Pooled Resources

An experimental investigation of salt production and pottery manufacture within the LIA and Romano-British landscape of Poole Harbour, Dorset.

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Abstract

Pooled Resources: An experimental investigation of salt production and pottery manufacture within the LIA and Romano-British landscape of Poole Harbour, Dorset.

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This paper explores links between Late Iron Age and Romano-British industries, around Poole Harbour, Dorset. Focusing on two major economic activities in the production of salt and a major pottery industry, South East Dorset Black Burnished Ware 1 (SEDBB1). Excavation has revealed evidence for a landscape heavily exploited for production and trade from the Late Iron Age. Previous work has identified potential links between crafts in their production techniques, common resources and post-production distribution (e.g. Gerrard 2008; Trim 2017). The irrational distribution of SEDBB1 has been examined theoretically and the ware has been suggested as a proxy for the distribution of Poole Harbour Salt. Examining this hypothesis, this study takes a practical approach to exploring craft commonality and expand the available knowledge of past Poole Harbour industries. Utilising experimental archaeology, to replicate the salt production process, and conventional fieldwork techniques, an increasing scale of industry through time is observed. The role of briquetage elements, technological change and the intended use of SEDBB1 are also clarified. A desk based assessment of spatial and temporal distribution within the study area suggests the presence of a proto-*oppidum* and the role of imperial control in the success of Poole Harbour products. The study concludes that there is validity to using SEDBB1 as a proxy for other products, though only to military markets. Additionally suggesting Poole Harbour as a major supply facility for the Roman Army, with potential connections with the *Classis Britannica.*

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Introduction

This thesis presents the results of an investigation of the production of salt and ceramics around Poole Harbour during the Late Iron Age and Romano-British Periods (c. 100 BC – 410 AD). Carrying out a programme of field work, desk-based assessment and experimental recreation of industrial processes the study attempts to engage directly with past processes and the materials that they employed. Previously the author has carried out experimental research (Trim 2017) into the production of a significant ware known as South East Dorset Black Burnished Ware 1 (SEDBB1). One of the results of this previous work was stressing the importance of not viewing industrial practices in isolation, highlighting potential links with other industries carried out in the same time and space. Building on this work the intention was to study two industries that exhibit strong evidence for interconnectivity. The following aim was therefore developed to frame the intentions of the study.

> **To explore the commonality of craft knowledge, skills and processes around Poole Harbour, during later prehistory and the Romano British period, focusing on the salt industry and links with SEDBB1 production identified in a previous study.**

A brief review of general literature on this topic (e.g. Allen and Fulford 1996; Gerrard 2008) served to highlight that many of the suggested links between the two industries were implied rather than determined by active research. Additionally the eventual distribution of SEDBB1 products has been suggested to be due to dissemination of salt, though this point is contested. This debate allows the framing of an overall research question for the study, in turn informed by the author's previous work.

> **Can a greater understanding of the process of making salt, its spatial relationship with other industries and the scale of production around Poole Harbour rationalize the success of SEDBB1 and clarify post production links?**

Working towards answering this overall research question allows discussion and insight into other theories proposed by previous researchers; such as the potential of the area forming part of an imperial estate or how the Iron Age inhabitants of the study area received the invading Roman forces.

Figure 2: Pooled Resources Study Area

Having an in-depth local knowledge of Poole Harbour, from previous research and a lifelong residency in the area, allowed an informed approach into the definition of the study area (fig. 2). Whilst the chalk uplands south of the Purbeck ridge present a huge amount of data in respect of Early and Middle Iron Age occupation, it is the heathland shores of Poole Harbour that are most pertinent to the study of LIA and RB industries. For this reason the ridge itself is used to define the southern extremity of the study area, though reference will be made to settlements on and south of this line. There is little evidence for intense occupation of the dense heathland environment now occupied by the town of Bournemouth to the east of

Poole Harbour. However the sea levels in antiquity are suggested to have been considerably lower, possibly to the extent that the Hook Sands formed part of the harbour entrance in antiquity. The navigation hazards presented by the Hook Sands are likely to have been pertinent in antiquity as they are today, sited immediately to the south east of the harbour entrance. The eastern extent of the study area is therefore chosen to include the Hook Sands, and thereby the eastern extent of the harbour itself. To the north there is evidence for activity throughout the time period under study but, having no river access to the harbour directly, is excluded from the study area as being of secondary focus on the Poole Harbour environs. The northern extent of the study area is therefore limited by the line of latitude where the Sherford River becomes a stream. To the west it is important to include the modern town of Wareham, as this appears the focus for SEDBB1 production from the 1st century AD onwards. The town lies at the confluence of two rivers, the Piddle and Frome, and it is suspected these provided transport routes in the past. To the west of the town a major SEDBB1 production site was noted at Worgret. Therefore the western extent of the study area is set to include Worgret but no further, as no evidence for industrial activity is known up river. The resulting study area covers approximately 180 km^2, focused on Wareham and Poole Harbour.

Having established an aim for the study and developing a research question to focus the research within the given study area the following chapters set out the process of the research project itself. Initially an in-depth review of the literature is carried out in order to identify areas where detailed understanding is lacking. In the second chapter these gaps are reaffirmed and a series of objectives are set out, through which an approach to the aim can be made. The subsequent four chapters then detail the techniques employed to address each objective, before a final discussion in Chapter 7 draws the separate threads together and addresses the research question.

Chapter 1 – Literature Review

Having set out an overall aim and research question a detailed review of the literature is now required. Through this process it will be possible to identify gaps in the understanding of the industry. These gaps can then be examined in order to draw a series of measurable objectives from which a programme of research can be designed. Therefore this chapter sets out a brief description of why salt is important in archaeological studies, before reviewing the detailed evidence for its production in the study area. Finally connections with another significant industry, South East Dorset Black Burnished Ware 1 (SEDBB1), are identified.

The importance of Salt

Today the use of salt is very much taken for granted, being a common ingredient for cooking and used in many industrial processes (Kurlansky 2002). Indeed the word salary, derived from the Latin for salt, gives credence to its economic value in the past. Evidence for salt production dates as far back as the Neolithic period in Europe (Chapman *et al.* 2001; Tencariu *et al.* 2015). Its value in the past can be seen to be primarily concerned with the preservation of foodstuffs but salt can also be used for seasoning food, strengthening clay before firing and as an antiseptic (Hathaway 2013). This primary function continued until the invention of refrigeration, being vital to feeding the Royal Navy during the Napoleonic Wars for example (MacDonald 2014).

Today significant amounts of salt are mined from subterranean seams, giving the rock salt commonly used at the dinner table (Kurlansky 2002). In the past, however, access to such resources was less readily available. As a result alternative methods of salt production were necessary with one of the greatest sources being the salt contained within seawater. Additionally in certain inland locations the presence of salt water springs allowed for salt production away from the coast. Despite its obvious importance to the economies of the past little is recorded in ancient sources regarding its production and distribution (Harding 2013).

Salt Production: An Overview

Due to its soluble nature salt is almost invisible in the archaeological record and therefore alternative indicators for the presence of production must be sought (Hathaway 2013). This presents a level of complexity in recognizing such processes as a variety of methods have been and are employed to produce salt. Mining has already been mentioned but other techniques include the burning of halophyte plants and the processing of their ashes, evaporation by solar power or artificially heating or use of a graduation tower (Harding 2013). In southern Europe the use of large coastal salt pans are a common sight even today and this method is thought to have dominated Roman and Etruscan salt production (Harding 2013). Seawater typically contains 3.5% salt, a mixture of Sodium Chloride and other less desirable salts (Harding 2013). Therefore nearly a litre of water must be evaporated to extract the salt content, a lengthy process even with the benefits of a Mediterranean climate. In the temperate climes of Northern Europe alternative methods were employed, generally involving the boiling or heating of seawater in ceramic vessels. These vessels, along with associated hearth furniture, are referred to as Briquetage. Evidence for their use is apparent across Europe, from Britain (Farrar 1975), through France (Daire 2003) and across to Romania (Tencariu *et al.* 2015). Often this process involved the creation of dense blocks of salt known as salt cakes, allowing for ease of transportation (Harding 2013; Tencariu *et al.* 2015). This practice does seem to have, at least within Britain, ceased by the Late Iron Age (LIA) when large quantities of crystallised salt were preferred (Hathaway 2013).

It seems that the briquetage technique of salt production rose to dominance during the Iron Age and by the time period of this study certainly dominate British salt production sites (Harding 2013; Hathaway 2013). Being an island Britain is surrounded by seawater and several centres for production are focused on the coast, such as the Red Hills of Essex (Fawn *et al.* 1990) and Dorset (Farrar 1975). The Fenland of eastern England contains large quantities of evidence for inland or coastal salt exploitation (Lane and Morris 2001). Exploitation of inland spring water, often referred to as soda springs, is known at sites such as Droitwich (Woodiwiss 1992). The exact methods varied, including variation in the use of direct or indirect heat, as do the forms and types of briquetage employed (Hathaway 2013). Despite this, the technique was essentially the same, evaporating seawater or brine until salt crystallised and could be collected.

Poole Harbour – An Iron Age and Romano-British Industrial Heartland

From the Late Iron Age until the end of Roman occupation the material resources of Poole Harbour and neighbouring Isle of Purbeck were heavily exploited. Most notable of these industries was production of nationally significant SEDBB1 (Williams 1977). The presence of shale seams in Kimmeridge Bay allowed significant production of vessels, bracelets and other commodities. These desirable products were traded throughout the British Isles and into continental Europe (Wessex Archaeology 2003). The suitability of Purbeck Marble for building prompted quarrying on a large scale, being utilised in the construction of Fishbourne Palace and *Aquae Sulis* (Bath) (Cunliffe 1971). Evidence for large scale salt production throughout this period has also been recovered from a multitude of sites around the harbour's edge (Hathaway 2005).

The landscape comprises of a heathland environment interspersed with river valleys and the salt marshes bordering Poole Harbour. Archaeological and environmental evidence suggest the soils had been degraded by overuse in the Bronze Age and that there was little occupation in the Early and Middle Iron Age (Allen and Scaife 1991). The landscape appears to have been reoccupied in the LIA, with the construction of a port at Cleavel Point and an economy focused on cross-channel trade (Cox and Hearne 1991). Today Poole Harbour is a large expanse of open water but lower sea levels suggest the LIA environment is likely to have been one of creeks and estuaries (Wilkes 2004). The LIA culture of the study area is ascribed as belonging to a tribe known to us as the Durotriges, believed to have controlled Dorset and parts of Somerset and Devon (Papworth 2011).

The Roman invasion of AD 43 saw a continuity in the economic focus of the study area, with settlement changes brought about by increasing sea levels (Cox and Hearne 1991; Coles and Pine 2009). The arrival of Rome heralded an upturn in the success of the local Durotrigian Black Burnished Ware, eventually to become known to archaeology throughout Roman Britain as SEDBB1 (Williams 1977). Alongside the success of the ceramic products an intensification in the production of salt can also be observed (Farrar 1975; Hathaway 2005).

Production Sites of LIA and RB Poole Harbour

A full gazetteer of production sites, known within the study area and dating to the period under study, is included within Appendix A. Of these sites several appear to be integral to one another and are therefore grouped together for ease of referencing within this thesis. The first of these is named the Cleavel Point Complex, comprising of settlement evidence from the Ower Peninsula, and Green and Furzey Islands. This includes the Green Island Causeway between Ower and Green Island. The second is the Corfe River Complex, relating to sites separated by the Corfe River known as West and East of Corfe River. The final grouped site is the Hamworthy Complex, comprising of evidence from several locations on the Hamworthy Peninsula and West Quay Road close to Poole Quay. For detail of these sites and the other locations mentioned in the text refer to Appendix A and figure 3 overleaf.

Salt Production in Poole Harbour

As discussed, prehistoric production of salt in Northern Europe generally makes use of evaporation through the application of heat from fire. This form of salt production requires significant amounts of clay for constructing evaporation vessels, hearths and associated props and furniture. Access to salt water or brine is also essential, along with sufficient fuel for reducing the brine to salt crystals. Given the estuary like conditions of Poole Harbour in the Iron Age it is eminently suited to salt production. Indeed the focus of salt production within Iron Age and Roman Dorset is centred on Poole Harbour and the Isle of Purbeck, with occasional outliers at places such as Wyke Regis and Portland (Farrar 1975).

In a review of Dorset Prehistoric and Roman saltworks Farrar (1975) subdivides known sites into two clearly defined groups, separated by both time and the Purbeck Ridge. The southern group is concentrated around Kimmeridge Bay, where evidence suggests the easily accessible shale seams were employed as fuel. The northern group was situated around Poole Harbour and the adjoining heathland. The general picture is that of the southern group being Middle Iron Age in date, with the Northern Group developing from the LIA continuing throughout the Roman occupation. This reflects the broader interpretation of a wholesale change of focus of occupation from the chalk uplands to the south of the ridge down onto the heathlands around the shores of Poole Harbour (Papworth 2011).

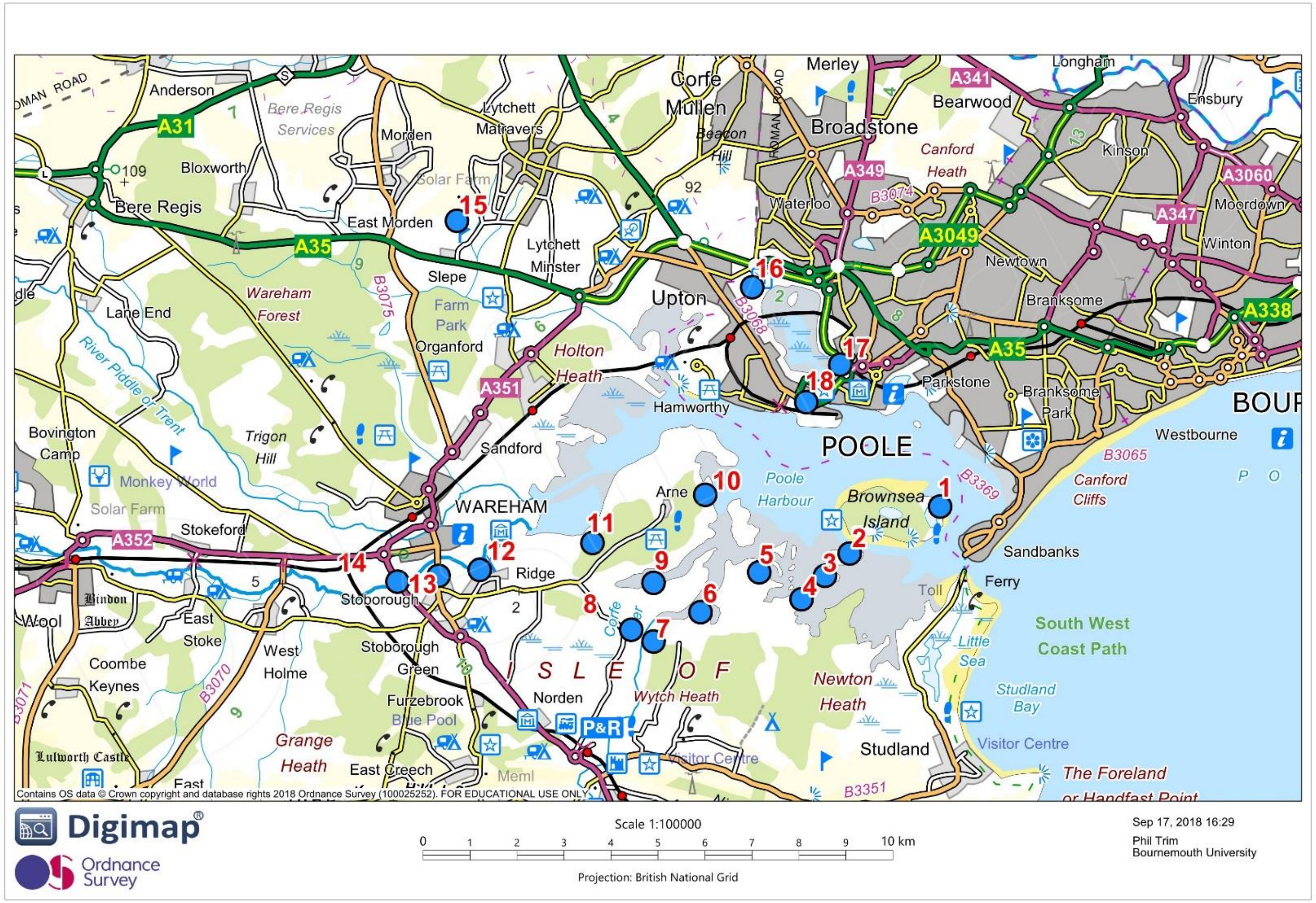

Figure 3: Location of Production Sites

1. Brownsea Island 2. Furzey Island 3. Green Island 4. Ower 5. Fitzworth 6. Point Ground 7. East of Corfe River 8. West of Corfe River 9. Middlebere 10. Shipstal Point 11. Arne Heath 12. Redcliff 13. Stoborough 14. Worgret 15. Bulbury Camp 16. Boathouse Clump 17. Poole Quay 18. Hamworthy Peninsula

Briquetage – Evaporation Vessels

As for other salt making industries, traces of the final product are almost impossible to recover from excavation. Instead the presence of briquetage is used as a proxy for the presence of such activities. From these, interpretations of how each type may have functioned within the process are drawn.

For Poole Harbour saltworking, two distinct types of evaporation vessel were initially identified; Hobarrow pans and Fitzworth troughs (Farrar 1975). The Hobarrow pans are slab built sub-rectangular trays, with rounded corners and near vertical sides. No complete example has been found but they are estimated to be 500 x 300mm in plan and 150 – 200mm deep (Farrar 1975). The type site for these vessels is a large mound of saltworking debris overlooking Hobarrow Bay on the south coast of the Isle of Purbeck (Calkin 1948b). The vessels recovered from the type site are of an order of 30mm thick in a coarse gritty fabric (Farrar 1975), distinct from the thinner (less than 20mm) vessels constructed in an iron rich clay with quartz sand inclusions found around the shores of Poole Harbour (Cleal 1991). This suggests the salt workers employed materials close at hand, rather than preferentially selecting materials for their individual properties.

The Fitzworth troughs are hemispherical vessels thought to be coil built up as cylinders, before being cut in half to form two vessels. Sealing of the open end of the cylinder prior to dissecting with a disc of clay created two vessels from one process (Farrar 1975; Morris 2001b). These forms were identified from fragments recovered from the Fitzworth Peninsula, a headland immediately west of the Ower Peninsula on the southern shores of Poole Harbour (Calkin 1948a). The fabric in which they are constructed, being considerably finer than the coarse Hobarrow Pans, bears strong resemblance to that used in SEDBB1 manufacture (Farrar 1975).

In addition to these first two forms identified by Farrar, a third form has been suggested following the Wytch Farm Oilfield project of the late 1980's. Cleal (1991) identified types of container similar to the sub-rectangular Hobarrow pans, but appearing to be broadly oval in plan. The presence of this third type, on contemporary salt working sites outside of Dorset, has been noted by Hathaway (2013). However, the lack of firm evidence for their use on other sites around Poole Harbour may indicate that these are in fact just minor variations of the Hobarrow type. Given the imprecision of any briquetage typology a degree of variation within the two types suggested by Farrar (1975) is to be expected. Moreover, given the nature of briquetage and its use, recovered vessels are very fragmentary. As a result interpretation of the forms of briquetage is problematic, differentiated by shards being either curved or flat (Hathaway 2013). Given that the trays often have rounded corners and the troughs flat ends the hazards in interpretation are clear. Though the general picture is of the two broad types described above, upon which discussion will be restricted for the purposes of this study.

The precise function or relative performance of the types is unclear, though the phasing of their use has been investigated. For Farrar (1975) the Hobarrow pans are in use earlier than the Fitzworth troughs, the former developing in the Later Iron Age with the latter coming into use in the Roman Period. The pans belonging to his southern group and the troughs the northern, except at Hamworthy which Farrar (1975) considered an outlier. However, excavations at Hamworthy (Lyne 1994) did recover evidence for Fitzworth troughs from later contexts. At the nearby 2nd century AD site of Boat-House Clump, excavations revealed a process exclusively reliant on Fitzworth troughs (Jarvis 1986b). Sites such as Ower (Woodward 1987) and West Quay Road (Watkins and Anderson 1994), present a more complex intermingling of the two vessel forms. All these sites, with the exception of Hamworthy, belong to the Northern Group. In the Fens, Morris (2001a) suggests the troughs are a Middle Iron Age technology, with the flat Hobarrow like trays coming into use in the Late Iron Age. In Hathaway's (2013) study of the south of England she attributes the initial use of both small cylindrical and rectangular vessels to the Early Iron Age, with vessels more typologically similar to Fitzworth troughs coming into use in the Late Iron Age. Within Poole Harbour evidence for the use of small Fitzworth troughs can be observed at the West of Corfe River site from the Late Iron Age (Cleal 1991). Though use of the larger troughs described by Farrar (1975) generally occurs in contexts dated after the Roman conquest, they are likely to have been in use at the same time as Hobarrow pans on some sites.

What the motivating factors were behind the selection of one vessel type over the other has yet to be ascertained. Lane and Morris's (2001) work in the Fens suggested that the flat based pans, with their greater volume, were for boiling brine. The troughs in this instance were employed to form salt cakes as a secondary part of the process. Should this be the case it might reasonably be expected to recover a similar number of both types from any one site. This does not appear to be the case for the south of England, where flat trays occur much more frequently than the troughs (Hathaway 2013). Moreover sites, such as Boat House Clump (Jarvis

1986b), where only one type is evident may imply a different process or use such as for the marketing of the salt (Jarvis 1986). There is, however, an alternative form of vessel which occurs in abundance on some sites from the 1st century AD that may supplement the troughs. The multiple excavations on the Hamworthy peninsula recovered significant amounts of SEDBB1 vessels. The vast majority of which is an oxidised red or orange, 84% of the assemblage in one case (Jarvis 1994), rather than the deep black expected of this ware. Additionally, of this same assemblage, storage jars contribute 60.9% of the vessel forms. Lyne (1994) suggests this level of oxidised SEDBB1 indicates the production of pottery alongside Hobarrow Pan based salt working during the 1st century AD, followed by a period of inactivity in the area. Then at the beginning of the 3rd century AD saltworking resumes, by which time the processes employed have changed to include a few Fitzworth containers with the majority of brine boiling being carried out in storage jars. In support of this Lyne suggests the lack of potting activity at Boathouse Clump may be the reason behind that site's reliance on Fitzworth containers. Certainly, when compared to the SEDBB1 production site of Bestwall, the percentage of oxidised vessels is similar (81%) (Lyne 2010). It is, however, possible to imagine the SEDBB1 vessels being used to form salt cakes in a similar manner to the role of troughs proposed by Morris (2001a). Whilst others have proposed the use of SEDBB1 essentially as packaging for salt transportation (Hawkes 1987).

The very fact that Poole Harbour continues to use ceramic vessels for evaporating salt water throughout the Roman period can also be seen to be unusual. Elsewhere, such as the Somerset Levels, the evidence for Late Roman ceramic briquetage is missing. It is suggested that lead or iron pans were used instead (Hathaway 2013). However, given Poole Harbour's long established pottery traditions, it is perhaps only to be expected. An in depth review of possible connections between the salt and SEDBB1 pottery industries is provided later in this chapter.

Briquetage – Hearth Furniture

In addition to evaporation vessels there are a variety of repeatedly recognised forms that are not vessels. Recorded as briquetage or kiln furniture, these items are variously described as pedestals, props, clips, bars, slabs and Ad-Hoc supporting material (Hathaway 2013). The role within the salting process of these items is generally interpreted to be one of supporting and stabilising vessels over the heat source. Interpretations are based on distinguishing characteristics noted from their recovery (Hathaway 2013). Whilst these artefacts are to be found on most salt works of the period across the UK, only the items that occur in significant numbers within Poole Harbour assemblages will be examined in detail herein.

Seemingly the most common non-vessel briquetage forms, occurring almost universally across the Poole Harbour sites, are the props or pedestals (Farrar 1975) (fig. 4). These are generally crudely made in raw clay, presumably as the need arose, often twisted or bearing the imprint of fingers where they have been squeezed to shape (Farrar 1975; Jarvis 1986; 1994). The bases are generally splayed and flat, whilst the tops often bear the imprint of the vessel which they supported or a narrow slot suggested to accommodate the bars discussed below. In cases where the ends of the props have not been adapted to accommodate vessels it is suggested soft plastic clay was used to facilitate this function (Lyne 1994). These so called prop attachments have been recovered and appear over-fired other than on their under sides. The illustrated example (fig. 5) clearly demonstrate the ability to accommodate the ends of props. They are formed in a soft and crumbly clay fabric, suggesting they were not fired along with the vessels. Rather that they were allowed to bake in the sun and/or part fired during use (Hathaway 2013).

Figure 4: Pedestals from Hamworthy (Hathaway 2013)

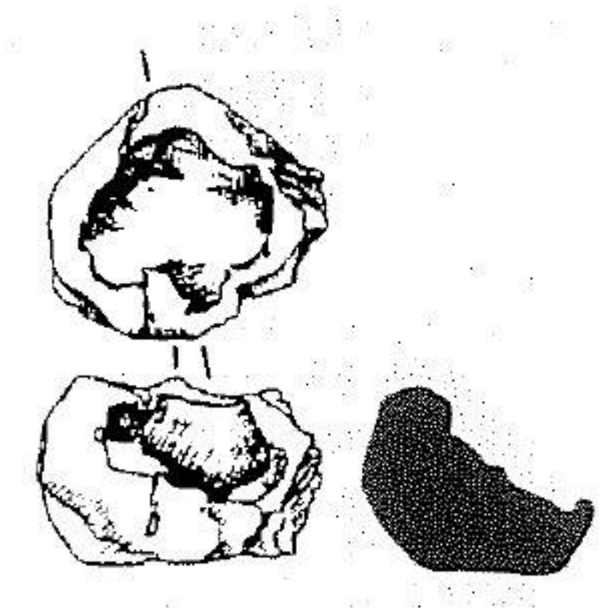

Figure 5: Prop attachment from Boathouse Clump (Jarvis 1986b)

Less common, but still significant in number, are the bars or fire bars which Hathaway (2013) suggests come in a variety of forms across the south of England (fig. 6). Within Poole Harbour several types can be observed including square/rectangular, circular, tongue shaped and thumbed bars. Some of these bars are also referred to as slabs (e.g. Cleal 1991; Hathaway 2013), implying they were intended to separate the vessels from direct heating as suggested in the Fenland examples (Lane and Morris 2001). Examination of these forms by Lyne (1985; 1994) has attributed them as bars designed to support briquetage vessels over the hearth. Hearths within the study area, described in more detail below, do not appear to function with a remote heat source and flue. Indeed the props, bearing notches at the top, appear designed to accommodate the edges of the thumbed bars, further promoting the idea that the flat rectangular bars were used to support the vessels in some way.

Of particular note for use of bars, is that the thumbed and flat rectangular bars only seem to occur in conjunction with the use of Fitzworth troughs. This is best shown at Boat House Clump, where only Fitzworth troughs were employed in the salt making process (Jarvis 1986). Elsewhere, such as at Hamworthy where Hobarrow pans and SEDBB1 dominate, bars are rarer and square or circular in section (Lyne 1994;

2009). At Ower, where the Mid to Late Iron Age contexts contain Hobarrow pans and the later Romano-British (RB) contexts include the Fitzworth troughs, a mixture of Types 1 & 2 along with a tongue shaped bar (Type 5) were recovered from excavation (Hawkes 1987; Cleal 1991). This trend, coupled with the presence of props whose ends bear clear impressions of the base of Hobarrow pans, imply the use of broad flat bars is intertwined with the use of troughs. Conversely the pans may have been supported by pedestals alone, with occasional use of square or circular bars to provide additional support.

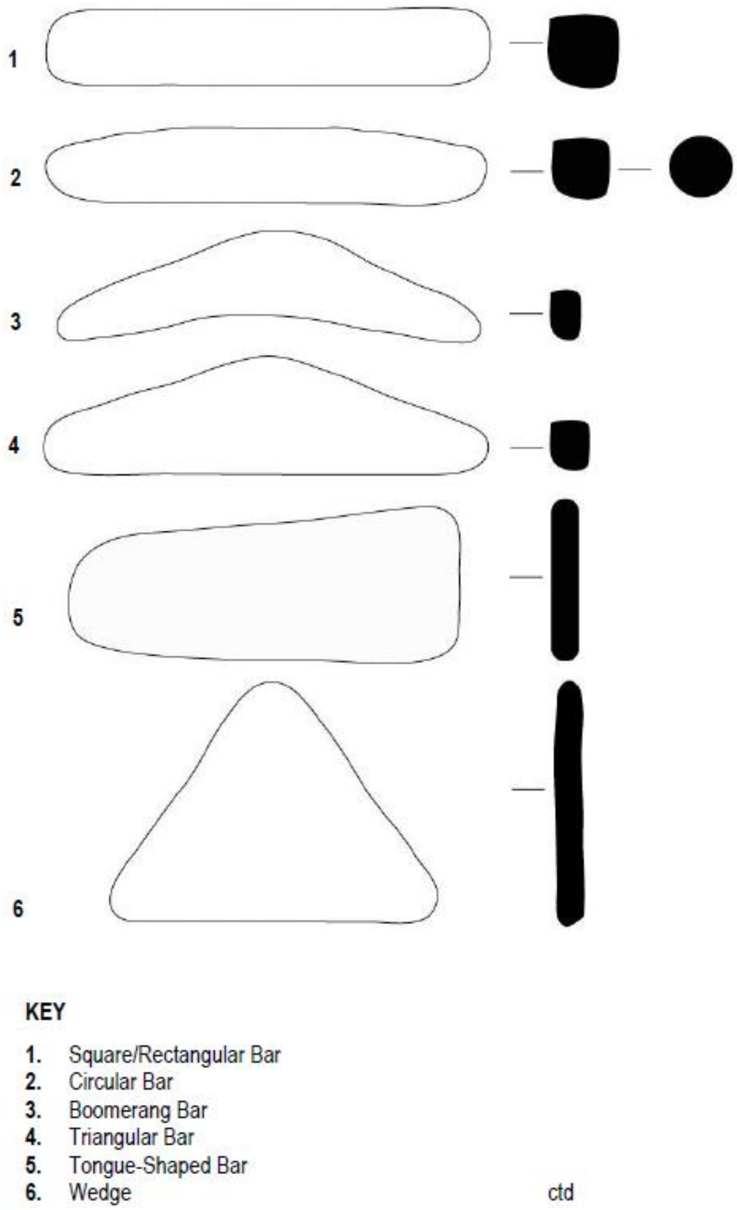

Figure 6: Hathaway Bar typology (2014)

Hearths

Whilst discovery of hearths during excavation would seem the most compelling evidence for salt production, it has proven difficult to identify such features as being exclusively for that purpose. Additionally, despite the large number of identified salt works in the study area, firm evidence for salt boiling hearths is minimal. Unlike the SEDBB1 kilns at Bestwall, where partial loads were left in situ (Ladle 2010), no similar combination of hearth and briquetage has yet been discovered. Furthermore the role of simple open hearths or bonfires to heat brine or dry salt is not fully understood. Such ephemeral features are indistinguishable in function from cooking fires or other roles. However, there are a few examples from the Poole Harbour salt production sites that require examination.

The foremost of these was discovered during pre-construction work at Shapwick Road, Hamworthy. Here a rectangular pit (fig. 7), 1.85m x 1.25m in plan and 0.5m in depth, was discovered built up of raw clay blocks. The lower fills were comprised of charcoal rich sandy-silts, suggested to be remnants of the fuel used during its last use, above which a large concentration of briquetage and baked clay was recovered (Bellamy and Pearce 2001). Parts of the upper lining had been fired with the unfired parts showing discolouration indicative of exposure to heat. Based on pottery typology, a late 1st century date is attributed to this feature (Bellamy and Pearce 2001). The lack of associated stoke hole or flue indicates the use of direct heat would have been employed in this process (Hathaway 2013).

A similar structure was also noted at the 12 West Quay Road excavations, situated a short distance across the Poole Lifting Bridge and considered a subsidiary site to the Hamworthy Complex (Watkins and Anderson 1994). Evidence of a third possible 'Hamworthy Type' salt boiling hearth was noted in the section of the pipe trench at Boat House Clump, Upton (Jarvis 1986b). Though only partially excavated, the feature appears to have two clay built walls roughly 1m apart where part of the clay lining has been fired. The fill contained briquetage and the lower fills consisted of sooty black sand, as well as reddened sand, indicative of a low temperature thermal process (Jarvis 1986b).

Figure 7: Hamworthy Type Salt Boiling Hearth (Hathaway 2013)

In addition to the hearth noted at Shapwick Road a second hearth-like feature was excavated 1.5m away. This sub-circular feature, 1.38m in diameter and just under 0.5m in depth, contained a mixed fill of heat-discoloured clay and silty clay including a few fragments of briquetage (Bellamy and Pearce 2001). The thickness of the burnt clay within the feature, and its close proximity to the rectangular hearth, led the excavators to interpret this as a secondary hearth associated with salt production. How exactly this would have functioned in the salt making process is uncertain. The thick clay base seems excessive for a simple platform to bear a fire. If its role was for the drying of salt crystals prior to distribution as suggested by Hathaway (2013), then a formal hearth would seem superfluous for the task. Interestingly there is no mention of similar associated features from the 12 West Quay Road excavations (Watkins and Anderson 1994).

These examples, being from the northern shore of the harbour, are all firmly 1st century AD or later and date from after the Roman Conquest. Though sites from the RB period do occur on the southern shore, such as Fitzworth and Arne (Calkin 1948b), these have seen little in the way of formal excavation. The exception to this is the Ower Peninsula, though excavation has been limited to pipe trenches and small area archaeological investigation (Woodward 1987; Cox and Hearne 1991). However it is on the southern fringes of the harbour that evidence for pre-Roman salt working is most prevalent. Work expanding the Wytch Farm oilfield has allowed excavation of several sites as well as survey and review of other areas (Cox and Hearne 1991). Despite this, however, the evidence for salt boiling hearths is not as clear as at the later sites.

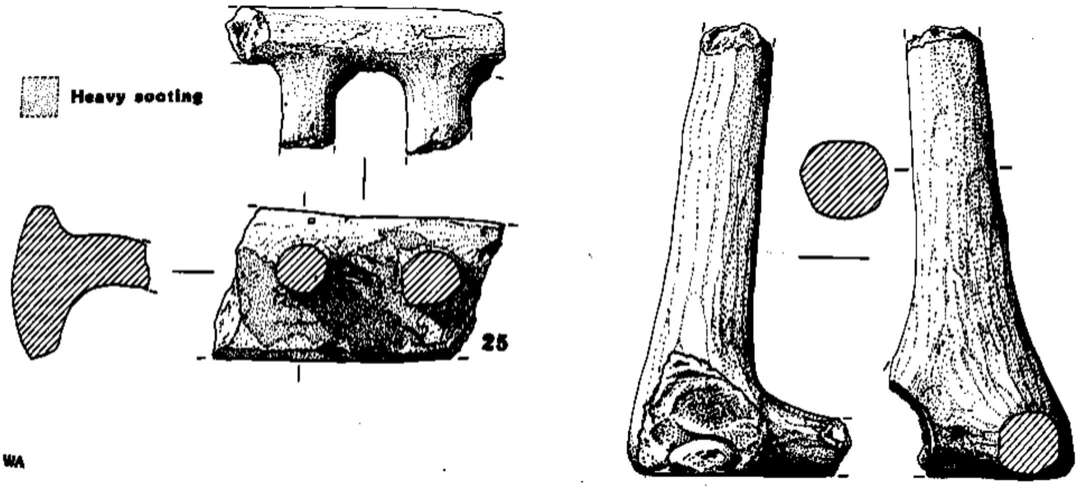

Figure 8: Possible gridded hearth elements from Ower (Cleal 1991)

Hathaway (2013) points towards a clay lined gully from the East of Corfe River site, approximately 0.67m wide by 2m in length. Though the lining is fired the excavators interpreted this as a flue for a clamp kiln (Cox and Hearne 1991). Experimental work has shown that it could have functioned in this manner (Dr D Pitman personal communication 2018) and therefore it is discounted as a potential salt boiling hearth. A second type was also suggested by Hathaway (2013) from artefacts recovered from the same site (fig. 8). This is suggested to be similar to the gridded hearths known from France (Daire 2003). However only one shard is known from the excavation and is constructed of a fine reduced fabric that has been burnished. The excavator considered this may have been for the display of other goods (Cleal 1991) and the finish suggests it was not intended to form part of a hearth structure. The final evidence presented for salt boiling hearths is from Furzey Island. Here two small clay structures have been noted, a small clay lined circular pit and a similar pit adjoining a larger sub-circular clay lined pit (fig. 9). The pits have been attributed as salt boiling hearths with the larger adjoining feature suggested to be a brine settling tank (Hathaway 2013). It is possible to draw comparison between the suspected hearths and circular clamp kilns excavated elsewhere in the study area (Hearne and

Smith 1991; Cox and Hearne 1991). However the presence of a settlement tank and briquetage from nearby cliff edges support their use in salt production.

Figure 9: Iron Age Hearths on Furzey Island (Hathaway 2013)

Industrial Connections – SEDBB1

Production of the RB coarseware SEDBB1 and its Iron Age development is centred on the iron rich clays of Poole Harbour. A recent study into the production of the ware highlighted possible links between that industry and others being carried out locally, including iron smelting, charcoal manufacture and salt production (Trim 2018). The presence of large quantities of locally produced coarseware at the salt production sites has already been noted above, but links between the two industries are potentially more significant than that. Both industries require the same basic resources of clay, firewood and water. Their production processes both require the creation of vessels, though the final goods may differ. Even their initial distribution has been suggested to be closely linked if not co-dependant (e.g. Woodward 1987; Allen and Fulford 1996; Gerrard 2008). Here each stage of the manufacturing processes is assessed in order to highlight connections between the two industries.

Pooled Resources

As mentioned the raw materials required to produce SEDBB1 and salt are broadly the same. This co-dependency for materials can be evidenced in the archaeological record by several sites where both industries are suggested to carry out production concurrently. Pre-conquest sites such as the Corfe River and Cleavel Point Complexes exhibit evidence for kilns, BBW wasters, briquetage and possible hearths and associated structures (Cox and Hearne 1991). For the 1st century AD the Hamworthy Complex exhibits evidence for both practices being carried out in the form of large quantities of SEDBB1 vessels, briquetage, definite salt boiling hearths and possible kiln structures (Smith 1930; Coles and Pine 2009). However, sites from the 2nd century appear to separate the two practices at least in terms of location. Though, as addressed below this may not represent a complete separation of the two trades.

Beyond the sharing of raw materials, mutual utilisation of the processed clay used to make vessels can be observed. Whilst the clay used to create the Hobarrow pans appears to be solely for that purpose, being a rough sandy fabric with little processing, the same cannot be said for the Fitzworth troughs. Examination of the fabric used to manufacture the troughs has highlighted distinct similarities with that employed to construct SEDBB1, albeit oxidised rather than reduced (Farrar 1975; Jarvis 1986; Cleal 1991). The use by both industries of this finer sand tempered clay may represent a mutual concern for its production prior to use on separate sites for incorporation into appropriate vessels.

It appears likely that the skill set required to manufacture the vessels may also exhibit links between the two industries. Though the Hobarrow pans were probably constructed using the slab building method (Hathaway 2013) it is suggested that the troughs used the coil building method (Farrar 1975). The SEDBB1 vessels were universally hand built using the same coil building method, though hand wheels may have been employed to achieve the regular finish (Williams 1977). It is therefore reasonable to suggest that there is a connection between the use of coil building and construction of both SEDBB1 and Fitzworth troughs. Especially as a high level of skill would be required to manufacture both the troughs, and the large storage size vessels present in the SEDBB1 typology from the 2nd century AD (Lyne 1993).

Post Production Connections

As alluded to there are suggestions that connections between SEDBB1 and salt may go beyond those associated with their manufacture. Woodward (1987) proposed that SEDBB1 should be viewed as little more than packaging for the transportation of other produce. Certainly with initial post-AD 43 connections to *Legio II,* and therefore the Roman military and their demand for salt, possible connections can be observed from the distribution pattern of SEDBB1 and the location of Roman garrisons (Fulford 1996).

This pattern of distribution is viewed as being irrational, prompting suggestions of alternative factors driving SEDBB1 distribution beyond that of its sale simply as a ceramic ware (Allen and Fulford 1996). If the dissemination of SEDBB1 was deemed to be rational it would be expected that its use would be centred upon the kiln sites, with frequency of occurrence falling off with increasing distance from the centre (Gerrard 2008). Whilst the distribution of Durotrigian BBW can be seen as fitting this model of rationality, being restricted to Durotrigian territory, its later distribution cannot. For example, large concentrations of the ware are evident on both the Antonine and Hadrian's Wall, far removed from the production centres. Yet its trade eastward into the neighbouring Atrebatan territory within Hampshire appears to be minimal (Gerrard 2008). With the presence of *Legio II* at the nearby Lake Farm Vexillation Fortress, Wimborne, and subsequent concentrations of SEDBB1 occurring at Forts established or garrisoned by the same legion, the possibility of military supply contracts has been proposed (Allen and Fulford 1996). However, the great distances involved in transporting vessels to the frontier have raised the question of why less remote sources of coarsewares were not sought. Rival industries were certainly created, such as BB2, but again these are still far removed from the eventual consumers (Gerrard 2008). As a ceramic product alone there appears to be some issues in determining the driving factors for the distribution of SEDBB1.

Addressing this discrepancy in the irrationality of SEDBB1 distribution Gerrard (2008) looked at other requirements that the Legions would need satisfying. The foremost among these being the ability to feed the garrisons, particularly in remote areas such as Hadrian's Wall. With as many as 20,000 troops in post-conquest Britain (James 1984) the demand for meat would have been significant. Moreover the need to preserve meat, presumably by salt or brine, would in turn demand significant amounts of salt. Therefore, Gerrard (2008) argues, it is the demand for salt by the legions that drove the trade links between the south coast and the north of the province. Clearly Poole Harbour, with its long established ceramic and salt production industries at the time of the AD 43 conquest, was eminently suitable to provide both salt and pottery. Indeed examination of the faunal remains from pre-Roman Ower have suggested the manufacturing of salt may be closely linked with the exportation of salted meat (Maltby 2006). Potentially, as suggested by Woodward (1987), distributed as one product with SEDBB1 serving as packaging for the salt or salted meat. Though this need not be the case, as the ability to fulfil multiple requirements of the Roman military may simply have allowed access to distant places rather than alternative local suppliers being sought (Gerrard 2008).

Were the non-local distribution of SEDBB1 constrained to sites with military connections it would be possible, if the concept of the ware as packaging be accepted, to see the distribution pattern as a proxy for the trade of Poole Harbour salt. This, given the usual difficulties in observing the salt trade post production, would be extremely useful in understanding the trade network within Britain during the RB period. However, significant amounts of the ware can be found on non-military sites. These include urban centres such as Corinium (Cirencester), villas such as Gatcombe, Somerset and rural sites such as Oakridge, Basingstoke (Allen and Fulford 1996). There is even evidence of SEDBB1 from saltworking sites remote from Poole Harbour, such as Droitwich (Woodiwiss 1992). In contrast to Gerrard's point (2008) regarding SEDBB1 being preferred to establishing closer industries, such as in the northern frontier zone, the ware seems to have been capable of penetrating markets with already established industries. This implies that the ware may have had qualities placing it over locally produced products, such as the ability to withstand thermal shock brought about by use in open-hearth cooking (Allen and Fulford 1996). Additionally Allen and Fulford (1996), who concur with the concept of supplying pottery to the military through the procurators office, suggest penetration into civilian markets is enabled through the fulfilling of military demands. Essentially by creating a surplus of vessels it would be possible to disperse these at major points, such as towns and cities, along the trade routes followed to fulfil military demand.

Whilst the driving factors behind the proliferation of SEDBB1 are yet to be firmly established, the benefits of understanding these are clear. Even though it is likely that they will never be fully understood, despite being part of only the second rung of Hawkes' Ladder of Inference (1954), the nature of complex arrangements with the Roman authorities can be allow insight into the dispersal of other goods.

Chapter 2 – Rationale, Aim and Objectives

As laid out in the introduction the project has a very broad aim, partly drawn out of the success of a previous study focusing on the production of SEDBB1 (Trim 2017). For clarity the aim is restated below:

> **To explore the commonality of craft knowledge, skills and processes around Poole Harbour, during later prehistory and the Romano British period, focusing on the salt industry and links with SEDBB1 production identified in a previous study.**

From this aim a more specific research question was determined in order to give the study direction and enable the assessment of the relative success of the research programme. Again the research question is repeated here for clarity:

> **Can a greater understanding of the process of making salt, its spatial relationship with other industries and the scale of production around Poole Harbour rationalize the success of SEDBB1 and clarify post production links?**

In order to begin to answer this question the areas where the general understanding of the industry can be developed must first be defined. The literature review has served to identify such areas that can now be drawn out in more specific terms.

Missing Links

Though the number of sites, where salt production is observable, is high for the relatively small area in which they are situated, intra-site organisation is poorly understood. Conversely other industries, such as SEDBB1, have benefitted from the total excavation of particular production sites such as Bestwall. Here it was possible to define working areas and the phasing of the site (Ladle 2010). None of the salt production sites have benefitted from such large scale investigation and therefore it is difficult to understand how significant salt production is on any one site. Hamworthy, for example, has not been fully excavated because of the level of post-Medieval development on the peninsula and what has been examined may relate to Roman military activity or ceramic production as much as salt production (Bellamy and Tatler 2006; Coles and Pine 2009). The Corfe River sites, though bare of any subsequent development, have only been partially excavated and the evidence suggests a very mixed pattern of industrial processes. Whereas sites such as Boathouse Clump and Arne are so poorly understood that little more can be said of them than that salt production probably took place there (Smith 1933; Jarvis 1986b). In order to examine the spatial relationships of the ceramic and salt industries, a greater understanding of the spatial organisation of salt production in isolation would be required.

Though the detail of intra-site site organisation of salt production is lacking somewhat, there is a greater depth of knowledge on the spatial relationships between sites, greatly assisted by the level of investigation into ceramic production. Similarly typological dating of Durotrigian BBW and SEDBB1 forms has added temporal detail to the location of sites. This evidence has led to suggestions of patterns of movement within the occupation of the wider landscape (e.g. Farrar 1975; Cox and Hearne 1991). The gazetteer of sites, Appendix A, hints at a more complex pattern of movement within the study area. However, despite the available data, the spatial and temporal relationships between industries, domestic and agricultural occupation have not been significantly examined. Though of interest in itself, a fuller understanding of these aspects may assist in explaining changes that occurred following the Roman invasion and the impact this had on the native population. Furthermore the occupation, abandonment and occasional reoccupation of different areas of the harbour edges may shed light on landscape and environmental changes. Of particular note is the suggestion that rising sea levels motivated the abandonment of the Cleavel Point Complex, though evidence suggests reuse of this area from the 4th century AD (Woodward 1987; Cox and Hearne 1991). The benefit of understanding the temporal and spatial aspect of production within the immediate landscape should help to heighten knowledge of organisation of industries and how they may have interacted. It may also assist with understanding wider trends such as the Roman trade and transport network within the province and beyond.

Beyond the organisation of industry within the study area, it is the detail of the salt production process which presents the greatest dearth of knowledge. Excavation has provided many fragments of the equipment used to produce salt from the LIA and Roman periods, though without at least partially complete vessels any suggestion of their dimensions is purely hypothetical (e.g. Farrar 1975). More recent work has suggested implications for how the different elements of briquetage may have functioned (Hathaway 2013). Dating based on pottery typologies has provided temporal resolution for the use of different evaporation vessels, though only vague suggestions have been provided for the reasoning behind this technical change (e.g. Jarvis 1986; 2009). Additionally, beyond the assumption that sea water is collected, possibly allowed to concentrate by solar evaporation and then heated to extract the salt, little is certain of the exact process employed. Indeed Poole Harbour seems unusual in the continuing use of ceramic evaporation vessels when elsewhere lead replaces ceramic (Hathaway 2013). Furthermore, given the soluble nature of the final product, it is near impossible to grasp the likely scale of production. Especially so given the suggested fragility of the vessels used and therefore likely excessive levels of production waste, exemplified by the mounds of briquetage at Hobarrow (Farrar 1975) and Boathouse Clump (Jarvis 1986). It is evident that an attempt at replication of the process with direct engagement with the materials is required to approach an understanding of Poole Harbour salt production.

The literature review has also highlighted the complex nature of post-production links between the salt and SEDBB1 industries. The validity of using SEDBB1 distribution as a proxy for that of Poole Harbour salt certainly requires further examination. Additionally the suggested links (e.g. Gerrard 2008) need exploration from the aspect of the scale of the two industries and their production. Indeed most studies of this aspect of Poole Harbour production can be said to have worked from point of consumption inwards to the source of production, potentially overlooking details such as immediate links into the transport network and methods of transport. Moreover the implications of the production processes involved, along with the siting of the two industrial processes in regards to one another, have not been fully considered. This discussion over how the final products of each industry therefore needs to be readdressed, with a greater focus on the dissemination outward from the source which potentially may shed more light on the issue.

Objectives

Identification of gaps in our knowledge demonstrated by the literature review allows for the drawing out of a series of measurable objectives and therefore a rationale for the research elements of this thesis. Set out below are a series of objectives developed from those areas defined above, designed to meet the research question and overarching aim of this study:

1. **Expand our knowledge of poorly understood sites**
   The literature review and site gazetteer have served to highlight the level of variability in the investigation of production sites. Through a programme of site visits, field walking, geophysical survey and limited excavation it should be possible to increase understanding of suitable sites. Increasing available detail of such sites may allow insight of their role in production, their extent and consequently the scale of production at each location. This in turn will feed into the next objective concerning the relationships between sites in both time and space.

2. **Carry out an in depth review of the spatial and temporal observable relationships between sites.**
   Several authors have commented on suggested patterns of settlement within the study area (e.g. Farrar 1975; Cox and Hearne 1991; Papworth 2008; 2011) but have not necessarily studied it in depth or across the whole of Poole Harbour. By using the dating and location data from the site gazetteer, coupled with additional data gained from Objective 1 and detail of the suggested sea level changes, a fuller picture may be drawn. Utilising GIS software to create a map progression from the Middle Iron Age through to the end of the Roman occupation, observable patterns and their implications for transport, industrial cooperation and organisation may be drawn. Additionally it will allow a review of suggested settlement patterns within the study area, including the effects of sea level changes within the analysis as suggested by Keith Jarvis (1992). The implications from this process can then be drawn together with the other strands on the discussion of post-production connections.

3. **Engage directly with the techniques of briquetage production**
   Whilst we are aware of the various equipment employed to produce salt in the study area, the exact details and nature of such are as yet elusive. Previous studies (e.g. Trim 2017) have met with success in not only reproducing SEDBB1 fabric, but also drawing social implications from the process. By attempting to reproduce examples of briquetage it is hoped that

unforeseen parallels between the two industries, along with direct implications for each industry, may be observable.

4. **Carry out a programme of experiments attempting to recreate the salt production process.**
   In order to further our understanding of the process by which the inhabitants of Poole Harbour in the LIA and Romano British periods won salt from sea water a more practical approach is required. Therefore it is intended to attempt to recreate the process based on suggestions developed through examination of the briquetage. How the arrangement of hearths and evaporation vessels affected the process can be tested through experimentation. The changes in vessel technology can be assessed in terms of performance and reliability. Suggestions of clay vessels producing purer salt than metal vessels can be tested. Additionally the role of items, such as the thumbed bars observed at Boathouse Clump (Lyne 1984), can be explored.

Beyond these immediately measurable objectives are the suggested post-production links between salt and SEDBB1 production. Definitive answers from this discussion may not be obtainable, particularly as the products of the salt industry are not observable in the archaeological record. Similarly the intended use for SEDBB1, without literary sources describing its use, is likely to remain unknowable. However, the additional data provided by this study is likely to be relevant to this discussion and therefore an attempt to address this point will be made in light of the results of each individual objective.

From the available literature it has been possible to identify five areas where there are significant gaps in the current knowledge of the landscape and industrial processes. Against each of these gaps a suitable research objective has been drawn. These objectives will permit the examination of organisation, scale and the relationships between differing crafts. On a broader spectrum it will be possible to assess the implications of spatial and temporal occurrences of the two main industries under investigation within this study. Experimental work will be able to address the technological changes observed in the archaeological record, whilst assessing the capabilities of the production techniques and the role of elements of briquetage that so remain unclear. Finally the results of these investigations can be drawn together into a wide ranging discussion with a view to answering the research question and furthering our understanding of a heavily industrialised landscape. To this end the following four chapters each detail the approach taken to achieve the individual objectives laid out above, given the variety of techniques that will be applied in their resolution. Finally a discussion chapter will draw together the separate elements of the research programme before a concluding chapter detail what has been learnt, what requires further testing and evaluating the relative success of this research project.

Chapter 3 - Fieldwork

As laid out in the previous chapter the first objective of this study is to attempt to expand the available knowledge on the most poorly understood sites identified within the site gazetteer (Appendix A). The sites having potential for additional study are reviewed, before being narrowed down to an appropriate shortlist. Visits carried out to the shortlisted sites are detailed herein, along with the rationale behind the final selection of not only site but appropriate technique to be employed. Finally the results of each element of the fieldwork are presented and their significance and impact upon the study discussed in brief. The results are then carried forward into Chapter 4, examining settlement distribution and landscape change, before being addressed in detail in the discussion chapter.

Site and Technique Selection

The literature review and site gazetteer have served to highlight where the available detail of the archaeology present ranges from high to low. In certain cases, such as Bestwall, the features were subject to near total excavation and therefore can be discounted immediately. In other cases modern development, scheduling, or rising sea levels, e.g. Brownsea Island, preclude the examination of such locations within the time and budget constraints of this study. However, there are a number of locations which are relatively easy to access and where the landowners are known and easily approachable. These then form the basis of the initial shortlist and are set out overleaf (Table 1), the reasons for and against each site are reviewed before selection of a few sites for field visits and assessment.

Geophysical Survey

As part of a broad suite of techniques available to archaeology for the assessment of archaeological deposits, geophysical survey is a non-intrusive form of survey that has met with much success (English Heritage 2008). The author has significant experience carrying out such surveys in the field. The equipment required for such a survey is readily available from the university stores and is therefore felt to be a suitable technique for application to the study area. The benefits of magnetic survey are in the identification of sub-soil features that have magnetically enhanced fills

(Clark 1996). The nature of the sites, due to the industrial activities carried out in antiquity, is such that ditches and other negative features are likely to be filled with the debris of such processes. This should result in strong signals against the relatively neutral background of the local geology, Poole Formation of sands gravels and clay (British Geological Survey 2018). Whilst it is not generally possible to assign dates to geological survey (EAC 2018), where previous excavation or field walking has been able to ascertain the likely dates of occupation it can serve to increase limited understand of the extent and nature of sites.

Site Name	Reasons For	Reasons Against
Boathouse Clump	- Keyhole watching brief only. - Property of Local Authority. - Public space: interest in archaeology.	
Arne (Shipstal Point)	- No formal excavation or survey. - Property of RSPB. - Public Space: Interest in archaeology.	- Site likely to be truncated by rising sea levels and coastal erosion.
Arne (Salterns Copse)	- Property of RSPB. - Public Space: Interest in archaeology.	- Previous work carried out here, though difficult to locate reports
Middlebere	- Field walking Survey Only - Property of National Trust	- Land controlled by tenant farmer
Point Ground	- High resolution Magnetometry survey - Property tenanted by family of project supervisor	- May not relate to time period under study.

Table 1: Potential sites for fieldwork

Of the five sites listed above two have been subject to geophysical survey. The results of Point Ground (see below) are available from recent work carried out by Bournemouth University (Dr D Pitman personal communication 2018). Though the Salterns Copse work is so far untraceable from available literature, it would seem unproductive to essentially repeat existing investigation. Of the remaining sites two are situated on publicly accessible land where the landowner is easily identifiable. Boathouse Clump is situated on the Upton Country Park Estate, maintained by the Borough of Poole as an outdoor space for public recreation. The Arne Peninsula is dominated by a nature reserve run by the RSPB and open to the public. The suspected site at Middlebere, however, is under the control of tenant farmers and access is likely to be restricted by such activities. Therefore it was decided to carry out site visits to Shipstal Point and Boathouse Clump to assess the potential for survey on the ground.

Excavation

Figure 10: Gradiometer survey of Point Ground and location of trial trench (Amended from Cheetham and Pitman Forthcoming)

As alluded to in the previous section the dating, phasing and function of archaeological deposits cannot normally be determined by geophysical survey alone. The most reliable way to ground truth survey results is through excavation of geophysical anomalies. Whilst time and resources are limited within the current study, there is some scope within the project for a limited programme of trial excavation to evaluate features recognised by survey. The high resolution survey carried out at Point Ground (fig 10), Wytch Farm, has highlighted the presence of highly magnetic features close to the harbours edge. This site seems ideally located for salt production, being close to salt marshes and shallow areas of the harbour. The immediate landscape is also rich with deposits of both white ball clay and ferruginous earthenware clay, both of which were exploited for the experimental parts of this study (Chapter 5). The field itself lies on a small headland between Middlebere and Fitzworth, two larger headlands where evidence for LIA and RB industry has been discovered (SY 9796 8571). Permission for the work has already been granted by the tenant farmer, Mr R Pitman, and the landowner due to existing relationships with Bournemouth University. Given these factors it was decided to excavate a trial trench over one of the features for the purposes of dating the survey and potentially identifying the function of the site. The results of this excavation are detailed later in this chapter.

Site Visits and walkovers

Two site visits were carried out on the 13th, to Shipstal Point, and 14th January 2018, to Boathouse Clump, the results of these visits are detailed below.

Shipstal Point, Arne

The site first noted by Smith (1933) at Arne is some 340m south of Shipstal Point itself. It is easily locatable to the practised eye, as the existing footpath runs through the site itself. Unfortunately this has meant that pedestrian traffic is slowly eroding through the archaeological deposits, as shards of pottery and possible briquetage were evident on the surface of the path (fig. 11). The immediate terrain is reasonably steep, rising to 15m OD within 100m of the shoreline. The ground is given over to heathland for the promotion of habitats suitable for wild birds. These conditions are not conducive to carrying out a survey as the gorse and other shrubs are above head height with only a few small clearings amongst them. Accessing the site with equipment would also be difficult as access is restricted to pedestrian only.

Due to these difficulties the site at Shipstal Point is discounted for the purposes of surveying within this project. However, there is some concern over the potential for damage to the site being caused by the path. In this respect contact was made with the RSPB and a meeting arranged on site to discuss the potential options for protecting the archaeology. The author met with the Senior Site Manager, Peter Robertson, on the 30th April 2018. After demonstrating the location of the site and the ceramic evidence showing on the surface, it was agreed that the RSPB will relay the path with a thicker bed of gravel. During the discussion it was advised that the RSPB would not be averse to clearing the ground, of gorse and other shrubs, in order to facilitate a survey as part of their heathland management. This would have to be carried out during the winter months, when the vegetation was not actively growing, and though not achievable within the current study there is scope for further work to be done here.

Figure 11: Erosion of archaeological deposits, Shipstal Point, Arne (Personal Collection 2018)

Boathouse Clump, Upton

This site, discovered during the laying of pipelines in 1984 (Jarvis), is located within the grounds of Upton Country Park. This estate comprises of approximately 140 acres of parkland and gardens, with the Grade II* listed Georgian Mansion House of Upton House at its centre (Upton Country Park 2018). The site itself is located approximately 400m SSW of Upton House, in a field previously used as farmland since converted to open green space for public recreation. The ground is given over to grass, split between pasture and a public area. No evidence for archaeological activity was immediately apparent during the site visit, however the presence of a Roman Road in the field is noted Ordnance Survey (2017).

From the field visit it was evident that the site of Boathouse Clump, sitting squarely within the middle of a large open field, is suitable for survey by magnetometry. Contact was made with Ed Cvijan, Visitor Services Officer at Upton House, and a meeting on site to discuss the potential survey was arranged for the 10th April 2018. After discussion on site with Mr Cvijan and the site manager Adam Butcher they were happy to proceed, having discussed the matter with David Watkins of Poole Museum. The only caveat was that a formal report was created and copies provided to Upton Country Park, Poole Museum and the Dorset Historical Environment Record. At the time of writing all of the parties concerned have been sent a copy of the report by email, with physical copies provided to Upton Country Park.

Geophysical Survey: Boathouse Clump

A formal report, describing the survey method, site background, geology and results is included as Appendix B and therefore only a brief overview is included here. The survey itself was carried out over five days between the 17th and 25th April 2018, with the assistance of a colleague and fellow student Mr H Dunn. The total area being surveyed amounting to approximately 158 ha.

Survey Results

The resulting data plot (fig. 12) from the survey has revealed a large variety of sub-soil anomalies focused in the northern half of the survey area, with the location of Jarvis' (1984) observations at is southernmost edge. The pipeline, laid in 1984, is clearly observable running across the survey area along with the modern gravel footpath constructed in 2013-14. These features are marked in red on the interpretation plot (fig. 13) with the intersection with the road and saltworking area clearly marked as observed by Jarvis (1984). In addition to these two subsoil features, the survey area is split roughly along the north-south axis by a wire fence that divides the pasture area from the public.

Figure 12: Gradiometer survey, Boathouse Clump, Upton
(Trim and Dunn 2018 – Appendix B)

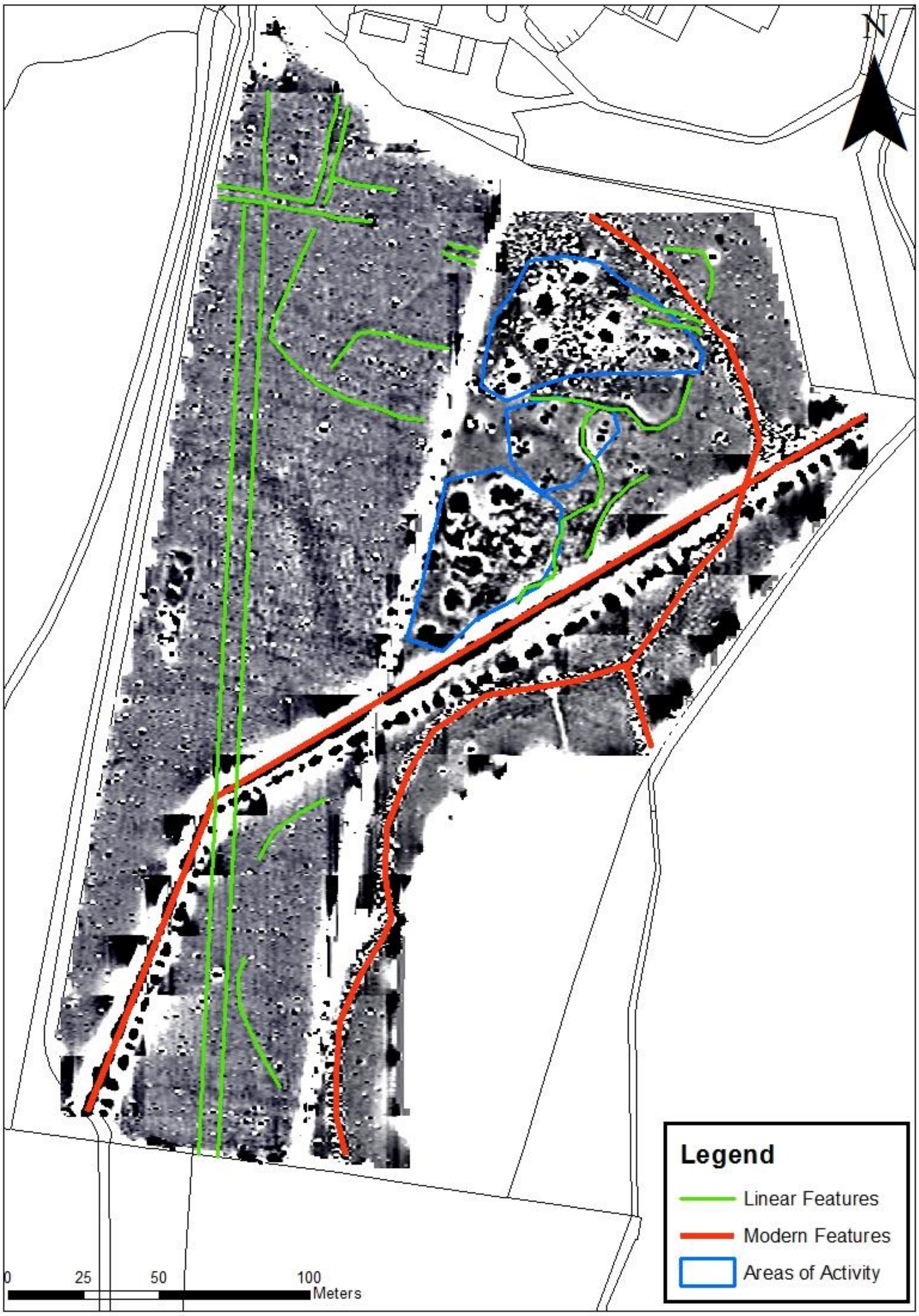

Figure 13: Interpretation of Boathouse Clump Survey (Trim and Dunn 2018)

In addition to the modern features noted above there is a large quantity of linear features, marked in green, and three distinct areas of possible industrial activity ringed in blue. Of the linear features perhaps the most easily distinguishable is that of the line of the Roman road, defined by two faint parallel linear features most likely to be roadside ditches. This anomaly conforms to the line of Roman road noted on Ordnance Survey maps (2017). This road is believed to have been constructed in the 1st century AD and runs from the fortress at Lake Farm to the end of the Hamworthy Peninsula (Field 1992), excavations in Hamworthy have confirmed the presence of a Roman road of similar construction (e.g. Jarvis 1983). The road, from the south, enters the survey area west of centre running straight before exiting in the northwest corner. The line of road continues through the car park past the features noted in 1995 (Anderson), before leaving the grounds in approximately the same position as the modern roadway. Intriguingly, where the road leaves the survey in the northwest corner, a series of very similar linear anomalies run perpendicular and parallel to the road for short sections. The significance of this will be addressed in the next section.

South of these linear features, tentatively interpreted as roadways or tracks, and east of the line Roman road, is what appears to be a sub-rectangular enclosure. The easternmost corner of which either respects or is respected by the line of the road. This feature continues up to the modern fence bisecting the survey area, but is difficult to trace into the eastern half of the survey area. This is due to a large amount of enhanced features, possibly associated with industrial activity. This may represent multiple phases of the site, with the enclosure being obscured by later activity. However, of the three areas highlighted in blue, the northernmost appears to be the result of modern disturbance and it is this which most obscures the possible continuation of the aforementioned enclosure. However, despite probable modern activity, it is possible to discern the continuation of a broadly west-east aligned roadway and other ditch like features. The southernmost area of activity correlates with the location of the features identified by Jarvis (1984) and appears to be enclosed by curvilinear ditches. Between the two areas is a third area which shows four distinct anomalies broadly similar in form to a percent symbol, with each appearing to be enclosed by ditches with high magnetic enhancement. This may be modern activity but the presence of ditches and proximity to other working areas suggest a similar age to the other features. In any case they do not appear to conform to either features ascribed to salt production, nor the updraft kilns in use by the 2nd century by the SEDBB1 industry. Assuming the antiquity of these features suggest a site with multiple industrial practices being carried out at this location.

Discussion of Survey Results

The intention of the survey is to expand the available knowledge of a poorly understood site by determining its extent and subsequent implications for scale of industry. Other production sites, such as Ower and Bestwall, are clearly delineated by rectangular enclosures, presumably demarking separate working areas (Woodward 1987; Ladle 2010). It therefore seemed reasonable to expect something similar of Boathouse Clump, a clearly defined site dedicated to the production of salt. Whilst the southernmost activity area appears to correspond with this manufacturing process, clear demarcation through ditches is not immediately apparent. Additionally there is the potential for other industrial practices being carried out immediately to the north. This in itself is not completely unusual, the Hamworthy and Corfe River Complexes exhibit evidence for multiple industries (Cox and Hearne 1991; Coles and Pine 2009) though this evidence is primarily LIA in date.

The arrangement of linear features in the north west corner of the survey area, morphologically identical to the known road and both respecting and intersecting with it, alludes to a far larger site than initially suspected. The presence of additional Roman features, less than 200m northwards along the line of the road, in the main car park suggests wider occupation of the area (Anderson 1995). A 3rd – 4th century coin hoard (Watkins 1986) discovered beyond the Upton Bypass (A35), a find type often deposited on the edge of settlements, further broadens the possible area of RB occupation. Therefore, rather than a discreet production site, the evidence from Boathouse Clump and this recent survey may highlight an industrial element of a larger settlement. Indeed comparison with examples such as the 3rd to 4th century RB settlement at Wellingham Farm, East Sussex, show striking similarities between the internal road layout and the collection of possible roadways in the northwest corner of the site. Furthermore, this tantalising suggestion of the edge of a settlement also bears close resemblance to a settlement much closer to Upton Country Park and directly connected by road. The site of Shapwick, Dorset, is located approximately 10km north west of Boathouse Clump and approximately 1.5km from the Badbury Rings Hillfort. Shapwick sits alongside a Roman road that leads to the fortress at Lake Farm, which in turn is connected to Hamworthy and Upton (Papworth 1997). The large scale survey (fig. 14) carried out there reveals yet more features that appear similar to those revealed by this survey, with intersecting linear features suggestive of a pattern of roads or track ways. The combination of this evidence certainly adds weight to the suggestion that the plateau, currently occupied by Upton House, is the site of a settlement, possibly dating from the 2nd to 4th centuries AD. This would mean that the site of Boathouse Clump is not a dedicated production site per se, but an industrial area of a small town or village.

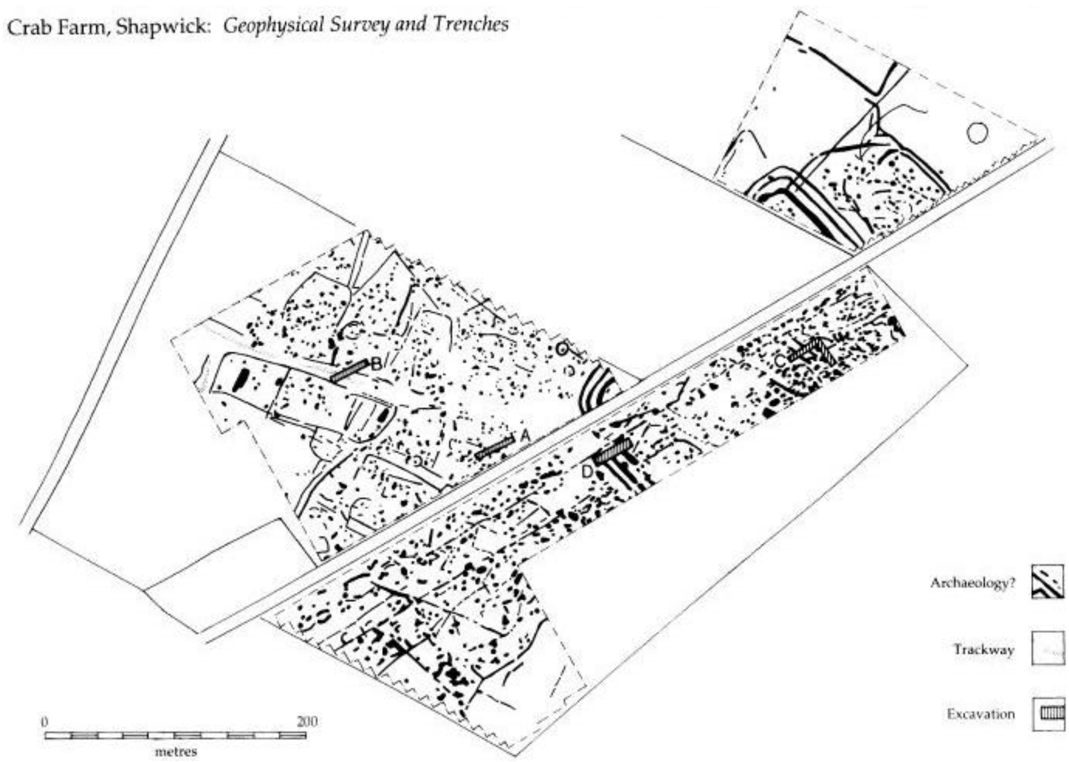

Figure 14: Shapwick Romano-British Settlement (Papworth 1997)

The location of such a settlement is perhaps unsurprising, given its proximity to transportation links and neighbouring industrial sites. Any goods produced here could easily be moved northwards by road to the Lake Farm Fortress, whilst it was in use for a few decades after the invasion, and then onwards towards Dorchester or Silchester. The potential of Hamworthy as a port facility would allow easy access for riverine and maritime transport. In turn allowing the distribution of goods back across the channel, upriver to Dorchester, or around the coasts of Britain perhaps in supplying the legions on the northern frontier at Hadrian's Wall. Conversely its position, in conjunction with the Hamworthy Peninsula, would allow the accumulation of products from the hinterland of Dorset down the rivers before redistribution further afield.

Such a role may mean that the production of salt at Boathouse Clump may not have been the focus of its economy, rather a subsidiary activity possibly for the supply of the settlement alone. Though given the large number of sites, as described in the Gazetteer (Appendix A), that are producing salt it is likely that it is just one element of a complex industrial economy. Should the suspected settlement provide evidence for large scale domestic occupation, then this may begin to fill in the gaps for where the industrial workers are living. Sites such as Bestwall, Hamworthy, Corfe River and Ower present little in the way of firmly domestic occupation for much of their use (Cox and Hearne 1991; Coles and Pine 2009; Ladle 2010).

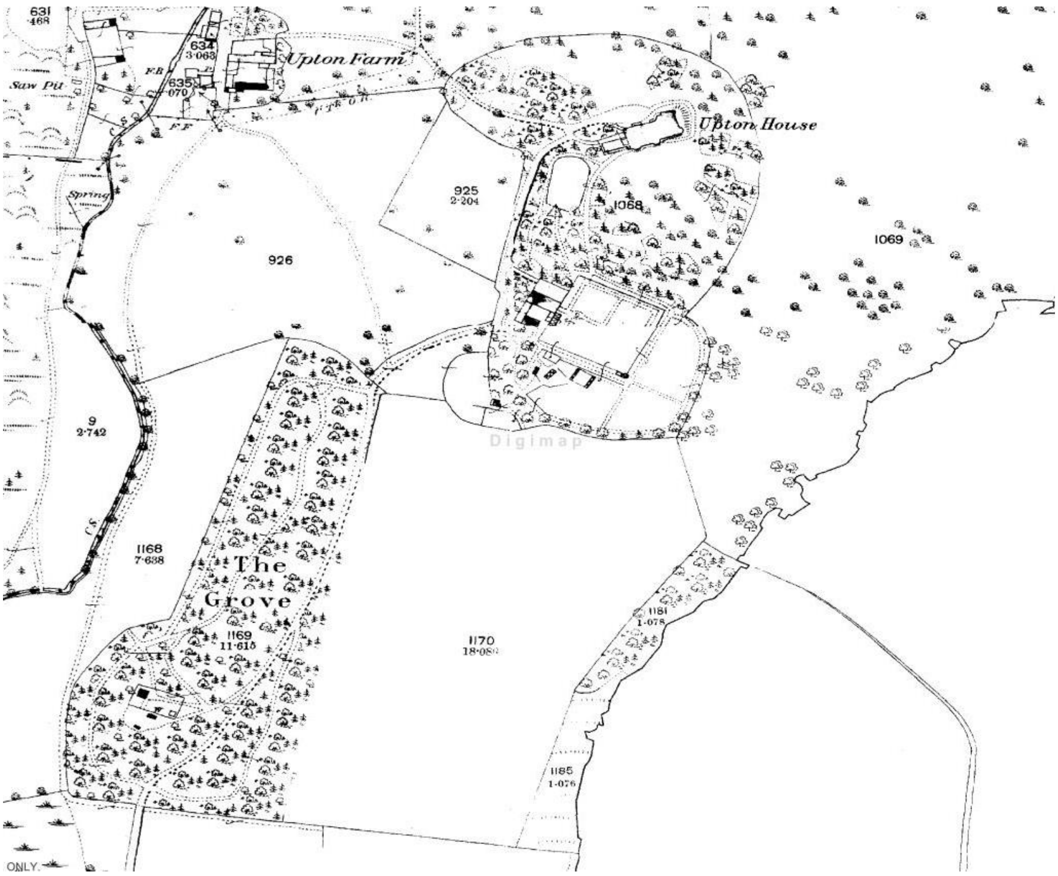

Figure 15: Upton Country Park c.1880
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Though the balance of evidence points towards the features noted by the survey being RB in date this interpretation should be approached with caution. It is worth restating that geophysical survey cannot date features by itself and therefore the features highlighted by the survey may not relate to the period under study. Their location within the grounds of, and so close to, the complex of buildings and formal gardens of Upton House give rise to the possibility of a post-medieval date. However, historic mapping (fig. 15), at least since the 1880's, does not indicate the presence of any activity that corresponds to the features. However, this does not rule out the potential for earlier activity, since returned to farmland. Certainly only further investigation, by means of excavation and broadening the survey area, would be able to confirm or deny the interpretation of the presence of a RB settlement.

Trial Excavation: Point Ground, Wytch Farm

As previously discussed within this chapter the results of a recent magnetometry survey at Wytch Farm have revealed large numbers of anomalies in a field known as Point Ground. These features have the potential to be part of the saltworking industry of Poole Harbour. Given the proximity of known LIA and RB period sites, such as Fitzworth (Calkin 1948b) and the Corfe River Complex (Cox and Hearne 1991), these features have the potential to be from the period under study. After discussion with Dr Pitman, thesis supervisor and resident of Wytch Farm, it was agreed to carry out a trial trenching exercise to evaluate the possible function and date of the anomalies. The work carried out forms part of not only this study but also the wider ranging Productive Landscapes and Creative Environments (PLACE) project being run by Dr Pitman and Bournemouth University. The work on this site continued beyond the trial trenching and was the location for Bournemouth University's Field School for archaeology students. Therefore the results presented here are only a summary of the findings, with fuller records contained within Appendix C.

Results

Excavation of a 7 x 2m trial trench revealed evidence for two linear features, perpendicular to the trench. These linear features appeared to contain demolition rubble, containing large quantities of vitrified material, ash and fired clay. As a result the anomaly under investigation was interpreted to be a structure, the life of which ended in a destruction event involving extremely high temperatures. The only datable material recovered was a fragment of medieval sandy ware (fig. 16), dating the features to around the 12th century AD. Though this feature was not of a date relevant to the period it still had the potential to be connected to the salt production industry.

Figure 16: Medieval Sandy Ware Shard from Point Ground (Personal Collection 2018)

Following the trial trenching the site was selected for the location of the summer field school for Bournemouth University's Archaeology, Anthropology and Forensic Science Department. Larger trenches were opened that confirmed that the linear features noted during excavation did not relate to one another. Instead they formed part of two separate features suspected to be salt boiling hearths. Additional ceramic dating evidence confirmed a medieval date for the activity. In addition to the open area excavation several satellite trenches were opened to target other areas of the field, including a possible enclosure ditch in the north east corner of the field. Here evidence for a kiln structure of RB date was discovered in the form of a pit with a fired clay lining (fig. 17). The fill of the pit contained oxidised shards of SEDBB1 and a rim shard of a large storage vessel suspected to have been incorporated as part of a flue (fig. 18).

Figure 17: Potential Romano-British Kiln, Point Ground (BUARC 2018)

Despite initial results not relating to the time period under study within this project subsequent work as revealed hints of RB production on the headland. Despite the evidence being minimal it does stand up against several other poorly understood or investigated sites, such as nearby Middlebere or Shipstal. Therefore the presence of production here during the study period in question is assumed and carried forward to the next chapter.

Figure 18: Fragment of storage jar incorporated into kiln structure, Point Ground (Bordona Foz 2018)

Chapter 4 – Spatial Changes over Time

The second objective of this study, detailed in Chapter 2, was to carry out an in depth review of the spatial and temporal relationships between sites and industries. As identified there is a significant level of detail available for the occurrence of varying industrial activities around LIA and RB Poole Harbour. Being able to plot the location and timeframe of particular production sites with a high level of confidence allows for the assessment of settlement patterns over time. Added data regarding such variables as the arrival of Roman authority, rising sea levels and the introduction of roads also increases the level of potential insight into the motivations for settlement patterns. Within this chapter GIS mapping is employed to illustrate snapshots in time within the Poole Harbour landscape. The implications of observable changes are discussed before proposing an overall pattern of movement over the 500 years under study.

Methods and Methodology

Whilst the exact nature of landscape changes over so long a period, so far into the past, is difficult to determine, there is some evidence to provide a general overview. Studies into sea level changes (e.g. Heyworth and Kidson 1982; Long *et al.* 1999; Edwards 2001; Johns *et al.* 2015) provide a starting point from which to address the nature of the harbour in antiquity. Evidence from excavation and artefact recovery, such as the submerged settlement on Brownsea Island (Jarvis 1993) or the Poole Log Boat (Peers 1965), can add localised detail to the overall picture.

The available literature concerning sea level change since the MIA is somewhat contradictory, ranging from 3.66m (Waddelove & Waddelove 1990) to 1.99m with a stable to falling sea level for the period under study (Long *et al.* 1999). It is clear that, though some investigation has been carried out, a complete picture of sea level within the harbour has yet to be defined. Additionally the shallow nature of the harbour precludes simple application of the reduced sea level to bathymetric data, at – 3.55m the harbour would almost completely dry out following two millennia of silting.

Despite these difficulties an attempt to recreate representations of the harbour area can still be attempted. Evidence from archaeological excavation, such as the submerged settlement off Brownsea Island (Jarvis 1993) and the Green Island

Causeway (Markey *et al.* 2002), all provide vital clues as to the likely sea level at various points in time. The presence of rivers and streams, combined with the author's local knowledge, also contribute to the estimation of past shorelines. It is on this basis that the maps contained within this chapter (figs. 25-8 & 30) were created in order to illustrate discussion of potential landscape changes. With archaeological evidence being the primary factor in determining possible shorelines, tempered by suggested sea level data. Bathymetric data is loosely consulted before estimated tidelines created based on the author's interpretation. The presented maps should therefore be seen only as estimated impressions of the harbour environment, and are in no way suggested to be accurate depictions of past shorelines.

The maps reflect the following points in time;

- Prior to the initial occupation of the landscape in the LIA.
- 1st century BC Iron Age occupation.
- The abandonment of sites suggested by a rise in sea level during the first half of the 1st century AD.
- The initial effect of the Roman invasion of AD43.
- The mid-late Roman resurgence of SEDBB1.

At each stage the causes, effects and implications of the observable changes will be discussed before being brought together at the end of the chapter to present an overall pattern of movement within the study area.

Poole Harbour: Current Landscape and Recent Changes

Modern day Poole Harbour is a large expanse of shallow open water interspersed with several small islands, bordered by creeks and small bays and fed by several rivers and streams (fig. 19). The northern edge of the harbour is dominated by the Borough of Poole, with dense urbanisation stretching from Sandbanks to Hamworthy. This town, now the centre of maritime industry within the harbour, began to develop sometime in the 12th or 13th centuries (Andrews 2010). To the west, at the confluence of the Rivers Piddle and Frome, lies the town of Wareham. The oldest part of the town is enclosed by banks and ditches of probable early medieval date, as Wareham was one of King Alfred's burhs (Buxton 2010). The southern edge of the harbour is rather more rural, consisting of heathland interspersed with farmland mostly used as pasture for cattle.

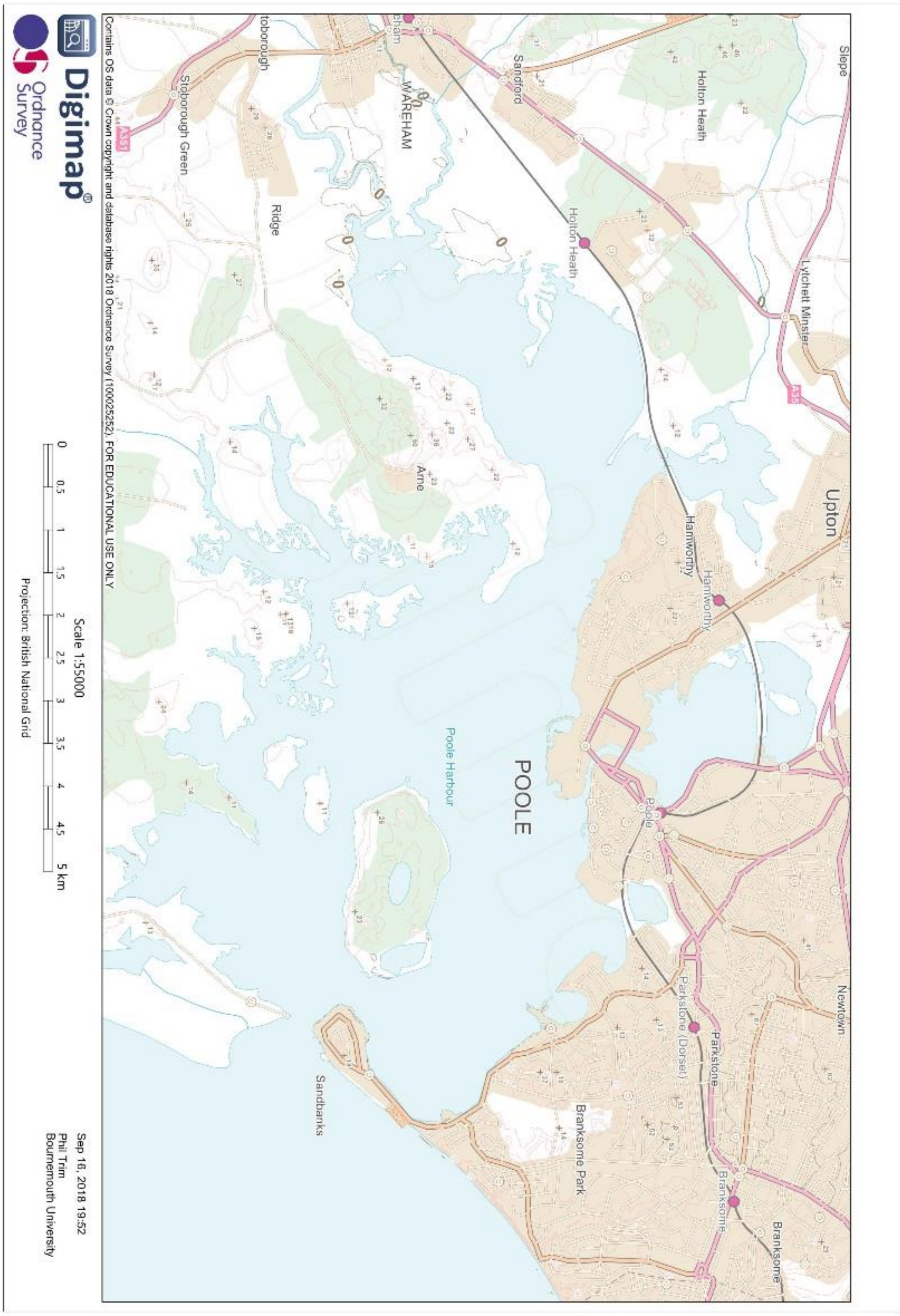

Figure 19: Poole Harbour 2018

Consultation of the chart of Poole Harbour highlights several areas where human action has altered the seabed. Immediately outside the harbour entrance the presence of the Training Bank can be observed (fig 20). This ridge of rock was constructed in 1860 in order to direct the flow of water from the harbour directly out into Poole Bay (SCOPAC 2018). Previously the sandbanks known as Hook Sands had presented a shipping hazard, causing the wreck of a 17th century Dutch vessel (Palma & Parham 2006) and created a meandering channel by which to access the harbour.

Inside the harbour the Middle Ship Channel (fig 21) is maintained by dredging to a depth of 7.5m to ensure larger shipping can reach the ferry terminal and quays at Hamworthy. These port facilities themselves are constructed on made up ground and comparison with a historic map from the 1920s (fig 22 & 23) highlights how much the peninsula has expanded in the last century. Other historic projects have at times reclaimed land around the harbour edges, such as St. Andrews Bay on Brownsea Island and Middlebere Lake (Le Pard 2010).

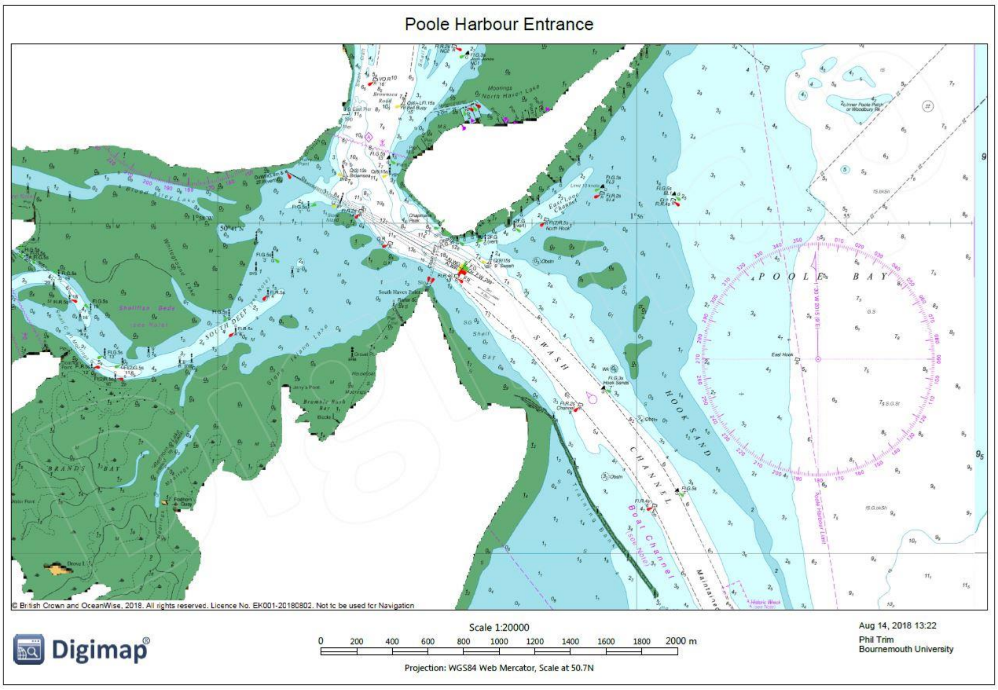

Figure 20: Poole Harbour Entrance

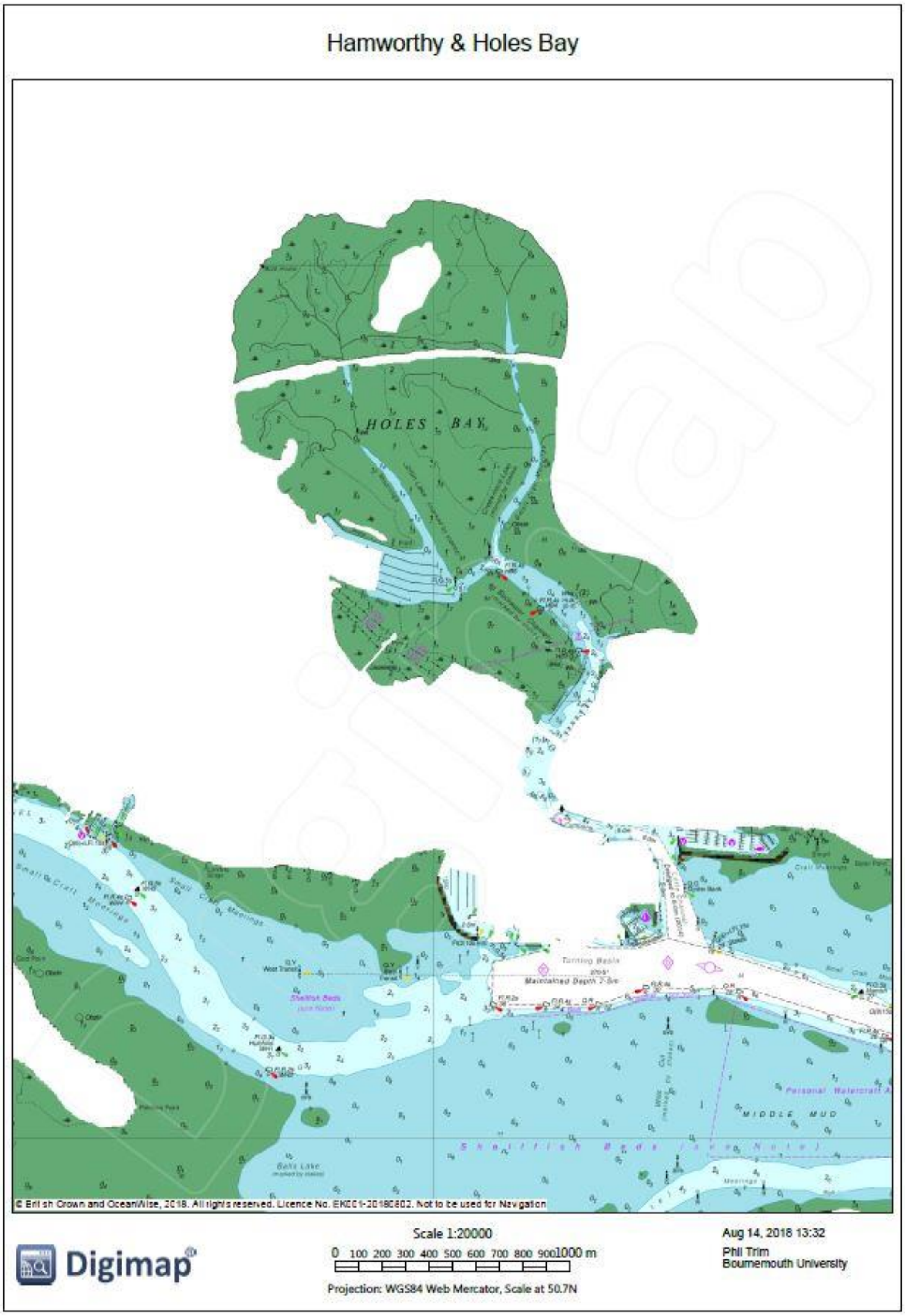

Figure 21: Hamworthy Peninsula and Holes Bay

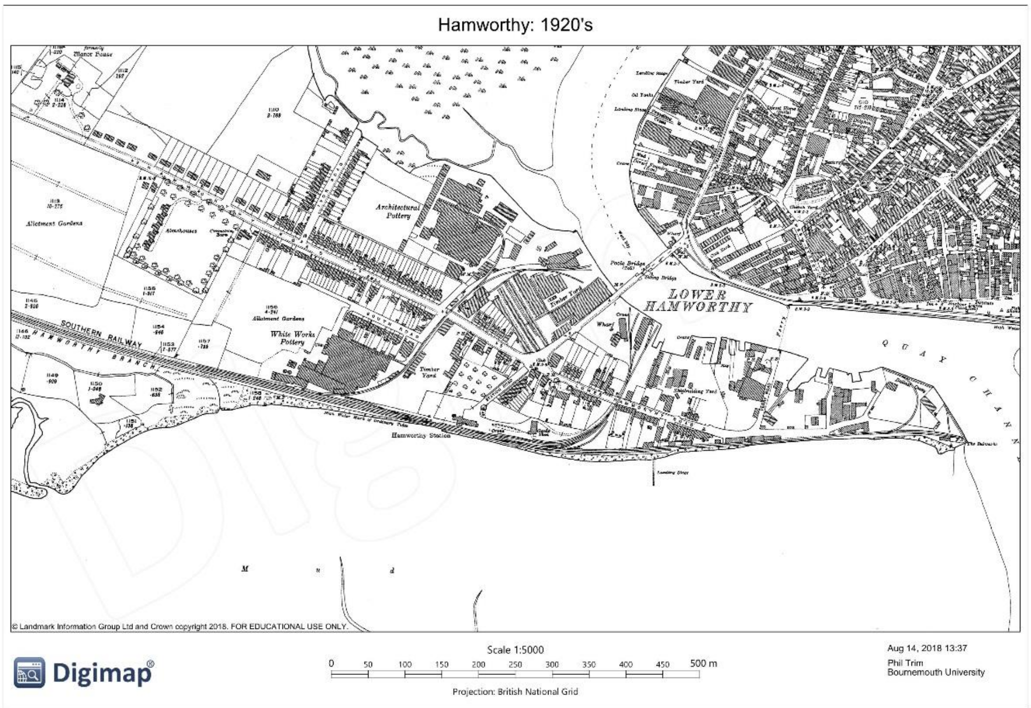

Figure 22: Hamworthy in the 1920s

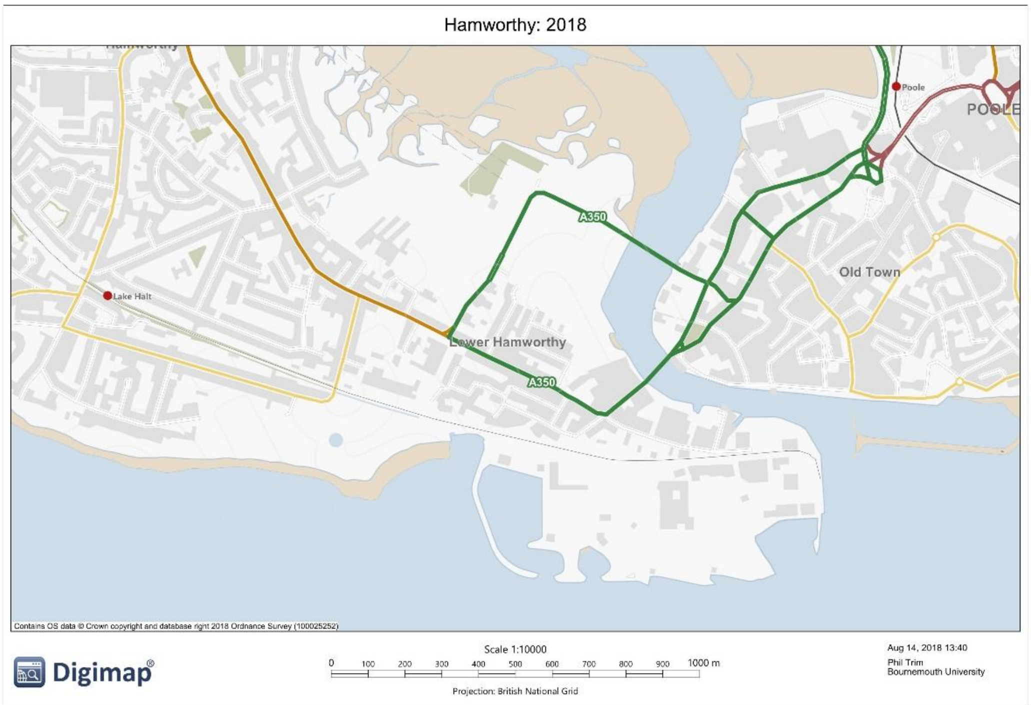

Figure 23: Hamworthy in 2018

Middle Iron Age – A Starting Point

Though this study focuses on LIA and RB activity, it is important to understand the earlier landscape. Prior to the study period, the densest occupation had been located on the Purbeck uplands, to the south of the study area and Purbeck Ridge. This is an area of good agricultural land with access to the English Channel in areas such as Kimmeridge Bay, where evidence for MIA salt working can be found (Farrar 1975). Conversely the land north of the ridge was, as it is for the most part today, a heathland environment unsuitable for large scale agriculture (Scaife 1991). It is into this environment that the occupiers of the Cleavel Point Complex moved in order to access resources for industry and construct the moles across the South Deep channel (fig 24). The first map interpretation has been created for the point prior to the wholesale occupation of the landscape.

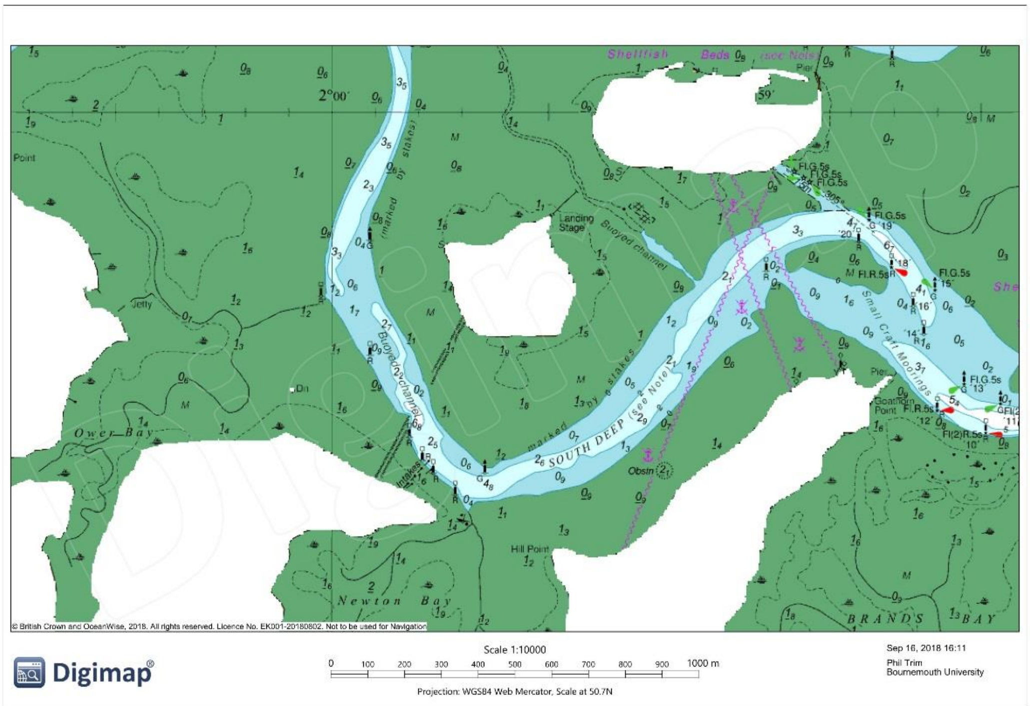

Figure 24: Cleavel Point Complex and South Deep, Poole Harbour

In terms of sea level, studies have suggested as much as 3.66m rise since the 1st century AD (Waddelove & Waddelove 1990). Such an interpretation is supported by the excavation of the quays of the Green Island Causeway (Markey *et al.* 2002). The tops of which are currently buried beneath silt and submerged to a depth of -0.89m Ordnance Datum (OD), in order to function with sufficient freeboard it is suggested that sea levels would need to be around 3.55m lower than today (Wilkes 2004).

Therefore, for the MIA shoreline an approximate figure of -3.5m is used to determine the sea level, at a date of c.300 BC which is suggested by C^{14} dating as the earliest possible date of construction for the moles (Markey *et al.* 2002). Additionally the presence of a log boat, also carbon dated to 300 BC, north of the harbour entrance suggests the likelihood of a river channel to the north of Brownsea Island.

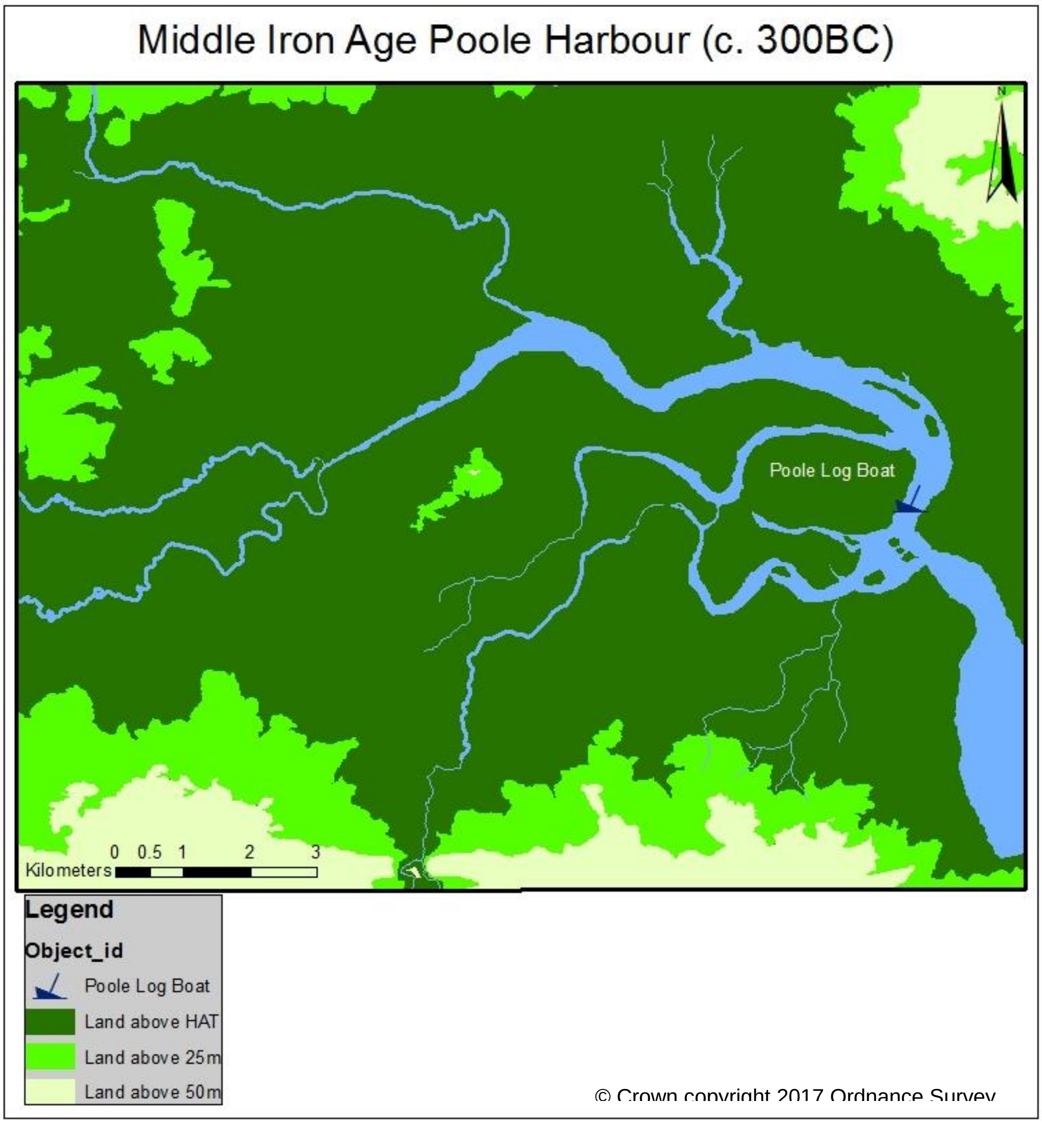

Figure 25: Impression of Poole Harbour *c.*300BC

The map (fig 25) is drawn based on loose interpretations of the possible course of rivers, with the line for highest astronomical tide (HAT) being extended outwards to incorporate salt marshes and the shallowest areas of the harbour. The result, as suspected by many authors (e.g. Jarvis 1993; Cox and Hearne 1991; Wilkes 2004), being that the harbour is in fact a series of shallow tidal creeks and estuaries. This allows for the creation of the South Island, whereby Green and Furzey Islands were one land mass (Cox 1989; Cox and Hearne 1991). This map appears to show a land link with Brownsea Island, though this is unintended as the land closest to (HAT) would presumably have been a wetland environment.

This suggested shoreline and marsh-like estuary environment is seemingly an unappealing one in which to live. Being backed by heathland, with poor soil quality, would create severe difficulties in subsistence farming alongside a wet environment in which to live. However the sheltered nature of the creeks and river channels would provide for a safe harbour. Given the development of Hengistbury Head as a port-of-trade during the same period (Cunliffe 1987), and the exposed nature of the coastline to the south of the Purbeck Ridge, a desire for a safe harbour for trade may have influenced the occupation of this area.

Late Iron Age – Occupation and Exploitation of Poole Harbour resources.

Excavation evidence points towards the firm establishment and functioning of Cleavel Point Complex during the first half of the 1st century BC (Woodward 1987; Cox 1989; Cox and Hearne 1991). The Corfe River Complex had also been established (Cox and Hearne 1991), with possible occupation on the Fitzworth Peninsula (Calkin 1949b). Sites around Wareham, such as Stoborough and Worgret, also exhibit evidence for domestic occupation at this time (Hearne and Smith 1991; Lyne 2002). This date, *c.*75 BC, has been selected as it represents a peak for the use of Cleavel Point Complex as a harbour, prior to inundation by rising sea levels.

The shoreline has been brought forward from the MIA interpretation as the location of sites at this time and their long term occupation implies relatively stable conditions. Otherwise the sites known to have existed at this date have been plotted, along with the location of the Green Island Causeway (fig. 26).

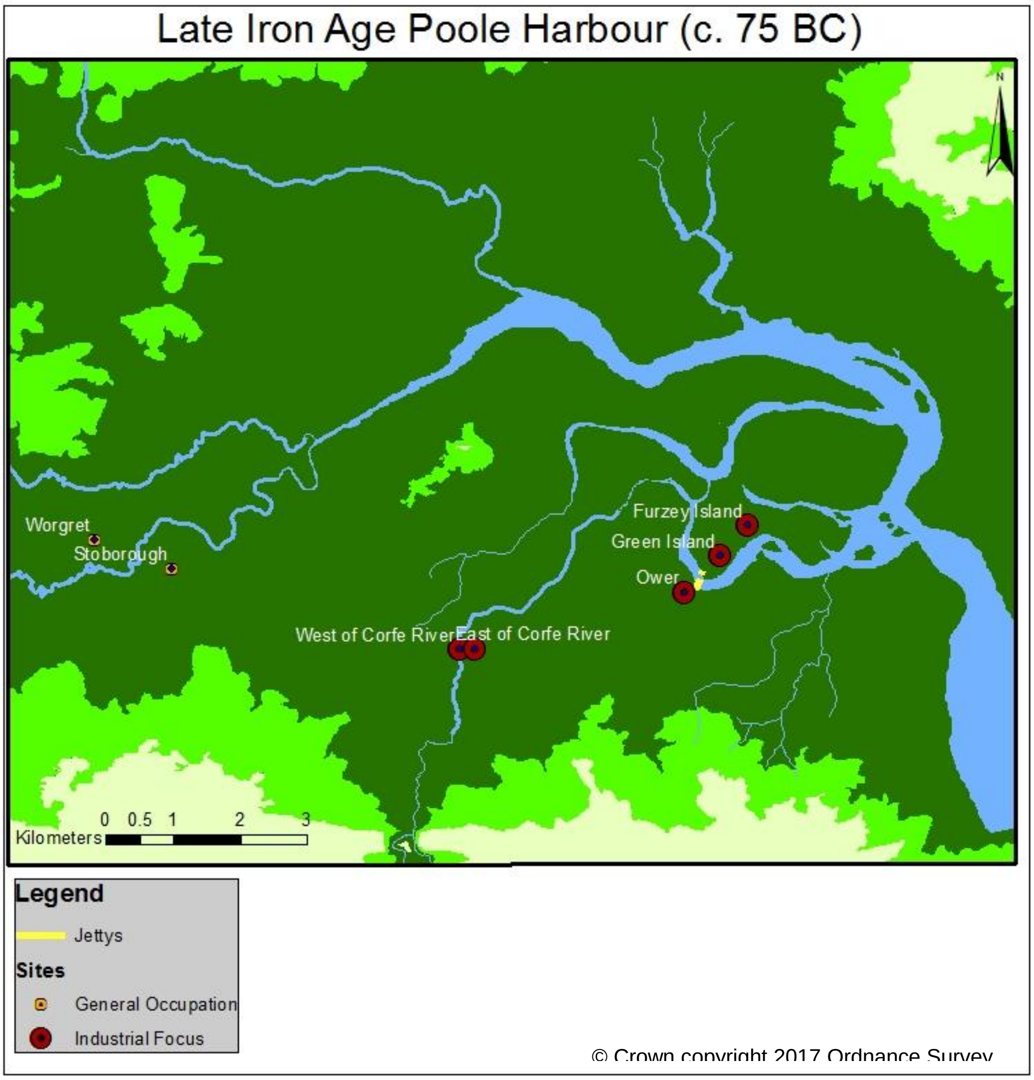

Figure 26: Impression of Poole Harbour and Site Locations *c.*75BC

The distribution of sites highlights the focus around the main river channels, presumably for the purpose of not only a safe harbour but the movement of goods and produce by riverine routes. The Corfe River may have provided access as far as the Purbeck Ridge and the Rivers Frome and Piddle would allow travel into the Dorset hinterland, where occupation of the fertile chalk uplands is widely known (e.g. Russell *et al.* 2016). In particular it is likely to have been possible to have transported goods up the Frome as far as Maiden Castle, Dorchester. Indeed the presence of imported and Poole Harbour manufactured goods (Sharples 1991) can be seen to support this suggestion. Though transport by coastal routes to Weymouth and then overland to Maiden Castle are also possible.

Early 1st Century AD – Rising Sea Levels

Several pieces of evidence point towards a significant increase in sea level around the second quarter of the 1st century AD. Most significant is the cessation of activity on Furzey Island, *c.*AD 20 (Cox 1989; Cox and Hearne 1991). This points towards the separation of Green and Furzey Islands around this time, reinforced by the decline in activity on the Ower Peninsula. Similarly, evidence for occupation and activity at the Corfe Rover sites seems to be declining before complete abandonment during this time (Cox and Hearne 1991). This is the last period of great change within the landscape prior to the Roman invasion and a date of *c.*AD 25 has been chosen to explore those changes.

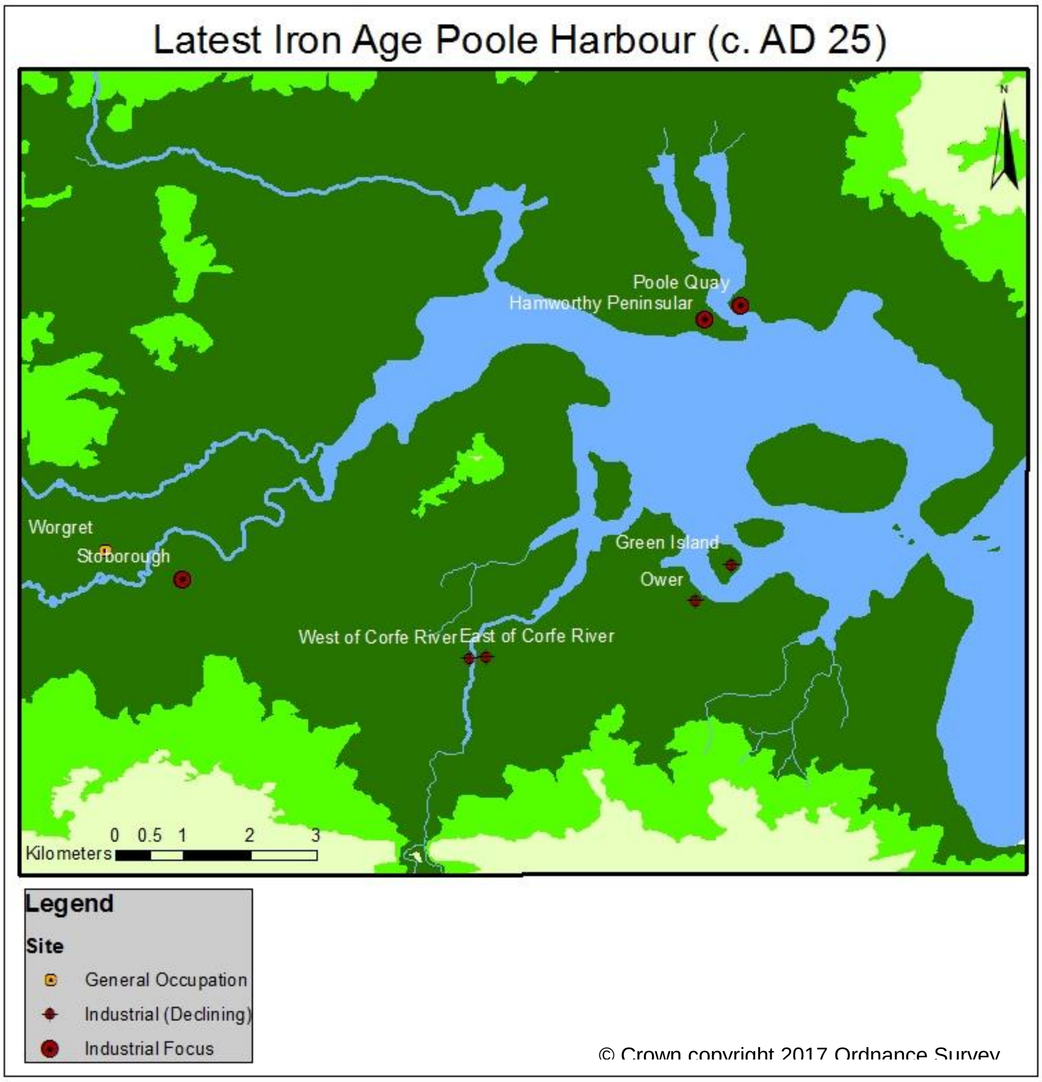

Figure 27: Impression of Poole Harbour and Site Locations c.AD 25

The inundation of the low lying central part of the suggested South Island (See previous section) certainly implies an overall rise in HAT. Unfortunately the evidence for sea-level changes pertaining to Poole Harbour does not currently have the required resolution for exact suggestions of a possible shoreline at this time. However Green and Furzey Islands are very low lying, and the open water of Ramshorn and Balls Lakes to the west of these islands is still very shallow today. Assuming that much of this area was given over to salt marsh it is likely that the same inundation would have turned these areas into open water. The Latest Iron Age (LLIA) shoreline (fig 27) then is based solely on these factors, assuming a rise in HAT of around 1m. This allows for the split in South Island and opens up the harbour area towards what we see today. Long and Round Island, immediately east of the Arne Peninsula, are practically one island today at low tide and so remain so for the purposes of this map.

Other than the obvious impact on the complexes at Cleavel Point and Corfe River evidence suggests the commencement of industrial activity elsewhere in the harbour at sites either new or previously domestic in nature. Stoborough shows evidence for a shift in settlement focus towards the production of Durotrigian BBW, along with an intensification of occupation (Lyne 2002). The Hamworthy Complex also shows evidence for large scale salt production from this point in time, with evidence for possible pottery manufacture. It has been suggested that the peninsula was a replacement for the harbour at Cleavel Point, now under threat due to rising sea levels (Bellamy and Pearce 2001; Coles and Pine 2009). Though this function is debatable, as only a small amount of imported wares are present, its development as a port may coincide with a loss of cross-channel trade following Caesar's subjugation of Armorica (Cunliffe 1982). Should this be the case the focus on domestic pottery may instead be representative of domestic trade, where imports may not have focused on minerals such as tin and copper ores. Such resources are likely to have been processed and traded out of the settlement and thus be unobservable in the archaeological record.

Late 1st Century AD to 2nd Century AD – Roman Occupation

The most significant event for the British Isles in the 1st century AD is the Claudian invasion of AD 43, subjecting the inhabitants of Britain to Roman rule for the following centuries (Russell and Laycock 2010). In respect of the study area it is apparent that legionary forces moved into Dorset soon after the capture of

Camulodunum of AD 43. A legionary fortress was constructed at Lake Farm, Wimborne, by *Legio II Augusta* along with roads before being abandoned a decade or so later. Tacitus refers to Vespasian as the *Legate* commanding the legion and Suetonius recorded the area of operations, conquering the Isle of Wight and south west of England (Manning 2002). This period of change appears to have had a significant effect on the study area and so the next map reflects these changes at a point shortly after *Legio II* moved west towards Exeter, *c.*AD 90.

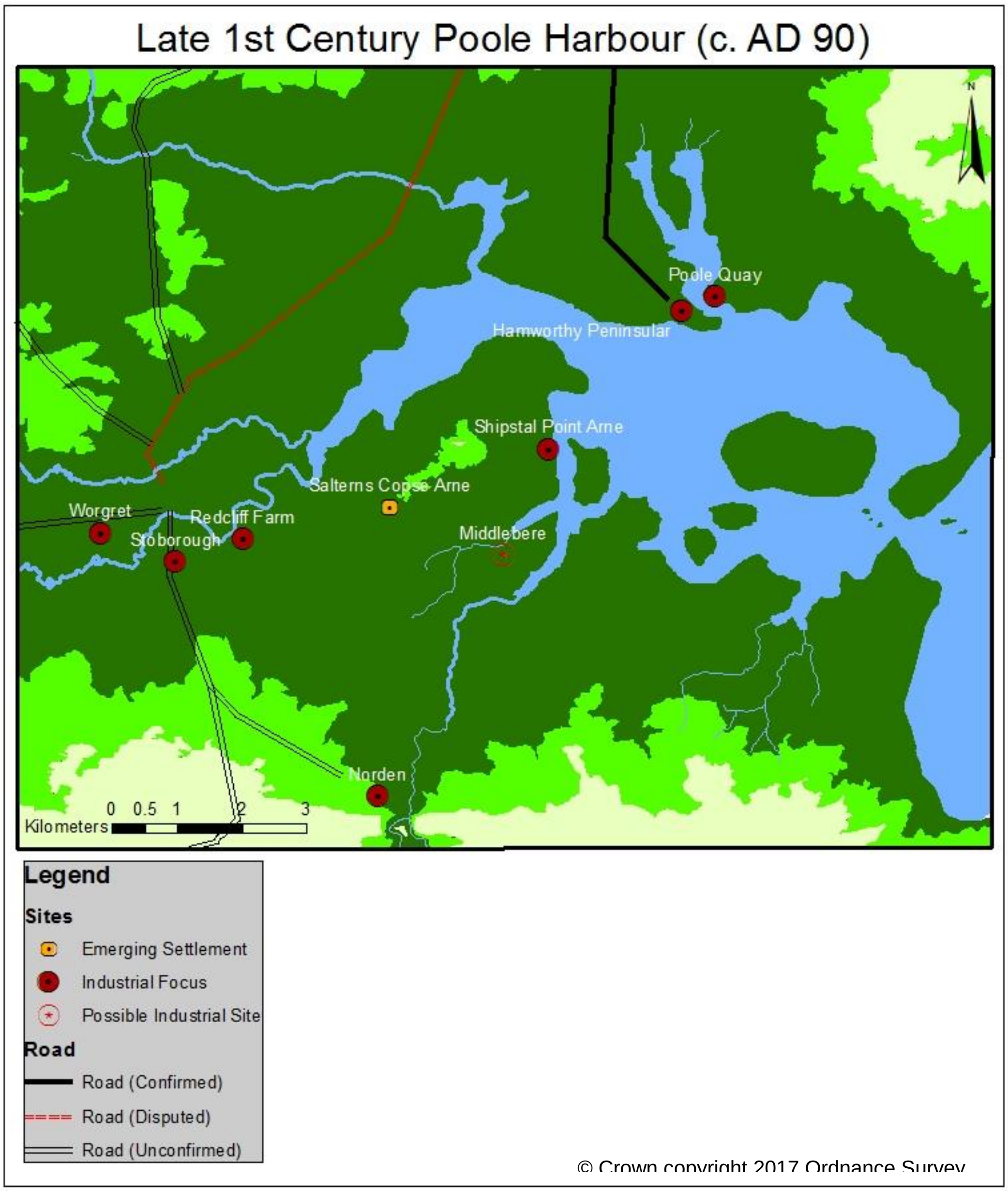

Figure 28: Impression of Poole Harbour and Site Location c.AD 90

Evidence remains limited for this time in respect of sea level changes, though Edwards (2001) points towards a period of stability. Therefore the shoreline estimated for the LLIA is carried forward, with emerging and declining sites dating to this time plotted against it (Fig 28).

There is little evidence for early Roman occupation at either of the Cleavel Point or Corfe River Complexes, both sites exhibiting evidence for abandonment and are therefore removed from the map. The intensification of SEDBB1 production around Wareham continues with evidence of production at Worgret, Redcliff and continuity at Stoborough. Evidence for salt working at this time continues at the Hamworthy Complex, possibly alongside SEDBB1 production. Significantly the construction of a double ditched enclosure, of which two sides have been located, suggests the presence of a Roman military supply base (Bellamy 2001). This interpretation is reinforced by the construction of an early Roman road linking Lake Farm and Hamworthy (Field 1992), confirmed by excavation (Keen 1980; Jarvis 1983; 1986a). Further evidence includes the recovery, by fishermen, of several complete SEDBB1 vessels from the waters at the eastern tip of the peninsula (Smith 1943). Possibly indicating the presence of a shipwreck or goods lost during loading. Also the discovery of a substantial Roman donkey mill, the largest of its kind discovered in Britain at 0.61m in diameter and weighing 150kg (fig 29) (Smith 1930; British Museum 1951), implies use of the peninsula as a port or supply base. Such an object would correspond to the processing of large amounts of grain, as might be expected if the site were collecting grain for redistribution or supply to the army. Interestingly the stone from which the mill is manufactured originates from Niedermendig (British Museum 1951), 100km down the River Rhine from Mainz & Strasbourg where *Legio II* had been stationed prior to the conquest of Britain (Keppie 2002).

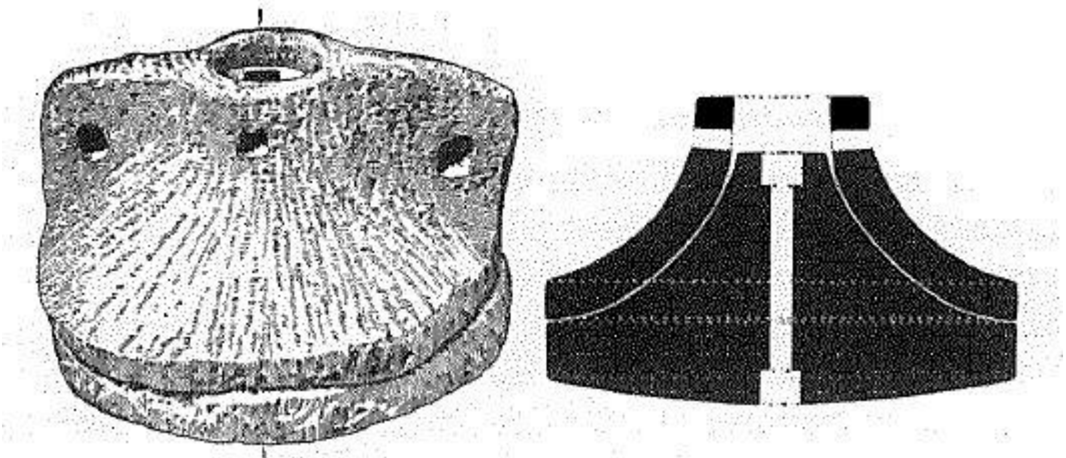

Figure 29: Roman Mill Stone from Hamworthy (British Museum 1951)

Further roads have been suggested by Field (1992) to radiate from modern day Wareham. However, recent investigation (Ladle 2012; Buxton 2013) has cast doubt on the suggested road from Lake Farm to Wareham. The purported road from Wareham southward to Norden (Field 1992), running through the site of Stoborough, has also been investigated and appears genuine (Hearne and Smith 1991). The three other roads shown on the map, leading west to Dorchester, northwest to Woodbury and north to Bulbury Camp, are yet to be confirmed. Quite why a road would be needed for the latter is unclear, as occupation of the enclosed area appears to be sparse (Stewart and Russell 2017) and there is little to suggest a significant role in the trade network or industry elsewhere in the study area. Though Cunliffe (1972), reviewing artefacts recovered from Bulbury, suggested that the ferrous objects represented an ironsmith's tools and stock in trade.

Mid to Late Roman Occupation – Regaining market control

Having lost dominance of the northern markets, to imitation wares (e.g. BB2), SEDBB1 regains control, *c.*AD 250, reasserting its dominance over imitation wares (Williams 1977). Within the study area a surge in new productions sites can be observed from the late 2nd century onwards, peaking around the mid-3rd century. The final map (fig. 30) therefore reflects this point in time, highlighting the probable peak of Romano-British production around Poole Harbour. The LLIA shoreline is carried through for the reasons discussed in the previous section.

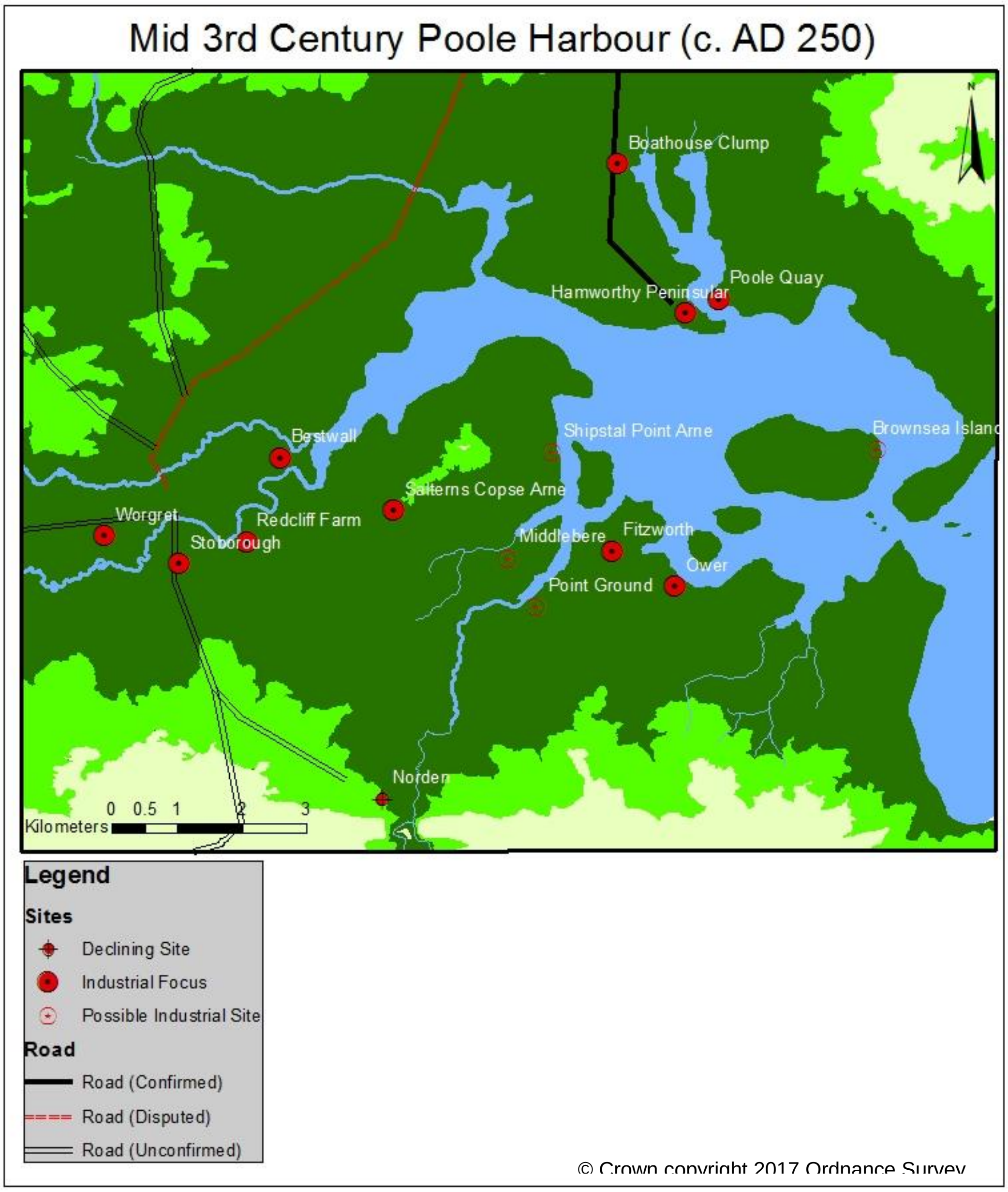

Figure 30: Impression of Poole Harbour and Site Location c.AD 250

Commencement of occupation at Bestwall continues the intensification of SEDBB1 production around Wareham. Salt working is evident at Boathouse Clump, alongside a resurgence of the industry at Hamworthy. The possible settlement at Boathouse Clump, see Chapter 3, may play a significant role in the accumulation and distribution of products from Poole Harbour.

Reoccupation of the southern fringes of the harbour is also evident from Arne Heath, Shipstal Point, Middlebere, Point Ground, Fitzworth, Ower and Brownsea Island. Not all of these sites are firmly dated nor their exact role in the production of goods confirmed. Brownsea Island will likely forever remain a mystery, due to being below current sea-level. However, it is important in highlighting the potential for further settlements lost to rising sea levels. Indeed the increasing number of locations, where evidence for Romano British industry is noted, suggests a densely populated landscape. Attempts at quantification of SEDBB1 output (Allen and Fulford 1996) certainly suggest the presence of large numbers of potters. This density of exploitation of the resources within the study area is arguably not seen again until the medieval period, with monastic controlled salt production (Barker 2006).

Summary

Late Iron Age Poole Harbour

The MIA the landscape around Poole Harbour was a sparsely occupied heathland as far as available evidence suggests. Into this environment communities, previously utilising the Purbeck uplands for self-subsistence, migrated and set up a formal port facility at the Cleavel Point Complex. Subsequent expansion sees the creation of the Corfe River Complex and probable occupation on the Fitzworth Peninsula. Evidence suggests the economy no longer focused on subsistence farming, rather on the production and trade of goods such as ceramics, salt and shale goods. Faunal evidence has suggested the salting, and therefore presumably trade of, meat products, in turn implying trade in other agricultural products. The settlements themselves show a degree of preplanning, being delineated into small enclosures with interconnecting tracks and paths. The effort required to create the Green Island Causeway and presence of imported wares is indicative of the importance of trade routes at this time. This reflects broader trends along the south coast of England (Cunliffe1978; Wilkes 2004), and locally when compared to the rise and fall of trade of Hengistbury Head (Cunliffe 1987).

Rising sea levels appear to have prompted significant change in spatial organisation, if not the economic focus of the area. It may never be possible to ascertain whether the separation of Furzey and Green Island was a sudden event, possibly due to storm surge from the rivers, or a more gradual process over a decade or so. Either way it would certainly have been a significant event in the lives of the inhabitants. On a more practical level it would have resulted in the Green Island Causeway not only becoming unusable, but also a serious hazard to navigation. To simply build new quays further up the South Deep channel, at

Fitzworth for example, would therefore be impractical. This may have formed part of the reasoning behind the apparent relocation to Hamworthy, though loss of trade with Gaul will have limited subsequent development there. In any case, on the eve of the Roman invasion, Poole Harbour represented probably the most significant port for the tribe or confederation known as the Durotriges. Trade at this time is likely to have had a primarily domestic focus, though limited quantities of imported goods may have filtered westward from South East England (Cunliffe 2008).

Romano-British Poole Harbour

Whilst the exact date of the arrival of legionary forces in Dorset is unclear the evidence points towards the presence of *Legio II* within a few years of the initial conquest, before relocating to Exeter by AD 60. The most immediate impact on the landscape appears to be the construction of at least one road linking Lake Farm Fortress with a probable supply base at Hamworthy (fig. 31). Coles and Pine (2009) questioned the possibility of a supply base, citing the lack of legionary artefacts as pointing towards a non-military function. This may be the case but consideration of several other factors is required in this instance. Firstly there is an assumption that only legionaries were present and would carry out the construction, maintenance and operation of such a supply base. This omits the possibility of auxiliary forces or Roman naval forces, such as the poorly understood *Classis Britannica*, being involved in the landing and transportation of goods. Were the supply base garrisoned by such troops it would likely leave a different imprint on the archaeological record to those of the Legions. Furthermore, the briefness of such a base's use, coupled with the subsequent slighting and industrial reoccupation of the site, may have occluded definitive evidence of military occupation. For these reasons, along with the definite military style road to Lake Farm, it is assumed within this study that a supply base was present at Hamworthy.

Other roads were probably constructed at this time, linking Wareham, Norden, Flowers Barrow and Bulbury Camp to the road network. Construction of roads, alongside military installations, is a common occurrence during campaigns to subjugate regions. Placement of forts at crossing points in the landscape, such as rivers, allowed control of movement. Interestingly, for the study area, there is little evidence of such control being imposed despite such activity elsewhere in Dorset (e.g. Hod Hill, Lake Farm).

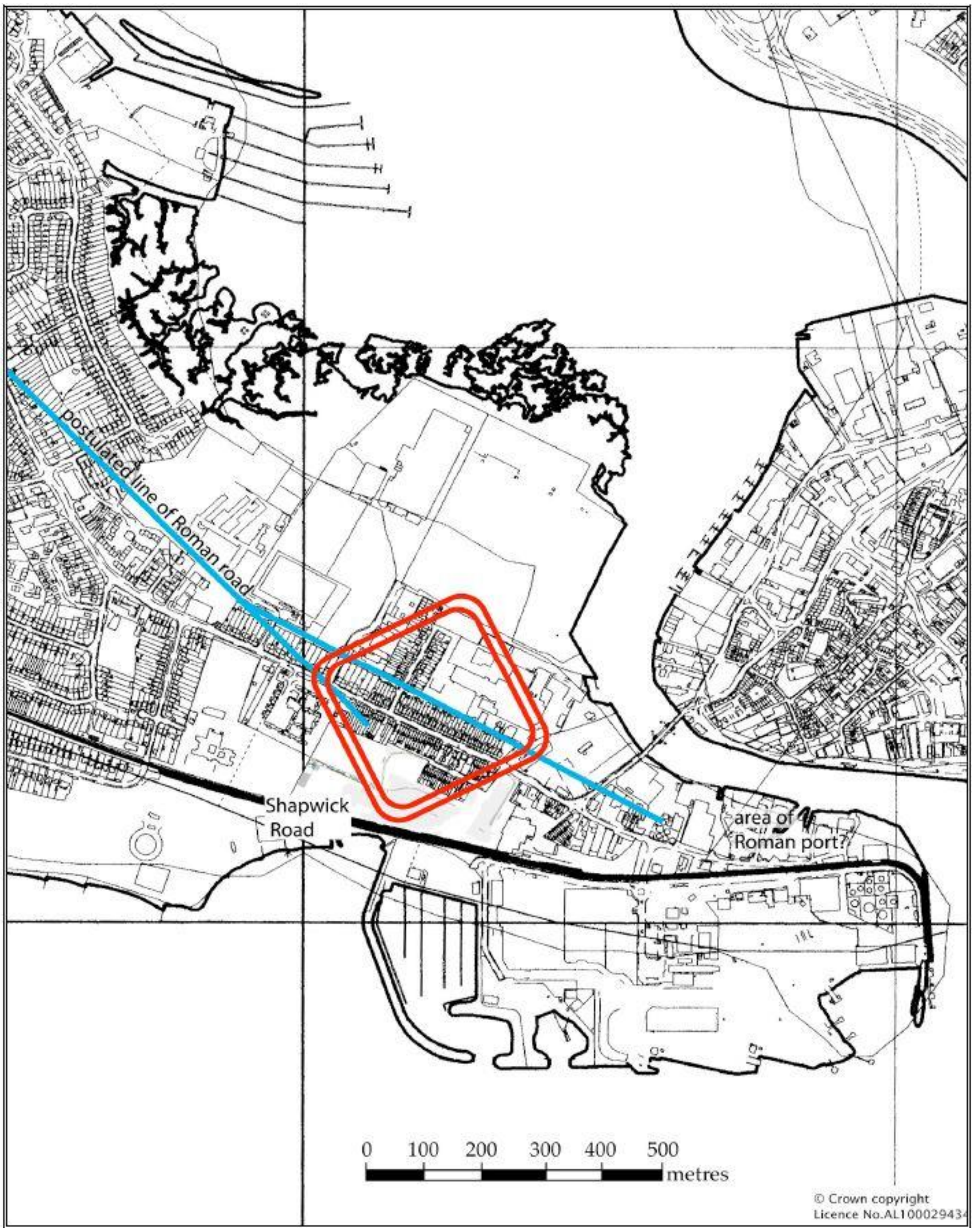

Figure 31: Interpreted line of possible Legionary Supply Depot, Hamworthy (Bellamy 2001)

Beyond physical changes to the landscape the arrival of the 2nd Legion seems to have had a dramatic and almost instant impact on the local economy. Evidence from early Roman contexts at Lake Farm, Waddon and Hod Hill shows a very early adoption of Durotrigian BBW (Papworth 2011). Presence of the same wares in early military contexts at Exeter and Carleon (Williams 1977), established by the 2nd Legion after the abandonment of Lake Farm (Manning 2002), is indicative of direct supply to the legion outside of Durotrigian territory.

Following the LLIA/Early Roman focus of settlement at Hamworthy and Wareham, as production increases, occupation of the landscape intensifies. By the mid-Roman period (fig. 29) nearly every peninsula in the south of the harbour is occupied, seemingly for the production of salt and possibly SEDBB1. Unlike the LIA production centres, these industries appear to undergo a degree of separation in their spatial distribution. SEDBB1 production is focused around Wareham and the River Frome where, whilst still within tidal waters, the concentration of salt is likely to be low. Salt production is spread throughout the shallowest areas of the harbour, where salt marsh and slow moving water are likely to have a higher salt content. The Hamworthy Complex continues to be involved in production and may still have served as a port, potentially having a significant role in the redistribution of SEDBB1, Salt and other Poole Harbour products. Wareham, with its potential road links, may have been important in terrestrial distribution. Alternatively the possible settlement at Upton, see Chapter 3, may have fulfilled this purpose.

Conclusion

Attempting to recreate the possible landscape of the study area at times of significant change has permitted identification of a broad pattern of settlement distribution. Firstly an initial occupation of an almost empty landscape, followed by a relocation to the north of the harbour amid increasing sea levels. A third stage, following the Roman invasion, opens up the landscape with the construction of roads alongside the focusing of SEDBB1 production around Wareham. The final stage, seeing an increase in the density of occupation coupled with an evident surge in production capacity, during the reoccupation of abandoned sites and occupation of virgin sites. Against this pattern it is possible to observe a post AD 43 separation in space of the two main industries under study herein. The distribution of sites has allowed insight into the location of theoretically significant sites at Wareham and Upton, which so far have not been thoroughly investigated. The spatial location of sites also allows an initial insight into how dissemination of Poole Harbour goods may have been organised. These details allow an approach towards the overarching research question being addressed by this study (p. 26) and will be explored in depth in Chapter 7.

Chapter 5 – Briquetage Production

The third objective of this study, see Chapter 2, was to engage directly with the production of briquetage evident within the study area. Whilst there is an understanding of the form and construction of evaporation vessels, this major element of salt production has only been explored theoretically. Therefore within this chapter an experimental approach is taken towards the investigation of the briquetage components employed by Poole Harbour salt working. A re-examination of the evidence is undertaken, before a method of construction is devised and the eventual vessels constructed. These vessels can then be taken forward into the next chapter to address the actual process of salt production.

Experimental Archaeology – a valid approach?

By definition, the nature of experimental archaeology should be of a purely scientific method, involving the determining of a hypothesis regarding a physical process from the past and testing of such a hypothesis (Hansen 2014). The reality, however, is often far from purely scientific investigation. Intangible variables, such as ritualistic behaviour, are extremely difficult to account for. Other factors can also dominate and manipulate results, such as a lack of data from the archaeological record, or perhaps more significantly the researcher carrying out such experiments (Hansen 2014). Such critique of the process, of experimental archaeology, has led to significant debate over its validity as a tool for examining the past.

Archaeology seeks to study a variety of past human activity and therefore relies on plethora of techniques. Such techniques can be seen to be scientific or humanistic in their approach (Coles 1979). In this instance scientific refers not to the tools and equipment employed in the field, rather the precision of quantification and the statistical interrogation of data. Humanistic is concerned with a qualitative evaluation of human actions and events (Wiley 1985). Experimental archaeology can be perceived to be either scientific, humanistic or both (Doonan and Dungworth 2013), the value of either aspect often determined by the researcher themselves. In trying to clarify this disparity, in the appreciated value of experimental work, two key terms have been defined; experimental and experiential. The former refers to adherence to the scientific process and the interrogation of empirical and measurable data. Experiential results, however, are concerned with the experience of past processes and the human element of production choices (Doonan and Dungworth 2013). Proponents of the experimental side of the process argue that there is little value in addressing the humanistic and experiential concerns of a process (Reynolds 1999).

Clearly a precise and rigorous approach to any form of experimental work is essential to producing meaningful results. However, to concentrate on pure data alone, omits the inherent variability of human behaviour, the very matter which archaeology attempts to study. The firing of ceramic vessels, for example, though a physical and chemical process, does not happen without human action. To isolate scientific data from accompanying anthropogenic behaviour cannot be true reproduction of a past process, instead creating a new scientifically controlled lab-based process that may bear no resemblance to the archaeological evidence which the experiment is attempting to create. Similarly experiential data in isolation, directed by modern conceptions and the understandings of material science, is unlikely to reflect the true experience of an ancient potter. Historical re-enactment for example, an area where the author has some experience, is on the surface a potentially valuable experiential process in the investigation of life during specific periods of history. However it has many limitations that would not have been considerations in the past, which necessarily skew interpretation. Recreation of combat, is a case in point, is governed by considerations of health and safety, and cannot be considered an entirely reliable experience of the conditions in which weapons were used. Conversely edge wear analysis and recreation, carried out in a lab, is unlikely to give any sense of the environment in which such wear is derived. However, a combined approach may present a fuller picture of how blades are used in such circumstances. This would allow application of rigorous scientific method alongside insights gained from experiential data. Such insight, generally derived outside of a rigorous application of the scientific method can prove valuable in forming hypotheses for future work, with the results being tempered by acknowledgement of the limitations of both processes. It is from this standpoint that this study approaches the techniques of briquetage and subsequent salt production methods.

Clay Preparation

Review of the literature has identified two differing forms of evaporation vessel, Hobarrow Pans and Fitzworth Troughs, constructed using different methods and clay fabrics. The Hobarrow Pans are made in an extremely coarse fabric, containing high levels of quartz sand temper that is poorly sorted and unrefined. The Fitzworth Troughs are made in a finer fabric tempered with well sorted quartz sand, which resembles that used in SEDBB1 manufacture (Lyne 1994). Examination of archaeological examples at Dorchester Museum **(fig. 32)** appear to conform to this supposition.

Figure 32: Shards of Hobarrow Pan (left) and Fitzworth Trough (right), Dorchester Museum (Personal Collection 2018)

In order for any comparison of the two vessel types to be meaningful, an attempt to faithfully reproduce the archaeological fabric must be attempted. Previous work (Trim 2018) with SEDBB1 fabric has established a reliable process for replicating the clay used for Fitzworth troughs, and a similar approach can be taken for the Hobarrow Pans. Tables 2 & 3 illustrate the process carried out to produce workable clay in preparation for vessel construction. The raw clay was obtained from the banks of the Corfe River (SY967 840). This clay is predominantly orange or buff in colour, being an iron rich sedimentary clay of the type commonly found around Poole Harbour. Clay seams of this nature are known to have been exploited for SEBB1 production (Trim 2018) and presumably by the salt industry too.

Clay Type:	Fine – Fitzworth Trough	
Step	**Process**	**Description**
1	Drying Raw Clay	Partially hydrated clay is not particularly absorbent, therefore the raw clay was dried in a drying oven at a temperature of 70°C until all moisture had been driven off.
2	Crushing/Powderizing Clay	To facilitate even mixing of the clay matrix and therefore a homogenous fabric the clay was crushed and ground with pestle and mortars until a fine powder.
3	Mixing of Dry Ingredients	The powdered clay was then mixed with kiln dried paviour sand, a fine well sorted sand. SEDBB1 fabric is believed to be about 15-20% sand (Jones 2017) and the same ratio was used for this fabric.
4	Levigation	Previous work has demonstrated that the SEDBB1 fabric was levigated to increase the homogeneity of the fabric (Jones 2017). This process simply involves the dry ingredients being dropped into water, allowing the heavier elements to settle and lighter clay and organic particles to float. The water is poured off carrying organic impurities and smaller clay grains with it.
5	Drying out for use	A plaster bat was employed to draw moisture from the clay until it had reached a suitable level of plasticity. The resulting clay was then sealed in cling film until required.

Table 2: Clay processing - Fitzworth Toughs

Clay Type:	Coarse – Hobarrow Pan	
Step	**Process**	**Description**
1	Drying Raw Clay	See Table 2.
2	Crushing/Powderizing Clay	See Table 2. The raw clay was only crushed for the coarser fabric.
3	Mixing of Dry Ingredients	A higher ratio of sand was employed for the coarser fabric, approximately 25-30%. In this instance the clay used was taken from Bournemouth Beach, being less well sorted and containing larger particles.
4	Levigation	Though the archaeological fabric is quite coarse the dry ingredients still require hydration. Instead of dropping into water, however, water was added to the dry mix until all the clay and sand was covered. Organic components were picked out by hand, where possible.
5	Drying out for use	See Table 2.

Table 3: Clay processing - Hobarrow Pans

Vessel Construction

The construction techniques employed for Hobarrow Pans and Fitzworth Troughs are firmly recognised. Hobarrow Pans were constructed by slab building, whereas the Fitzworth troughs are coil built in a similar manner to SEDBB1 (Farrar 1975). The sub-rectangular form of the Hobarrow type vessels is suited to slab building, where flat slabs of clay are rolled out and dried to a leather hard state, then joined together with slip and allowed to dry (Rice 2005). The coil building technique (fig. 33) requires the rolling out of clay cylinders, which are formed into a ring on a base and then smoothed into the preceding layers of clay. Additional coils are added, varying the length to change the outer profile of the vessel, until the vessel is formed (Rice 2005). The finished cylinder is then thought to have been capped with a disc of clay before cutting the vessel in half, resulting in two troughs from one construction process (Farrar 1975). This appears a complex process, with evident difficulty in sealing the inner edge of the cylinder to the capping disc. An alternative method may have been to build the cylinder half the required height, bisecting it along its length and then joining the two open ends. Both methods will be attempted to ascertain their difficulty.

Figure 33: Coil built vessel under construction (Personal Collection 2018)

Whilst the construction method is clear the exact size the Hobarrow Pans is unknown, as no complete profile is known from the archaeological record. Farrar (1975) estimated the pans to be in order of 50 by 30cm in plan and 20cm deep, based on what he considered reasonable for the potential weigh of the vessel in terms of moving it on and off a hearth. There is even less evidence for the dimensions of Fitzworth Troughs, though examination of associated hearths may give some indications. There is little to suggest the use of indirect heat or formal oven like arrangement (Hathaway 2013). Therefore, the hearth structures from Hamworthy and Upton must have provided a low constant heat, without flame as the vessels are not fire blackened. In order to do this the vessels would necessarily have been suspended over the top which, given their depth of up to 0.5m, would be difficult to achieve without spanning the hearth. The excavated hearths are constructed with and inner width of *c*.0.8m. They demonstrate a close connection with Fitzworth Troughs, and it therefore seems reasonable that the vessels would be *c.*0.95m in length. In terms of width or diameter Farrar (1975) estimated this to be *c.*0.4m.

To ensure a meaningful comparison of the two vessels forms, in terms of relative performance, they should be of a similar size. Therefore the replica troughs and pans will be 1m long with an external width or diameter of 0.3m, the pans being *c.*0.2m in depth. Each were built in the respective fabrics discussed above (signpost), the step by step process laid out below in tables 4 and 5.

<table>
<tr><td>Vessel Type:</td><td colspan="6">Hobarrow Pan</td></tr>
<tr><td>Step</td><td colspan="2">Process</td><td colspan="4">Description</td></tr>
<tr><td>1</td><td colspan="2">Rolling out the slabs</td><td colspan="4">Using two 22x50mm batons as guides, clay slabs were formed using a glass cylinder as a rolling pin to ensure even thickness. Three slabs were rolled out for each vessel, a base and two sides.

Figure 34: Rolled out slabs
(Personal Collection 2018)</td></tr>
<tr><td>2</td><td colspan="2">Drying to Leather Hard</td><td colspan="4">The slabs were covered in material in order that they would dry slow and evenly, to reduce the risk of cracking or deformation as the clay dried.</td></tr>
<tr><td>3</td><td colspan="2">Mixing the Slip</td><td colspan="4">A thick slip, to act as glue during the construction, was mixed from dry clay powdered with a pestle and mortar and water.</td></tr>
<tr><td>4</td><td colspan="2">Assembly</td><td colspan="4">A pointed pottery tool was used to score the slabs where the base and the edge of the side pieces meet. This allows a keyed surface in which the slip can penetrate both pieces and provide an effective join. The slip was applied before lifting the first side piece onto its long edge and then married up with the base. The side piece was arranged so that its short sides would meet the second side piece in the middle of the base. This way the weakest part of the vessel, its corners, would be formed from a single slab bent to 90°. The short end of the side pieces were then scored and the slip applied. The second side piece was then lifted onto its long edge, joined to the other side piece and cut to fit at the other. The base was allowed to overlap on the outer edge, this excess was then smoothed upwards to strengthen the join. On the inner edge coils of clay were pressed and smoothed into the join.</td></tr>
<tr><td>5</td><td colspan="2">Drying out for Firing</td><td colspan="4">The completed vessel was then left to dry, covered in materials for the reasons highlighted above.</td></tr>
<tr><td>Attempts</td><td>5</td><td colspan="2">Successful Vessels</td><td>2</td><td>Success Rate</td><td>40%</td></tr>
</table>

Table 4: Construction of Hobarrow Pans

<table>
<tr><th>Vessel Type:</th><th colspan="5">Fitzworth Trough</th></tr>
<tr><th>Step</th><th colspan="2">Process</th><th colspan="3">Description</th></tr>
<tr><td>1</td><td colspan="2">Constructing the base</td><td colspan="3">A circular base with a diameter of 30cm was constructed by rolling a slab of clay and then cutting round a wooden disc of an appropriate size.</td></tr>
<tr><td>2</td><td colspan="2">Coil Building</td><td colspan="3">Coils were rolled out by hand and added to the outer edge of the base or the preceding coil. The coils were smoothed into each other by hand and the use of wooden pottery scrapers. This process being repeated until a height of 0.5m (first attempt, see below) or 1m. This step was carried out in stages to allow the lower coils to harden in order to carry the weight added above.

Figure 35: Fitzworth Trough under construction (Personal Collection 2018)</td></tr>
<tr><td>3</td><td colspan="2">Capping</td><td colspan="3">Only the second attempt was capped. Another 30cm diameter disc of clay was created and allowed to harden until no longer flexible and able to hold its own weight. This was then placed on top of the cylinder and smoothed down around the edges.</td></tr>
<tr><td>4</td><td colspan="2">Bisecting</td><td colspan="3">A wire clay cutter and a safety knife were used to bisect the two cylinders. The first attempt then being laid flat on a surface and the two ends joined with a coil of clay, creating one trough. The second attempt, having been capped, produced two complete troughs from this process.</td></tr>
<tr><td>5</td><td colspan="2">Drying out</td><td colspan="3">The now complete vessels were allowed to air dry prior to firing, in excess of two weeks.</td></tr>
<tr><td>Attempts</td><td>3</td><td>Successful Vessels</td><td>2</td><td>Success Rate</td><td>67%</td></tr>
</table>

Table 5: Construction of Fitzworth Troughs

Results – Hobarrow Pans

Despite the seemingly simple nature of their construction the Hobarrow Pans proved rather difficult to build. Judging the dryness of the clay right was an initial area of difficulty. If the slabs weren't sufficiently dry then they deformed and stretched during assembly, being unable to hold their shape, leading to eventual collapse. On another occasion the slabs had been allowed to dry too much and were not flexible enough to form the corners without cracking. Once completed, issues were met with drying the vessels out, despite attempts to slow the drying by covering with material. Essentially the base, being exposed to the air on only one side and having been moistened during the application of the slip during construction, dried at a slower rate than the sides. Clay shrinks as it dries out, causing contraction of the top of the vessel, resulting in the ends of the base lifting 2-3cm. The base then dried at a faster rate, resulting in the bottom of the vessel contracting, the centre of which now lifted 2-3cm as the ends dropped. This final deformation stressed the dry rim of the vessel, causing cracking. Of the five attempts at construction only two survived the drying out process with any degree of success. These vessels, however, were far from perfect having hairline cracks originating from the rim and running towards the base. (fig. 36). Time constraints prevented further attempts and it was hoped that these imperfect vessels would be able to withstand the firing process.

Figure 36: Cracking in HP1 from drying out (Personal Collection 2018)

Results – Fitzworth Troughs

Two separate attempts were made to construct Fitzworth Troughs, using the methods described above. Little difficulty was encountered in the initial stages of construction, providing the working edge was sealed with cling film to ensure additional coils could be added. The first attempt, where a half height cylinder was constructed before bisection, was unsuccessful. The joining of the two halves to make a trough proved to be rather complex as they were not perfectly cylindrical. Additionally the contraction of the coil used to join the two halves contracted and cracked across the join. The second method worked much better and did not prove to be as complex as imagined. The cap was sealed around the outside of the cylinder and then the entire vessel bisected. This meant that access to the inner edge became possible and a coil of clay could be pressed into the internal join. The leather hard state of the clay cap gave it sufficient rigidity to support its own weight during drying. Little cracking was observed during the drying out process, resulting in two well-made troughs ready for firing (fig. 37).

Figure 37: Completed Fitzworth troughs (Personal Collection 2018)

Hearth Furniture Construction

Several different components of what is interpreted to be kiln furniture was noted from the review of available literature. For the most part these items appear to have been fabricated as required and appear unfired (Hathaway 2013). These items, such as the props recovered in conjunction with both pans and troughs, were made in the field when setting up the hearth for salt boiling. There is, however, one item of hearth furniture that appears to be constructed and fired prior to its immediate use. These are the thumbed bars noted at Boathouse Clump, which are suggested to have aided in the suspension of Fitzworth Troughs in conjunction with unfired props (Jarvis 1986; Hathaway 2013). In order to explore this possible use it was decided to attempt to recreate a pair. This was achieved rolling out two 1m x 0.2m slabs and then using a thumb to create the pattern around the edge before drying out for firing (fig. 38).

Figure 38: Completed Thumbed Bars (Personal Collection 2018)

Firing the Vessels

Excavated shards of the evaporation vessels point towards them having been fired to at least low firing temperatures (600-800°C). However, it is by no means clear what sort of kilns, if at all, were employed to fire them (Hathaway 2013). Farrar (1975) suggested that the briquetage and SEDBB1 vessels may have been fired together, with the pots being fumed black in a secondary process. It is now understood that the deep black colour of the ware is developed during a reductive firing (Trim 2018) and therefore the two ceramic products could not have been fired together. The site of Worgret (Hearne and Smith 1991) has shown the SEDBB1 was initially fired in bonfire clamps before moving to updraft kilns in the second century. Smith (1930) excavated a kiln structure that, from the limited recording, strongly resembles the base of an updraft kiln. There is no indication as to whether the clay lining had been oxidised or reduced, nor any clearly recognisable kiln load remaining in situ. It may be that this was connected with SEDBB1 manufacture, as proposed by Lyne (2009), or for the firing of briquetage. Given this lack of firm evidence for briquetage firing, and the author's previous experience with kilns (Trim 2017), it was decided to fire the vessels within an updraft kiln. This more formalised kiln structure allows greater control of temperature, as the load is separate to the heat source, and without being sealed will provide an oxidising atmosphere.

Kiln Construction

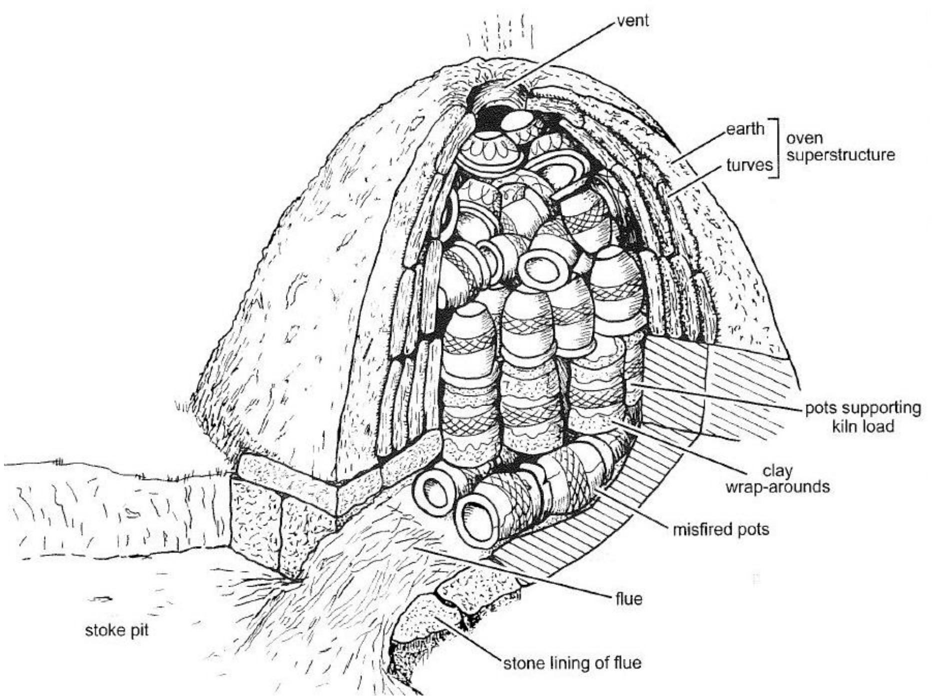

Figure 39: Interpretation of a Romano-British Updraft Kiln (Lyne 2010)

An updraft kiln (fig. 39) is simply a kiln chamber lined with clay at one end of a clay lined flue or fire box leading to a stoke pit. The load is placed in the chamber and turf built up around the load to form the walls of the chamber. The chamber is left open at the top and therefore acts as chimney, drawing air across the fire, through the fire box and up through the kiln chamber. The fire is kept burning until the chamber reaches the required temperature. In order to maximise the chances of a successful firing the kiln incorporated several engineering bricks to create a raised floor within. The kiln chamber was constructed in white ball clay, from the same source as the clay used for the vessels, with an internal diameter of approximately 0.5m to allow room for two evaporation vessels. The flue and stoke hole were excavated so as to provide a natural slope upwards to the chamber (fig. 40). The first firing encountered problems with airflow (see below) due to the turf construction of the chamber walls. Therefore the chamber walls were reconstructed in brick and partially lined with clay prior to the second firing (fig. 41), this meant that the load no longer had to bear the weight of the walls and ensured good airflow through the kiln (fig. 42).

Figure 40: Flue and Kiln Chamber during kiln construction
(Personal Collection 2018)

Figure 41: Reconstructed Kiln Chamber (Personal Collection 2018)

Figure 42: Reconstructed Updraft Kiln during firing, note the improved draw causing flames to emit from the chimney aperture (Personal Collection 2018)

Kiln Firings

Due to the size of the vessels it was decided to carry out two separate firings. This would allow a second chance should some error in the kiln construction or firing procedure cause a failure in the vessels.

The first firing, as described in the previous section, incorporated turf and earth into the chamber walls and for insulation. By necessity the turf was supported by the kiln load, with lumps of raw clay being used as spacers. The load comprised of the first Hobarrow Pan (HP1) and one of the Fitzworth Troughs (FT1), in addition the two thumbed bars were included to assist with holding the walls away from the vessels. This was a mistake as the process of constructing the turf walls broke a bar in two, the second fractured during the firing. In any case, once the kiln was loaded and the walls built to sufficient height, a fire was lit at the entrance to the fire box. The draw on the kiln was not as desired, though the temperature inside was increasing steadily with only a small fire as indicated by a thermocouple within the kiln chamber. After several hours of steadily increasing temperature, the kiln plateaued at around 275°C. The draw through the firebox was still slight and therefore the opening at the top of the kiln was carefully widened to allow greater airflow. This changed the dynamic of the firing fundamentally, dramatically increasing the airflow and allowing the base of the chamber to reach temperatures sufficient to cause the vessels to glow a dull orange. Increasing the fuel load allowed the temperature to rise to a maximum of 624.8°C. This temperature was taken at the base of the chamber with a thermocouple that was enveloped in an over-large ball of clay, likely to have caused the sensor to give a lower reading. Some 9.5 hours after the start of the firing the temperature could not be increased, so no further fuel was added to the firebox and the kiln was allowed to cool.

For the second firing, building on the observations regarding the kiln lining, the above ground portion of the chamber was remodelled as detailed above. Additionally, as the bed of burning coal had partially limited airflow during the first firing, the stoke hole was dug to a greater depth. Once loaded with HP2 and FT2 and lit, the kiln exhibited a notable improvement in airflow. Flames were now being pulled from up to 1m away from the firebox into the kiln and the column of smoke rising from the chamber aperture was greater, implying a good draw through the structure. After 6.5 hours the kiln had reached a maximum temperature of 802.3°C, the thermocouple this time not being shielded within clay. The vessels inside were glowing a bright orange and appeared to be fired, no more fuel was added to the kiln and it was allowed to cool.

Firing Results

As alluded to in the previous section results from the two firings proved to be mixed. The initial firing contained HP1 and FT1 and the two, now broken, thumbed bars. Of the two vessels only HP1 survived relatively intact, several of the hairline cracks caused by drying out had expanded and lengthened, though the vessel was structurally intact. FT1 on the other hand had split where two coils had joined together, and was therefore abandoned. The clay was a buff colour similar to prior to firing, but had darkened somewhat. This is probably a reflection of the poor airflow through the kiln, preventing oxidation of the iron content of the clay and a change to the expected orange colour.

In contrast the second firing, containing HP2 and FT2, produced altogether more satisfactory results. Both vessels were complete when removed from the kiln, though as with HP1 the cracks on HP2 had expanded and some slight hairline cracks had appeared on FT2 (fig. 43). The clay had fired well to a distinct orange colour and the vessels produced a clear ringing note when struck. These vessels, along with HP1, were then patched slightly with wet clay in an effort to improve their water retention capabilities.

Figure 43: Fired Evaporation Vessels (L-R HP1, FT2, HP2, FT1)
(Personal Collection 2018)

Conclusion

This attempt to replicate LIA and Romano British briquetage vessels has been an informative process, even if not a total success. The difficulty in constructing slab vessels of such size has highlighted one possible technological difference between the two vessel types. Evaluation of two possible methods for constructing Fitzworth Troughs adds significant weight to Farrar's (1975) interpretation of their construction method. The success of the second firing points towards a possible kiln technology for firing the vessels, so far unrecognised in the archaeological record. Though, as evidence suggests they were only in use from the 2nd century AD, this does not assist with the firing technology employed for the earlier Hobarrow Pans. That the thumbed bars did not survive the firing process unfortunately curtails any detailed investigation into their use, though their evident frailty may indicate that their use is not as originally interpreted. The details, in addition to providing vessels for an evaluation of salt making techniques, will prove useful in the final discussion chapter when examining links between the two industries under study herein.

Chapter 6 – Making Salt

The final objective set out in Chapter 2 was to carry out a programme of experimentation attempting to recreate the LIA and RB salt production method. In the previous chapter replica evaporation vessels we constructed and fired in preparation for this final stage of the study. Now these vessels will be employed, alongside elements of hearth furniture yet to be constructed, in an attempt to produce salt from sea water. After a brief re-evaluation of the evidence discussed in Chapter 1 is set out, before a programme of experiments are designed to test hypotheses drawn from the re-evaluation. The process and results of the experimental work are described before being discussed in detail.

Methods and Methodology

There is some detail available on the different aspects of the process within the study area, including the forms of briquetage, hearths and settling tanks used to produce salt. How exactly these elements fit together to produce salt is less clear. It does seem, however, that the two main forms of evaporation vessel, Fitzworth troughs and Hobarrow pans, were used in slightly different ways. In either case the vessels must be suspended over a sufficient heat source to boil the water. Examples of recovered hearth furniture, props and pedestals for example, are usually a pale buff orange colour.

This implies that, whilst they have been heated enough to partially oxidise the iron content of the clay, the fabric itself is still soft and unfired (Hathaway 2013). This implies the use of indirect heat to boil the salt water, a method present within South West England on Early and Middle Iron Age salt production sites such as Wyke Regis (Farrar 1963) and Trebarveth, Cornwall (Peacock 1969). However, as established, there is little to suggest this is the case. The later hearth structures do not appear to be constructed to accommodate an upper surface for indirect heating, having no flue to allow air to the fire (Farrar 1975). Similarly the evidence within Poole Harbour for clay slabs or stones to use as a heated platform for the vessels is almost non-existent. In the case of the flat bars, which could have been used to create indirect heat, they are insufficient in quantity in comparison to the vessels making this method seem unlikely. Therefore for this stage of experimentation direct heat will be employed.

The correlation between the occurrence of Hamworthy Type hearths and Fitzworth Troughs, to the exclusion of Hobarrow Pans, is taken as evidence that the two vessel types were used in different manners. This presents an issue, as one of the areas to be tested is a comparison of their relative performance towards and understanding of technological choices made in antiquity. Using different hearth types would introduce additional variables, thereby reducing the efficacy of any comparison. Therefore both vessel types will use the same hearth type. Accordingly, given the mixed interpretations for the possible early hearth structures (see p. 26), a Hamworthy Type will be recreated given its firm association with salt production.

As excavation has not discovered a hearth with associated vessels and briquetage in situ, then some interpretation is required as to how the accoutrements of salt production were arranged. It has been established that direct heat is likely to have been used during production and that the vessels were likely large enough to span the width of the hearth (see p. 77). Therefore a system where the vessels are suspended over the hearth will be utilised, thereby adding a degree of separation between vessel and fire. This could easily be facilitated with the use of simple pedestals at each corner, fabricated as required and allowed to harden in the sun.

Invisible Variables

So far the discussion has concerned itself with elements of the production sequence for which the archaeological record has provided tangible evidence. There are, however, likely elements that so far remain invisible to archaeologists. The resulting product of the process is unobservable from the archaeological record. Indeed the very suggestion that briquetage is related to winning salt is almost entirely implicit. It is not intended here to debate this matter or suggest alternatives, but it is a point worth noting.

When considering the potential for Poole Harbour salt to be preferable to other sources (Hathaway 2013), then methods of purification must be considered. Sea water contains salts other than the sodium chloride that comprises table salt. The other salts present in sea water are suggested to give either a bitter or chalky taste (CRDG 2018). Such salts may have been the preferred taste or be irrelevant depending on the use of the resulting product, such as tanning of leather (Woodiwiss 1992). Human consumption of the entire output of the industry is by no means certain.

It is difficult to determine which variables to test, being invisible by definition, though there are hints as to what may have been employed. One such case is that of animal fat or beeswax being used to seal the inside of the clay vessels to prevent salt adhering to them. Experimental work in Romania (Tencaiu *et al.* 2015), attempting to create salt cakes from saline spring water, demonstrated that the clay evaporation vessels would need to be lined in order to separate the cake from the mould. This was achieved by sealing the vessels with fat or a lining of leaves (fig. 44), technique potentially being a universal approach in salt production in antiquity.

Figure 44: Lining evaporation vessels *(Tencaiu et al. 2015)*

This in turn raises the question of whether the Poole Harbour salterns were manufacturing salt cakes or preferred a granular product. The EIA evidence from south of the Purbeck Ridge, with small cylindrical vessels that designed to be cracked in half to remove the resultant cake, suggests use of salt cakes at this date (Farrar 1975). However, the LIA Hobarrow Pans and RB Fitzworth Troughs do not seem to follow this pattern. Certainly, for the troughs, their interpreted size would seem entirely impracticable for salt cake production. A 1m long half cylinder of packed salt at an approximate volume of 49,000 cm^3 is likely to have been quite heavy and cumbersome, therefore leaving the cake susceptible to damage. Similarly the pans would produce a cake of around 15,000cm^3 (based on Farrar's 30cm x 50cm x 15cm dimensions). Salt has a density of around 2.16g/cm^3, therefore the resulting salt cake could potentially weigh 32.4Kg for a Hobarrow Pan. The Fitzworth Trough, with a half cylinder salt cake roughly 12.5cm radius and 1m length, could weigh in at 105 Kg. This would seem impractical for transport or sale. Certainly Hathaway (2013) suggests a move away from the Bronze and Early Iron Age method of producing small salt cakes to the production of loose granular salt. The advantages for transport, easy division for sale and the ease of packing large quantities of food stuffs into salt seems clear. Therefore for the purposes of this study no attempt to produce salt cakes will be made.

Raw Materials – Seawater

The most common source of salt water, within the British Isles, is sea water. Poole Harbour presents an optimal environment for the collection of seawater (Chapter 2), as conditions would contribute to the concentration of the salt content within the water (Hathaway 2005). However, since antiquity, Poole Harbour has been heavily exploited for industrial and recreational purposes. This is likely to have contaminated the water to some degree, in addition to the silts in the water from the rivers flowing into the harbour. It was therefore decided, in order that resulting salt be fit for human consumption and for ease of access, to collect water from the beach in Poole Bay (SZ 065 896). When tested with a salinity refractometer the salinity was 3.2%, slightly less than the suggested average salinity of seawater (USGS 2016).

The sea water was collected and allowed to stand and settle before being strained through material, thereby removing sand and larger organic inclusions. The sources (e.g. Farrar 1975; Tencaiu *et al.* 2015; Hathaway 2013) all point towards sea water being concentrated into a brine prior to the final stage of evaporation into salt crystals. This step would necessarily speed up the final process but is not, apart from in the creation of salt cakes, an essential element. This study did not have the facility to easily reduce the quantity of water collected, some 80l. Furthermore the study area, lacking firm evidence for large salt pans by which to evaporate the sea water, does not immediately point towards this step being used in the area. There are certainly features that appear to relate to the processing of sea water prior to boiling (e.g. Smith 1930; Farrar 1975; Coles and Pine 2009). These features, including pools and ditches, appear to relate to the collection of seawater and subsequent settling to remove sand silt and other impurities from the solution. Depending on the length of time the water is left in these features, along with the prevailing climate and rainfall, some concentration is likely to have occurred. However, given insect predilection for salty liquids, these feature may have been covered to keep out flies and so on. This being the case and without firm evidence to support the wholesale reduction of seawater to brine this study will attempt to produce salt directly from the seawater collected.

Testable Hypotheses

The above examination of possible methods of salt production now allows the development of several hypotheses that can be tested through a programme of experimentation. Results from these experiments, successful or otherwise, will further the understanding of the Poole Harbour salt production process. It must be considered, however, that simply because a method works it does not necessarily follow that the exact same technique was employed in antiquity. Conversely firm negative results may indicate how things were not done, assuming that essential elements for the process were not omitted. That being the case the salt making experiment will attempt to test the following hypotheses;

- **Hearth depth prevents sooting of the evaporation vessels**
  As there is no evidence for sooting on the exterior of the vessel shards, nor the associated hearth furniture, the accuracy of any replication can be measured by the presence or absence of sooting on the vessels.

- **The Fitzworth Troughs were more effective at producing salt than the earlier Hobarrow Pans**
  Relative performance of the two vessels was assessed to ascertain if any difference in their ability to produce salt is observable. Their robustness and ability to hold water was noted. Their effectiveness in evaporating salt water, and therefore produce salt, was evaluated by recording the quantity of water added to each vessel and the amount of salt produced.

- **Poole Harbour Salt was "purer" and therefore preferred by the market.**
  Suggestions that the salt produced in the study area were preferential to other sources, possibly due to the effect of the clay vessels was tested. By producing salt in a metal pan in addition to the clay vessels the resulting product was subjected to X-Ray Fluorescence (XRF) to see if its chemical make-up differs between the two materials.

- **The evaporation vessels require lining with an impermeable substance to function correctly.**
  The final hypothesis concerns the likelihood that the vessels may have been sealed in some way to improve their water retention ability. This is tested by repetition of the experiment, by ceramic alone and then lined with fat.

Hearth Construction

As detailed earlier in this chapter the experiments utilised the Hamworthy Type hearth, which are most firmly associated with salt production. Essentially a clay lined sub-rectangular pit, measuring approximately 2m x 1m and 0.8m in depth. A fire is lit in the bottom and the evaporation vessels suspended above in order to reduce the seawater to salt. This simple feature (fig. 45) was created by excavating a pit of the above dimensions using hand tools. Due to the extreme heat experienced during June and July 2018 the clay seam had baked to a very hard state. Therefore, instead of cutting blocks of raw clay for the construction, the orange iron rich clay was puddled with water and a small amount of straw before being formed into bricks. These bricks were then used to construct the lining of the hearth, resulting in internal dimensions of 0.8m x 1.8m x 0.5m. The hearth was then allowed to harden in the sun in preparation for the salt making attempts.

Figure 45: Completed Hamworthy Type Hearth (Personal Collection 2018)

Figure 46: Hand formed props hardening in the sun (Personal Collection 2018)

Experimental Salt Production

The attempts to manufacture salt using the techniques discussed above took place on 7th July 2018 in hot sunny weather. For each vessel being used (HP1 and 2, and FT 2) four bespoke props were fabricated (fig. 46) the day before, from puddled raw clay, and allowed to harden in the sun. On the day of the experiments a fire was lit within the hearth structure and built up with aged cordwood to create a bed of hot embers that were burning without flame. Each vessel was filled with 4 litres of water before being carefully placed onto their respective props, thereby suspending the vessels over the heat source. Periodically, as the level in the vessels dropped, additional water was added and the amount recorded. It was observed that each vessel was dripping water from their base at different rates, this is likely as a result of the cracks formed during drying and firing, despite patching with wet clay. After 2 hours HP1 was abandoned as the flow of water out of the vessel was too great and affecting the heat source. Similar problems occurred with HP2 and FT2, therefore experimentation ceased after 3 hours. The continual loss and replacement of water in the vessels meant that only a gentle simmer could be achieved in any one, but only for short periods when close to drying out. Measuring of the salt content with a refractometer gave variable results at different times, though no reading was higher than 4.2%. This meant that the salt was not being retained in the vessel but instead flowing into and presumably through the fabric. After the experiment had ceased it was evident, as the vessels dried out completely, that salt crystals were effervescing out of the clay fabric (fig. 47). This very small amount of salt was scraped from the vessel and collected for later assessment.

Figure 47: Salt effervescing from the fabric of the vessels
(Personal Collection 2018)

Results

As alluded to above the structural integrity and water retention properties of the vessels deteriorated rapidly during the experiment. This failure curtailed a full investigation of the hypotheses proposed earlier in this chapter, however negative results can still be informative of the process.

- **Hearth depth prevents sooting of the evaporation vessels**

The outer surfaces of the vessels and props were heavily fire blackened by the experiment, an indication that the process had not precisely replicated the process. This is likely to be the result of the fuel used and the way the heat source was maintained. The fire was initially built up and allowed to burn down to embers, without much in the way of flames (Fig. 48). After the vessels were placed, it was apparent that the heat was dropping and didn't seem sufficient to heat the water to a boil. The water leaking from the vessels, though only a slow drip at this stage, contributed to the fire dwindling. As a result further fuel was added to the fire, this process being repeated at several points during the experiment. The result being that the fresh fuel burned with a strong yellow flame, which in turn enveloped the vessels depositing soot. In hindsight the level of burning embers within the hearth needed to be far greater prior to placing the vessels over the heat. This would have provided a greater temperature without flames and reduced smoke, preventing the fire blackening of the vessels. Additionally a bed of embers gives a consistent level of heat, rather than the variable heat delivered by the flames. This would have been beneficial in reducing damage to the vessels caused by thermal action, extending their effectiveness.

Figure 48: Bed of coals within the hearth, note bead of water dropping from FT2 (Personal Collection 2018)

Consideration of the fuel that was employed in the past appears pertinent in retrospect. Though the sooting may have been prevented or reduced by the above suggested alterations, a smokeless fuel presents an alternative solution. There is no environmental assessment of the contents of a Hamworthy Type hearth available from the literature (Jarvis 1986b; Watkins and Anderson 1994; Bellamy and Pearce 2001; Coles and Pine 2009). However, when considering the predominantly heathland environment of the study area, access to sufficient quantities of the cordwood employed would be difficult. The use of other organic fuels, such as gorse and heather, seems unlikely as this type of fuel burns quickly with lots of smoke. A fuel that burns with a shorter flame and is known to have been used in LIA and RB

Poole Harbour is peat (Gale 2003; Jones 2017). Another alternative would have been to use shale, though the use of this for creating jewellery and vessels suggests it would have been to valuable resource to simply burn. In any case, without further detail, these considerations are merely conjecture. What can be said is that the depth of the hearth alone is not sufficient to prevent sooting without further attention being paid to how the fire is managed and the fuel that is employed.

- **The evaporation vessels require lining with an impermeable substance to function correctly.**

Though the cracks, developed during firing and drying the vessels, exacerbated the flow of water from the vessels it was apparent that the fabric was highly permeable. Prior to placing on the hearth it was immediately apparent that capillary action was allowing water to move through the fabric. A tideline was evident on the exterior (fig 49) of the vessels and this moisture was directly exposed to the heat and, at times, the flames. The result being that salt crystals accumulated on the outside of the vessel, in some places forming stalactites of salt. Discolouration from smoke resulted in an impure salt, which is unlikely to have been of use, suggesting this was not an intended effect of the process. Despite not being able to test the application of a sealant on the vessels it seems highly likely one would have been used.

Figure 49: Tideline on exterior of HP2 due to capillary action (Personal Collection 2018)

- **The Fitzworth Troughs were more effective at producing salt than the earlier Hobarrow Pans**

The failure of the vessels at such an early stage precluded any meaningful result in regards to the relative performance of the two types. However given their similar size and therefore surface area of the water, it seems unlikely that any significant difference in the rate they produce salt would have been noted. Rather the differences noted in the previous chapter regarding the difficulties in construction would seem to be the greater factor in the change in technology.

- **Poole Harbour Salt was "purer" and therefore preferred by the market.**

It is not possible to compare the products of different salt making sites from Roman Britain today. However, a comparison of salt made both in ceramic and metallic vessels may provide some insight into the possibility of a purification effect of ceramic in salt production. To this end, in addition to the attempts to reproduce the LIA and RB process, salt was produced using a metal pan heated as a control (fig. 50). The ability to retain liquid within this vessel meant that a large quantity of salt was produced. The salt recovered from HP2 and FT1, along with the metallic control vessel, were subjected to X-Ray Fluorescence in laboratory conditions.

Figure 50: Galvanised steel vessel used to create control salt (Personal Collection 2018)

The main salts occurring in seawater are Calcium Carbonate ($CaCO_3$), Gypsum ($CaSO_4 \cdot H_2O$), Sodium Chloride (NaCL), Potassium Chloride (KCl) and Magnesium Chloride ($MgCl_2$) (CRDG 2018). Oxygen, Carbon, Hydrogen and Sodium are too light to be accurately detected by XRF and therefore cannot be used in this assessment. Chlorine, the main constituent of the desired NaCl, can be detected and theoretically would be the only element noted if the sample comprised NaCl alone. Additionally Potassium and Magnesium can be detected and will indicate the levels of KCl and $MgCl_2$. However the samples all returned results below the limit of detection for Mg. Calcium is the final proxy to be used, for noting the presence of $CaCO_3$ and $CaSO_4 \cdot H_2O$. Each sample was scanned three times and the results presented in Table 6 are mean averages of these values. Details of the equipment use and full results are contained within Appendix D.

Element / **Sample**	**Chlorine (Cl)**	**Potassium (K)**	**Calcium (Ca)**	**Balance (inc. O, H, Mg, Na, C)**
Control	31.2	0.39	0.66	64.8
Hobarrow Pan 2	29.8	0.59	0.04	67.6
Fitzworth Trough 2	29.8	0.57	0.04	66.5

Table 6: XRF analysis of salt samples as percentages of total sample

Before examining these results it is important to note that the small sample size allowed by the failure of the vessels does not allow any firm conclusions to be drawn from the data. Rather this data serves as a useful indicator of what may or may not be happening during the salt making process.

The limited data shows a small increase in K for the ceramic vessels (~ 0.2%) and a decrease in Ca (~ 0.6%) and Cl (~ 1.4%). Additionally there is small increase in the proportion of undetectable elements within the balance (~ 2-2.5%). Very small changes overall but as a fraction of the total amount of each element they represent interesting results. Salts precipitate from solution at varying levels of concentration depending on their solubility, illustrated in Table 7.

The reduction of Ca indicates removal of the least soluble salts, $CaSO_4 \cdot H_2O$ and $CaCO_3$. In turn increasing the proportion of the most soluble salts (KCl and MgCl2), indicated by the rise in the proportion of K. However, if the non-chloride salts are removed, a proportional increase in Cl would also be expected. Instead the proportion of Cl decreases, contradicting the implication of the changes in Cl and K.

Salt	Solubility
Calcium Carbonate ($CaCO_3$)	≈ 70 ppt
Gypsum ($CaSO_4 \cdot H_2O$)	≈ 100 ppt
Sodium chloride (NaCl)	≈ 130 ppt
Potassium and Magnesium salts (KCl and MgCl2)	> 150 ppt

Table 7: Solubility of salts within sea water (CRDG 2018)

It remains unclear whether the ceramic vessels are providing a purification effect. If they were then the effect of the differing precipitation points of the salt would have to be a factor, along with the porosity of the fabric. If the vessels were lined then the permeability of the clay would be negated. Therefore any purification would rely directly on the precipitation points. With even a vague understanding of this in the past it would be possible to remove the chalky calcium salts by simply heating the water slowly and discarding the first salt to crystalize. The remaining liquid would then contain the chloride based salts. Further heating would allow Sodium Chloride to precipitate whilst retaining the Mg and K salts. A similar effect would be possible with the use of iron or lead pans.

Conclusion

This chapter set out to reproduce the method by which salt was produced in the LIA and RB periods around Poole Harbour. Whilst not a complete success this process has allowed some insight into the possible production techniques and technological choices of the industry. Sooting of the vessels has suggested an alternative fuel may be required, and a need to build and manage the fire differently. Failure of the vessels at an early stage, whilst curtailing the experiments, points towards the use of animal fat or similar to line the vessels. Though it also prevented a comparison of relative performance in terms of salt produced in a given amount of time. Finally an examination of the chemical make-up of the resulting salt has lent a scientific aspect to the discussion of a possible preference for Pool Harbour produced salt in antiquity. The following chapter will now combine these observations with those from the previous objective.

Chapter 7 – Discussion

The preceding chapters have addressed the objectives set out in Chapter Two, drawn from the literature review. Each of the objectives has allowed further insight into the methods of salt production, the pattern of settlement and the scale and organisation of both salt and SEDBB1 manufacturing. These objectives were designed with a view to approaching the overall research question regarding the so-called irrational distribution of and post-production links with SEDBB1. It now remains to bring the results from each chapter together in a discussion revolving around the commonality of craft knowledge and processes. Links between industries present within the study area are highlighted herein, along with implications of the changing patterns of settlement. Finally the suggested post-production connections between salt and SEDBB1 are addressed and a rebuttal of previous work suggested.

Salt Production – The Poole Harbour Way

Though the attempt to replicate the method, by which salt was extracted from seawater, was not a resounding success, it has been able to provide some further detail. Of the many industrial processes observable in Late Iron Age and Roman Britain, the production of salt is arguably the simplest. Essentially sea water is evaporated until only salt remains. Sea water, however, contains many impurities such as sand, grit and organic matter. Furthermore the inclusion of Gypsum and Calcium Carbonate would add a chalkiness to the salt.

The difficulties encountered with producing the briquetage, despite the author's limited experience, point towards a high degree of skill required of the salt workers in antiquity. Exemplified in the failure of the pots during the experiment, simply lighting a fire below a vessel containing seawater is not enough to ensure success. Control of the heat source and ensuring the correct fuel is used all contribute to extending the life of the vessels. The whole process requires a significant time investment in collecting and processing the raw clay, constructing the vessels, building a kiln and firing the vessels, and the constructing the hearth and hearth furniture, all before a single gram of salt can be produced. Production of sea salt cannot be seen as a casual endeavour therefore and the scale of the industry around Poole Harbour suggests this industry was a primary focus of the economy at the time.

The level of skill and understanding of salt production goes beyond simply extending the lifespan of the vessels. There are suggestions that Poole Harbour salt was preferred to other sources (Hathaway 2013) and by implication that the product was in some way purer. As demonstrated in Chapter 6, different salts will precipitate at different concentrations. This is known from our modern understanding of chemistry, but from experience of making salt it could be worked out from taste alone. If the Iron Age salt workers from the study area were aware that the first salt to crystallise gave an undesirable chalky taste they could easily scoop it from the solution. This would go some way towards purifying the salt and increasing the level of Sodium Chloride in the resulting product. This exemplifies a remarkable understanding of the materials with which they are working in a similar way to that thought to be shown by the SEDBB1 potters (Trim 2017).

Therefore the fabrics of the ceramic vessels are unlikely to have played a role in purification, supported by the likelihood they were lined with fat to improve water retention. To date there appears to have been no attempt to carry out lipid analysis on briquetage in the published literature and this technique may yield some interesting results. It does lead to one important point, albeit from a point of relative ignorance in respect of this technique, regarding the interpretation of lipid residue analysis. Simply that all earthenware clay cooking vessels are likely to have had a degree of porosity and may therefore have required sealing in some way. Analysis that suggests the vessels were used to manufacture cheese or heat dairy products may instead be observing the results of using such fatty products to seal pots for use.

It would appear that the forms of the vessels, demonstrating a distinct technological change from Hobarrow Pans to Fitzworth Troughs, are not related to purification. Though fuller evaluation was curtailed by vessel failure, the change in technology seems not to relate to their relative performance. The factors determining speed of evaporation, such as surface area and wind speed (Akridge 2008), do not appear relevant to the change in form. Rather it seems the change is a result of the desire for increased production and therefore the need for larger vessels. The difficulties encountered during the manufacture of the pans point towards a limit in size for Hobarrow Pans. Conversely the troughs were far easier to construct at the larger size, using the method suggested by Farrar (1975). Though the inexperience of the author will have been a factor, consultation with a modern day potter supports this point (Stanley Personal Communication 2018).

This detail, regarding the change in technology, coupled with the results from Chapter 4 points towards a reappraisal of the two groups set out by Farrar (1975). Subsequent excavations have added an increased amount of resolution in terms of dating to the data interpreted by Farrar. His interpretation split the salt production sites into two groups in terms of geographical location, a southern group centred on Kimmeridge Bay and a northern group on the heathland around Poole Harbour. The southern group using the Hobarrow Pans and the Northern Group, with the exception of Hamworthy, utilising Fitzworth Troughs. More recent excavation has shown the presence of Fitzworth Troughs in later contexts from the Hamworthy Complex (Lyne 2009) and Hobarrow Pans in the early contexts on the Ower Peninsula (Cleal 1991). The evidence seems to indicate that use of the troughs is later than that of the pans, probably in connection with late 1st or early 2nd century links with the burgeoning SEDBB1 industry. Given the LIA movement from the Purbeck Ridge down to the southern edge of Poole Harbour and use of the pans, sites such as the Cleavel Point and Corfe River Complexes would seem to relate closer to Farrar's Kimmeridge Group (1975). This suggests a further sub-division, based on temporal changes rather than geographical is required. Farrar's Kimmeridge Group lies outside of the study area and, as the excavation reports and evidence have not been assessed during this investigation, is left for further work. However, for the Heathland Group, a sub-division between LIA and Romano-British salt working is required. Sites exhibiting evidence for the use of Hobarrow Pans, being Hamworthy (Lyne 2009), Corfe River and Cleavel Point Complexes (Cox and Hearne 1991), fall into the Late Iron Age Heathland Group. Conversely the firmly Romano-British production sites, Boathouse Clump (Jarvis 1986b), Arne, Fitzworth, Hamworthy Complex (Lyne 2009), would fall into a Romano-British Heathland Group. This is not to suggest that the use of the Fitzworth Trough is an entirely Romano-British invention, as examples of similar smaller troughs are known from the Late Iron Age onwards. Rather that wholesale use of large troughs is predominantly evidenced for later sites, with the apparent abandonment of the Hobarrow Pans.

Industrial Connections

The major part of the aim of this study is to explore the commonality of craft knowledge, skills and processes within the study area from the LIA through to the end of Roman Occupation. Chapter 4 served to identify spatial and temporal links between industries, highlighting that production sites were very mixed at this time. Moreover that there is a strong likelihood most industrial processes were taking place within two major production sites of the Cleavel Point and Corfe River Complexes. However, beyond sharing space, little can be said to link the differing processes. The fabrics used to produce Durotrigian BBW and Hobarrow Pans are distinct from one another. The evidence for kilns, hearths and settlement tanks is intermixed so that in some cases features could potentially belong to either industry.

In complete contrast to this the two industries, from the 1st century AD onwards, appear to separate in their spatial relationship with the focus for SEDBB1 manufacture moving upriver, away from salt water. In terms of the processes and techniques a much closer relationship can be observed, particularly so prior to and during the production processes. These connections are explored below.

Pre-Production Links

As identified in the previous section, the first connection between the two main industries under study, is in production of the vessels. The fact that the same fabric type is used by both industries seems to indicate a greater connection than a simple sharing of ideas. For SEDBB1 the high quartz content points towards the final vessels having good thermal properties, in that they are more resistant to stresses placed on the vessels during cooking (Allen and Fulford 1996). The refinement of the clay through levigation also allows for a homogenous fabric, permitting a smooth finish and easy burnishing. The briquetage vessels do not require such aesthetic qualities and the properties imbued by the high level of quartz need not be so refined. Indeed the fabric used for the earlier Hobarrow Pans could also be used in coil building and presumably produce appropriately sized troughs. The implication, therefore, is that the clay is being prepared in the same way by the same people. It may have been the case that the salt makers procured processed clay from the potters as required. Alternatively the collection and processing of the clay, given the likely scale of the two industries, may have been a near full time occupation and that whoever carried this out supplied both industries.

The second connection is use of the coil building technique to fabricate the troughs and SEDBB1. It is clear from the quality and uniformity of SEDBB1 vessels that a highly developed level of skill was required by the potters. To a lesser extent the same can be said of the Fitzworth Troughs, the difficulty there being the ability to keep the vessel circular and the sides straight. The troughs themselves, once finished, are heavy to move around and unlikely to be resistant to much in the way of being roughly handled. This suggests that they were unlikely to be made at a SEDBB1 production site such as Bestwall, but made close to the hearths on which they would eventually be used. This has implications for the role of specialism within the Romano-British society around Poole Harbour. Is it the case that almost everyone had a level of ability and knowledge of pottery techniques? That everyone had the developed understanding of kiln technology and the process of firing the kilns? Perhaps most importantly how were people learning and developing these skills? The answer may lay in the two pre-production connections identified here. In that the younger workers in the study area are somehow employed in some form of general apprenticeship, learning their trade by extracting and processing raw clay and developing their skills in producing the rough ceramic vessels of briquetage. It is easy to imagine a situation where the more able potters from amongst the apprenticeships eventually graduate to working on the SEDBB1 production sites. The remaining trainees, as it were, being incorporated into other trades such as salt production.

Salt Production Process Links

Connections between SEDBB1 manufacture are also evident from the process of winning salt from sea water. The most obvious of these links being the presence of large quantities of oxidised SEDBB1 shards on almost all of the Romano-British salt production sites. Lyne (1994) suggests this is indicative of pottery production, comparing the oxidised wares to the wasters and discarded vessels from sites such as Worgret. The presence of what appears to be an updraft type kiln, discovered by Smith (1930), could again be argued to support this suggestion. However, as has been shown in Chapter 5, it is possible that this kiln was built for the firing of evaporation vessels. Additionally, large storage jars dominate the assemblage, certainly for the 3rd century vessels. This suggests three possible factors contributing to the presence of such quantities of SEDBB1; SEDBB1 production, SEDBB1 wasters were used by the salt industry or Hamworthy’s potential role as a port.

Subsequent excavation and publication of sites such as Worgret, Redcliff and Bestwall have given a detailed picture of the nature of SEDBB1 production. The evidence from Hamworthy, so far, does not appear to conform to this picture. Only one possible kiln structure has been noted and that from largely amateur excavation in the 1930s, whereas Bestwall had over 30 kilns in a relatively small area. Hamworthy does, however, exhibit plenty of firm evidence for salt production. It may be the case, as suggested earlier, that some form of apprenticeship for potters was feeding both industries. If this is the case then a small level of SEDBB1 production at Hamworthy may relate to this activity. Though the resulting pots, if less than perfect in form or oxidised fabric, would not necessarily be sent to market.

The second factor is that the misfired or oxidised SEDBB1 vessels are being appropriated for salt production. Their ability to withstand the stresses of being heated and used within cooking have already been attested. Additionally the dominance of large storage jars (Lyne 1994) supports the idea that they are being used to heat brine or sea water. Alternatively they may have formed a secondary element to the process where salt crystals are scooped from the larger evaporation vessels, into the SEDBB1 jars and allowed to dry over heat before being packaged for transport. Given the apparent integration between the two crafts, an arrangement whereby the potters around Wareham sent wasters down river to the salt producers to be used there may have existed. This seems particularly relevant when considering the potential of the Hamworthy Complex as the main port facility within Poole Harbour. If this were the case then it would be reasonable to expect all of the goods to be exported to be stockpiled here ready for shipment. This third factor does not explain the presence of SEDBB1 wasters at other sites such as Arne however. Though as small harbour vessels are likely to have been plying between the various sites in the harbour and up the rivers, moving goods ready for shipment, it does suggest the physical method by which they may have travelled.

Assuming that at least some of the wasters were employed in producing salt then the role of some items of hearth furniture may be explored. An attempt to reproduce the thumbed bars noted at Boathouse Clump (Jarvis 1986) was reported in Chapter 5. Though the bars did not survive the firing process, probably as a result of mishandling, there is the suggestion of a role they may have played. Rather than being used to support the large evaporation vessels their bevelled edge may have been intended to support the rims of misfired SEDBB1 storage jars. As a side project to this study several such vessels had been built and were fired, allowing an opportunistic discovery of this potential use (fig. 51). When combined with the notched props, suggested to be for accommodating the bars (Hathaway 2013), this could prove an effective means for suspending storage jars over a hearth.

Figure 51: Possible use of thumbed bars (Personal Collection 2018)

Irrational Distribution and Post Production Links

It has been established that the distribution of SEDBB1 vessels is seen as irrational (p.23), being distributed far from the production sites with neighbouring areas like Hampshire seeing little use of the ware. This has led to suggestions of its use as packaging for other products, such as salt and salted meat (Woodward 1987). Allen and Fulford (1996) preferred a combination of military supply contracts and the heat resistant qualities of the ware as the rationale behind SEDBB1 distribution. Gerrard (2005) highlights that, though a major part of the economy, SEDBB1 production did not occur in a vacuum. Rather it formed part of a larger and complex economic system of production and supply, as opposed to being an economic activity in its own right as suggested by Allen and Fulford (1996). Indeed Gerrard highlights the mutual requirement for raw materials for both salt and SEDBB1 production as an indication of the integrated economy. Examination of the production process throughout this study, particularly Chapters 5 and 6, supports this argument. Shared materials, pottery techniques and the possibility of at least a partially shared workforce can all be seen as strong indications of a complex economic system. Gerrard (2008) argues, therefore, that the distribution of SEDBB1 can be used as a proxy for the distribution of not only salt but other so far invisible Poole Harbour products, at the same time acknowledging the potential of SEDBB1 as packaging. Examination is required of two separate points here; the purpose of SEDBB1 in this system and the validity of using the vessels as a proxy for Poole Harbour products.

SEDBB1 production has been shown to be a labour intensive process (Trim 2018), requiring a high degree of skill to achieve the distinct lustrous black finish for which it is known. Additionally, though this is so far untested by experimental work, it has suspected qualities in terms of being resistant to thermal shock during use for cooking. These factors alone seem sufficient to suggest it is over engineered for the simple role of packaging other products. Transport of the ware must have presented difficulties in antiquity, needing to be packed in straw or similar to cushion it. Even so a large degree of breakage could be expected, though Allen and Fulford (1996) suggest the use of mule trains may have mitigated this to a degree. To pack such vessels with salt would seem impractical for ensuring the contents reached their destination intact. Furthermore the added weight of the ceramic vessels would necessarily reduce the quantity of salt that could be transported by terrestrial transport. Assuming that Poole Harbour was supplying the legions, prior to and alongside penetrating civilian markets, then a large amount of salt would be required. Gerrard (2008) suggests in order of 113 tons *per annum* simply to keep the estimated 15,000 troops of the 4th century army based in *Britannia* fed with salted mutton, this figure is likely to increase for other supplies such as salted pork. To transport such large quantities by splitting it into small heavy vessels would seem inefficient and irrational. If, as is assumed here, the legions required large stockpiles of salted meat to keep the army fed then what containers were they using to salt the meat? Preserving large quantities of salted meat was essential to the Georgian Navy, having to feed the hundreds of crewmen aboard vessels that often spent many months at sea. This practice relied on the use of wooden barrels or casks, watertight vessels that could hold up to 1000 litres (MacDonald 2014). The use of barrels is known from Egyptian tombs from at least 2000 BC and was documented by Herodotus in 500 BC (Twede 2005). Indeed their use within Romano-British salt production is noted at Droitwich, where they had been incorporated into settlement tanks (Woodiwiss 1992). Due to their durable nature, ease of reuse and organic construction, evidence for their use is often missing from the archaeological record. As a result their significance is often overlooked, despite being the perfect vessel for the transportation of a multitude of products. It is therefore suggested that the primary vessel employed for the transport of Poole

Harbour salt, and potentially the SEDBB1 vessels, is within wooden casks. These casks could then be employed to salt and store meat for the army, before being returned empty for refilling.

What of the validity of using SEDBB1 as a proxy for the supply of salt, in particular to the Roman Army, from Poole Harbour? It has been shown that the production of these goods is intrinsically linked throughout the manufacturing process. It does not, however, necessarily follow that they shared the same eventual markets. Both Gerrard (2008) and Allen and Fulford (1996) suggest that the success of the economy of Poole Harbour relied heavily on fulfilling military supply demands. The occurrence of Durotrigian BBW/SEDBB1 at Lake Farm Fortress (Field 1992), constructed soon after the invasion of AD 43, and the subsequent bases of *Legio II* certainly implies strong connections between the potters and the military. A connection that continues throughout the construction and use of the Hadrian and Antonine Walls (Williams 1977). Besides their need for ceramic wares, the Roman Army would also require large quantities of other supplies such as salt, grain, leather and hides, wine, beer and wool. As set out in Chapter 4 the LIA focus of Poole Harbour appears to be one of trade and exchange, with the Cleavel Point Complex initially and the Hamworthy Complex subsequently acting as ports-of-trade. This would mean that *Legio II* encountered a readymade economic system of supply, bringing agricultural produce down river from the Dorset hinterland and trading those outwards. Whether by force or agreement it would seem highly probable that Poole Harbour was set up to continue to supply the legion as they moved westwards. Gerrard (2008) points out that the Roman Army lacked a logistics corps, which may be true for campaigns remote from the sea or navigable rivers. However, as pointed out in Chapter 4, the *Classis Britannica* is likely to have supported Vespasian and his legion. If an arrangement had been created for Poole Harbour to supply initially *Legio II* and then the wider Roman forces, then all the necessary elements were in place. As far as can be observed from the available evidence it would seem reasonable to suppose that where SEDBB1 travelled, then other products are likely to have travelled with them. However, this can only be said of military sites and even this is tentative as this does not explain the loss of market share in the 3rd century. Civilian markets may have been supplied on a much more ad hoc basis, or given their access to more local agricultural products, it may be the case only SEDBB1 was able to penetrate them.

Logistics and Transport

The possibility of Poole Harbour actively supplying remote areas of Britain poses the question of exactly how the production sites link into the Roman transport network. Differing authors favour different methods of transport for SEDBB1, such as the mule trains proposed by Allen and Fulford (1996). Chapter 2 suggested that the *Classis Britannica* may have had a role to play and maritime transport certainly appears to have played a significant role prior to the arrival of Rome. It is likely that the road network may have had a role to play, with established connections to Hamworthy and from Wareham to Norden. Significantly the evidence for the roads does not suggest that they were improved in any way following their early legionary construction (e.g. Jarvis 1986a). This seems contrary to their use by the expanding industries present in the study area, suggesting a continuing focus on maritime transport. Building a road to Dorchester, one of Field’s (1992) so far untested routes, would seem superfluous when greater loads could as easily be carried by boat. If, as is suggested here, the barrel was the primary vessel used for transportation then these are specifically designed to be stacked within a ship’s hull (MacDonald 2014). This suggests that the complex at Hamworthy continued to fulfil the role of port facility within the harbour. Unfortunately its continuing suitability for this purpose may prevent a full archaeological appraisal of the peninsula, now under modern development and reclaimed land.

Towards complexity

The first significant change in the Poole Harbour landscape, noted in Chapter 4, is the initial movement into the heathland/wetland environment from the chalk uplands south of the Purbeck Ridge. Prior to this, EIA and MIA occupation of the Isle of Purbeck appears preoccupied with subsistence farming, with elements of production from salt and shale working. Environmental evidence (e.g. Allen & Scaife 1991) suggests that the land surrounding Poole Harbour was poorly suited to agriculture and grazing. Though rich in other resources this represents a major alteration in the lifestyle and economy for the occupiers of the Cleavel Point and Corfe River Complexes. No longer would a subsistence economy provide necessary food and animal products. Rather the new market economy in which they were engaging would have to flourish sufficiently in order to provide for their dietary requirements. This represents a clear increase in the economic complexity of the LIA society of Poole Harbour and the Isle of Purbeck.

Evidence for other elements of social complexity are less clear however. Such major upheaval could be argued to imply the action of centralised control, with the changes being instigated by the upper echelons of a stratified society. Yet evidence for a clearly defined central place, such as a chieftain’s hall or defended enclosure from which such central control emanates, appears to be lacking. The hilltop enclosure of Bulbury Camp, which overlooks the Sherford River Valley and Poole Harbour, may have fulfilled this function but evidence so far suggests a 1st century AD date for its construction and use (Cunliffe 1972). Material wealth does not appear to show any great variation in the LIA sites, suggestive of a more egalitarian society.

Becoming Durotrigian

The name given to us for the people inhabiting LIA Dorset and the surrounds, the Durotriges, comes from Ptolemy. The validity and structure of such a tribe has long been debated, though recent studies have suggested a conglomeration of culturally similar societies bound together by trade, pottery and coinage (Papworth 2008). Rather than a unified state, governed centrally from places such as Maiden Castle, each area was independent whilst relying on the connections with other groups under the Durotrigian umbrella. Papworth (2011) compared this to membership of the European Union, retaining your cultural identity whilst acknowledging the benefits of mutual support.

Against this background the changes in Poole Harbour can be seen to reflect wider changes in Durotrigian territory, and to some extent across Iron Age Britain as a whole. Though excavation at Flowers Barrow Hillfort, occupying the western end of the Purbeck Ridge, has been minimal it is supposed that it was abandoned during the LIA. This reflects broader patterns across the Wessex region in hillfort abandonment, such as Danebury in 100 BC (Cunliffe 1984). Within Durotrigian territory a more specific pattern of movement from hilltop to riverside settlement is apparent, such as at The Bury (Papworth 2011), and here in Poole Harbour. This change would seem to represent a wider pattern of increasing economic and social complexity. The insular nature of each zone, dominated by hillforts, was abraded for an increased involvement in trade and the provision of exotic goods such as Italian wine. Additionally the reduction in defensives measures and increased ability for communication between geographically distant settlements implies a desire for closer ties with neighbouring areas.

Part of the wider pattern of settlement change within the south and east of England concerns the construction and occupation of so-called *oppida.* Essentially it refers to settlements that can loosely be called towns and generally encompasses large areas of enclosed land. From an archaeological point of view definitions vary but are likely to represent the focus of settlement within an area. As such a level of planning in their layout should be evident, a complexity in building construction, a focus for trade and industry, a degree of urbanisation and presence of a social elite (Collis 1984). The terms relevance here, other than as part of wider trends, comes from a description of Vespasian's campaigns in the south west of England. According to Suetonius, Vespasian defeated two tribes, assumed to be the Durotriges and Dumnonii, fought 30 battles and captured 20 *oppida* (Forester 2009). It is commonly accepted that this refers to the hillforts of Dorset, though most archaeologists agree that most hillforts do not come under the definition of an *oppidum* (Collis 1984). The layout of settlement, with its focus on trade and industry, in the mid-1st century AD seems to fit with how *oppida* are defined. The settlements at the Cleavel Point and Corfe River Complexes certainly appear planned and the same may have been true of Hamworthy, though obscured by modern development. As mentioned above, Bulbury Camp may have acted as a central place and/or residence of the elite. Though it seems questionable that an egalitarian type society could not develop towns. Extensive evidence for domestic occupation does appear to be lacking from the known sites, suggesting a so far undiscovered focus for domestic living. There is no clear defensive element to the area though, as with Colchester, the surrounding rivers harbour and sea may have served this purpose. Admittedly it is highly difficult to argue for complexity in building construction, though how this would be observable with circular buildings is uncertain. The same status has been argued for the much smaller settlement activity at Hengistbury Head, albeit with clearly defined defensive ditches and the presence of a mint. In this light the environs of Poole Harbour appear to present a reasonable case for designation as a proto-*oppida*.

Romanizing the Durotriges

Haverfield (1912) defined a process of cultural assimilation within Roman provinces as that of Romanization. Essentially this is a process that assimilates cultural identities with that of the Roman identity, getting native populations to buy into being Roman. Thereby becoming part of the system, rather than subjugated by it. Methods include the identification of Roman Deities with indigenous ones, such as the combination of the native Sullis and Roman Minerva at the springs of Bath (Russell and Laycock 2010). Evidence in the south east of England suggests this process began far in advance of the AD 43 invasion, with similar effects being apparent as far as West Sussex (Manley 2002).

Papworth (2008) argues, to a lesser extent, the same for the Durotrigian territory. The desire for exotic goods, such as wine, a decrease in distinctly Iron Age traits and use of coinage all suggested to support this argument. Additionally, given the independent nature of different areas of the Durotrigian Zone, a variation in the degree of Romanization is suggested across the area. With frontier areas such a Poole Harbour and Hengistbury Head, having the most direct interaction with cross channel trade, being the most Romanized. Consequently the more remote areas of the Dorset hinterland are less so. In this way Dorset can be seen as LIA Britain in microcosm, with the south east predisposed to Rome and the west and north being resistant to it. Evidence for potential conflict, following the Claudian invasion, seems to support this picture, being almost non-existent in the east. In the west a possible war cemetery at Maiden Castle may represent evidence for conflict with the Romans (Redfern 2011). Further north and west, at Ham Hill and South Cadbury, evidence for the un-ceremonial dumping of bodies into ditches presents a more convincing argument for resistance (Papworth 2011).

The lack of centralised control and potential for a receptiveness to Roman rule in the east of Dorset may go some way to explaining the presence of the fortress at Lake Farm. If the inhabitants of Poole Harbour and Hengistbury Head welcomed the arrival of the Romans, then siting supply depots in their immediate territory (i.e. at Hamworthy) is all the more logical. Indeed the rapid adoption by *Legio II* of local wares, and probable subsequent reliance on Poole Harbour for supply, would seem to support the suggestion of a peaceful take over. Significantly the Roman army appears not to have left garrisons behind them as they moved westwards, slighting the fortifications at Lake Farm for example (Manning 2002). Given the LIA society of Poole Harbour appears to have been geared for trade and not defence or warfare, then the Roman Invasion may have represented a business opportunity rather than a loss of freedom and cultural identity. Indeed the evidence suggests a continuity of cultural identity and practice well into the 2nd century AD (Papworth 2011).

An Imperial Connection

The first recorded name of an individual in the history of Dorset is that of *Legate*, later Emperor, Vespasian (Forester 2009). Exactly when his command of *Legio II* ended is unsure but it is generally accepted he commanded the legion during their conquest of Dorset (Manning 2002). It is suspected, therefore, that the initial adoption of Durotrigian BBW occurred under his tenure. The next boost in the success of Poole Harbour pottery, now Romano-British SEDBB1, occurs during the reign of Hadrian in connection with the construction of Hadrian's Wall (Williams 1977). However, despite this apparent success, there appears to be no significant evidence for the accumulation of wealth within the study area. This seems odd given the level of trade and industry evident from the archaeological record. The lack of accumulated wealth, or grand villas clearly benefitting from the economy of Poole Harbour, has been cited as an indication of the area being within the purview of an imperial estate (Sunter 1987). The coincidence of two stages in the expansion of SEDBB1 production and the presence of one future and one current emperor in Britain would seem to support this suggestion. Additionally it would add clarity to the irrational distribution of SEDBB1, if such supply arrangements were at the behest of imperial authority.

Elsewhere in the province, such as the silts around the Wash, the presence of salt production and other factors have also led to the suggestion of imperial or state ownership (Crawford 1976). It may have been the case that Vespasian took ownership of the area while present at Lake Farm, in the years after the invasion, and passed ownership to his successors. Suetonius tells us that Vespasian encountered financial difficulty during his time in Africa, having to mortgage "his whole property" to his brother. This potentially could have included the Poole Harbour area, though if he owned such lucrative estates it is strange that he encountered financial difficulty. Alternatively, as commonly happened throughout the history of the Roman Empire, the apparently peaceful assimilation of the study area may have been brought about by some form of client arrangement. Whereby the existing ruler continues in control until their death, when their lands are inherited by the Imperial State (Russell and Laycock 2010). Assuming that Bulbury Camp represents the central place of a social elite in the 1st century AD, the cessation of occupation prior to the 2nd century could be explained. It is, however, extremely difficult to differentiate imperial and private estates, or verify their existence, without literary sources or inscriptions (Crawford 1976). That there is so far no evidence for the accumulation of wealth in the study area, though, certainly lends itself to remote ownership and administration.

Chapter 8 – Conclusion

Building on previous research into production of BBW (Trim 2017), this study explored connections between two major industries of Late Iron Age and Romano-British Poole Harbour. Setting out to explore the success of South East Dorset Black Burnished Ware 1, an in depth review of relevant literature allowed the creation of four objectives. Approaching each of these objectives permitted a wide-ranging discussion, granting greater insight in to links between crafts within the study area, with a view to answering the overall research question.

The first objective of the study was to carry out targeted fieldwork to expand the existing knowledge of two of the poorer understood production sites. The literature review served to identify gaps in the knowledge of a salt working site known as Boathouse Clump. The resulting geophysical survey appears to show that this is not a discreet production site, instead potentially forming part of a much larger settlement centred on Upton House. The survey results also highlighted the potential for multiple industries having taken place here in addition to salt working. The land here is relatively undeveloped and certainly justifies further investigation to establish the exact nature and extent of the settlement.

The second element of fieldwork was to carry out small scale excavation on Wytch Farm, ground truthing a geophysical survey carried out by Bournemouth University. The trial trench revealed evidence of a medieval date and appeared not to relate to this study. However, further work by the university field school revealed not only evidence for medieval saltworking but a possible kiln structure of Romano-British date. The results have demonstrated the continuity of salt production in the southern part of Poole Harbour, reinforcing the importance of an industry often undervalued during archaeological investigation. The potential Romano-British production site has added to the picture of dense occupation and exploitation of the landscape during this period. These two elements successfully met the objective set out for Chapter 3, additionally feeding into the second objective.

The next stage in the study was carry out an in depth review of settlement patterns within the study area, using GIS software to enhance our understanding. Though many partial reviews of this nature had been carried out, such as the Wytch Farm Oilfield project (Cox and Hearne 1991), none had attempted to view all the available data for the study area. The review initially highlighted the significance of the move from the Purbeck uplands down to the heathland environment on the shores of the harbour. This allowed discussion over the implication of increasing economic and social complexity of the pre-Roman society, leading to the suggestion of Poole Harbour as a proto-*oppidum.* The highlighting of the spatial relationships between trades suggests a separation in space, if not resources and workforce, after the Roman Invasion, in turn informing discussion of production links and post-production connections. Finally the chapter allowed a very general picture of the effect of sea level changes on settlement to be explored.

The third objective to be approached was that of direct engagement with the raw materials and manufacturing techniques of the briquetage employed to produce salt. This process has allowed significant insight into the technological changes observed in the evaporation vessels. Leading to the suggestion that the need for ever larger vessels, as the scale of production increased, determined the change. This in turn fed into the discussion of post-production connections in terms of increasing supply to the Roman army, possibly as a result of imperial influence.

The successful construction of four briquetage vessels, two of both Hobarrow Pans and Fitzworth Troughs, then allowed an approach to the final objective. Here attempts were made to replicate the methods employed in antiquity to produce salt. Whilst these experiments cannot be said to be resounding successes, they have added to the discussion of how such a process may have functioned. The need to seal the inside of the vessels prior to use was identified. Additionally any suggestion of the purification of the final product would seem to rely on the understanding of the salts contained within sea water rather than properties imbued by the clay fabric. Again the failure of vessels, and consequent lack of resulting salt, have set groundwork for further experimentation into the salt production process.

The results of each of the objective chapters were brought forward into the final discussion. The greater understanding of the how, where and intensity of Poole Harbour salt production, provided by the previous chapters does provide insight into SEDBB1 success. The argument put forward by Gerrard (2008), regarding Poole Harbour acting as a supply base for the army, appears to be strengthened by these results. Though it is argued here that the vessels were not used as packaging for salt, with barrels being a more viable solution, that salt and other products travelled with SEDBB1 to military markets appears a sound suggestion. Therefore viewing SEDBB1 as a proxy for the distribution of Poole Harbour products can tentatively be supported, though this cannot be inferred for non-military markets. The irrational distribution of the ware can also be explained in these terms and the potential for the production being controlled by an imperial estate further supports this suggestion. Furthermore the contributions from the mapping chapter suggests the focus of distribution was geared towards maritime and riverine routes rather than terrestrial transport.

This entire process has gone some way towards achieving the aim set out in the introduction and builds on previous work by the author (Trim 2017) highlighting the benefits of studying multiple industries simultaneously. Further links in technology, spatial distribution and craft specialisation between both salt and SEDBB1 production have been identified, serving to highlight the complex nature of an industry focused market economy that appears to have first welcomed Rome control and remained little changed by it throughout the occupation.

This study has highlighted the need for further work within the landscape of Poole Harbour in terms of both field work and experimentally in regards to the production of salt and use of SEDBB1 vessels. Primary among these concerns is the need to gain an understanding of the sites, such as Shipstal Point, Arne, and Middlebere, which are potentially at risk due to erosion and human activity. For the former, agreement in principal has been obtained from the RSPB to clear areas of gorse and heathland, at a seasonally appropriate time, in order to carry out a geophysical survey. In reality, with the suggestion of further sites across the Arne peninsular, a wide scale programme of survey is required. Such an undertaking, though costly in terms of man hours, is necessary to grant fuller understanding of an area which lies roughly equidistance from the production sites noted at Wareham, Hamworthy and Cleavel Point. Depending on the results, and most necessary for the endangered Shipstal Point, a series of target excavation would be required in order to ground truth the results. Perhaps less significantly the site noted by Papworth at Middlebere, where the evidence is constrained to field walking alone, requires similar treatment and assessment of any potential threats to its preservation.

This study has successfully surveyed the site of Boat House Clump with the results revealing tantalising glimpses of a potential significant Romano-British settlement. However, before any firm conclusions can be drawn, ground truthing of the noted features must be carried out. It is hoped that this may be partly facilitated by the planned construction of a visitors centre on the footprint of the public toilets, situated in the main car park and funded by the Heritage Lottery Fund. It has been recommended to Upton Country Park that, as it was when the car park was constructed, a watching brief at the very least be carried out during construction. In addition to this the open lawns and pasture surrounding Upton House require surveying to ascertain if settlement evidence extends across the plateau upon which the house was built. Again any results, particularly so given the activity associated with the house since its construction, will need to be assessed by excavation.

Another site which requires further work is that of Bulbury Camp, a univallate enclosure dating to the 1st century AD. Clearly it had a role to play in the LIA landscape of Poole Harbour, though what this was cannot be fully understood on the current evidence. Stewart and Russell (2017) have recently carried out a geophysical survey of the Scheduled Monument, which ideally needs following up with a programme of excavation. Beyond understanding the interior is the need to verify the Roman road proposed by Field (1992) joining Bulbury with Wareham to the south. So far Field's work has presented mixed results, with the Wareham to Lake Farm section now likely a misnomer, therefore further work to verify the other proposed routes now being required.

In terms of experimentation it is clear that, whilst furthering the discussion of salt production, this study has not provided much in the way of definitive answers as to how the process was carried out. The function of many of the props and pedestals remains untested, the potential for lining the vessels can only be seen as informed conjecture and the rate at which salt could be produced remains elusive. Further experimentation is required to explore these areas, possibly separating the different vessel types as the oversized Hobarrow pans constructed herein deserve their own evaluation using appropriate hearths and techniques. Indeed the study of salt production as a whole is sorely lacking published experimental work, though casual endeavours of this nature are hinted at within the literature.

In the same vein the qualities of SEDBB1, so far only alluded to (e.g. Allen and Fulford 1996), have yet to be tested. This is surprising given its significance within Roman Britain and widespread use through several centuries. Though this study and previous work by the author (Trim 2019), amongst others (e.g. Jones 2017), has examined its production little has been done to examine its suitability as a cooking vessel. In order to address this attempts to faithfully recreate some of the forms is required, before further testing of the resulting vessels in reproducing appropriate dishes. Furthermore, it would seem an appropriate vehicle for exploring the results of lipid residue analysis alluded to herein, whereby the fats present should be utilised to attempt to seal the fabric of replica vessels before use in cooking.

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Appendix A – Site Gazetteer

The detail of individual production sites mentioned within the main text of the thesis is laid out below. Firstly the three sets of grouped sites or complexes are detailed, followed by sites that stand alone.

Hamworthy Complex (HWC)

Multiple excavations have been carried out on both the Hamworthy Peninsula, much enlarged today following land reclamation, and across the modern lifting bridge around Poole Quay. The excavations have been in close proximity to one another, leading to suggestions that they are part of one complex and will be treated as such for the purposes of this research.

Site Name:	Hamworthy Peninsula	**Date:**	1st Century BC/AD – 3rd Century AD
Industries Present:	Salt Working, *SEDBB1?*, Iron Smithing*, Shale Working*		

Description:

The first excavations were carried out in Hamworthy in the late 1920's by a local schoolmaster, subsequent excavations have been carried out by Poole Museum and as part of rescue operations prior to construction. Evidence of occupation has been recovered from the Late Iron Age through to 3rd Century AD. Pre-Roman imported wares and amphora have led to the suggestion that the occupation in Hamworthy may represent a port of trade, possibly replacing Cleavel Point Complex following a rise in sea levels. Additionally the presence of two large parallel ditches running for over 230m in SE-NW direction, picked up again after a 90° return, in addition to an early Roman road accessing the peninsula have led to suggestions of the presence of a supply base for the fort at Lake Farm.

Use of the peninsula seems to have experienced two peaks, the first in the 1st C AD and potentially connected with the abandonment of Cleavel Point and/or the presence of a legionary supply base. The second peak in the early 3rd C AD at a time when SEDBB1 experiences a market loss in certain areas.

Ceramic and Briquetage evidence suggest the presence of large scale salt working, supported by suspected hearth structures. The 1st century BC/AD process employing Hobarrow pans along with some SEDBB1 vessels, with the later salt working employing both Fitzworth troughs in limited numbers and SEDBB1 storage vessels. The oxidised nature of the vast majority of the SEDBB1 is suggestive of pottery production at Hamworthy, possibly supported by the presence of the base of a possible updraft kiln excavated in 1926.

Level of Investigation:	Mid-High – Amateur, small area and watching briefs
Sources:	Smith 1930; Jarvis 1994; Bellamy 2001; Bellamy and Pierce 2001; Bellamy and Tatler 2006; Coles and Pine 2009; Monteith 2011

Site Name: Poole Quay/Old Town **Date:** LIA/Romano-British

Industries Present: Salt working

Description:

Seen as peripheral to the activity on the Hamworthy peninsula two excavations have revealed evidence for salt working of a Romano-British date on the Poole Peninsula. The first at the site of The Foundry adjoining the modern waterfront of Poole Quay revealed a ditch of a probable Late Iron Age date containing fragments of Hobarrow pans. A short distance away at 12 West Quay Road more significant discoveries of probable Romano-British date were noted. These included two fire pits or hearths similar to the one noted at Shapwick Road, Hamworthy, containing fragments of Fitzworth troughs and SFDBB1.

Level of Investigation: Low-Mid – Small area excavation in advance of development

Sources: Watkins and Anderson 1994;

Corfe River Complex (CRC)

During expansion and pipe laying on the Wytch Farm Oilfield a series of archaeological investigations were carried out. These revealed and broadened knowledge of a variety of sites from multiple time periods, including further work at Cleavel Point. Two sites firmly dating to the Late Iron Age were discovered either side of the Corfe River on Wytch Farm, both exhibiting evidence for large scale industry and suggested to have formed part of one larger settlement.

Site Name: West of Corfe River **Date:** Mid-2^{nd} Century BC – 1^{st} Century AD

Industries Present: Salt Working, Shale Working, *Durotrigian BBW, Iron Smithing*

Description:

As with its neighbouring site, East of Corfe River, this site shows evidence for a range of industrial activities and appears to be sited between the Corfe River and large clay deposits. The clay deposits have clearly been exploited and no evidence has been found for this in the historical record, suggesting this may be related to prehistoric activity. The earlier date for this side of the river is connected with possible agricultural use in the 2^{nd} Century BC, though the pollen evidence suggests this use drops off by the 1^{st} Century BC. Again evidence for domestic evidence is lacking, suggestions are that the excavated area represents the periphery of a much larger site with domestic occupation to the south.

Level of Investigation: Mid – Commercial excavation

Sources: Cox and Hearne 1991

Site Name:	East of Corfe River	**Date:**	1st Century BC – 1st Century AD
Industries Present:	Salt Working, Shale Working, Durotrigian BBW, Iron Smithing		

Description:

A large site, at least 12 ha is suggested by the excavators, was discovered along the east bank of the Corfe River. Evidence for large scale industrial practices was noted, including potential BBW kilns of an Iron Age date and large quantities of briquetage. Environmental sampling indicated a limited amount of cereal cultivation locally, though notably evidence for domestic occupation of such a large site was lacking. Similarly there is little evidence of imported material, considered conspicuous given the close proximity to the suggested port at Cleavel Point.

Level of Investigation:	Mid – Commercial excavation
Sources:	Cox and Hearne 1991

Cleavel Point Complex (CPC)

Discoveries in the 1930's on the Ower Peninsula have led to a series of investigations of the Peninsula around Cleavel Point and the nearby Green and Furzey islands. This has revealed extensive occupation and industrial activity from the Middle Iron Age through to the end of the Roman Occupation, including two moles extending from the mainland and Green Island to form a sheltered harbour and Quay. Indications of the two islands being previously one landmass, with the obvious connected activity on both the Ower peninsula and Green Island, lead to suggestions that these sites form one larger complex and will be treated as such for the purposes of this study. Intriguingly, use of these sites appears to cease at the end of the first century BC, with HWC potentially replacing their function within the harbour and as a port of trade.

Site Name:	Green Island	**Date:**	*c.*150 BC – AD 50.
Industries Present:	Shale Working, Iron Smithing & Smelting,		

Description:

A series of test pitting exercises carried out on Green Island have revealed evidence for extensive occupation and intensive production of both iron and shale artefacts. The likely pre-Roman significance of the wearing of shale armlets, coupled with shale working being focused on an island, has led to suggestions that this part of the CPC represents a higher status part of the whole complex. The work carried out here supports the suggestion that Furzey and Green Island were once whole and traded with SW England and across the channel to Gaul. Unlike on Furzey use of the island appears to have continued into the Roman period, though by the 3rd/4th century phase on the mainland of Ower little activity seems to take place on the island.

Level of Investigation:	Mid – Low – Test pit survey and some Geophysical survey carried out by Time Team.
Sources:	Wessex Archaeology 2003; Wilkes 2004.

Site Name:	Furzey Island	**Date:**	1st Century BC - *c.* 20 AD
Industries Present:	Salt and Shale Working, Iron Smithing, Agriculture		

Description:

Forming the northern part of suggested “South” Island connected with Green Island to the south evidence suggests exploitation at least in part of Furzey Island for agricultural use. Later evidence shows a restructuring of the site, as observable on both Ower and Green Island, and an intensification of industry. Occupation of the island appears to cease in the early 1st Century AD, possibly as a result of rising sea levels and subsequent separation from Green Island. Evidence for salt production here, in the form of possible hearths and settling tanks, is greater than the other elements of the Cleavel Point Complex. Though a complete lack of briquetage recovered during excavation in the 1980’s should be noted.

A sub-rectangular bivallate enclosure was investigated on the western end of the island, facing towards the harbour entrance. The morphology of this feature, enclosing approximately 0.23 Ha, is suggestive of a Roman military installation or signal station similar in form to the suggested fort on the Hamworthy Peninsula. However a complete lack of evidence for either Romano-British or legionary occupation would appear to rule this out. This feature is likely to relate to LIA occupation, though its function remains unclear.

Level of Investigation:	Mid-High – Commercial open area and evaluation trenching
Sources:	Cox 1989: Cox and Hearne 1991; Wilkes 2004; Hathaway 2013.

Site Name:	Ower Peninsula	**Date:**	1: late 1st Century BC – 1st Century AD 2: 3rd – 4th Centuries AD
Industries Present:	1: Salt and Stone Working, Shale Working 2: SEDBB1 and Salt Working		

Description:

The site on the Ower Peninsula, the only scheduled ancient monument in this gazetteer, represents two seemingly distinct phases of activity. The first phase is definitively Iron Age, with occupation of the site seeming to commence in the 1st Century AD, with the settlement functioning as a port of trade as evidenced by imported ceramics. It is likely that the construction of two moles occurred either during this phase or possibly as early as the MIA. Faunal evidence is heavily biased towards pigs, with cranial elements dominating, which suggests the processing and possible curing or salting of pork for trade. As seen across the landscape the site appears to decline by the late 1st/early 2nd Century AD, with a final flourish possibly involving the distribution of stone from Norden (see above). However prior to this a marked down turn in occupation evidence and cease of imported wares implies the main function as a port ceased prior to the Roman invasion, coinciding with an increase in activity at Hamworthy (See Above).

The second phase begins in 3rd Century AD with a levelling of the site and construction of rectangular buildings. The site exhibits increased evidence for SEDBB1 production, including several kilns, and salt working, half of all the briquetage coming from horizons of this date. Other artefacts, such as spindle whorls and loom weights, hint towards some domestic occupation or possible cottage industry.

Level of Investigation:	Mid – Trial trenching and pipeline laying, extensive survey.
Sources:	Taylor 1959; Woodward 1987; Cox and Hearne 1991; Maltby 2002; Markey 2000; Markey et al 2002.

Site Name:	Arne (Shipstal Point)	**Date:**	Possibly 1st/2nd Century AD
Industries Present:	Saltworking, *SEDBB1?*		

Description:

A spread of briquetage fragments was noted over an area of 90 – 230m, investigation by HP Smith in 1933 may also have revealed a salt boiling hearth or possible pottery kiln. Never formally investigated or published therefore the full extent, exact date and function of the site remain unknown. The land currently falls within the boundaries of the Arne RSPB reserve.

Level of Investigation:	Low – amateur (unpublished)
Sources:	Smith 1933; 1943; Farrar 1952

Site Name:	Arne (Salterns Copse)	**Date:**	Romano British
Industries Present:	Salt Working, *SEDBB1?*		

Description:

A few written sources refer to a site here where, according to the Dorset HER, surface finds from plough soil and test pitting have revealed evidence of Romano British settlement and a possible pottery kiln. The HER also refers to a geophysical survey carried out but it is unfortunately untraceable, along with the report of the test pit survey. Pottery finds suggests occupation from the 1st/2nd to 3rd/4th Centuries AD.

Level of Investigation:	Low – untraceable excavation and survey reports
Sources:	Dorset HER; Farrar 1963

Site Name:	Bestwall, Wareham	**Date:**	3rd – 5th Centuries AD
Industries Present:	SEDBB1		

Description:

A large scale project carried out an almost total excavation of a dedicated SEDBB1 production site, where production of vessels is estimated to be in the millions. The site is positioned where the two largest rivers flowing into Poole harbour join, to the east of Wareham. It is perfectly situated for manufacturing, with access to raw materials and transport networks by road, river and sea.

Level of Investigation:	High – large scale open area excavation
Sources:	Ladle 2010

Site Name:	Boathouse Clump, Upton	**Date:**	2nd/3rd Century AD
Industries Present:	Salt Working		

Description:

Discovered during the laying of a pipeline in 1985. Evidence for salt production, including briquetage and a possible hearth structure, noted in the small area exposed by the pipe trench. Briquetage forms limited to Fitzworth troughs, thumbed bars and pedestals. Ceramic evidence points towards a mid-Roman date.

Level of Investigation:	Low – Watching brief only.
Sources:	Jarvis 1986b

Site Name: Brownsea Island **Date:** 3^{rd} – 4^{th} Centuries AD

Industries Present: *SEDBB1? Salt Working? Oyster Farming?*

Description:

The remains of a site thought to be of late Roman date were discovered in the inter-tidal zone to the east of Brownsea Island. Little remained of the archaeology in the early 1990's and continuing coastal erosion probably precludes any further investigation. It does however provide useful information on sea level changes within the harbour.

Level of Investigation: Low – small scale sampling and survey

Sources: Jarvis 1993

Site Name: Fitzworth **Date:** 2^{nd} – 4^{th} Century AD

Industries Present: Salt Working, *SEDBB1?*

Description:

Occupation on Fitzworth Point seems to exhibit evidence for a pottery and salt production site from the 2^{nd} Century to as late as the 4^{th} Century AD. This site lends its name to one of the briquetage forms used from the 2^{nd} Century onwards around Poole Harbour. A poorly understood site from multiple investigations, few of which are adequately published.

Level of Investigation: Low - Mid – Limited geophysical survey, interpretation of aerial photography and test pit survey.

Sources: Calkin 1948a & b; Cox 1981; David 1981

Site Name: Middlebere **Date:** 1^{st} Century AD?

Industries Present: Salt Working

Description:

During a survey of National Trust landholdings on the Middlebere Peninsula the presence of large quantities of briquetage and SEDBB1 vessels was noted in recent plough soil, the scatter extending for up to 100m NW-SE and 250m NE-SW.

Level of Investigation: Very Low – Surface finds from field walking only.

Sources: Papworth 1992.

Site Name:	Norden	**Date:**	c.70 AD – 4th Century AD
Industries Present:	Stone Working, tesserae production and Shale Working. *SEDBB1?*		

Description:

Survey and excavation at Norden have revealed a settlement geared towards the processing and redistribution of local mineral resources. Use of Purbeck Marble in the construction of the Flavian villa at Fishbourne suggest this site was in operation prior to 70 AD. Interestingly the success of the site appears to dwindle after the mid-2nd Century, before undergoing a revival in the last quarter of the 3rd Century AD.

Level of Investigation:	Mid – Excavation and Magnetometry Survey
Sources:	Sunter (1987);Cox and Hearne (1991)

Site Name:	Point Ground, Wytch Farm	**Date:**	TBC
Industries Present:	TBC		

Description:

Magnetometry survey carried out by Bournemouth University in a field historically known as Point Ground revealed a series of large sub-rectangular anomalies which may relate to salt production and/or the Late Iron Age to Romano-British periods.

Level of Investigation:	Low - Magnetometry Survey Only
Sources:	Cheetham and Pitman (Forthcoming)

Site Name:	Redcliff Farm	**Date:**	c. 80 AD – Late 4th Century AD
Industries Present:	SEDBB1		

Description:

A series of small scale excavations by Farrar revealed kiln structures and evidence for large scale SEDBB1 manufacture from circa 80 AD until near the end of Roman occupation. A potential maker's mark, the Redcliff motif, was recognised by Farrar as the first of its kind for the BBW industry.

Level of Investigation:	Mid – Small open area excavation and test pitting.
Sources:	Farrar 1978; 1981; 1984; Lyne 2002

Site Name:	Stoborough	**Date:**	LIA - Roman
Industries Present:	Durotrigian BBW and SEDBB1		

Description:

Test pitting either side of Nut Crack lane revealed evidence of settlement and pottery production spanning from the LIA to mid/late Roman period. An early Roman road is suggested to have followed the course of the South Causeway and therefore past this site.

Level of Investigation:	Low – amateur test pitting reported by third party posthumously
Sources:	Hearne and Smith 1991; Field 1992; Lyne 2002

Site Name:	Worgret	**Date:**	Late 1st Century BC – late 4th Century AD
Industries Present:	SEDBB1		

Description:

The site at Worgret, partly excavated during the construction of the Wareham by-pass, revealed extensive evidence of the first dedicated SEDBB1 production site. Occupation commenced in the LIA but there was little evidence to suggest the economic focus of the settlement. The Romano-British occupation is clearly attributable to the production of SEDBB1, apparently to the exclusion of all else. This site was able to show a technological shift in the kilns used to manufacture the wares, from pit-clamps to updraft kilns from the 2nd Century AD.

Level of Investigation:	Mid-High – Open area commercial excavation
Sources:	Hearne and Smith 1991

Appendix B - Survey Report

Boathouse Clump, Upton Country Park

Geophysical Survey Report

May 2018

Phil Trim BSc (Hons) & Hayden Dunn BSc (Hons)

Bournemouth University

Contents

1 Summary of Results

This report summarizes the results of a geophysical survey at the Romano-British salt making site known as Boathouse Clump, Upton Country Park Poole. The site was discovered during the laying of a pipeline in 1985 and examined as part of a watching brief by Poole Museum (Jarvis 1985b). Whilst evidence for salt production and a 2nd century AD date were recovered the limited nature of the excavations prevent a fuller understanding of the nature and extent of the site. As part of a Masters by Research degree thesis, titled Pooled Resources, several sites around Poole Harbour relating to the Roman production of salt and pottery were identified for field work and further investigation. Owing to the open field nature of the terrain Boathouse Clump was selected as suitable for geophysical survey.

With the objective of ascertaining the extent and nature of the site a Magnetic Gradiometry survey was proposed and carried out at the site, comprising approximately 158 hectares. The resulting survey, whilst establishing the southern extent of archaeological data, revealed a series of linear and pit like features suggestive of settlement relating to the previously recorded Roman road running through the survey area. Previous archaeological work, in the form of watching briefs and excavation, had identified evidence of Romano-British activity within the vicinity of Upton House. Although it is not possible to date features from survey alone, the combined evidence of these survey results and previous work imply the potential for the presence of a significant settlement so far unknown in any detail. These results suggest that further survey and ground truthing through excavation are required, especially so given the proposed development of the main car park and the construction of a new visitors centre.

2 Introduction

This report describes a geophysical survey carried out from 17th to 25th April 2018 by Phil Trim and Hayden Dunn of Bournemouth University and BU Archaeology. The survey was carried out as part of a Masters by Research project entitled Pooled Resources (Trim forthcoming). This project seeks to investigate the production of salt around Poole Harbour in the Late Iron Age and Romano-British periods and how that industry links with the significant local Black Burnished Ware industry of the same period (Trim 2018). Within the aim of the project is the intention to expand the existing knowledge of the production methods, inter- and intra-site organisation, and both spatial and temporal links with pottery production. This report was prepared with reference to the English Heritage Guidelines for Geophysical Survey (2008).

2.1 Site Location

Situated within the grounds of Upton Country Park, Borough of Poole, Dorset, the site is located approximately 350m south of Upton House, between the woodlands known as Boathouse Clump and The Grove. Named Boathouse Clump (Jarvis 1986b) the site is centred on National Grid Reference SY 99193 92565. Figure 1 illustrates both the location of identified archaeology and the proposed survey area.

2.2 Site Description/History

The site comprises a large open (approx. 158 ha) field bisected on the north south axis by an electric fence, separating pasture for sheep on the high ground to the west from the public recreation area to the east. The pasture area is situated along a gentle undulating ridge which drops away dramatically towards the edge of Holes Bay, some 50m to the east of the edge of the survey area. Two spurs protrude eastward from the edge of the pasture into the public area, bearing grass up to 0.5m in height, creating areas difficult to traverse due to the gradient and foliage.

The land forms part of Upton Country Park and has been ploughed and used as pasture for a significant length of time, as verbally advised by the tenant farmer. More recently land use has in part been altered to public recreation, with the addition of a wide gravel path, benches and small areas of trees being planted. To the east the site is bordered by salt marsh edging Holes Bay, which forms part of the Poole Harbour SSSI. North of the site lies the grounds of Upton House, including the visitor's centre, toilets, car park and Segway hire centre. South of the site the field continues beyond a hedgerow which is again split for pasture, for cattle, and public recreation.

Historically the Upton Estate has been in use as farm land since 1592, with Upton House itself being constructed from 1816-18. The estate continued in private ownership, as both tenanted farmland and private parkland, until 1957 when it was gifted to Poole Corporation and leased out as a private residence. Following the completion of the Upton Bypass in 1975 the estate became open to the public and continues to be so (Upton Country Park 2018).

From an archaeological perspective (Figure 1) several areas of work have been carried out, though in isolation have only allowed a suggestion of activity predating the 16th century records. Ordnance Survey maps note the presence of a Roman Road running roughly north-south along the western edge of the survey area, believed to have been constructed by *Legio II Augusta* shortly after the invasion of AD 43 to link the Hamworthy Peninsula with the vexillation fortress at Lake Farm, Wimborne (Field 1992). Laying of a pipeline allowed observation of the road, a gravel bed 0.3m thick, as well as the discovery of a possible salt production site dating to the 2nd century AD known as Boathouse Clump (Jarvis 1986a; 1986b). The features relating to salt production include a spread of briquetage, clay vessels and accoutrements for producing salt from seawater, along with a clay lined pit believed to be hearth for boiling brine (Jarvis 1986b). The research project, to which this survey pertains, selected this discovery for the focus of this investigation. In 1986, 600m north-north west of the survey area and north of the Upton Bypass (SY 995933), a metal detectorist discovered a hoard of Roman coins dating to AD 310 – 318 or later (Watkins 1986). Subsequently, during the laying of a car park and public toilets, a linear feature was noted containing several fragments of pottery and briquetage dating to the 3rd or 4th centuries AD. Additionally a fragment of imbrex, Roman roof tile, was recovered suggesting the possible presence of higher status buildings (Anderson 1995). During the laying of the path in eastern side of the survey area and the field immediately to the south, known as Half Moon, a watching brief had been carried out which noted the presence of medieval field boundaries and suggest farming activity possibly as far back as the 10th century AD based on ceramic evidence (Bellamy 2014). The most recent investigations targeted a rectangular enclosure (approx. 30x60m) that had been noted from aerial photography on Google Earth in the Half Moon field, which prompted geophysical survey and trial trench excavation. No firm dating evidence was recovered, nor any evidence for the use of the enclosure. However, the presence of a road and salt production suggests a Romano British date is likely (Hills 2016).

2.3 Geology

The survey area lies on the sand, silts and clays of the Palaeogene Poole Formation (British Geological Survey 2018).

2.4 Survey Objectives

A review of the available literature has highlighted the presence of a salt production site at Boathouse Clump (Jarvis 1986b), of which little is known other than its likely date and function. The aim of this survey is to ascertain the extent of the site through the application of geophysical techniques, specifically magnetic gradiometery. Additionally the likely results may allow comparison of site organisation with other known production centres on the fringes of Poole Harbour, such as Ower and Hamworthy (Woodward 1987; Cox and Hearne 1991; Coles and Pine 2009).

3 Methods

3.1 Grid Locations

The location of the survey grid is plotted on Figure 2 with the south western corner at SY399050 92390, based on the Ordnance Survey National Grid. The grid was set out using a Leica DGPS Viva GS 15, using Real Time Kinetic GPS data with an accuracy of 0.03m

3.2 Survey Equipment

The survey was carried out using a Bartington Instruments Ltd Grad 601-2 dual sensor Fluxgate Gradiometer, with a 1m spacing between sensors. The gradiometer was calibrated at separate zero points for the two sections of field, situated within 20m of the northern entrances to the relevant areas.

3.3 Survey Method

The survey was carried out in 20m x 20m grids, using parallel traverses starting at the south west corner. Traverses, ten per grid, were carried out at two meter intervals from the base line starting at 1m. The dual sensor array of the equipment then captured data 0.5m either side of the traverse. The gradiometer was set to record 8 readings per metre, resulting in 3200 readings for a full 20m x 20m grid.

3.4 Data Processing

In order to process the readings taken by the gradiometer, the results were downloaded using Terra Surveyor, a software package designed for the purpose. The following list details the basic processing carried out on all processed gradiometer data used in this report (also see Figure 3):

1. *DeStripe Median Sensors*
   Removes errors in data cause by uneven sensor movement.

Subsequently (Figure 4) the data were edged matched and destriped by individual grids as required, the fully processed plot has had the data clipped to between -5 and +5 nT.

4 Results

Letters in bold refer to labels on interpretation plot – Figure 5

4.1 Description

The results appear to show a mixture of modern disturbance overlying several areas of archaeological interest. The strong linear anomaly (**A**) crossing the survey area from the south west to the north east is assumed to relate to the pipeline laid in 1985 and detailed by Keith Jarvis (1985b). The curvilinear anomaly (**B**) giving dotted pattern of high and low magnetic signals relates to the footpath laid in 2014, which unfortunately fell outside of the watching brief by Terrain Archaeology (Bellamy 2014). The linear feature (**C**), and gap in the data, running approximately north south through the centre of the plot relates to the metal fence erected to separate the public area from the pasture during the same phase of construction. There is also a large dipole (**D**) in the extreme north west corner that corresponds with a metal water trough for the livestock.

In addition to these modern features there is a curvilinear anomaly (**E**) which is particularly indistinct and relates to a downward slope on the ground and is likely to be geological in nature. To the west of this are two anomalies lying very close to each other (**F** & **G**). The southern anomaly (**F**) is gives a very high magnetic reading and seems to be some form of ferrous litter in the ground and therefore likely to be modern in nature. Anomaly (**G**) does not give a clear picture of what this relates to and may represent something of archaeological interest.

Area 1 abuts the 1985 pipe trench and corresponds with the location of salt production evidence noted by Jarvis (1985b). Here can be observed 6 sub-circular anomalies, giving readings that imply high levels of burning rather than ferrous objects. **Area 2**, immediately north of **Area 1**, shows several curvilinear anomalies possibly enclosing 4 peculiar looking anomalies that closely resemble a percentage symbol (%). The latter anomalies may represent modern disturbance, though the suggestion that these are enclosed means they are likely to be archaeological in nature. **Area 3**, immediately north of area 2, shows evidence of modern disturbance probably corresponding with being used as a holding area for building materials visible from aerial photography (Figure 7). Certainly the series of sub-circular anomalies appear to give a dipole signal associated with ferrous material, along with a spread of disturbance giving similar signals to the recently laid pathways (**B**). However, within **Area 3,** it is possible to observe the continuation of two parallel linear features running west to east across the survey area and a curvilinear anomaly from **Area 2** and therefore this area is also likely to be of archaeological interest.

Several interconnecting linear anomalies are evident on the plot which span the survey area (**I-VI)**. **Linear I** runs from the north west corner to west of centre on the southern edge of the survey area, and consists of two parallel anomalies. Intersecting with this is a very similar anomaly, **Linear II**, running east to west and appears to continue either side of **Area 3** discussed above. Additionally, running parallel with Linear I and abutting Linear II, a further pair of parallel anomalies (**III**) can be observed. **Linear IV** initially continues the line of **III** and then turns through 90° continuing eastward until the fence (**C**) and possibly beyond, though this is less clear. The final two linear anomalies (**V** & **VI**) are visible to the west of the fence (**C**) and south of the pipeline (**A**). These curvilinear anomalies appear to relate to each other, indeed they may have met but the signal is too weak in the centre to be sure or ploughing has eroded the deposits.

4.2 Interpretation

Aside from the modern features revealed by the survey, which can easily be identified from the ground and recorded activity, there appears to be a significant level of archaeological activity within and surrounding the survey area. Whilst the exact nature of the anomalies or their likely date, cannot be determined by geophysical survey alone, it is possible tentatively to interpret some features based on previous archaeological work.

As discussed (Section 2.2) the presence of a Roman road within the survey area is well known, with at least one section being examined where it intersects with the pipe line (Jarvis 1986a). Whilst only showing faintly on the plot, it is possible to observe the course of the road represented by **Linear I**. The two linear anomalies presumably represent roadside ditches, conveniently following the projected line of the road detailed on Ordnance Survey maps (Figure 5).

Similarly, **Area 1** exhibits anomalies that may have been created by localised industrial activity resulting in pit like features whose magnetic signal has been enhanced by episodes of burning. These features, given their proximity to the hearth structure exposed by the pipeline (Jarvis 1986b), may be associated with Romano British salt production. Excavation would be able to confirm if these are more hearths or spreads of ceramic briquetage. Furthermore the evidence for industrial activity in **Area 2** is supported by the apparent continuation of ditch like features, represented by the curvilinear anomalies noted above. In particular the anomalies described as appearing like the percent symbol (%), appear to represent a group of pits or possibly kiln structures with associated stoke holes. This is further reinforced by the apparent enclosure of each pit group by the magnetically enhanced curvilinear anomalies, presumably ditches containing refuse from the industrial activity. Unfortunately **Area 3** contains too much noise or disturbance to suggest what may have occurred there, though the continuation of linear features probably representing ditches suggests some archaeological activity and may be resolved by excavation.

In both form and signal response **Linear II** and **III** very much resemble **Linear I** and so may represent additional roads or track ways. Should these prove to be contemporary in date, which seems likely given that they interconnect in an apparently deliberate fashion, then these results may represent the edge of a settlement of Romano-British date. Of course, given the proximity of Upton House and its associated structures, these may represent more recent roads that have simply reused the existing roadbed laid down by the Romans. However these linear features do bear a strong resemblance to those surveyed during the Culver Project at Wellingham Farm, East Sussex (2013) (Figure 6). Excavation has confirmed this to be the street layout of a roadside Romano British Settlement dating to the 3rd and 4th centuries AD. Furthermore the discovery of features of this date, a few hundred metres to the north of the survey area (e.g. Anderson 2005), support the interpretation of a Roman settlement at Upton Country Park. Indeed the coin hoard deposited in the 4th century AD (Watkins 1986), likely to be hidden on the outskirts of a settlement, would further support this interpretation.

Linear IV, again representing a ditch, forms a sub-rectangular enclosure that may continue into or under **Area 2.** Within this boundary there are a few hints of possible pits and ditch features, however its relationship with the possible road system to the north and the industrial areas to the south east is unclear. It may represent earlier occupation of the site with the road (**Linear I**) respecting the boundary ditch, conversely the enclosure may abut an existing road making it later than its late first century construction. In either case its date and function can only be supposition without verification through exaction.

Finally the two linear features south of the pipe line and west of the fence line (**V** and **VI**) appear to represent another enclosure, though it is by no means certain that the two segments of ditch relate to one another. Unfortunately the continuation of these ditches to the east of the fence line is obscured by the footpath and restricted area alongside the nature reserve.

5 Conclusion

5.1 Assessment of achievement

The aim of the survey was to establish the extent of the salt production site known as Boathouse Clump (Jarvis 1986b). Rather than allow clear definition of the site the survey results have instead shown that the potential for Romano British archaeology at Upton Country Park may far exceed previous expectations. On the assumption that the collection of linear features (**I-IV**) relate to settlement, potentially extending at least as far as the main car park, with associated industrial activity (**Areas 1-3**) the whole site may be of much larger significance than suspected. However, given the nature and long use of the estate, no certainty can be attached to the dates suggested for these features by survey alone.

5.2 Implications & Recommendations

Working on the assumption that the features highlighted by the survey are from antiquity and not medieval or later, then the history of occupation at Upton Country Park is even more complex than supposed. The Georgian House at Upton lies on a relatively flat plateau and it may be the case that the settlement evidence covers a broad area either side of the course of the Roman Road. Its proximity to Holes Bay, with access to Poole Harbour, may suggest the site played a significant role in the trade of known Poole Harbour products from this period (e.g. Black Burnished Ware, salt). Similarly the evidence that could be gleaned from such a site may have a role in informing of the Romanization of the local tribe, known as the Durotriges.

On this basis it is recommended that the presence of significant Roman archaeology be incorporated into the estate management plans. Any future ground breaking work on the estate should be approached with caution, with archaeological investigation and observation being applied in advance wherever possible. From an archaeological point of view further survey is required to establish the potential area of settlement, particularly along the course of the road and around the edge of the plateau upon which Upton House is situated. Evaluation of the archaeological deposits through trial trenching would be essential in confirming the date of any of the features highlighted by the survey itself.

6 Acknowledgements

This survey has been carried out by two students from Bournemouth University, who kindly allowed their equipment to be used in obtaining the data. Additionally the support and advice of several of the teaching staff must be acknowledged, in particular that of Dr Eileen Wilkes, Dr Derek Pitman and Paul Cheetham.

Upton Country Park were also immensely helpful in allowing the survey to be carried out and expressing a particular interest in the results, particularly the help provided by Ed Cvijan and Adam Butcher.

Poole Museum provided great help in supplying details of previous excavations and giving official approval for the survey to go ahead through David Watkins.

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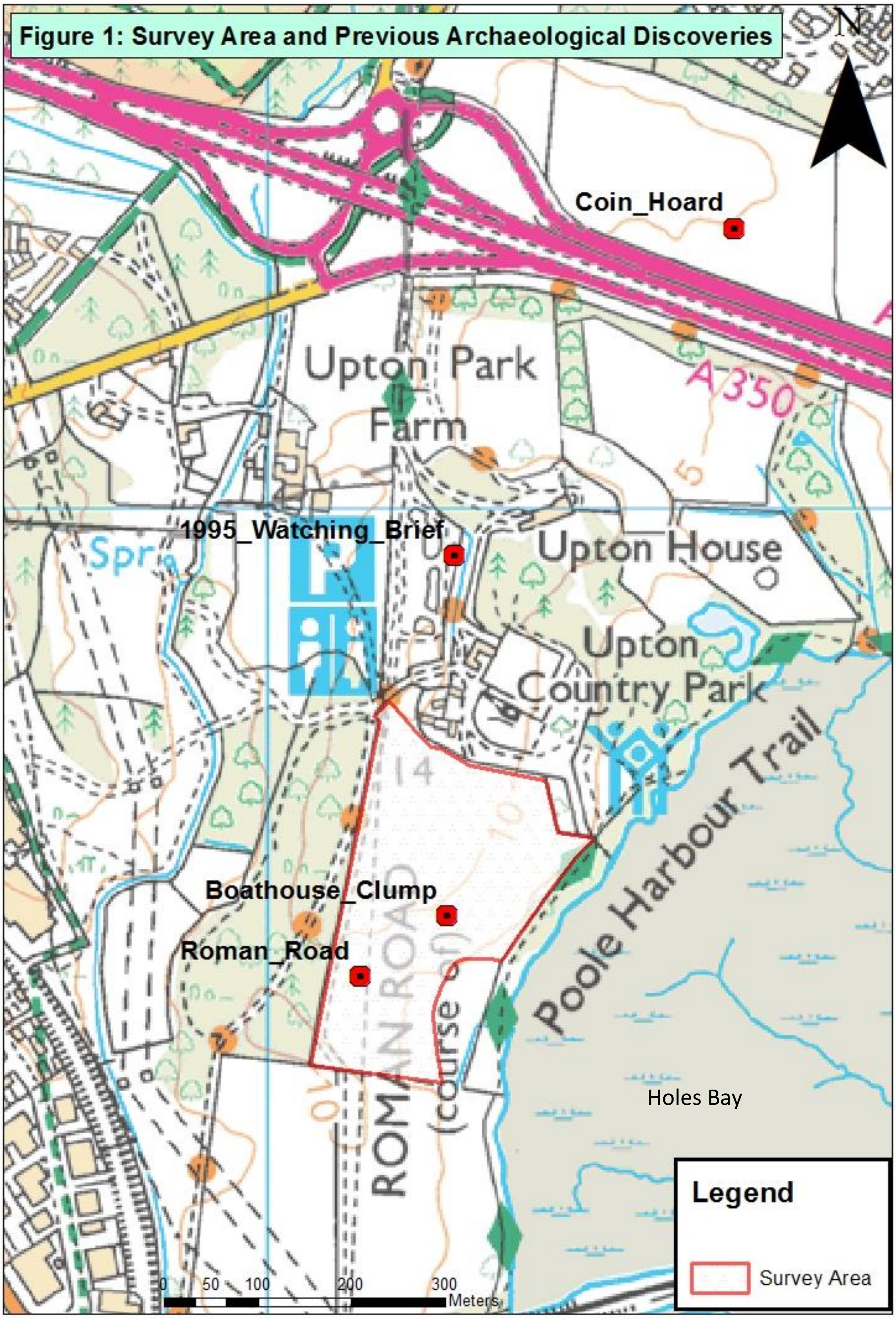
8 Appendix (Figures mentioned in text)



Z = Approximate location of Zero Points


Figure 3: Magnetic Gradiometry Plot (Raw Data)
N
0
20
40
80
120
Meters


Figure 4: Magnetic Gradiometry Plot (Processed Data)
N
0
20
40
80
120
Meters

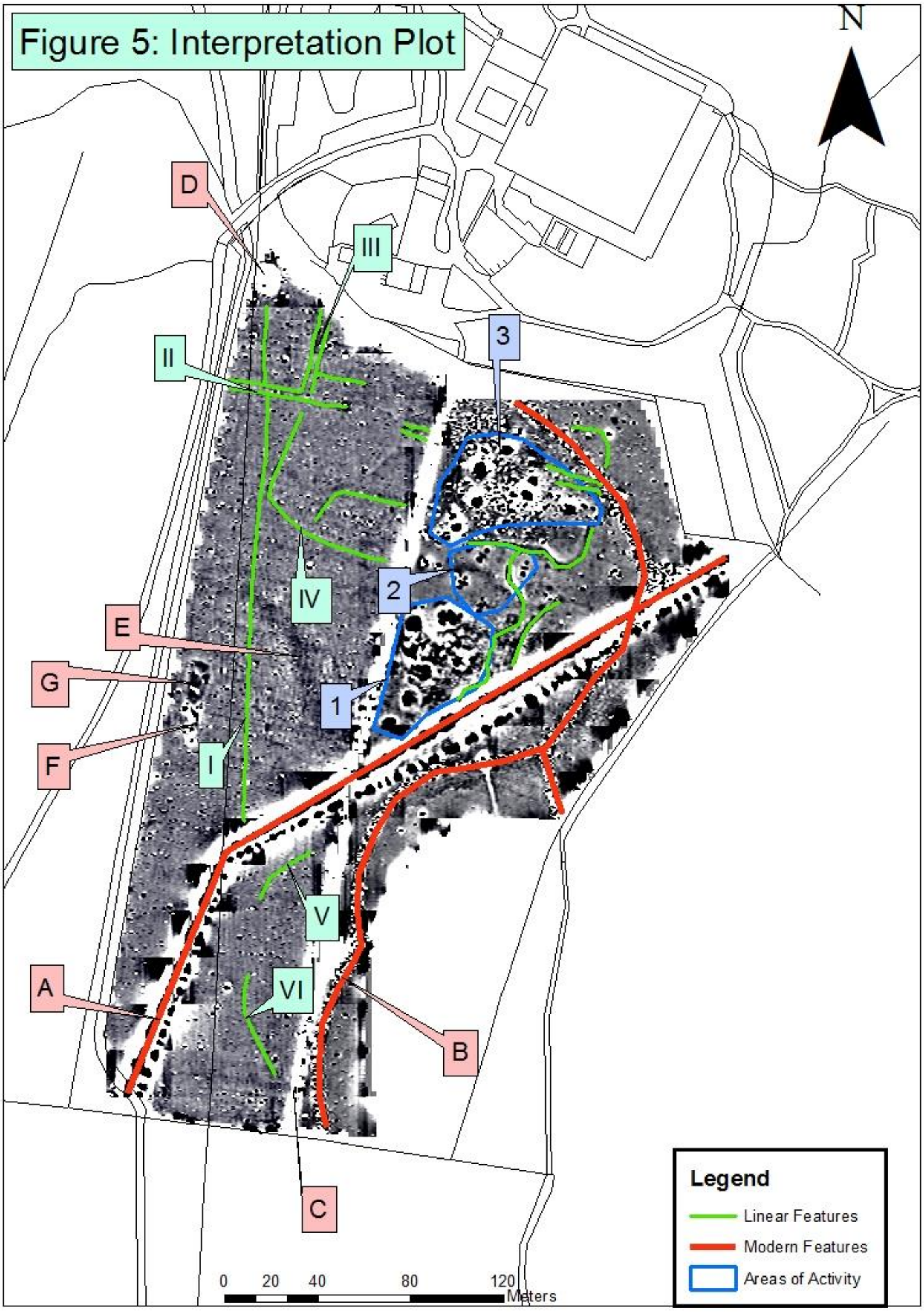


Figure 5: Interpretation Plot
N
D
III
II
3
IV
2
E
G
1
F
I
V
VI
A
B
C
0 20 40 80 120
Meters
Legend
Linear Features
Modern Features
Areas of Activity

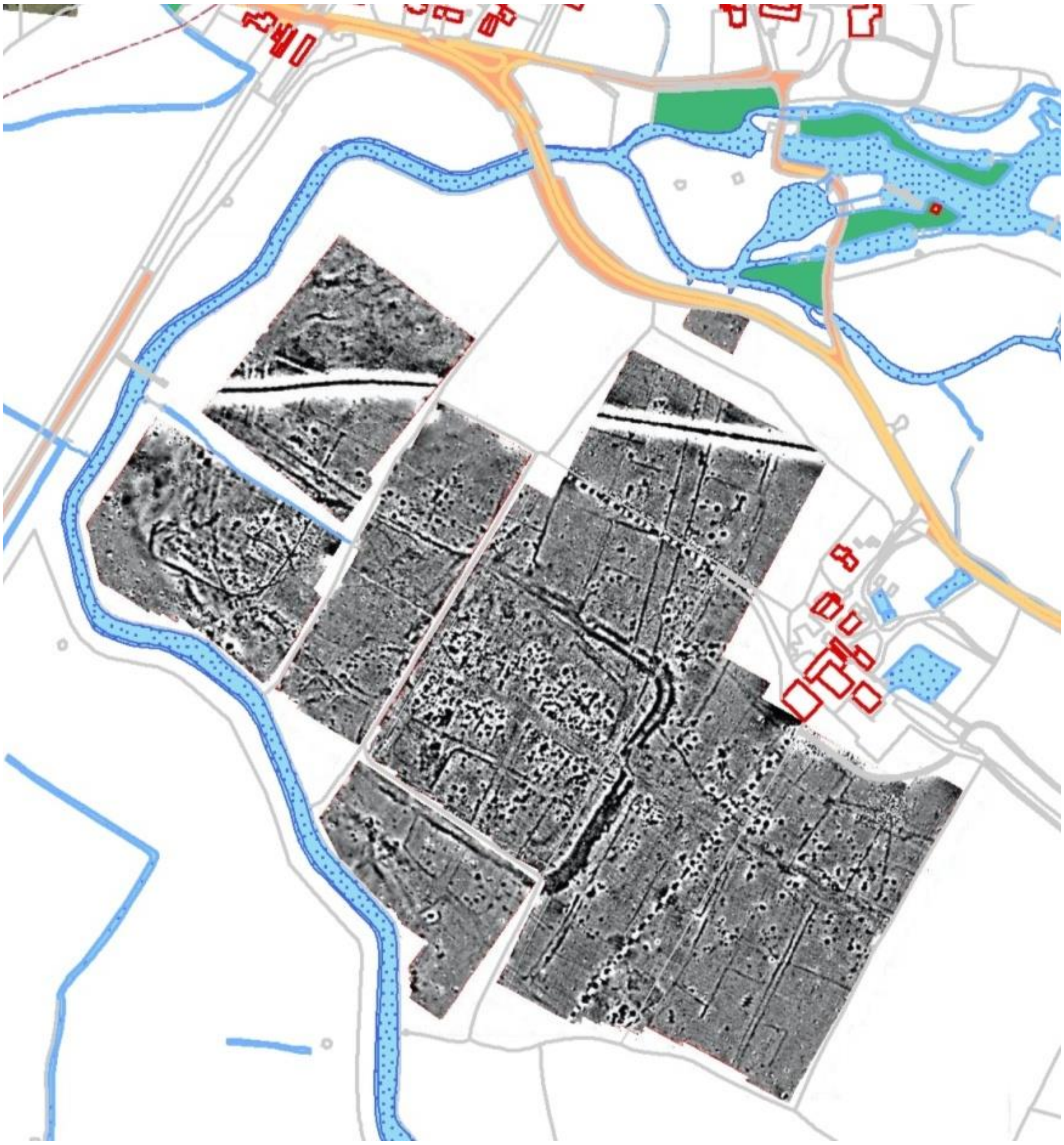


Figure 6: Magnetometry Survey of a Roman Settlement at Wellingham Farm (Stavely 2012)

Figure 7: Building Materials deposited over Area 3 (Bing 2018)

Appendix C – Point Ground Excavation

Site Background

The field of Point Ground forms a small headland jutting out into an area of Poole Harbour known as Wych Lake, a curious difference in spelling from Wytch Farm to which the land belongs. It is bounded on three sides by salt marsh, with its landward side demarked by a ditch that may have resulted in the field becoming an island at high tide in the past. A causeway constructed in the 20th Century allows access to the south west corner of the field. Work nearby has suggested that the ground is made up by an over burden of dark ashy soil built up during the post-medieval period (Cox *et al.* 2009). The bedrock geology is of Broadstone Clay Member with superficial deposits of clays, silt sand and gravels (British Geological Survey 2018).

Trench Location and Methods

The trench was targeted to cross a distinct sub-rectangular anomaly (see fig. 12 – Chapter 3) that was approximately 5m wide, the trench therefore being laid out at 7m by 2m perpendicular to the anomaly in order to catch the full extent of the potential feature. The corners of the trench were set out using differential GPS to ensure accuracy over the georeferenced survey results. De-turfing and excavation of the trench was carried out by hand tools only, with the assistance of Miss M Bengtson, Mr C Gray, Mr S Hirst and Mr H Dunn. The excavation was supervised and carried out by the author with Dr Pitman assisting and overseeing the progress and providing technical advice and support. The work itself was carried out in damp conditions between 17th and 20th January 2018.

Results

Excavation began with removal of turf and topsoil (101), which consisted of a dark black brown sandy loam rich in charcoal containing occasional fragments of post-medieval ceramic (fig 52). This sealed a subsoil (102) of similar soil composition that contained frequent flecks and inclusions of burnt clay and ceramic, believed to be intrusive due to ploughing and mole activity. Sealed beneath the subsoil were layers (103) & (104), again of dark black brown sandy loam. Layer (103) contained patches of dark grey loamy sand likely the result of mole activity brought up from below. Layer (104) was broadly similar to (102) but contained increasing ceramic inclusions. These layers are suspected to be the initial soil accumulation as they seal clear anthropogenic layers beneath. Layer (105) was distinctly different from the layers sealing it consisting of a dark yellowish/orangey red. It contained large inclusions of raw, though oxidised, clay as well as frequent large (20-30cm^3) irregular blocks of a highly vitrified lightweight material. This layer was suspected to be a demolition layer or possibly connected to a high temperature industrial process. Layer (105) was contained between two linear features, (106) and (108), which ran from either section roughly perpendicular to the trench on a north-south alignment. Both layers consisted of a mixture of orange oxidised and white ball clay interspersed with thin seams of dark black brown soil. Linear (108), at the eastern end of the trench, was only partially investigated due to the water table being level with the top of the feature. Layer (107), abutting linear (106) west of the area contained by the two linear features, again appeared to be a destruction layer. Though it consisted of dark black brown sandy loam it contained patches of dark brownish orange sand and medium blocks of the clays present in (106). Sealed beneath (107) and (103) and outside of the area defined by the two linear features, layer (110) was a layer of dark grey/black sandy loam-loamy sand. This layer (110) had no inclusions and sealed the natural geology of mid-grey sand beneath and is therefore suspected to be a buried soil cut by the linear features. Like (105), layer (109) was a destruction layer or possible lens within (105) consisting of a black charcoal and ash rich sand. This layer could not be fully explored due to the encroaching water table and excavation ceased at this level.

In terms of finds only one recognizable shard of pottery (fig. 16 Chapter 3) came from a semi secure context, being embedded in the top of the destruction layer (105). Though a body shard the fabric is distinctive enough to place it as a medieval sandy ware, being very rough and containing large quartz inclusions. Beyond this, despite extensive sieving of spoil, the only other find was that of large quantities of the vitrified material discussed above.

Working Hypothesis

The dearth of datable material from the layers above the water table make phasing and dating of the features difficult. The one piece of evidence, a single shard of medieval pottery, points towards activity being of a similar date and therefore unhelpful in a study of LIA and RB saltworking. However documentary evidence (Cox and Hearne 1991) is suggestive of a connection to salt production as the area is known to have been under monastic control at this period for the production of salt.

The two parallel linear features, (106) and (108), appear to be walls of cobb construction that correspond to the outer edges of the sub-rectangular anomaly noted on the magnetometry survey. It was therefore suspected that they represented a structure of some form, possibly as part of a harbour side settlement. The high level of vitrified material within the structure, coupled with the oxidised clay from the suspected walls, seemed to be indicative of a destruction event involving extremely high temperatures required for vitrification.

Further Work

As mentioned above the site of Point Ground was selected for the location of Bournemouth University's summer field school for 2018, during which the experimental work of this study was carried out as described in Chapters 5 and 6. The excavation took place over five weeks during June and July, with a large area being opened up over the trial trench to include additional anomalies detected during the magnetometry survey. This revealed evidence for the nature and use of the site and highlighted the dangers of interpretation from essentially keyhole excavation. The linear features did not correspond to walls or any part of a structure as suspected, linear (106) ceased 5-10cm into the southern section with the (107) forming part of a sub-rectangular feature approximately 2m across. This changed the interpretation dramatically with similar sub rectangular features dotted across the excavated area. These now being interpreted as medieval salt boiling hearths. The layers noted during the trial trenching were set into a terrace created in the natural slope of the site, which in turn had been filled with industrial debris and several possible hearth structures.

Despite the medieval date of the features contained within the main area of excavation a satellite trench in the northeast corner of the field provided evidence for RB activity. Here a strong magnetic anomaly (fig. 17 Chapter 3) was investigated and a feature consisting of a clay lined pit approximately 2m x 1m was revealed. The lining of the pit had been subject to heat and was partially fired, with clear signs of oxidising of the iron rich clay. Contained within the pit were fills that may have represented collapsed super structure, along with oxidised pottery dating from the LIA and RB periods. The ceramics included examples of oxidised SEDBB1 and a large rim shard of a large storage vessel possibly included as part of a flue system. The initial interpretation is that this feature is a pottery kiln from the 1st or 2nd centuries AD, though its form is quite different to the later updraft kilns it may be of the earlier clamp kiln form. An alternative explanation would be that of a salt boiling hearth, explaining the oxidised nature of the clay, with the presence of SEDBB1 being expected as discussed in Chapter 7. Reference to the plot of the geophysical survey results (fig 3.5) potentially shows an enclosure in the north east corner of the survey area, enclosing the kiln/hearth feature. This appears to be sufficient evidence to suggest the presence of industrial activity on the headland of the periods relevant to this study.

Discussion

Though the initial excavation was not able to add greatly to this study it has served to reinforce the historical importance of the salt industry within Poole Harbour. The identification of a possible RB kiln or salt boiling hearth, situated on the harbour side within an enclosure is significant in terms of this study. Though little can be said without further investigation, the presence of industrial activity from a RB date serves to highlight just how heavily the landscape was exploited at this time. From Ower through to Arne every headland can now be seen to have seen industrial activity during the LIA and RB periods, potentially 10 sites within an area of $10km^2$. Point Ground is well located for access to the harbour and the Corfe River, potentially providing access to Norden and the Corfe River Complex.

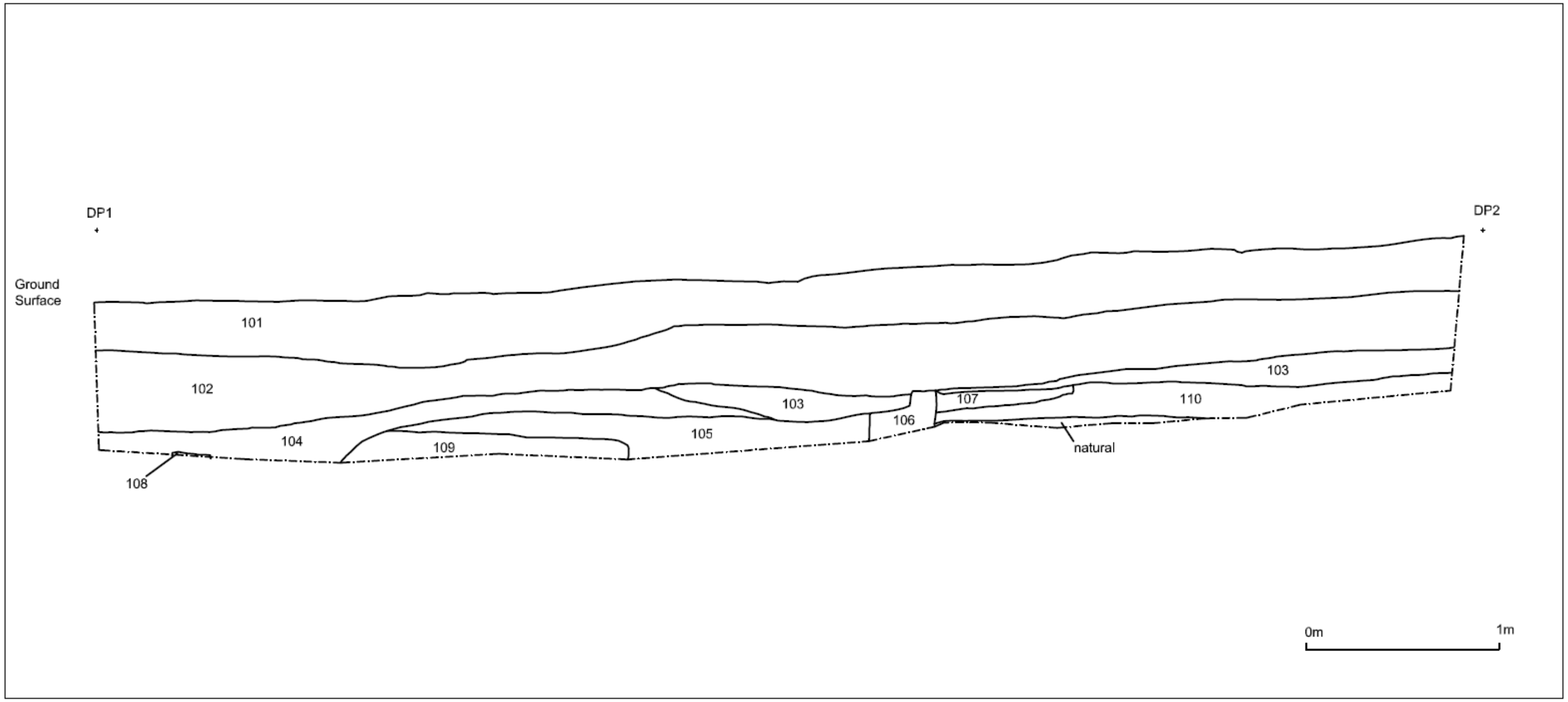


Figure 52: Section recording of Point Ground trial trench

Appendix D – XRF Results

Reading No	Time	Type	Duration	Units	Sequence	Res	EScale	Shape Time	SAMPLE	LOCATION	INSPECTOR	COR 1	COR 2	MISC	NOTE	User Login	Flags
501	21/08/2018 14:20	System Check	51.64	cps	Final	176.5	7.15	1								Experts	
502	21/08/2018 14:21	System Check	53.65	cps	Final	160.2	7.17	4								Experts	
503	21/08/2018 14:32	Mining	150	%	Final				till-4pp	salt	kw for phil trim					Experts	
504	21/08/2018 14:36	Mining	150	%	Final				till-4pp	salt	kw for phil trim					Experts	
505	21/08/2018 14:40	Mining	150	%	Final				till-4pp	salt	kw for phil trim					Experts	
506	21/08/2018 14:46	Mining	150	%	Final				sample1-hp2	salt	kw for phil trim					Experts	
507	21/08/2018 14:49	Mining	150	%	Final				sample1-hp2	salt	kw for phil trim					Experts	
508	21/08/2018 14:52	Mining	150	%	Final				sample1-hp2	salt	kw for phil trim					Experts	
509	21/08/2018 14:59	Mining	150	%	Final				sample2-ft1	salt	kw for phil trim					Experts	
510	21/08/2018 15:03	Mining	150	%	Final				sample2-ft1	salt	kw for phil trim					Experts	
511	21/08/2018 15:06	Mining	150	%	Final				sample2-ft1	salt	kw for phil trim					Experts	
512	21/08/2018 15:10	Mining	150	%	Final				sample3-ft1	salt	kw for phil trim					Experts	
513	21/08/2018 15:13	Mining	150	%	Final				sample3-ft1	salt	kw for phil trim					Experts	
514	21/08/2018 15:16	Mining	150	%	Final				sample3-ft1	salt	kw for phil trim					Experts	
515	21/08/2018 15:21	Mining	150	%	Final				clay1-control	salt	kw for phil trim					Experts	
516	21/08/2018 15:25	Mining	150	%	Final				clay1-control	salt	kw for phil trim					Experts	
517	21/08/2018 15:30	Mining	150	%	Final				clay1-control	salt	kw for phil trim					Experts	
518	21/08/2018 15:35	Mining	140.4	%	Final				clay2_HP_outside	salt	kw for phil trim					Experts	
519	21/08/2018 15:39	Mining	150	%	Final				clay2_HP_outside	salt	kw for phil trim					Experts	
520	21/08/2018 15:42	Mining	150	%	Final				clay2_HP_outside	salt	kw for phil trim					Experts	
521	21/08/2018 15:45	Mining	150	%	Final				clay2_HP_outside	salt	kw for phil trim					Experts	
522	21/08/2018 15:49	Mining	150	%	Final				clay2_HP_inside	salt	kw for phil trim					Experts	
523	21/08/2018 15:52	Mining	150	%	Final				clay2_HP_inside	salt	kw for phil trim					Experts	
524	21/08/2018 15:56	Mining	150	%	Final				clay2_HP_inside	salt	kw for phil trim					Experts	
525	21/08/2018 16:00	Mining	150	%	Final				clay2_HP_break	salt	kw for phil trim					Experts	
526	21/08/2018 16:03	Mining	150	%	Final				clay2_HP_break	salt	kw for phil trim					Experts	
527	21/08/2018 16:07	Mining	150	%	Final				clay2_HP_break	salt	kw for phil trim					Experts	
528	21/08/2018 16:11	Mining	150	%	Final				clay3-ft-outside	salt	kw for phil trim					Experts	
529	21/08/2018 16:14	Mining	150	%	Final				clay3-ft-outside	salt	kw for phil trim					Experts	
530	21/08/2018 16:18	Mining	150	%	Final				clay3-ft-inside	salt	kw for phil trim					Experts	
531	21/08/2018 16:21	Mining	150	%	Final				clay3-ft-inside	salt	kw for phil trim					Experts	
532	21/08/2018 16:24	Mining	150	%	Final				clay3-ft-inside	salt	kw for phil trim					Experts	
533	21/08/2018 16:28	Mining	150	%	Final				clay3-ft-break	salt	kw for phil trim					Experts	
534	21/08/2018 16:31	Mining	150	%	Final				clay3-ft-break	salt	kw for phil trim					Experts	
535	21/08/2018 16:34	Mining	150	%	Final				clay3-ft-break	salt	kw for phil trim					Experts	
536	21/08/2018 16:38	Mining	150	%	Final				till-4pp	salt	kw for phil trim					Experts	
537	21/08/2018 16:41	Mining	150	%	Final				till-4pp	salt	kw for phil trim					Experts	
538	21/08/2018 16:44	Mining	150	%	Final				till-4pp	salt	kw for phil trim					Experts	

Nb	Nb Error	Sr	Sr Error	Zr	Zr Error	Rb	Rb Error	Fe	Fe Error	Mg	Mg Error	Al	Al Error	Bal	Bal Error	Si	Si Error	P	P Error	S	S Error	Cl	Cl Error
0.002	0.001	0.01	0.001	0.03	0.001	0.01	0.001	3.89	0.033	0.72	0.475	5.383	0.127	61.79	0.186	24.79	0.133	0.18	0.016	0.139	0.006	0.013	0.002
0.002	0.001	0.01	0.001	0.03	0.001	0.01	0.001	3.87	0.032	0.96	0.492	5.484	0.132	61.01	0.185	25.17	0.133	0.17	0.016	0.145	0.006	0.013	0.002
< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	3.11	1.603	23.14	0.246	< LOD	0.002	59.93	1.035	0.67	0.068	0.558	0.033	0.051	0.01
< LOD	0.002	0	0.001	< LOD	0.002	0.01	0.001	0.02	0.004	< LOD	4.12	< LOD	0.301	66.33	0.182	< LOD	0.13	0.15	0.04	2.88	0.04	29.95	0.174
< LOD	0.002	0	0.001	< LOD	0.002	0.01	0.001	0.02	0.004	< LOD	5.278	< LOD	0.302	66.56	0.179	< LOD	0.094	0.18	0.04	2.809	0.04	29.78	0.176
< LOD	0.002	0	0.001	< LOD	0.002	0.01	0.001	0.01	0.004	< LOD	4.931	< LOD	0.376	66.55	0.182	< LOD	0.094	0.15	0.04	2.834	0.04	29.8	0.177
< LOD	0.002	0.01	0.001	< LOD	0.002	0	0.001	0.01	0.004	< LOD	4.827	< LOD	0.326	64.59	0.197	< LOD	0.097	0.2	0.042	2.686	0.041	31.34	0.189
< LOD	0.002	0.01	0.001	< LOD	0.002	0	0.001	0.01	0.004	< LOD	4.737	< LOD	0.429	64.95	0.193	< LOD	0.097	0.14	0.041	2.647	0.041	31.11	0.187
< LOD	0.002	0.01	0.001	< LOD	0.002	0	0.001	0.01	0.004	< LOD	6.46	< LOD	0.327	64.78	0.193	< LOD	0.098	0.15	0.042	2.679	0.041	31.23	0.194
< LOD	0.002	0	0.001	< LOD	0.002	0.01	0.001	0.01	0.004	< LOD	4.589	< LOD	0.406	67.48	0.178	< LOD	0.095	0.22	0.04	2.414	0.038	29.21	0.173
< LOD	0.002	0	0.001	< LOD	0.002	0.01	0.001	0.01	0.004	< LOD	4.024	< LOD	0.321	67.64	0.175	< LOD	0.094	0.17	0.04	2.424	0.038	29.13	0.169
< LOD	0.002	0	0.001	< LOD	0.002	0.01	0.001	0.01	0.004	< LOD	4.002	< LOD	0.371	67.62	0.177	< LOD	0.093	0.18	0.039	2.421	0.038	29.12	0.17
< LOD	0.002	0	0.001	0.03	0.001	0	0.001	2.41	0.024	< LOD	0.558	6.777	0.131	63.23	0.178	25.3	0.133	0.09	0.014	0.545	0.009	< LOD	0.003
< LOD	0.002	0	0.001	0.02	0.001	0	0.001	2.52	0.025	< LOD	0.716	5.305	0.119	69.28	0.157	21.49	0.122	0.09	0.012	0.053	0.004	< LOD	0.003
< LOD	0.002	0	0.001	0.03	0.001	0	0.001	2.61	0.025	< LOD	0.701	5.458	0.124	68.32	0.157	22.04	0.124	0.1	0.014	0.024	0.004	< LOD	0.003
< LOD	0.002	0.01	0.001	0.02	0.001	0	0.001	0.62	0.012	< LOD	3.916	< LOD	0.292	66.01	0.163	0.779	0.066	< LOD	0.056	5.438	0.051	24.36	0.129
< LOD	0.002	0.01	0.001	0.02	0.001	0	0.001	2.51	0.027	< LOD	0.785	4.834	0.126	66.36	0.181	22.38	0.143	0.08	0.016	0.293	0.008	1.021	0.01
< LOD	0.002	0.01	0.001	0.02	0.001	0	0.001	2.48	0.026	< LOD	0.759	4.758	0.126	66.7	0.161	22.17	0.128	0.09	0.016	0.29	0.008	1.002	0.009
< LOD	0.002	0.01	0.001	0.02	0.001	0	0.001	2.49	0.026	< LOD	0.986	4.916	0.145	66.41	0.169	22.29	0.129	0.08	0.016	0.288	0.008	1.009	0.009
< LOD	0.002	0.01	0.001	0.03	0.001	0	0.001	1.79	0.021	< LOD	3.385	1.46	0.156	64.02	0.172	7.433	0.076	< LOD	0.05	12.6	0.072	7.825	0.047
0.002	0.001	0.01	0.001	0.02	0.001	0	0.001	2.24	0.024	< LOD	1.856	2.776	0.154	64.79	0.17	12.94	0.094	0.04	0.022	7.886	0.052	6.115	0.038
< LOD	0.002	0.01	0.001	0.03	0.001	0	0.001	1.94	0.022	< LOD	3.343	1.777	0.167	62.05	0.174	8.58	0.078	0.06	0.025	13.92	0.076	5.896	0.036
0.002	0.001	0	0.001	0.03	0.001	0	0.001	2.68	0.026	< LOD	0.878	5.361	0.134	63.34	0.177	27.02	0.138	0.09	0.014	0.027	0.004	0.323	0.004
< LOD	0.002	0	0.001	0.03	0.001	0	0.001	3.22	0.029	< LOD	0.89	5.239	0.134	64.02	0.175	25.92	0.136	0.09	0.014	0.008	0.004	0.248	0.004
< LOD	0.002	0	0.001	0.03	0.001	0	0.001	2.38	0.024	< LOD	0.624	5.001	0.112	63.64	0.176	26.46	0.14	0.11	0.015	0.089	0.006	0.728	0.007
0.002	0.001	0.01	0.001	0.02	0.001	0	0.001	2.87	0.028	< LOD	1.861	3.096	0.171	63.03	0.185	12.76	0.097	< LOD	0.035	3.906	0.033	9.928	0.057
0.002	0.001	0.01	0.001	0.03	0.001	0	0.001	2.92	0.028	< LOD	2.698	3.253	0.221	63.61	0.173	13.31	0.101	< LOD	0.043	3.177	0.03	11.11	0.062
0.002	0.001	0.01	0.001	0.03	0.001	0	0.001	3.08	0.029	< LOD	0.835	5.711	0.146	61.11	0.189	23.83	0.129	0.13	0.017	2.417	0.022	0.613	0.006
< LOD	0.002	0.01	0.001	0.02	0.001	0	0.001	3.07	0.028	< LOD	1.294	5.492	0.183	62.33	0.182	23.56	0.127	0.12	0.017	2.398	0.022	0.602	0.006
0.002	0.001	0.01	0.001	0.02	0.001	0	0.001	3.07	0.028	< LOD	0.805	5.619	0.14	61.65	0.184	23.63	0.126	0.09	0.016	2.382	0.021	0.608	0.006
0.002	0.001	0.01	0.001	0.02	0.001	0	0.001	2.9	0.028	< LOD	0.812	5.199	0.131	62.98	0.179	26.28	0.138	0.1	0.015	0.26	0.007	0.969	0.008
0.002	0.001	0.01	0.001	0.02	0.001	0	0.001	2.9	0.027	< LOD	0.685	5.196	0.122	62.93	0.176	26.31	0.137	0.09	0.016	0.264	0.008	0.973	0.008
0.002	0.001	0.01	0.001	0.02	0.001	0	0.001	2.89	0.027	< LOD	0.731	5.144	0.123	63.22	0.178	26.15	0.137	0.08	0.015	0.261	0.007	0.965	0.008
0.002	0.001	0.01	0.001	0.03	0.001	0.01	0.001	3.82	0.032	0.77	0.464	5.811	0.131	60.77	0.187	25.54	0.133	0.18	0.016	0.143	0.006	0.021	0.002
0.002	0.001	0.01	0.001	0.03	0.001	0.01	0.001	3.82	0.032	< LOD	1.159	5.849	0.176	61.02	0.182	25.89	0.134	0.18	0.016	0.151	0.006	0.022	0.003
0.002	0.001	0.01	0.001	0.03	0.001	0.01	0.001	3.81	0.032	< LOD	0.993	5.845	0.16	61.34	0.184	25.69	0.135	0.18	0.016	0.144	0.006	0.02	0.002

K	K Error	Ca	Ca Error	Ti	Ti Error	V	V Error	Cr	Cr Error	Mn	Mn Error	Co	Co Error	Ni	Ni Error	Cu	Cu Error	Zn	Zn Error	As	As Error	Se	Se Error	Mo
2.04	0.035	0.43	0.034	0.37	0.008	0.02	0.005	0.01	0.003	0.04	0.008	< LOD	0.013	< LOD	0.004	0.02	0.002	0.006	0.001	0.01	0.001	< LOD	0.002	< LOD
2.1	0.035	0.46	0.034	0.37	0.008	0.02	0.005	0.01	0.003	0.05	0.007	< LOD	0.013	< LOD	0.004	0.02	0.002	0.006	0.001	0.01	0.001	< LOD	0.002	< LOD
8.47	0.367	1.99	0.175	1.74	0.091	0.08	0.022	0.07	0.016	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD
0.6	0.018	0.04	0.02	0.01	0.002	0	0.002	0.01	0.002	< LOD	0.009	< LOD	0.003	< LOD	0.004	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD
0.59	0.018	0.05	0.019	0.01	0.002	0	0.002	0.01	0.002	< LOD	0.009	< LOD	0.003	< LOD	0.004	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD
0.58	0.018	0.05	0.019	0.01	0.002	0	0.002	0.01	0.002	< LOD	0.009	< LOD	0.003	< LOD	0.004	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD
0.39	0.015	0.67	0.036	< LOD	0.003	< LOD	0.002	0.01	0.002	< LOD	0.011	< LOD	0.004	< LOD	0.005	< LOD	0.002	0.066	0.002	< LOD	0.002	< LOD	0.002	< LOD
0.38	0.015	0.65	0.035	< LOD	0.004	< LOD	0.002	0.01	0.002	< LOD	0.011	< LOD	0.004	< LOD	0.005	< LOD	0.002	0.067	0.002	< LOD	0.002	< LOD	0.002	< LOD
0.39	0.015	0.66	0.035	< LOD	0.004	< LOD	0.002	0.01	0.002	< LOD	0.011	< LOD	0.004	< LOD	0.005	< LOD	0.002	0.064	0.002	< LOD	0.002	< LOD	0.002	< LOD
0.58	0.017	0.05	0.02	0.01	0.002	0	0.002	< LOD	0.004	< LOD	0.009	< LOD	0.003	< LOD	0.004	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD
0.55	0.017	0.04	0.019	0.01	0.002	0	0.002	0	0.002	< LOD	0.009	< LOD	0.003	< LOD	0.004	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD
0.57	0.018	0.04	0.02	0.01	0.002	0	0.002	0.01	0.002	< LOD	0.009	< LOD	0.003	< LOD	0.004	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD
0.77	0.019	0.37	0.025	0.4	0.007	0.01	0.004	0.01	0.002	0.01	0.007	< LOD	0.01	< LOD	0.004	< LOD	0.002	0.003	0.001	0	0.001	< LOD	0.002	< LOD
0.69	0.018	0.09	0.02	0.36	0.007	0.02	0.004	0.01	0.002	0.01	0.007	< LOD	0.011	< LOD	0.004	< LOD	0.002	0.004	0.001	0	0.001	< LOD	0.002	< LOD
0.78	0.019	0.13	0.022	0.42	0.007	0.02	0.004	0.01	0.003	< LOD	0.01	< LOD	0.011	< LOD	0.004	< LOD	0.002	0.004	0.001	< LOD	0.002	< LOD	0.002	< LOD
0.23	0.01	2.22	0.042	0.04	0.002	0.01	0.002	0	0.002	< LOD	0.012	0.01	0.004	< LOD	0.004	< LOD	0.002	0.014	0.001	< LOD	0.002	< LOD	0.002	< LOD
1.32	0.026	0.66	0.033	0.41	0.007	0.02	0.004	0.02	0.003	< LOD	0.01	< LOD	0.011	< LOD	0.004	< LOD	0.002	0.028	0.001	< LOD	0.002	< LOD	0.002	< LOD
1.31	0.026	0.65	0.033	0.4	0.007	0.01	0.004	0.02	0.003	0.02	0.007	< LOD	0.011	< LOD	0.004	< LOD	0.002	0.027	0.001	< LOD	0.002	< LOD	0.002	< LOD
1.34	0.025	0.65	0.032	0.4	0.007	0.01	0.004	0.02	0.003	0.01	0.007	< LOD	0.011	< LOD	0.004	< LOD	0.002	0.029	0.001	< LOD	0.002	< LOD	0.002	< LOD
0.65	0.017	3.92	0.058	0.2	0.005	0.01	0.003	0.01	0.002	< LOD	0.015	< LOD	0.01	< LOD	0.004	< LOD	0.002	0.014	0.001	< LOD	0.002	< LOD	0.002	< LOD
0.73	0.019	2.12	0.047	0.24	0.006	0.01	0.004	0.01	0.002	0.01	0.007	< LOD	0.01	< LOD	0.004	< LOD	0.002	0.016	0.001	< LOD	0.002	< LOD	0.002	< LOD
0.73	0.019	4.71	0.065	0.23	0.006	0.01	0.003	0.01	0.002	0.01	0.007	< LOD	0.011	< LOD	0.004	< LOD	0.002	0.017	0.001	< LOD	0.002	< LOD	0.002	< LOD
0.65	0.017	0.06	0.018	0.33	0.006	0.01	0.003	0.01	0.002	0.02	0.007	< LOD	0.011	< LOD	0.004	< LOD	0.002	0.004	0.001	< LOD	0.002	< LOD	0.002	< LOD
0.66	0.017	0.13	0.021	0.34	0.006	0.01	0.003	0.01	0.002	0.02	0.007	< LOD	0.012	< LOD	0.004	< LOD	0.002	0.003	0.001	< LOD	0.002	< LOD	0.002	< LOD
0.68	0.017	< LOD	0.039	0.34	0.006	0.01	0.003	0.01	0.002	< LOD	0.016	< LOD	0.01	< LOD	0.004	< LOD	0.002	0.004	0.001	< LOD	0.002	< LOD	0.002	< LOD
1.34	0.026	0.92	0.036	0.33	0.007	0.03	0.004	0.01	0.003	0.02	0.007	< LOD	0.012	< LOD	0.004	< LOD	0.002	0.028	0.001	< LOD	0.002	< LOD	0.002	< LOD
1.36	0.026	0.73	0.034	0.33	0.007	0.03	0.004	0.01	0.003	0.03	0.007	< LOD	0.012	< LOD	0.004	< LOD	0.002	0.03	0.001	< LOD	0.002	< LOD	0.002	< LOD
1.11	0.024	0.77	0.034	0.4	0.008	0.01	0.004	0.01	0.003	0.02	0.007	< LOD	0.012	< LOD	0.004	< LOD	0.002	0.018	0.001	< LOD	0.002	< LOD	0.002	< LOD
1.12	0.024	0.79	0.034	0.39	0.007	0.02	0.004	0.01	0.003	0.02	0.007	< LOD	0.012	< LOD	0.004	< LOD	0.002	0.018	0.001	< LOD	0.002	< LOD	0.002	< LOD
1.1	0.024	0.79	0.035	0.39	0.008	0.01	0.004	0.01	0.003	0.01	0.007	< LOD	0.012	< LOD	0.004	< LOD	0.002	0.017	0.001	< LOD	0.002	< LOD	0.002	< LOD
0.81	0.02	0.06	0.021	0.34	0.007	0.01	0.004	0.01	0.003	0.01	0.007	< LOD	0.012	< LOD	0.004	< LOD	0.002	0.004	0.001	< LOD	0.002	< LOD	0.002	< LOD
0.81	0.02	0.05	0.021	0.35	0.007	0.01	0.004	0.01	0.003	0.02	0.007	< LOD	0.011	< LOD	0.004	< LOD	0.002	0.005	0.001	< LOD	0.002	< LOD	0.002	< LOD
0.8	0.019	0.05	0.021	0.34	0.007	0.01	0.004	0.01	0.002	0.02	0.007	< LOD	0.011	< LOD	0.004	< LOD	0.002	0.004	0.001	< LOD	0.002	< LOD	0.002	< LOD
1.96	0.033	0.4	0.032	0.35	0.008	0.01	0.004	0.01	0.003	0.05	0.008	< LOD	0.013	< LOD	0.004	0.02	0.002	0.006	0.001	0.01	0.001	< LOD	0.002	< LOD
2.02	0.034	0.43	0.033	0.36	0.008	0.01	0.004	0.01	0.003	0.05	0.008	< LOD	0.013	< LOD	0.004	0.02	0.002	0.007	0.001	0.01	0.001	< LOD	0.002	< LOD
1.98	0.033	0.4	0.032	0.35	0.008	0.01	0.004	0.01	0.003	0.05	0.008	< LOD	0.013	< LOD	0.004	0.02	0.002	0.006	0.001	0.01	0.001	< LOD	0.002	< LOD

Mo Error	Pd	Pd Error	Ag	Ag Error	Cd	Cd Error	Sn	Sn Error	Sb	Sb Error	Ba	Ba Error	W	W Error	Au	Au Error	Pb	Pb Error	Bi	Bi Error
0.002	< LOD	0.002	< LOD	0.005	< LOD	0.002	0	0.002	< LOD	0.002	0.04	0.005	0.03	0.005	< LOD	0.002	0.01	0.001	0.01	0.001
0.002	< LOD	0.002	< LOD	0.006	< LOD	0.002	0	0.002	< LOD	0.002	0.04	0.005	0.03	0.005	< LOD	0.002	0.01	0.001	0.01	0.001
0.002	< LOD	0.003	< LOD	0.017	< LOD	0.004	0.01	0.007	< LOD	0.007	0.17	0.022	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002
0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.004	< LOD	0.002	< LOD	0.007	< LOD	0.007	< LOD	0.002	< LOD	0.002	0.01	0.001
0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.003	< LOD	0.002	< LOD	0.007	< LOD	0.007	< LOD	0.002	< LOD	0.002	0.01	0.001
0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.003	< LOD	0.003	< LOD	0.007	< LOD	0.007	< LOD	0.002	< LOD	0.002	0.01	0.001
0.002	< LOD	0.002	< LOD	0.004	< LOD	0.002	< LOD	0.004	< LOD	0.002	0.01	0.005	< LOD	0.009	0	0.001	0	0.001	0.01	0.001
0.002	< LOD	0.002	< LOD	0.004	< LOD	0.002	< LOD	0.004	< LOD	0.003	0.01	0.005	< LOD	0.009	< LOD	0.002	0	0.001	0.01	0.001
0.002	< LOD	0.002	< LOD	0.003	< LOD	0.002	< LOD	0.005	< LOD	0.002	< LOD	0.008	< LOD	0.009	< LOD	0.002	0	0.001	0	0.001
0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.007	< LOD	0.007	< LOD	0.002	< LOD	0.002	0.01	0.001
0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.003	< LOD	0.002	< LOD	0.007	< LOD	0.007	< LOD	0.002	< LOD	0.002	0.01	0.001
0.002	< LOD	0.002	< LOD	0.002	< LOD	0.002	< LOD	0.003	< LOD	0.002	< LOD	0.007	< LOD	0.007	< LOD	0.002	< LOD	0.002	0.01	0.001
0.002	< LOD	0.002	< LOD	0.006	< LOD	0.002	< LOD	0.002	< LOD	0.002	0.03	0.004	< LOD	0.005	< LOD	0.002	< LOD	0.002	< LOD	0.002
0.002	< LOD	0.002	< LOD	0.007	< LOD	0.002	0	0.002	< LOD	0.002	0.03	0.004	< LOD	0.006	< LOD	0.002	0	0.001	< LOD	0.002
0.002	< LOD	0.002	< LOD	0.003	< LOD	0.002	< LOD	0.004	< LOD	0.002	0.02	0.004	< LOD	0.005	< LOD	0.002	0	0.001	< LOD	0.002
0.002	< LOD	0.002	< LOD	0.005	< LOD	0.002	0	0.002	< LOD	0.002	0.03	0.005	< LOD	0.006	< LOD	0.002	0	0.001	< LOD	0.002
0.002	< LOD	0.002	< LOD	0.004	< LOD	0.002	< LOD	0.003	< LOD	0.002	0.03	0.005	< LOD	0.006	< LOD	0.002	0	0.001	< LOD	0.002
0.002	< LOD	0.002	< LOD	0.005	< LOD	0.002	< LOD	0.004	< LOD	0.002	0.03	0.005	< LOD	0.006	< LOD	0.002	0	0.001	< LOD	0.002
0.002	< LOD	0.002	< LOD	0.005	< LOD	0.002	< LOD	0.004	< LOD	0.002	0.03	0.005	< LOD	0.006	< LOD	0.002	0	0.001	< LOD	0.002
0.002	< LOD	0.002	< LOD	0.005	< LOD	0.002	< LOD	0.003	< LOD	0.002	0.03	0.004	< LOD	0.006	< LOD	0.002	0	0.001	< LOD	0.002
0.002	< LOD	0.002	< LOD	0.006	< LOD	0.002	< LOD	0.002	< LOD	0.003	0.03	0.004	< LOD	0.006	< LOD	0.002	0	0.001	< LOD	0.002
0.002	< LOD	0.002	< LOD	0.003	< LOD	0.002	< LOD	0.002	< LOD	0.002	0.03	0.004	< LOD	0.006	< LOD	0.002	0	0.001	< LOD	0.002
0.002	< LOD	0.002	< LOD	0.006	< LOD	0.002	0	0.002	< LOD	0.002	0.03	0.004	< LOD	0.006	< LOD	0.002	0	0.001	< LOD	0.002
0.002	< LOD	0.002	< LOD	0.005	< LOD	0.002	< LOD	0.003	< LOD	0.002	0.03	0.005	< LOD	0.006	< LOD	0.002	0	0.001	< LOD	0.002
0.002	< LOD	0.002	< LOD	0.003	< LOD	0.002	0	0.002	< LOD	0.002	0.02	0.004	< LOD	0.006	< LOD	0.002	0	0.001	< LOD	0.002
0.002	< LOD	0.002	< LOD	0.009	< LOD	0.002	< LOD	0.003	< LOD	0.002	0.04	0.005	< LOD	0.006	< LOD	0.002	0	0.001	0	0.001
0.002	< LOD	0.002	< LOD	0.01	< LOD	0.002	< LOD	0.002	< LOD	0.002	0.04	0.005	< LOD	0.006	< LOD	0.002	0	0.001	0	0.001
0.002	< LOD	0.002	< LOD	0.005	< LOD	0.002	< LOD	0.004	< LOD	0.002	0.03	0.005	< LOD	0.006	< LOD	0.002	0	0.001	< LOD	0.002
0.002	< LOD	0.002	< LOD	0.005	< LOD	0.002	< LOD	0.003	< LOD	0.002	0.03	0.005	< LOD	0.006	< LOD	0.002	0	0.001	< LOD	0.002
0.002	< LOD	0.002	< LOD	0.005	< LOD	0.002	< LOD	0.002	< LOD	0.002	0.04	0.005	< LOD	0.006	< LOD	0.002	0	0.001	< LOD	0.002
0.002	< LOD	0.002	< LOD	0.005	< LOD	0.002	< LOD	0.004	< LOD	0.002	0.03	0.005	< LOD	0.006	< LOD	0.002	0	0.001	0	0.001
0.002	< LOD	0.002	< LOD	0.007	< LOD	0.002	< LOD	0.004	< LOD	0.002	0.04	0.005	< LOD	0.006	< LOD	0.002	0	0.001	< LOD	0.002
0.002	< LOD	0.002	< LOD	0.006	< LOD	0.002	< LOD	0.003	< LOD	0.002	0.04	0.005	< LOD	0.006	< LOD	0.002	0	0.001	< LOD	0.002
0.002	< LOD	0.002	< LOD	0.003	< LOD	0.002	< LOD	0.002	< LOD	0.002	0.04	0.004	0.02	0.005	< LOD	0.002	0.01	0.001	0.01	0.001
0.002	< LOD	0.002	< LOD	0.005	< LOD	0.002	< LOD	0.002	< LOD	0.003	0.04	0.005	0.03	0.005	< LOD	0.002	0.01	0.001	0.01	0.001
0.002	< LOD	0.002	< LOD	0.005	< LOD	0.002	< LOD	0.002	< LOD	0.002	0.04	0.004	0.03	0.005	< LOD	0.002	0.01	0.001	0.01	0.001