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Introduction

> ‘I should like to show Posidonius some glassblower who, by his breath, molds the glass into many shapes which scarcely could be fashioned by the most skilful hand’
> (Seneca, *Moral Letters to Lucilium* XC.3I in (Fleming, 1999, p. 37))

1.1. The Research Aims

The Romans traded and consumed more glass than any other previous civilisation. They invented glassblowing, which was the most significant innovation in manufacturing technology since the introduction of core-formed glass objects some 1500 years earlier. With the spread of the Roman Empire, the glass industry rapidly expanded using safe trade routes. The major regions of glass production were the Phoenicio-Syrian Coastline from 63 BCE and Egypt from 30 BCE. Over this period, glass rapidly changed from being luxury objects to include also common domestic products just at the same time that the new glassblowing technology was introduced into the industry. The transparency, impermeability and durability were intrinsic qualities of glass that quickly made it a preferred substance for tableware, windows, storage, preservation, and distribution of products (Grose, 1977, pp. 9–10).

Glass can survive for long periods in the ground although it can be prone to weathering and deterioration. It can be a valuable source of dateable archaeological data as it existed in many product forms and can reveal cultural insights at all levels of ancient societies through analysing, characterising, and interpreting artefacts (Price and Cottam, 1998; Fleming, 1999; Shepherd and Wardle, 2009). Glass vessels were also seen as luxury goods with associations with power and status and therefore relevant to the assessment of the socio-economic circumstances (Koster, 2006, pp. 48–52; Morley, 2007b, pp. 39–54).

The study scope was based on glass class vessel groups because of their value to communities in social lifestyle situations and their role as traded goods compared to other materials offering similar uses (e.g. metal and pottery). Other glass class groups include construction glass such as windows and tiles, utensils such as stirring rods, and personal objects such as gaming counters and jewellery. These are discussed where they can add additional context (Erdkamp *et al*., 2020, pp. 1–36).

The aims of this research are to gain insights into the capability of the glass industry to make, move and trade glass products and to better understand the socio-economics of Roman Britain that drove the glass trade from 50 BCE to 500 CE. This study used typological and epigraphical evidence to investigate the patterns of the movement of glass into and within Roman Britain from manufacturing sites across a network that spanned the Roman Empire over the period 43 to 500 CE. The research questions and objectives were developed with these aims.

1.2. Research Objectives

The objectives included analysing the fragmentary glass evidence of the profiles of glass vessel compositions on sites and of the distribution of glass vessels across Roman Britain regions.

The research objectives were to:

1. Carry out comparative proportional analyses of the compositions of the sites’ glass
2. Analyse the glass types and the sites’ contexts
3. Assess the association of glass types across the civil and military sites
4. Carry out comparative proportional analyses of the regional distribution of glass
5. Assess the distribution of glass to military and city sites
6. Investigate the production of glass from glass working centres

Objectives 1–3 are related to profiles of glass from sites in Roman Britain that could define the types of settlements as urban or rural, civil or military and the patterns of glass that can be associated with the material cultures of these communities together with an understanding of the economic, social, and trading models in Roman Britain from glass.

Three analytical techniques were used to reveal patterns that could reflect trade and social models for settlement sites. The first technique was to perform comparative proportional qualitative analysis of glass vessel types as site profiles that could define the patterns of glass types on sites. The second technique was to interpret statistical associations of glass types with site types through using correspondence analysis. The third technique used was a ranking system of site scores developed for this study to compare sites and based on the presence of glass forms.

Objectives 4–6 are directed towards revealing patterns of distribution across regional Roman Britain. Analyses of the Romano-British corpus were used to confirm the regional proportional vessel distributions which could be relevant to understanding the Roman economy and trade. This included the likely trade routes for the transportation of heavy bulky goods between sites using roads, rivers,

and sea. Patterns of distribution could also reveal possible trade routes to military sites and to large cities and material movements into and within Roman Britain. Finally, the study investigated the glass types produced in Roman Britain, the locations of known glass-working centres in Britain and the trade and transport scenarios related to the distribution patterns across the regions.

1.3. The Research Questions

In the modern world, the use of technologies provides near real-time visibility of the market demand for products, the movement of goods over long distances in relatively short timeframes, and the conversion of currency and use of world-wide finance systems. My proposition was that the Romans were no less ingenious than we are today. However, they operated within the constraints of those times without modern technology but still innovated to overcome those challenges. This research lifted the cover on such ancient practices by researching the end-to-end global supply chain management of glass.

This research addressed questions related to the socio-economics and material cultures associated with the communities on Romano-British settlements and the ability of the traders and producers to meet a market demand for glass. The focus was on two groups of questions.

The first group of questions were concerned with the fragmentary glass evidence on each of the settlement sites. These questions were essentially related to the proportional compositions of glass vessel fragments on settlement sites that could be assumed to represent the original population of glass vessels. The analysis of the patterns of glass vessel assemblages on settlement sites provided insights into the material cultures of the ancient communities and indications of the economic prosperity of settlement site types. The questions posed were:

1. What are the analytic profiles of glass that can indicate a characteristic profile of a settlement type?
2. Are we able to distinguish between a military and civil settlement?
3. How was glass used on the settlements and what can the materials tell us about the drinking, eating and storage cultures?
4. Can glass provide an indication of the cultures of the settlement communities?
5. How did Continental glass supply drive demand in Roman Britain?
6. What can glass tell us about the economic, social and supply models in Roman Britain?

The second group of research questions explored the production, movement and trade of glass into and within Roman Britain. They focussed on the role of glass manufacturing and the supply of glass vessels in Roman Britain which provides a better understanding of the trading and transport mechanisms that could have been in place. The questions were:

7. What was the distribution of glass in Roman Britain?
8. What can that tell us about the movement of glass into and around Roman Britain?
9. What was the role of glass manufacturing in Roman Britain and on the Continent?
10. How was glass transported on the Continent?
11. What could have been the relationships between the glass workshops in Germany, France and Roman Britain?

1.4. Research Approach

The research approach was based on addressing the aims, the objectives and the research questions. The purpose of the literature review was to examine the current academic body of knowledge of the topics relevant to this research, including any gaps in knowledge that could have implications for this study. The topics covered in Chapter 2 ‘The Current Knowledge of the Markets for Glass Vessels and the Roman Glass Industry’ include a review of the Roman economy and trade, the value of glass in the Roman world, the consumer demand for glass products with the background to the glass-working industry, the trade in Roman glass and the historical context of Roman Britain.

The principles of using the material record for analysis are set out in Chapter 3 ‘Methodology’. Compiling the study data included the collection and collation of catalogued glass vessel data from the excavation reports of the sites selected for the study. The individual catalogued numbered entries are usually of a recovered single fragment but can be several fragments of a vessel type, colour and characteristics. These individual accession line records of the fragmentary finds are the basis of the database and the base database unit is assumed to be an individual artifact. The methodology encompassed defining the typology that would be used to organise the glass fragmentary data. The availability and access to archaeological glass data was a significant factor when selecting sites and this is discussed in this chapter. The individual accession line records also included the deposition context and the dating details. The relevance of the use of qualitative and quantitative techniques, comparative proportional analysis and multi-component statistical correspondence analysis techniques are covered in this chapter. Finally, the principles of the data model, the database design and managing the database are set out with the details for the site profile model and the distribution model.

Chapter 4 ‘The Presentation and Assessment of Data for Analysis’, explains the task of choosing the published material data, confirming the quality and quantity of the glass from the chosen assemblages was sufficient for analysis. Information on archaeological deposition and dating is also needed to be sufficiently robust to assess potential root causes of any data bias. Information about the sites chosen for the study is presented as a tour of the military sites starting with London, and then the forts and

fortresses in this order: Wales and the Marches, Lancashire and Yorkshire, Cumbria and Northumberland, Hadrian's Wall and finally Scotland. This is both geographically and chronologically following the occupation of Britain northwards. This section is followed by descriptions of the chosen towns/industrial settlements and rural farming settlement sites, large cities and finally shrines and temples. The next three sections in this chapter detail the glass vessel characteristics, dimensional data and the overall Romano-British corpus of study. These sections justify the relevance of the data for the analysis in Chapter 5: 'Characteristics of Sites Glass Profiles' and Chapter 6: 'The Trade and Distribution of Glass'.

Chapter 5 addresses the research questions 1–6. The approach was to first establish the site glass profile for Colchester, as the largest selected settlement site, by analysing the separate city internal sites as well as the city overall. This included defining the sites' chronological profiles for the periods pre-Boudican and post-Boudican. These analyses were then applied to the other large city, fortress, town and industrial settlement, rural and military fort sites using comparative proportional analysis and correspondence analysis. A site scoring model developed to qualitatively rank sites based on the inventory of glass types is described in this chapter. The analyses of the civil and military sites' glass evidence and associated archaeological contexts were compared for patterns that could suggest socio-economic differences. The analysis of the shrines and burial sites with a summary concludes this chapter.

Chapter 6 'The Trade and Distribution of Glass' addresses the research questions 7–11, through the analysis of the distribution of the glass evidence across Roman Britain. The chapter sections include interpreting the overall distribution of glass to establish how far vessel types travelled and for any patterns associated with a proximity to road, river or sea access and including historical contexts. The trade in particular vessel types such as drinking vessels and bowls, and large container bottles was then assessed. The relevance of glass manufacturing and distribution was assessed through an analysis of glass production in Roman Britain, in detail for London, and comparisons with Aix-en-Provence in the Roman province of *Gallia Narbonensis* in the south of France (McGowen, 2014). The evidence related to the production of large glass bottles, transport networks and trading interconnectivity are discussed. These sections finally are brought together as a discussion of the trading models for Roman Britain and the role of the military supply organisation.

The final Chapter 7 'Conclusions' returns to the aims, and the research questions with a review of the contributions from this research to the body of knowledge of the Roman economy, the social and material cultures in Roman Britain, with insights of the trade, distribution, glass production and transport systems based on the study of glass. This chapter includes a section that sets out the learnings from this research including that for data management that is such a cornerstone of this study. Finally, the chapter has concluding statements with further research opportunities identified.