex geology of Scotland produces significant changes in biosphere strontium isotopes at a relatively small geographical scale so, whilst identified as non-local, movements in these instances may not necessarily have covered large distances. The English Midlands displayed least mobility, with strontium isotope results consistent with the Cretaceous and Jurassic geology of places of burial in all but one instance. However, as many as nine individuals out of 30 in this region may possibly have been mobile on the basis of $\delta^{34}S$ and other isotopic evidence. One of these, a secondary burial from Irthlingborough, Northamptonshire (Figure 7), has sufficiently extreme differences between bone and dentine $\delta^{34}S$, $\delta^{15}N$ and $\delta^{15}C$ values to suggest that he grew up some distance from where he was buried.

The Peak District of central England

The Peak District produced the highest percentage of non-local people ($^{87}Sr/^{86}Sr$ isotope-detected) other than in Scotland. Furthermore, unusually high strontium isotope ratios (higher than 0.7145) were recorded for eight of these individuals of both sexes (from barrows at Hazelbadge Hills [Barnatt & Collis 1996: 184], Bee Low [Marsden 1970], Smerrill Moor [Bateman 1861: 102], Waggon Low [*ibid*.: 77–9] and Monsal Dale [*ibid*.: 84–6]). Such high ratios are extremely rare in any European population outside Scandinavia since they are produced by consumption of crops grown on ancient or granitic rocks.

Another of these Peak District individuals is a middle-aged man with childhood cranial modification from Bee Low (Figure 8), who was buried in a round barrow with a bronze pin and two possible awls but no pot, in *2200–2030 cal BC* (*95% probability*; SUERC-31855). Whilst his strontium isotope value is not unusual for the Peak District, his extreme oxygen isotope ($\delta^{18}O$) ratio of 16.2‰ is equivalent to that of the Amesbury Archer several centuries earlier (Chenery & Evans 2011), indicating that the Bee Low man grew up in a cold and 'continental' climate, either in eastern Scotland or outside Britain. The BPP $\delta^{18}O$ values are from biogenic phosphate, as are those from the Amesbury Archer, so they are comparable in this respect. The Bee Low man also stands out on account of his unusually high $\Delta^{34}S_{(bone-dentine)}$ value (8.5‰), which suggests migration from a region further from the coast than the Peak District (or eastern Scotland), *i.e*. continental Europe.

Similarly low $\delta^{18}O$ ratios (16.2‰) were obtained from only two other burials, both from eastern Scotland, whose overall isotopic results suggest that they are probably indigenous to that region. The Amesbury Archer's example of long-distance mobility thus appears to be an exception rather than the norm. Unfortunately, the level of geographical imprecision in $\delta^{18}O$ values for Britain and Europe hinders attempts to distinguish origins on the far side of the English Channel, whilst the similarity of geology on either side of the Channel also inhibits recognition by strontium isotope analysis of cross-Channel migrants to Britain.

Southern England: a migration stream into Wessex from the west or north?

Ten individuals in Wessex (both male and female, buried with and without Beakers) have a range of strontium isotope ratios between ~0.7120 and 0.7140 (Figure 9). These include three of the 'Boscombe Bowmen' (Evans & Chenery 2011). Such values derive from Palaeozoic rocks such as Devonian sandstone or Silurian mudstones or they may result from a combination of atmospheric deposition (*e.g*. rainfall) and granitic or gneissic bedrock; they cannot be obtained from the Chalk or from adjacent Mesozoic and Cenozoic sediments. This suggests a migration stream from the west or north into Wessex, or from beyond the shores of Britain (either Ireland or the Continent). The wide range of $\delta^{18}O$ values (16.9‰–19.3‰) amongst this group makes it unlikely that they derive from a single place of origin.

Conclusion

One paradigm for explaining and characterizing Bell Beaker transmission was first put forward by Brodie (1994; 2001), who proposed that the Beaker way of life spread through exchange of marriage partners. Vander Linden (2006; 2007) emphasises that Bell Beaker migration was not an all-pervasive wave of advance. Instead he suggests that Beaker networks may have adopted generalized marriage exchange, as opposed to restricted (Lévi-Strauss 1969), in which marriage partners marry out of the group with no immediate expectation of counter-marriage; in this way, know-how and ideas could have moved long distances, producing the fragmented geographical distributions characteristic of Beaker groups. Needham (2005; 2007) has also adopted aspects of this approach to explain the pioneering phase or 'bow-wave' of Beaker dispersal but disputes Brodie's proposed mode of inter-marriage. Instead, expansion led to inter-cultural contact in a reinforcing circle: if the indigenous response was favourable then Beaker groups consolidated and further expanded. Within a continuous process of budding-off, Beaker groups would have expanded, consolidated and extended.

Our research demonstrates a considerable degree of mobility between childhood and death, most of it probably within Britain and persisting over many centuries. Almost a third of the sampled population provide evidence that they were buried in a geological region different to that in which they grew up. Some regions show considerable evidence for inward migration, notably the Peak District, whilst others such as central England show virtually none.

For Bell Beaker people in central Europe, the proportion of migrants into local populations is estimated variously as 62% or 24%, depending on the method of determination (Price *et al*. 2004: 30). These movements are considered to have taken place throughout the Beaker period and involved either small groups or individual men and women (Grupe *et al.*1997; 1999; 2001; Price *et al.*1994; 1998; 2004). The more conservative estimate of 24% is based on the number of cases where tooth enamel values differ from bone or burial environment by >0.001. Applying similar criteria of >0.001 between enamel value and environmental value for Britain, the total of 29% is surprisingly close to the Continental estimate. The overall lack of distinction between male and female migration histories across Britain suggests that notions of exogamous exchange of female marriage partners do not explain the observed patterns of movement in Britain.

Despite the uncertainties of isotopic provenancing, we consider that most lifetime movement during the Chalcolithic–Early Bronze Age was within Britain rather than from Europe into Britain. There are a few examples, along with the Amesbury Archer, where migration from the European continent is the most likely explanation, and these occurred at different times during the period, not simply at its beginning. Taking into account the fact that isotopic analyses may identify only the first-generation migrants into a region, the consistent proportion of non-locals through time indicates a high and sustained degree of mobility, much of it multi-directional and much of it probably linked to mobile subsistence practices. Rather than positing mass-migration as the only process of Beaker expansion, we also suspect that cultural transmission (diffusion of a 'Beaker package', as proposed by Burgess & Shennan [1976]) was significant, especially in regions such as the English Midlands. This process of cultural transmission has been has characterised as 'emulation of what may increasingly have seemed to be a preferable way of life because of the advantages it brought' (Needham 2007: 44), accompanying the acceleration in growth of Beaker communities in the Later Chalcolithic (Needham 2012: 20–3, fig. 1.3).

The isotopic results provide a further dimension to previous studies of osteology and material culture, indicating that mobility was pervasive, regionally variable and long-term during the British Chalcolithic and Early Bronze Age. It is likely that these isotope data will soon be enhanced by those of ancient DNA for Britain, allowing us to assess the strength of our conclusion that both migration and emulation – rather than migration alone – were significant processes behind the Bell Beaker phenomenon in Britain and elsewhere.

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Table

Table 1. Numbers of individuals (c.2500-1500 cal BC) analysed by region within Britain and by broad period, showing those detected as likely 'non-locals' by $^{87}Sr/^{86}Sr$ isotope analysis.

	Total	Sr Movers	%	Standard error
Northern Scotland	27	18	67	9
Southern Scotland	13	3	23	12
Western Scotland	4	2	50	25
Yorkshire	68	13	19	5
Peak District	29	15	52	9
Wales	5	1	20	18
Kent	17	6	35	12
Somerset	3	1	33	27
Southern England	68	16	23	5
Central England	30	1	3	3
Total	**264**	**76**	**29**	**3**
Earlier Chalcolithic *c*.2450-2300 cal BC	32	10	31	8
Later Chalcolithic *c*.2300-2150 cal BC	59	19	32	6
Early Bronze Age *c*.2150-1500 cal BC	111	38	34	5
Undated burials with a Beaker	20	5	25	10
Undated burials without a Beaker	42	4	10	5

Figures

Figure 1. Distribution map of Beaker-period burials in Britain for which isotopic analysis has been undertaken.

Figure 2. Probability distributions for use of Beakers in burials in geographic regions of Britain: a) beginning of use; b) end of use.

Figure 3. The ceramic chronology for British Bell Beakers.

Figure 4. Two Beaker-period burials from the Queen Elizabeth the Queen Mother Hospital site, Margate. The earlier, male burial (SK167 with a Beaker and three arrowheads) has the highest $\delta^{15}N$ ratio (at 11.9‰) within the BPP dataset, and the female burial (SK168 with an arrowhead) has the most negative $\delta^{13}C$ (-22.3‰). Such extremes could result from non-normative diets or may indicate mobility. SK167 dates to *2330–2195 cal BC* (*94% probability; Wk-18733*) and SK168 to *2140–1955 cal BC* (*95% probability; OxA-V-2271-37*). Drawing by Irene Deluis after Moody 2008.

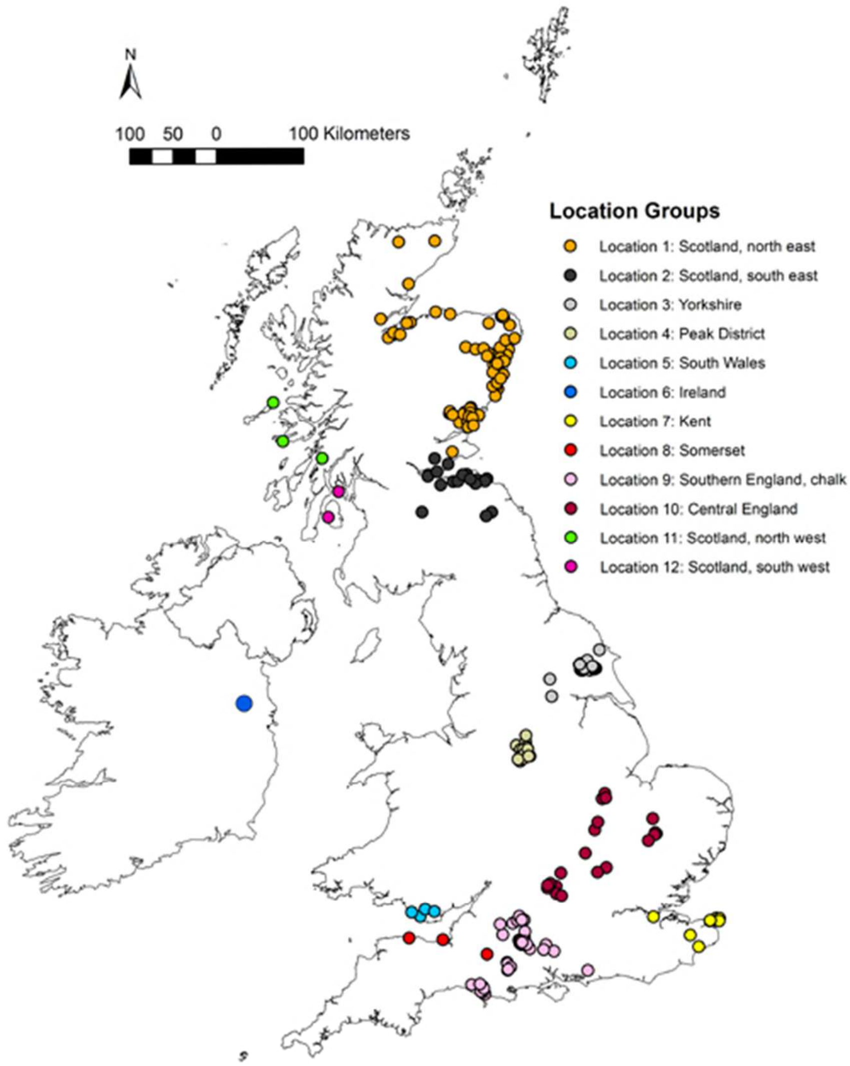
Figure 5. $\delta^{13}C$ values from bone and dentine (x and y axes respectively) for individuals from southern England, with one of the three 'Boscombe Bowmen' (SK300) highlighted as having a difference between the values for the two skeletal fractions which is more than 3 standard deviations from the mean of such differences.

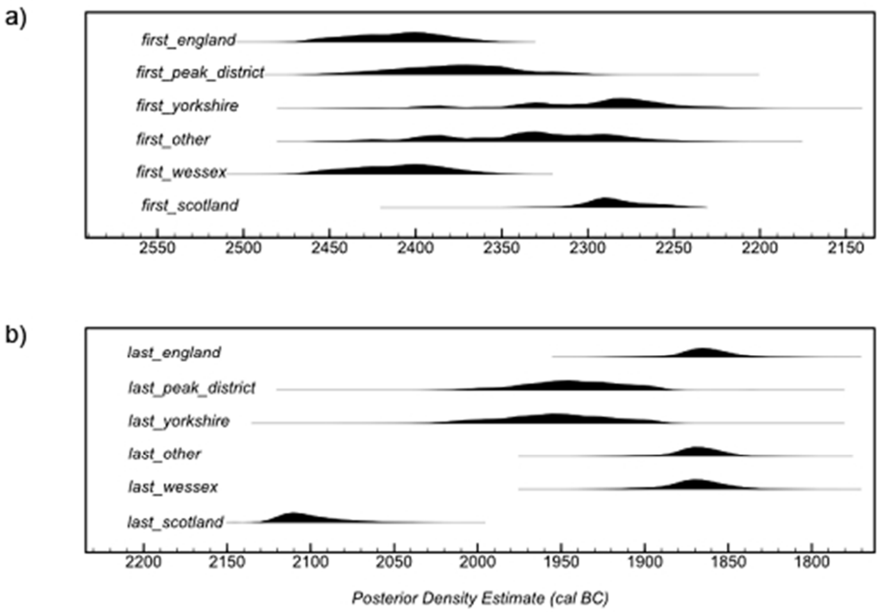
Figure 6. a) All of the enamel strontium data for Britain from non-Beaker People Project archaeological investigations of all periods (n>600; Evans *et al*. 2012); b) all of the enamel strontium data for Britain from the Beaker People Project (n=263), grouped by region.

Figure 7. A secondary burial (*1945–1730 cal BC* [*95% probability; UB-3147*]) into the top of a round barrow at Irthlingborough, Northamptonshire, is that of a young adult male with a bone pin. Extreme divergences between bone and dentine $\delta^{34}S$, $\delta^{15}N$ and $\delta^{15}C$ ratios indicate likely migration after childhood. From Harding & Healy 2007.

Figure 8. The skull from Bee Low, Derbyshire (SK200; J.93.944), demonstrating occipital flattening in two views: taken in *norma lateralis* (left) and *norma verticalis* Courtesy of Sheffield City Museum.

Figure 9. Top two rows: Beakers associated with nine of the 11 individuals from Wessex whose strontium isotope ratios indicate that they grew up some distance away from Wessex on Devonian/Silurian geology. Third row: Beakers in burials of non-migrants on south Wales Silurian geology. Fourth row: Beakers in burials of non-migrants on Wessex chalk. Fifth row: Beakers in burials of non-migrants on Devonian geology of southwest England. The second, third and fourth rows include Long Necked Beakers sharing Clarke's Southern British decorative motif group 4 (1970: 427). Whether decoration relates to place of origin remains inconclusive. From Clarke 1970, Woodward 1980 & Fitzpatrick 2011.


N
100 50 0 100 Kilometers
Location Groups
Location 1: Scotland, north east
Location 2: Scotland, south east
Location 3: Yorkshire
Location 4: Peak District
Location 5: South Wales
Location 6: Ireland
Location 7: Kent
Location 8: Somerset
Location 9: Southern England, chalk
Location 10: Central England
Location 11: Scotland, north west
Location 12: Scotland, south west



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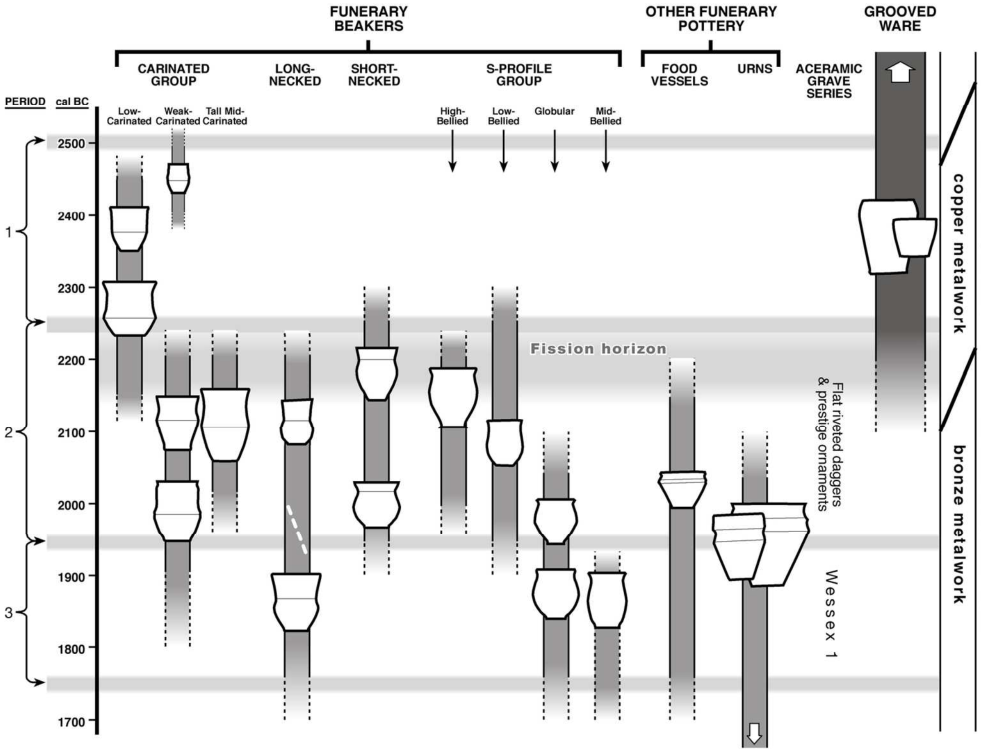

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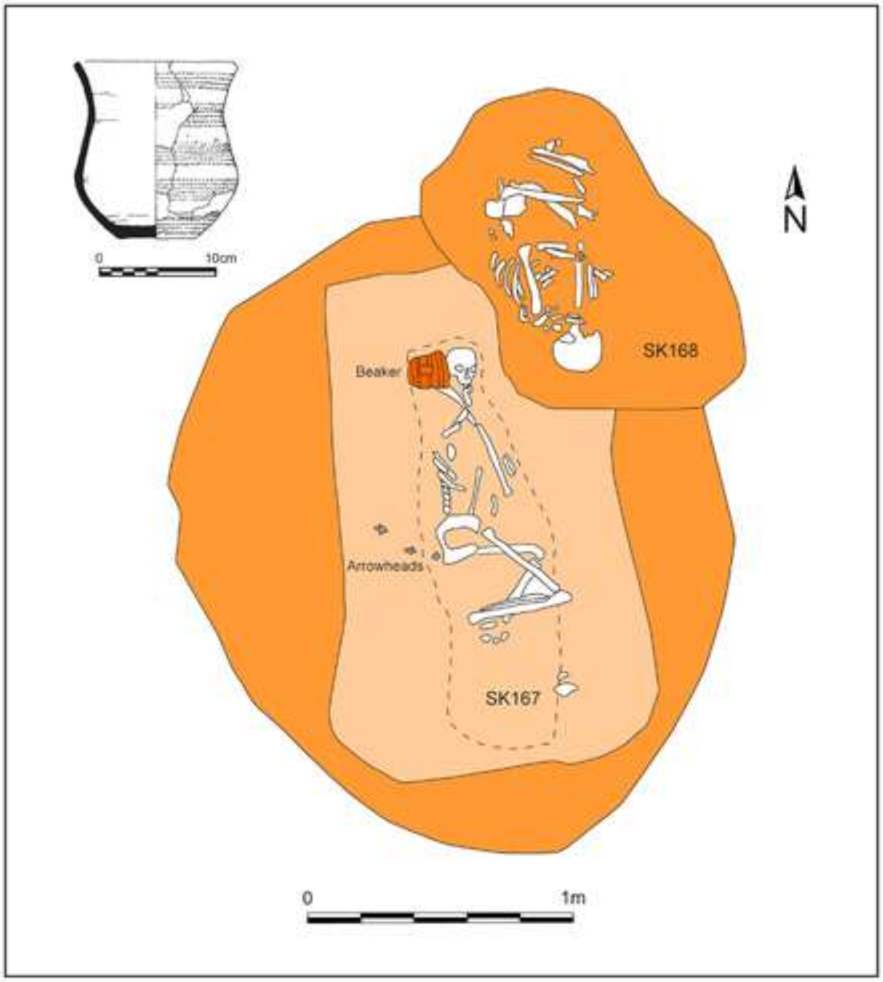
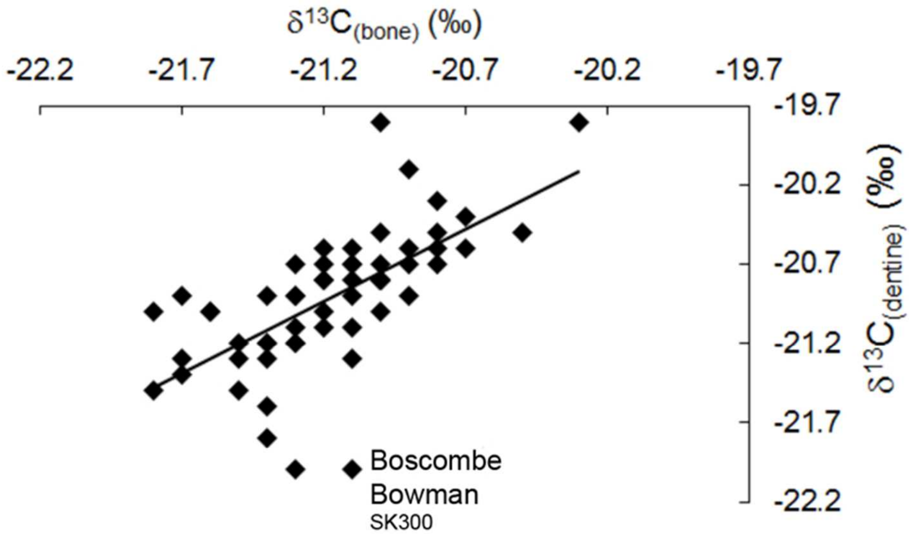
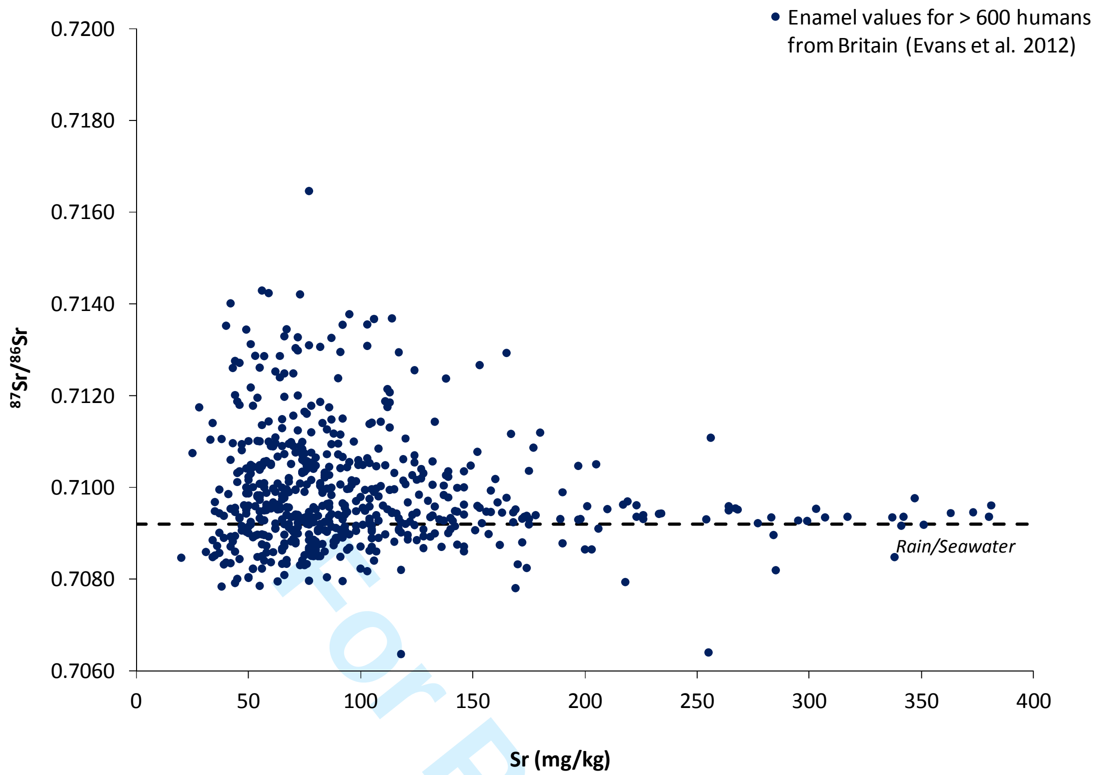
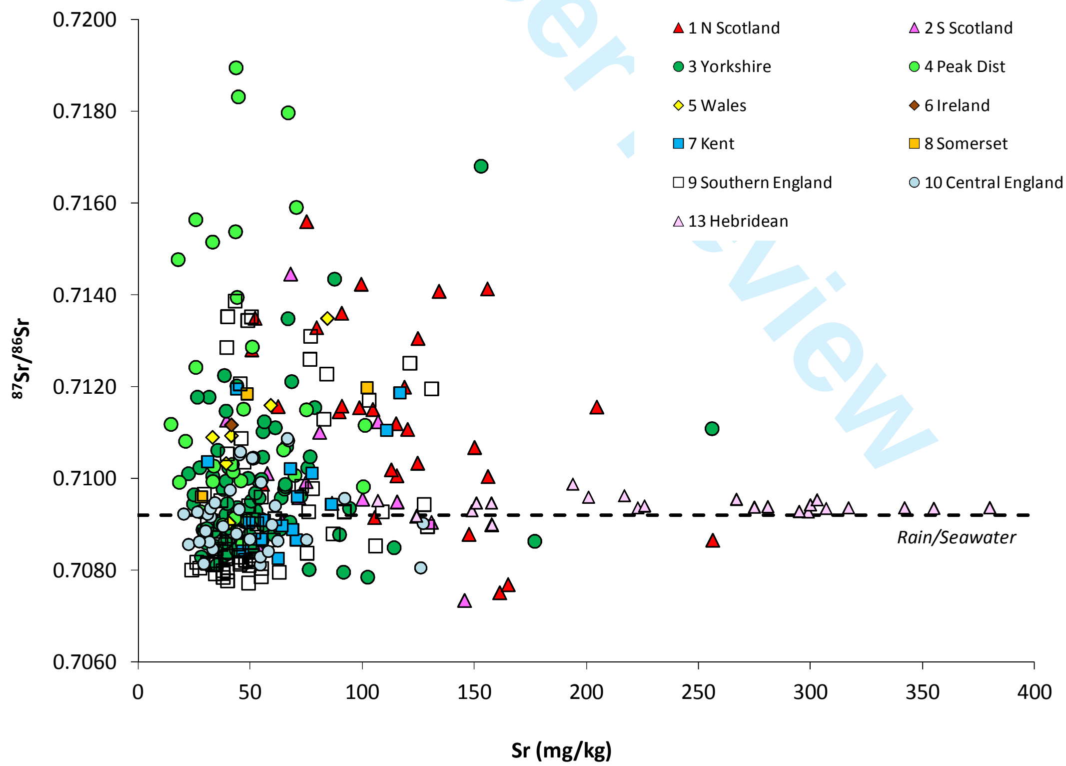


38x42mm (300 x 300 DPI)


δ13C(bone) (‰)
-22.2
-21.7
-21.2
-20.7
-20.2
-19.7
-19.7
-20.2
-20.7
-21.2
-21.7
-22.2
δ13C(dentine) (‰)
Boscombe
Bowman
SK300


Enamel values for > 600 humans
from Britain (Evans et al. 2012)
0.7200
0.7180
0.7160
0.7140
0.7120
0.7100
0.7080
0.7060
$^{87}Sr/^{86}Sr$
0
50
100
150
200
250
300
350
400
Sr (mg/kg)
Rain/Seawater

a.


1 N Scotland
2 S Scotland
3 Yorkshire
4 Peak Dist
5 Wales
6 Ireland
7 Kent
8 Somerset
9 Southern England
10 Central England
13 Hebridean
0.7200
0.7180
0.7160
0.7140
0.7120
0.7100
0.7080
0.7060
$^{87}Sr/^{86}Sr$
0
50
100
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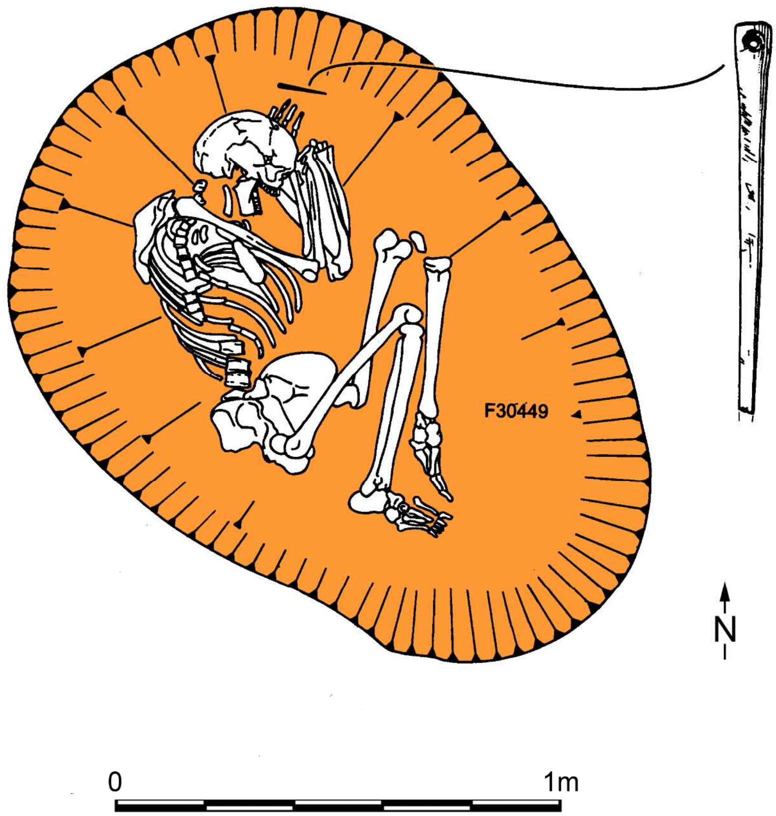
Sr (mg/kg)
Rain/Seawater

b.



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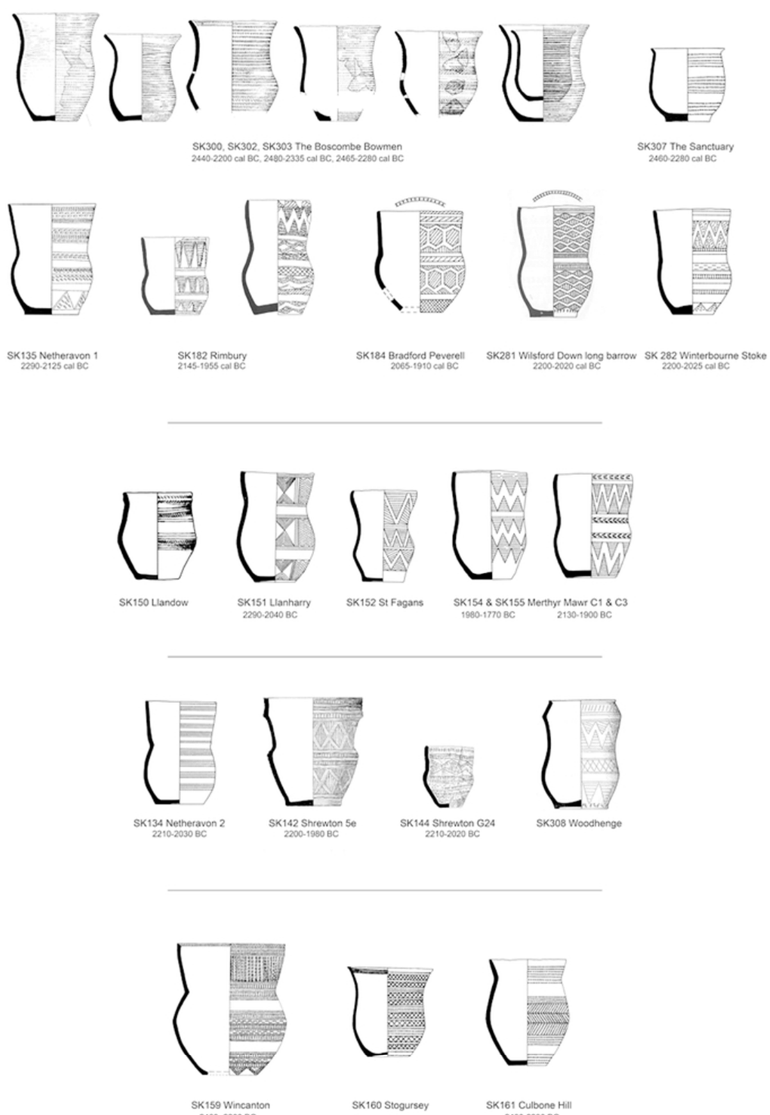
84x48mm (300 x 300 DPI)



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