Building Stonehenge? An alternative interpretation of lipid residues in Grooved Ware from Durrington Walls

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Abstract

Residues in Grooved Ware from Durrington Walls have been interpreted as the remains of large scale feasting associated with the construction of Stonehenge around 2500 BC. Whilst a function related to food consumption is possible, other explanations may be equally as plausible. An alternative interpretation not previously considered is that these residues could be related to a non-food use of animal resources, i.e. the production of tallow. This interpretation provides evidence supporting the 'greased sled' theory of how the megaliths were moved.

Lipid residue analysis and pottery function

The analysis of absorbed lipid residues is a well-established technique for determining the types of products processed in pottery. Research has focused largely on identification of animal fats, with analysis of plant residues focusing on those which have higher lipid contents i.e. waxy plants (Roffet-Salque et al. 2017). Usually a lipid concentration >5 µg g-1 is considered significant, with lower concentrations considered insufficient for interpretation of vessel use.

There is a recognition that products such as beeswax in vessels can have multiple uses – as a sealant for example, as well as an illuminant (Roffet-Salque et al. 2017). A combination of beeswax and tallow has been identified as an illuminant in medieval contexts (Frith et al. 2004) and Mottram et al. (1999), identified pig 'tallow' in medieval 'dripping dishes' as a receptacle for fat collection during spit roasting. Rendering of fat into tallow occurs when the fat is boiled or steamed in water, and skimmed from the surface, or in a dry process in a vessel with no water. Tallowis extracted from cattle and sheep and is hard, whilst pig fat produces a softer 'grease' product or lard. Traditional uses of tallow include making soap and candles and skin care products, including leather conditioning, and industrial lubricants. In prehistoric contexts, the Lascaux stone lamp has been suggested to be for fat burning (de Beaune 1987), and a Mesolithic 'blubber' lamp has been identified from Northern Europe (Heron et al. 2013). In these examples, the vessel form is unambiguously not a cooking vessel; usually with 'edible' products there is a general assumption that absorbed residues relate to food and consumption.

As part of the Feeding Stonehenge project (Parker-Pearson et al. 2011) over 300 sherds of Grooved Ware pottery were analysed. The aims of the project were to understand the material resources and social organisation required to build Stonehenge. A conclusion of this research was that pottery was more frequently used for cattle carcass processing with pig and dairy fats being found in much lower quantities (Craig et al. 2015). A further observation was the extremely high levels of lipid recovered, averaging 0.69 mg g^{-1}, with a maximum of 9.88 mg g^{-1} (Table 1, Figure 1). The average concentration of lipids preserved in archaeological pottery is usually around 0.1 mg g^{-1} (Evershed 2008). Comparable recoveries have been found in Egyptian lamps, where 17.8 mg g^{-1} were recorded (Copley et al. 2005a), and in a Neolithic vessel from Slovenia, containing birch bark tar at 3.06 mg g^{-1} (Šoberl et al. 2014). Exceptionally high preservation was also seen in vessels from the Libyan Sahara, with one sherd containing 17 mg g^{-1} (Dunne et al. 2012). Modern experimental analyses cooking lamb have produced maximum rim sherd values of 21.8 mg g^{-1} and ethnographic pots used to cook pork over 40 years produced a maximum rim sherd value of 5.4 mg g^{-1} (Evershed 2008).

The lipid residues from Durrington Walls are particularly interesting when compared to the faunal assemblage, which shows the opposite pattern – an overwhelming dominance of pig bones, with lesser amounts of cattle. The faunal data are also critical in that they point to different methods of carcass preparation. Burnt extremities on pig bones points to spit roasting of the pig carcass, and many of the pig carcasses were deposited in articulation. Zooarchaeological analysis has also identified patterns associated with marrow extraction. Interestingly the marrow extraction is more associated with cattle bones than pig bones (Albarella and Serjeanston 2002) with these being chopped into portions that would fit in pots, which would explain why the pottery is dominated by ruminant residues.

The roasting of animals in the Neolithic is seen as a rare cooking method from a zooarchaeological perspective, and if we assume that the pig fat in the pottery is the result of food processing, there is an apparent contradiction between spit roasting seen in faunal assemblage, and 'stewing' in the pot. Another explanation could be that we are looking at two different processes. Firstly, the spit roasting of the whole pig carcass, and secondly the collection of carcass fat in the large 'bucket' sized vessels. The collection of fat and rendering into tallow also makes it more storable. Ethnographic studies have shown that rendered fat may be stored in pits for extended periods of time without refrigeration (Albright 1982 p.186).

The construction of Stonehenge

The construction of Stonehenge remains an ongoing question of considerable academic and public interest (Harris 2016). The monument consists of large sarsen triathlons, up to 8m high and weighing 30 tons, and smaller bluestones, up to 3m and weighing 1 – 2 tonnes. It is generally accepted that the megaliths were moved by human effort rather than natural processes, with the sarsens originating in the

Marlborough Downs around 30km to the north, and the bluestones originating from Craig-Rhos-y-felin and Carn Goedog, over 140km away (Bevins and Ixer 2018). It is clear from work at Durrington Walls that the people who constructed Stonehenge were well organised, with large numbers of people coming from across the British Isles and beyond to take part in the construction process (Viner et al. 2010, Mays et al. 2018). The question how the stones were transported and erected is often presented with incredulity given the lack of modern technology, but in fact there are many examples of such engineering around the world in the third millennium, and there is ample ethnographic and experimental evidence indicating that people are quite capable of moving megaliths with 'pre-industrial' technology (e.g. Harris 2016, Adams 2009).

The labour input required for this undertaking was considerable, but not excessively so, and there have been numerous attempts at recreating the process of lifting a bluestone, though few of these have been systematic, or fully published. The most recent experiments have indicated that 10 people could move a 1 tonne stone at a pace of around 1.6 km per hour using a sledge system, and it is estimated around 20 people could move Stonehenge's smallest stone easily. This system involves placing logs on the ground as sleepers and pulling the stone, mounted on a sled, over them (Harris 2016). Ethnographic examples of a similar technology can be found in West Sumba, Indonesia, where there is an ongoing practice of megalithic tomb construction. The traditional method for transporting stones is to haul them on wooden sledges, with 100 – 1000 people involved for moving the largest stones. The process can take from 1 day to 1 month – each day a stone is moved, pigs and sometimes water buffalo are slaughtered to feed the labourers and spectators who view the process. These feasts can require over 100 pigs and 10 water buffalo (Adams 2009).

A sledge system would be more efficient with lubrication to decrease friction between the sled and the rollers. In Mesopotamia and Egypt, depictions indicate that liquid lubricant was used for sledge movement of large stone blocks. A famous painting from El Bersheh depicts the movement of a colossus using a sledge, and shows a person pouring liquid from a jar at the front of the sledge. This was suggested by Sir Austen Henry Layard to be grease (1853 p.115), though others have suggested water was used (Nosonovsky 2007). The use of tallow or lard for lubrication and lighting is well documented. In an earlier experiment, a team of engineers and stonemasons worked with archaeologists to carry out a series of practical experiments relating to Stonehenge's construction, using tools and methods thought to be available in the Neolithic. The most successful of their experiments involved a timber sledge used to haul a stone block along a greased timber slipway. A proprietary grease, chosen due to its similarity to tallow, was used (Richards and Whitby 1997).

Multiple functions and multi-proxy methods

The British Neolithic is a very well-studied period in terms of lipid residue analysis, with several studies suggesting Grooved Ware in southern Britain is correlated with pig feasting and ceremonial sites such as henges and timber circles, in contrast with contemporary non-Grooved Ware vessels and Scottish Grooved Ware (Mukherjee et al. 2007, 2008)Mukherjee et al. (2008) also noted that pig fat was observed in much lower quantities in domestic Grooved Ware contexts compared to ceremonial sites, at 3% versus 40%.

The prevalence of pig bones at these sites has also lent support to this interpretation. The association between pig bones and Grooved Ware is a well-known phenomenon in the late Neolithic of southern Britain (e.g. Hey et al. 2003, Edwards and Horne 1997), with pig bones comprising greater than 40% of assemblages, compared with early to mid Neolithic sites where they are typically less than 30% of the overall assemblage. This phenomenon has been variously interpreted as either a genuine feature of the late Neolithic economy or having a ceremonial function (Albarella and Serjeanston 2002).

The detailed intra-site study at Durrington Walls suggested that whilst ruminant products were more prevalent overall in the vessels, mixing between products did occur, and vessels used for pig products were more likely to be deposited in pit contexts (Craig et al. 2015). A more recent analysis looks in further detail at the potential mixing of different products, and suggests that two thirds of the vessels have dairy or ruminant fat as the main contributor, with 35% of sherds having large contributions (at least 50%) from porcine fat (Fernandez et al 2018). The disparity between faunal and lipid data deserves further scrutiny; why do we see pig lipids in pots, when faunal data indicates a different form of processing? Could the unusual assemblage at Durrington Walls be related to non-food use of ceramics and animal fat, i.e. tallow production as a means of lubrication? Whether or not this hypothesis is correct, the possibility alone highlights the importance of considering that there may be multiple functions and meanings of material culture (Oras et al. 2017), including those we may assume are obviously ‘food’ vessels. Perhaps the feasting on pigs was still part of the picture, with the collection of fat as part of the process – a multi-function product and a multi-purpose activity, comprising both food and non-food uses.

This reconsideration of the lipid residues provides evidence in support of the ‘greased sled’ theory as an explanation for the movement of the Stonehenge megaliths (Harris 2018), but there are still many questions that need to be addressed, the most obvious being the impact of differential preservation on the quantities of lipids recovered from archaeological ceramics. At the site level, there is the possibility that context type plays a role. One aim of the Feeding Stonehenge project was to explore variation in vessel use by context, and the dataset from the site is unique in this regard; most ceramic residue studies in the UK focus on broader inter-site comparisons, rather than detailed intra-site variations. It is only by analysing such large assemblages from a single site that we can begin to look at these sorts of variations. Unfortunately due to sampling limitations, the spread of samples across different contexts was very uneven. The majority of the assemblage analysed came from a single midden context, with smaller numbers from various pits and house floors. Whilst there is a statistically significant correlation between context type and ceramic residues, the grouping of samples is problematic – for example all pits are grouped as one context type. Dudd et al. (1999) also suggest a correlation between residue and context type in Grooved Ware from Upper Ninepence, with sherds from pit 133 containing more than 100 $\mu g\ g^{-1}$ compared to pit 198 which contained no detectable absorbed residues. Pit 133 was also noted to contain lithics in pristine condition, suggested to have been discarded into the pit immediately following production (Donahue and Burroni 2004). A tantalising hint perhaps at the possible 'special' nature of pit deposition.

The form of the ceramic vessel is important in the interpretation of food versus non-food residues. Non-food uses of pottery are generally interpreted from the vessel form, with residue analysis relying on pottery specialists to advise on the likely function. The production of tallow would certainly fit with the size of the 'bucket' like Grooved Ware vessels at Durrington Walls, some of which have rim diameters in excess of 40cm. This hypothesis could be tested by examining vessel characteristics in more detail, such as the relationship between residue, size and the sooting patterns, to try and understand further how the vessels were heated.

Dunne et al. (2018) acknowledge that, despite decades of methodological advances, there has been little critical reflection on the way we interpret pottery lipid residue data, particularly how residues relate to actual dietary practices and subsistence strategies. Their analysis of pottery from modern pastoralist communities in Kenya indicated intensive processing of ruminant carcasses, despite the fact that the community is not meat based at all. They demonstrate quite clearly that archaeological interpretations of pottery residues are often overly simplistic, and that despite being seen as a very 'processual' branch of archaeological science, the way these residues are interpreted is very much influenced by the assumptions of the analyst, and highlight the necessity of 'multi-proxy' approaches to archaeological questions (Shillito 2017) and the importance of reflecting on our assumptions during interpretation of scientific data.

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Site	**Number of Sherds**	**Average mg g^{-1}**	**Maximum mg g^{-1}**	**Reference**
Sweet Track*	1	1.08	1.08	Stott et al. 2001
Hambledon Hill*	3	0.50	0.79	Stott et al. 2001.
Hambledon Hill	23	0.18	1.47	Copley et al. 2005
Windmill Hill	35	0.13	0.85	Copley et al. 2005
Abingdon causewayed Enclosure	30	0.13	0.86	Copley et al. 2005
Eton Rowing Lake	39	0.1	0.52	Copley et al. 2005
Runnymede bridge	36	0.1	0.52	Copley et al. 2005
Yarnton Floodplain	26	0.11	1.84	Copley et al. 2005
Upper Ninepence	5	0.08	0.25	Dudd et al. 2009
Durrington Walls all	152	0.72	9.88	Craig et al 2015
Durrington Walls ruminant adipose	49**	1.2	9.88	Craig et al 2015
Durrington Walls porcine	25**	0.79	3.03	Craig et al 2015
Durrington Walls dairy	24**	0.67	4.56	Craig et al 2015
Durrington Walls all	33	0.34	2.14	Mukherjee et al. 2008.

Table 1: Numbers of Grooved Ware sherds analysed for lipid residues in published literature, showing average and maximum mg/g values for samples where recovery > 5µg g^{-1}.

*early Neolithic, unclear if these samples are Grooved Ware.

** Only includes samples where isotope result available.

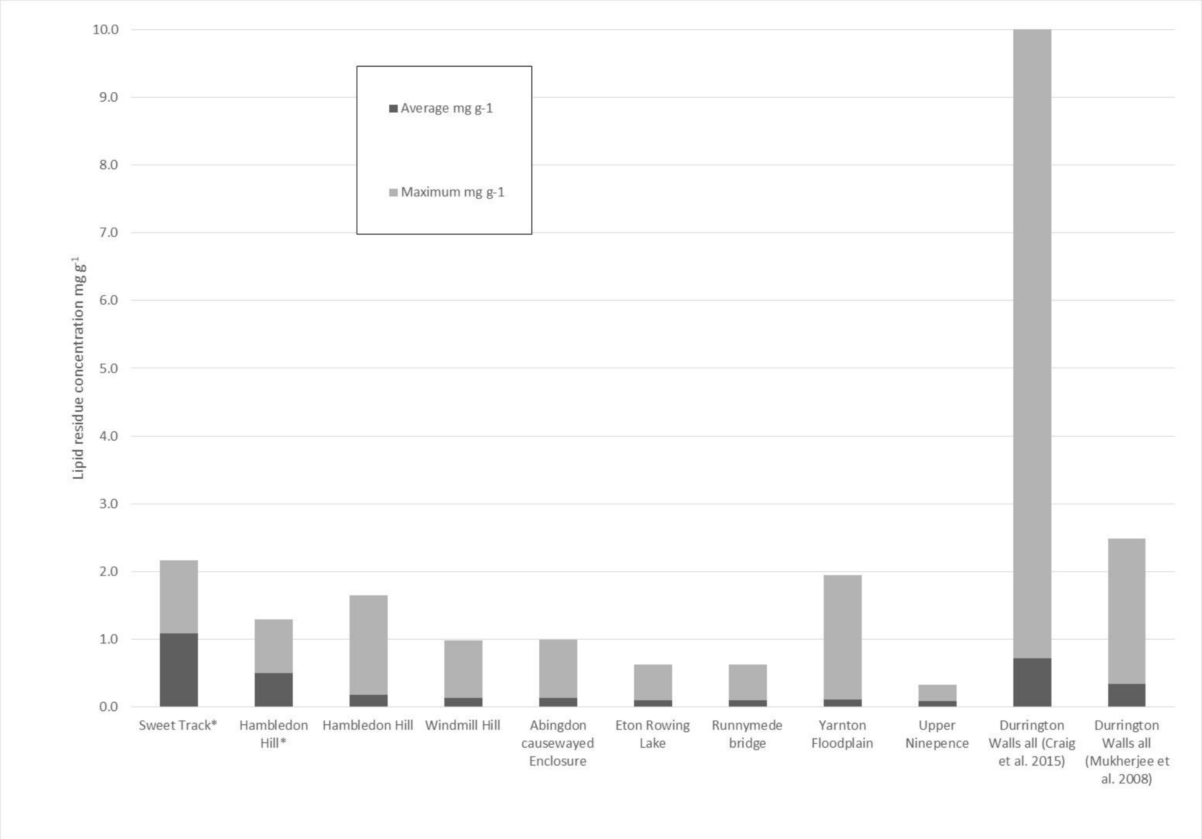

Figure 1: Average and maximum mg g^{-1} of absorbed lipid residue extracted from Neolithic Grooved Ware in Britain (samples with concentrations > 5µg g^{-1}). Data from references in Table 1.